Progress in preparing for climate change

2017 Report to Parliament

Committee on Climate Change
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Book 3 of 3

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The Committee would like to thank Lord Krebs, former Chair of the Adaptation Sub-Committee (until January 2017), for his contribution to this report.

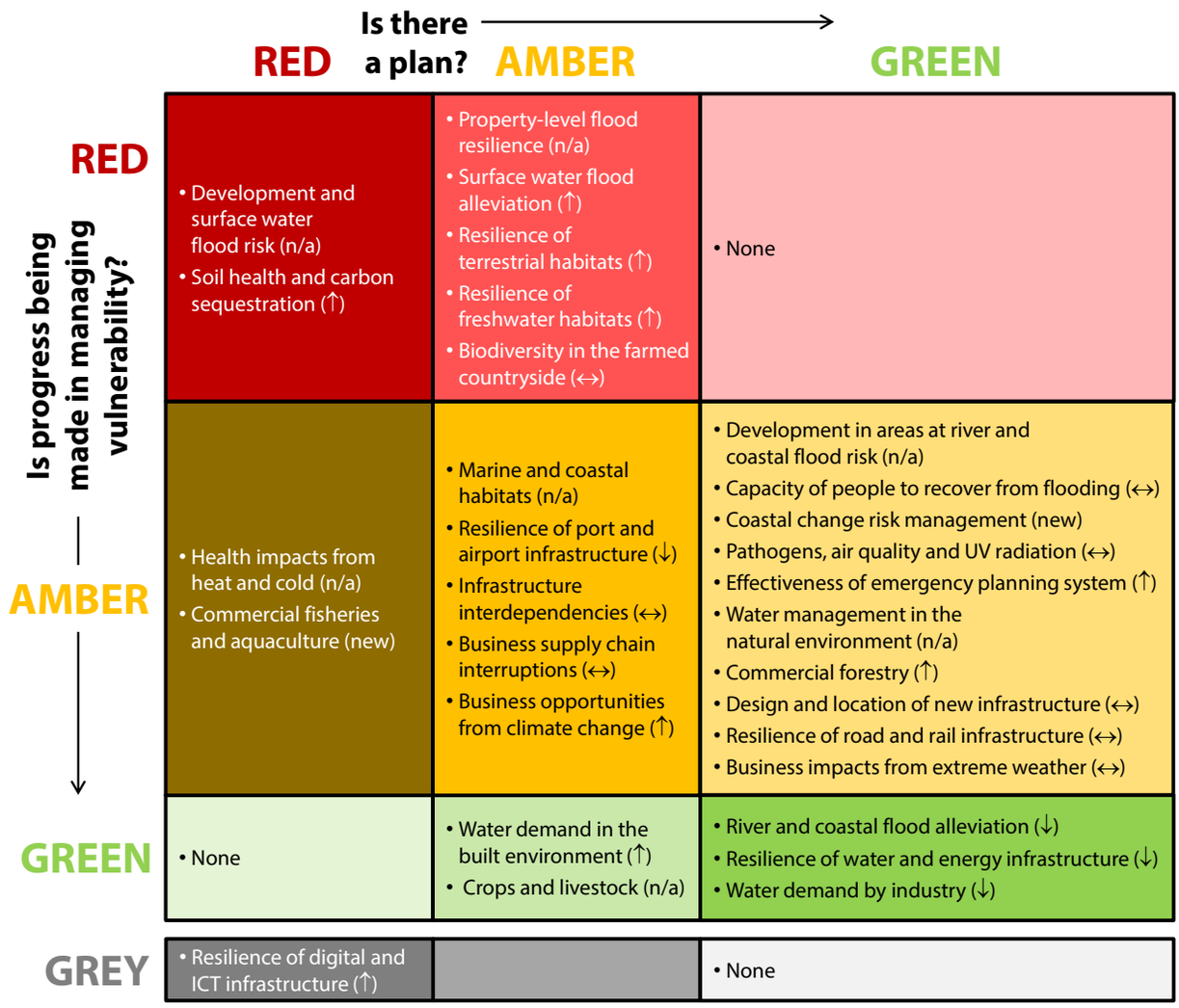
Executive summary

The risks posed by climate change have increased in a significant number of priority areas since our last progress report in 2015. As evidence of climate change mounts, it is clear that current policies and adaptation actions - as described in the National Adaptation Programme (NAP) and elsewhere - will not be sufficient to counter the risks identified. Opportunities for modest, timely intervention to avoid long-term problems are being overlooked. As a result, climate change risks serious costs and in some respects irreversible damage to the country.

- **Actions in the current NAP have largely been delivered.** 51% of actions are assessed as complete and an additional 35% are considered on track or ongoing by those responsible for their delivery. New measures have been introduced in some priority areas since our last report, in part prompted by events such as the severe storms and flooding in 2015 and 2016. Measures include more funding for flood and coastal defence projects, and steps to encourage flood resilient repairs to be made to affected properties as standard practice.
- **Progress is being made against some objectives.** Long-term plans and benchmarking against standards are helping to reduce the risks from climate change to water and electricity supply networks, although some disruption to services can still be expected in very severe weather. Flood risk management authorities are on track to achieve the goal to deliver new or replacement flood defences for 300,000 households between 2015 and 2021, and in doing so achieve an estimated 5% net reduction in expected annual flood damages.
- **Communities are becoming increasingly vulnerable to climate change.** Ten years on from the widespread floods in 2007 that affected large parts of England, the risks of surface water flooding are still not being adequately managed. Climate change has in effect been de-prioritised in the land-use planning system and, due to a lack of safeguards, new housing is adding to existing problems. Insufficient attention is being paid to adapting the built environment for increasing temperatures and intense rainfall events. The Environment Agency's climate change advice and support service that was working to build adaptation capacity within businesses, local authorities and other organisations has come to an end.
- **The natural environment can be expected to deteriorate further as the climate warms.** The condition of the natural environment has deteriorated since our last report, including in relation to freshwater and terrestrial habitats, and in the farmed countryside. It is now clear that important goals for 2020 contained in the current biodiversity strategy for England will not be achieved and this will make the natural environment less resilient to climate change. Restoration plans are in place for most upland peat habitats but the proportion in good condition has fallen. Public consultation on a new 25-year plan to improve the natural environment was expected in 2016 but has been delayed.

Figure 1 summarises the ASC's second assessment of the National Adaptation Programme. Our assessment concludes that vulnerabilities are increasing in seven specific areas (those shown in the top row of Figure 1) and the evidence of progress is mixed for the majority of adaptation priorities (those in the central row). The five priorities in the left hand column are those where current policies and plans need to be strengthened most urgently. Whilst many actions have been delivered, the current NAP does not adequately address those difficult, in some cases chronic, problems that demand a sustained, co-ordinated response from multiple actors in order to make a difference to long-term vulnerability.

Figure 1. Adaptation priorities: *are plans in place, and is progress being made?*



Source: ASC assessment of policies and plans, and progress, for each adaptation priority.
Notes: Adaptation priorities have been categorised as follows:

- **Red:** plans and policies do not account for climate change risks, 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, indicators of vulnerability are generally falling.
- **Grey**: insufficient evidence to form a judgement.

Key to changes since 2015: ↑ increased concern, ↓ decreased concern, ↔ no change since 2015, **new**: not part of 2015 assessment, **n/a**: scope of assessment changed so comparison with 2015 not possible.

This assessment makes a number of new recommendations for the Government as it considers its priorities for the next National Adaptation Programme. We reiterate our advice from our previous assessment in 2015: that the NAP should set clear priorities for adaptation, include measurable objectives that can be monitored and evaluated, and focus on the core set of policies and implementation activity that will deliver the most benefit. The previous Government accepted this advice in its formal response to our last report. We look forward to a stronger and more impact-focussed NAP being published in the next twelve months.

1. Introduction

This is the second statutory assessment of the National Adaptation Programme, required by the 2008 Climate Change Act to be conducted and published every other year.

Since the Adaptation Sub-Committee's first assessment of the NAP in June 2015, there have been significant developments in our understanding of the risks posed by climate change and of the steps being taken to adapt to these risks. The second UK Climate Change Risk Assessment (CCRA2), presented to Parliament in January 2017, provided an objective analysis from a national and a global perspective. This report updates and extends the ASC's analysis and advice on the current NAP, and makes further recommendations to the Government as it considers its priorities for the next NAP, expected by summer 2018.

2. Context

A number of significant events, in the UK and around the world, have occurred since the ASC last reported two years ago. These events reinforce the need for greater ambition in adaptation policies and activity going forward.

- **In 2016, atmospheric CO_2 concentrations averaged over 400 parts per million for the first time in at least 800,000 years.** The levels of other powerful greenhouse gases are also rising. Global average surface and ocean temperatures are continuing to increase in response, as are sea levels. 2014, 2015 and 2016 were the three warmest years globally on record, each with average temperatures more than 1°C above those in the late 1800s. Each of the last three decades has been successively the hottest on record.
- **Severe storms and flood events have caused widespread damage to communities and infrastructure**, in particular over the winter of 2015/16. More intense rainfall, and higher monthly rainfall totals in winter, are consistent with projections of the future climate. There is evidence that the warming of the atmosphere to date has already increased the chance of flooding in the UK. The rainfall and river flows in December 2015 highlighted the limited standards of flood protection in place for many communities, even those with defences built in recent years, and the severe disruption and knock-on consequences caused when power and telecommunications networks fail. The next NAP needs to assume that a significant flood event will occur somewhere in the country most years.
- **The Paris Agreement**, reached in December 2015, established a process for more than 180 countries to work together to hold global temperature rises to well below 2°C above pre-industrial levels. However, national commitments to date will not deliver the goals of the Paris Agreement. More than four degrees of warming this century cannot be ruled out on the basis of current projections and the next NAP needs to prepare the country for a range of potential future climates.
- **The UK's fifth carbon budget**, covering 2028 to 2032, was set by Parliament in July 2016 at the level recommend by the Committee on Climate Change. New and more ambitious policies will be needed to meet both the fourth and fifth carbon budgets. Wherever possible these policies should be designed both to reduce greenhouse gas emissions and enhance the country's resilience to the impacts of climate change.
- **The decision to leave the European Union** creates significant uncertainty around policies that support adaptation to climate change, as well as some opportunities. There is the potential to design more effective domestic land use and agriculture policies that contribute

to both emissions reduction and climate change adaptation. The transposition of EU environmental law into domestic legislation will need to at least sustain current levels of protection and enforcement.

- **In January 2017, the Government presented the second UK Climate Change Risk Assessment to Parliament.** This was informed by the ASC's Evidence Report for CCRA2 published in July 2016. The Government has endorsed the six areas of climate change risk identified by the ASC as the most urgent priorities for the next NAP. We expect the next NAP to include ambitious objectives, proposals and policies in these areas, and to describe how progress against objectives will be effectively monitored and evaluated.

3. Our second assessment of the National Adaptation Programme

The current NAP, published in July 2013, included 31 objectives and more than 370 actions split into six main themes: *built environment; infrastructure; healthy and resilient communities; agriculture and forestry; natural environment; and business*. Following the publication of CCRA2, the National Adaptation Programme is due to be updated in the next twelve months.

The ASC's statutory assessment of the NAP aims to determine the level of progress being made to prepare for climate change, focusing solely on England where policy responsibilities are devolved to Northern Ireland, Scotland and Wales. The assessment of progress is not straightforward. It relies on a combination of interpretation of available datasets and expert judgement by the ASC. Even where it is clear that actions are directly addressing risks and delivering benefits, other pressures, such as demographic change, may still mean the vulnerability to climate change impacts is increasing.

The ASC therefore assessed the NAP by asking three questions in each area identified as a priority for adaptation.

- **Is there a plan?** Are there policies and plans in place that address the relevant climate risks?
- **Are actions taking place?** Are NAP actions and other commitments being delivered that could help to reduce the impacts of climate change? Since our first assessment of the NAP in 2015 the proportion of NAP actions classed as complete has risen from 29 to 51%, with a further 35% considered on track or ongoing by those responsible for their delivery.
- **Is progress being made in managing vulnerability?** The most important element of the assessment examines the available evidence to conclude whether vulnerability to the impacts of climate change is increasing or decreasing.

The overall conclusion from the ASC's second assessment is that, despite some areas of progress, the level of risk has increased for a significant number of priorities (see Figure 1 above). The measures set out in the current NAP are not sufficient to avoid the impacts of climate change increasing.

Critically, more areas have been assessed as 'red' in terms of vulnerability than in 2015. Areas where concern has increased since our last assessment include the management of surface water flood risk - for both existing buildings and as a result of new development - and aspects of the natural environment, such as soil health, the resilience of terrestrial and freshwater habitats to climate change, and biodiversity in the farmed countryside.

Figure 1 also highlights five adaptation priorities where stronger policies and plans are urgently needed (shown in the left-hand column). As well as surface water management and soil health, stronger policies and plans are needed to avoid health and wellbeing impacts during periods of high temperatures, to manage risks to marine fisheries and aquaculture, and to increase the resilience of digital and telecommunications infrastructure.

Table 1 below summarises our assessment for the ten adaptation priorities where we have assigned a red rating, either on the basis of current policies and plans, or where the evidence suggests vulnerabilities are increasing.

Table 1. Adaptation priorities assigned a 'red' rating in the second assessment of the NAP

Adaptation priority	Is there a plan?	Is progress being made?	Rationale for RAG score
Natural environment (Chapter 3)			
Terrestrial habitats	Amber	Red	The target for 50% of terrestrial habitats to be in good condition by 2020 is unlikely to be met. Woodland planting rates are below the Government's 2013 target of 5,000 additional hectares per year.
Freshwater habitats	Amber	Red	Indicators of freshwater habitat condition and species abundance show downward trends. Only 20% of water bodies in England are meeting 'good' or 'high' ecological status. The Breeding Wetland Bird Index has dropped to its lowest level since it began in 1975.
Farmed Countryside	Amber	Red	Most of the available indicators for the farmed countryside continue to show long-term declines in species composition. Only farmland bats show a positive trend in abundance.
Soil health and carbon sequestration	Red	Red	The percentage of blanket bog Sites of Special Scientific Interest in good condition declined from 19% to 10% between 2003 and 2016. The last national surveys of soil condition in England in 2003 and 2007 suggest there have been losses in soil organic carbon since the 1970s. There is no plan in place to achieve the ambition for all soils to be managed sustainably by 2030.
Commercial fisheries and aquaculture	Red	Amber	There is no plan set out in the NAP or elsewhere to increase the resilience of marine fisheries and aquaculture to climate change. The proportion of UK fish stocks that are managed at full reproductive capacity and are being harvested sustainably varies over the long-term but remains low, at about 30%.

Table 1. Adaptation priorities assigned a 'red' rating in the second assessment of the NAP

People and the built environment (Chapter 4)			
Surface water flood alleviation	Amber	Red	Evidence suggests a significant and increasingly severe lack of capacity in the sewer network to cope with heavy rainfall events. The scale of the investment to tackle this issue has yet to be assessed and the ownership of the problem is fragmented between national and local government and the water industry.
Development and surface water flood risk	Red	Red	New development is highly likely to be adding pressure to existing drainage networks. There is little confidence amongst industry professionals that current policy is delivering high quality sustainable drainage systems (SuDS) in new development that achieve a range of co-benefits and can be adapted to cope with future change. DCLG did not present the findings of its SuDS policy review in time to inform this report.
Property-level flood resilience	Amber	Red	The six year flood defence investment plan includes proposals to protect 2,900 households from flooding using property-level resilience (PLR) measures. This compares with a cost-effective potential for at least 150,000 households to benefit from PLR. The number of high risk households is expected to increase to over 200,000 by the time Flood Re is withdrawn in 2039.
Health impacts from heat and cold	Red	Amber	There remain no plans in place to adapt the built environment (including homes, hospitals, care homes, schools and prisons) to be resilient to increasing temperatures. The lack of overheating standards for new development means the number of buildings that overheat will increase.
Infrastructure (Chapter 5)			
Digital and ICT infra-structure	Red	Grey	There is no apparent plan by industry or Government to address the critical telecommunications and data infrastructure vulnerabilities identified by the National Flood Resilience Review. As we reported in 2015, there is an absence of evidence, from both Government and the industry, to allow the ASC to assess the resilience of the sector.

Source: See the individual chapters of this report for more details.

4. Priority risks and recommendations

The results of our evaluation are summarised below according to the six priority areas of risk identified by CCRA2, highlighting both positive and negative developments over the past two years, and listing our highest priority recommendations.

The full list of recommendations is included at the end of this Executive Summary, presented in the order they appear in the chapters of this report.

4.1 Flooding and coastal change risks to communities, businesses and infrastructure

Progress in managing risks from river and coastal flooding has not been accompanied by similar advances in managing surface water flood risk. CCRA2 identified flooding as the greatest risk from climate change for businesses and infrastructure as well as for four million homes in England in vulnerable areas. Ten years on from the widespread flooding in 2007, that was predominantly caused by heavy rainfall overwhelming local drains and sewers, surface water flooding still receives less attention than is necessary to avoid risks escalating. For example, surface water flooding was ruled out of scope by the recent National Flood Resilience Review. The policies in place to prevent new development adding further pressure to the ageing sewerage network are weak and not enforced. More money has been allocated to flood and coastal erosion risk management as a result of recent storms but around a quarter of the £700 million announced in the 2016 Budget has not yet been allocated to projects.

Priority recommendations in this area are:

- **RECOMMENDATION 12:** ***More and better co-ordinated action is needed to manage the lack of capacity within drainage systems to cope with possible increase in the frequency and severity of heavy rainfall.*** *Defra and the National Infrastructure Commission should initiate a comprehensive assessment to quantify the need for investment and other policy actions to manage surface water flood risk, including, but not limited to, retrofitting SuDS. Urgent investments need to be considered by water companies and Ofwat as part of the 2019 price review, and the comprehensive assessment should be in place to inform local planning policy and major investment decisions in the 2024 price review.*
- **RECOMMENDATION 13:** ***Policy is needed urgently to address the outstanding barriers to deliver high quality, effective SuDS in new development that achieve the full range of potential environmental co-benefits.*** *In particular, there is a need for:*
    - *More comprehensive and ambitious national standards for SuDS.*
    - *The automatic right to connect new development to the existing sewerage network to be made conditional on the national SuDS standards being met.*
    - *A clear policy on who should maintain and adopt SuDS by default.*
- **RECOMMENDATION 14:** ***Defra should develop a long-term strategy to manage flood risk down to tolerable levels in each part of the country, so that as Flood Re is withdrawn properties can remain insurable at reasonable cost.*** *This should include:*
    - *Monitoring the impact of the actions adopted following the Bonfield Review to achieve, in five years' time, an 'environment where it is standard practice for properties at high risk to be made resilient'.*

- *Actively communicating the risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s.*
- *Ensuring that Flood Re incentivises households to take up property-level resilience measures, which insurers should allow to be implemented during post-flood repairs.*

4.2 Risks to natural capital including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity

Despite continued action and individual success stories, the overall vulnerability of the natural environment to climate change has not reduced since our last report and in some respects has increased. Most of the current policies and plans in place to support the resilience of the natural environment, including the biodiversity strategy for England, are coming to an end in 2020. The decision to leave the European Union creates further uncertainty, and an urgent need and opportunity to draw up new environmental policies that prevent climate change causing irreversible damage to the UK's native wildlife and other aspects of our natural capital.

Priority recommendations relating to natural capital are:

- **RECOMMENDATION 5:** ***A critical part of the next National Adaptation Programme should be a long-term plan for the natural environment that takes climate change into account,*** *builds on the level of ambition of current EU policies, and is consistent with the framework developed by the Natural Capital Committee. In line with the ASC's previous advice, there should be associated targets, actions, and a monitoring and evaluation framework.*
- **RECOMMENDATION 10:** ***To support adaptation efforts, a plan should be put in place to deliver the aspiration for all soils to be managed sustainably by 2030.*** *The plan should include a scheme to monitor uptake of soil conservation measures, and specific proposals to reverse the ongoing loss of lowland peat soils, in order to provide mitigation and adaptation benefits.*
- **RECOMMENDATION 11:** ***A target for restoring all designated upland blanket bog habitats to favourable condition by 2030 should be adopted*** *in order to contribute to both adaptation and mitigation efforts.*
- **RECOMMENDATION 7:** ***Research on the risks to the marine food chain and ecosystem from rising sea temperatures, deoxygenation and ocean acidification should be undertaken over the course of the next National Adaptation Programme period, to inform future marine and fisheries policies.*** *The research should assess the extent to which adaptive actions could increase the resilience of marine habitats and species to climate change.*

4.3 Risks to domestic and international food production and trade

A more proactive strategy is needed to ensure the availability of safe, affordable, nutritious food in the UK. This is a long-term risk for which action needs to begin now. The resilience of the UK food system will depend on the stewardship of natural resources here and overseas, and the effective management globally of food production changes and supply chain shocks. There is the potential for domestic production to increase in a warmer climate but this will be constrained unless more action is taken to address the declining quality of soils and projected water deficits in the most productive regions.

Priority recommendations related to food production and trade are:

- **RECOMMENDATION 9:** ***New agricultural land management policies should take account of the need to improve water quality and the condition of habitats and soils, in order to build resilience to climate change.*** *Targets should be set that focus on outcomes, and monitoring undertaken to understand if these targets are being met.*
- **RECOMMENDATION 10:** ***To support adaptation efforts, a plan should be put in place to deliver the aspiration for all soils to be managed sustainably by 2030.*** *The plan should include a scheme to monitor uptake of soil conservation measures, and specific proposals to reverse the ongoing loss of lowland peat soils, in order to provide mitigation and adaptation benefits.*

4.4 Risks to health, wellbeing and productivity from high temperatures

Increasing seasonal average and extreme temperatures, combined with a growing, ageing population, is expected to more than triple the number of heat-related deaths by the middle of the century, from 2,000 currently to 7,000 per year. There are as yet no policies in place to begin to adapt the built environment and existing buildings for increasing temperatures and heatwaves. A lack of relevant standards means new developments, including hospitals and care homes, will add to the number of buildings that overheat in warmer weather.

Recommendations 12 and 13 above promote the use of good quality SuDS and green infrastructure. These measures can contribute towards managing the urban heat island effect. Priority recommendations directly related to risks from high temperatures are:

- **RECOMMENDATION 16:** ***As recommended in our 2015 report, a standard or regulation should be put in place to reduce the risk of overheating in new homes.***
- **RECOMMENDATION 17:** ***Further action should be taken to assess and reduce the risks of overheating in existing buildings, with the priorities being hospitals, schools, care homes and prisons.*** *This could be undertaken for example through the relevant standards agencies such as the Care Quality Commission and Ofsted.*

4.5 Risks of shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology

Climate change is projected to reduce the amount of freshwater that can be sustainably withdrawn, whilst warmer weather and the growing population are expected to increase demand. The current system of abstraction licences needs to be reformed urgently so that water resources can be allocated more efficiently between different users and to protect the environment when water is scarce. The 2014 Water Act commits the Government to report to Parliament in 2019 on progress towards abstraction reform. The Water Act also placed a new 'resilience duty' on Ofwat, the industry regulator. New water resource management plans from water companies, due for consultation in early 2018, will look at least 25 years ahead and assess the vulnerability of water resources in a range of climate scenarios. The draft Strategic Policy Statement to Ofwat for the next price review, published in March 2017, underlined the importance of water efficiency and other demand-side measures in reducing pressure on water resources. The statement also placed new emphasis on investment in wastewater and drainage networks to prevent flooding, as part of improving network resilience. A National Policy Statement on major new water infrastructure is planned.

The priority for the Government and the water industry as part of the updated National Adaptation Programme should be the successful delivery of the proposals identified above in the next five years. Progress on enabling measures such as greater uptake of water metering by households also needs to continue. Because of the proposals already in the pipeline, there are no additional specific recommendations on water resources made in this report. However, these proposals must be delivered in line with the commitments made. For example, some aspects of abstraction reform rely on new primary legislation, requiring it to be made a priority for Parliamentary time.

4.6 New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals

Risks from new and emerging pests and diseases, and invasive non-native species, are potentially very high for people, animals and the natural environment. The warmer conditions expected with climate change will allow some pests, disease-carrying insects and other animals, and invasive non-native species, to extend their range.

The ASC's Evidence Report for CCRA2 identified an urgent need for further research to inform government policy and operational measures, such as additional surveillance of emerging pathogens and the monitoring of problem species. Nationally and internationally there is a need for more research to understand how pest and disease outbreaks can be contained. Continued collaboration with other countries – particularly within Europe – on surveillance and monitoring will be needed. The next NAP needs to develop the evidence base in these areas, together with the other issues highlighted as a 'research priority' in our CCRA Evidence Report, in order to inform future policies.

4.7 Cross-cutting recommendations for the next NAP

The Adaptation Sub-Committee has now assessed the current NAP twice, and as a result makes a number of general recommendations for the updated programme (Box 1).

These build on the cross-cutting recommendations first made in 2015 for the NAP to be more strategic and focused, develop a stronger evidence to monitor and evaluate key policies, and include an element of public engagement.

Box 1. Overarching recommendations for an updated National Adaptation Programme

RECOMMENDATION 1: *To ensure that activity and investments have a significant, cost-effective impact on reducing vulnerabilities, the second NAP should:*

- *set clear priorities for adaptation;*
- *ensure objectives are outcome-focused, measurable, time-bound and have clear ownership;*
- *prioritise the core set of policies and actions that will have the biggest impact;*
- *build on the breadth of community and business engagement in the first NAP; and*
- *include effective monitoring and evaluation.*

RECOMMENDATION 2: *The second NAP should address the important interdependencies between climate change risks and policy responses which fall within and across the remits of different government departments, and national, local and devolved governments, to ensure relevant policies and activity are co-ordinated across the programme.*

Box 1. Overarching recommendations for an updated National Adaptation Programme

RECOMMENDATION 3: *To ensure continuous improvement in the approach to reducing climate change risks, the second NAP should have a strong focus on evidence and evaluation:*

- *there is the need and opportunity to work through UK Research and Innovation and the individual research councils to develop the evidence base in time to inform the third UK Climate Change Risk Assessment in 2022, making full use of the new UK Climate Projections in 2018;*
- *more attention needs to be paid to the evaluation of existing policies and approaches in order to learn lessons for future initiatives; and*
- *the costs and benefits of more ambitious policy options need to be considered and appraised.*

RECOMMENDATION 4: *The Government should explore cost-effective ways to communicate the risks from climate change, and the actions that can be taken to reduce vulnerabilities. Priorities include:*

- *engaging vulnerable groups and communities exposed to specific risks such as higher temperatures, coastal change, and increases in flood risk;*
- *challenging the relevant professional bodies (such as the Landscape Institute, the Royal Town Planning Institute, and the Institution of Civil Engineers), and trade associations (for example the National Federation of Builders), to increase their level of engagement with members regarding climate change, and to improve the training, guidance and professional accreditation they offer; and*
- *raising awareness amongst the general public including through community groups and national membership organisations such as the National Trust, the Royal Horticultural Society, and the RSPB.*

Source: See Chapter 2: *The National Adaptation Programme* for more details.

Priority recommendations of a cross-cutting nature also appear in the infrastructure, business and local government chapters of this report.

Climate change poses multiple threats to UK infrastructure, making oversight by Government and regulators important because of the potential for systemic impacts. Whilst improvements continue to be made to increase the resilience of infrastructure services in individual sectors, recent severe weather events have highlighted important interdependency risks between networks. Storm Desmond showed that failures of electricity and telecommunications networks, and bridges, quickly and unpredictably affect other services, heightening disruption and hampering the efforts of the emergency services. A lack of information sharing by infrastructure operators regarding vulnerable assets continues to be cited by members of Local Resilience Forums as a barrier to more effective action.

- **RECOMMENDATION 21:** ***To assist with the assessment and management of interdependencies the Cabinet Office should review information sharing arrangements between infrastructure operators, as well as between operators and Local Resilience Forums.*** *Further steps may be necessary to ensure that the legal duties within the Civil Contingencies Act are being fulfilled in practice, including the duty for Category 1 and Category 2 responders to cooperate and share information.*

Businesses in England are exposed to a range of physical, financial and reputational risks from climate change. More businesses need to consider the resilience of their assets and operations in severe weather, as well as the consequences of indirect impacts from disruption to supply chains and distribution networks. The investment community is becoming increasingly interested in

the effects of climate change on risk-adjusted returns. Pressure is growing on companies to disclose how their assets and liabilities could be impacted, with investors expecting greater maturity in the assessment of climate change risks and the adaptation actions being taken.

- **RECOMMENDATION 22:** ***The Government should promote voluntary disclosure of climate change risks by both large and small companies, including the risks in relation to supply chains.***
    - *The investment community should further emphasise the need for meaningful disclosure of how companies assess and manage climate change risks, in line with the recommendations of the Task Force on Climate-related Financial Disclosures.*
    - *The Financial Reporting Council's UK Stewardship Code should ask investors to consider company performance and reporting on adapting to climate change.*
    - *As a form of disclosure, the Government should promote corporate natural capital accounting and reporting, as recommended by the Natural Capital Committee.*

Local authorities have a critical role to play in delivering many aspects of the current National Adaptation Programme. However, council budgets are stretched, and in the context of other priorities, climate change adaptation is often overlooked. The closure of the Environment Agency's Climate Ready Support Service in March 2016, together with six of Climate UK's nine regional climate change partnerships in England, means momentum in the sector is at risk of stalling. Pressure to meet the need for more housing has led to climate change in effect being deprioritised in the land-use planning system.

- **RECOMMENDATION 26:** ***To stimulate activity and improve monitoring and evaluation, local authorities should be included within the scope of the third round of reporting under the Adaptation Reporting Power.*** *Defra should identify the most efficient and effective means for local authorities to report on the action they are taking and the progress being made to prepare communities for climate change.*
- **RECOMMENDATION 28:** ***The Government should review the effectiveness of the land-use planning system in achieving reductions in greenhouse gas emissions from buildings and transport, and enhancing the resilience of communities and the built environment to the impacts of climate change.*** *The review should consider both strategic and local land-use allocation, and building and infrastructure design.*

5. Next steps

Under the Climate Change Act, the Government is required to respond to this progress report by 15 October 2017. The Government also has to update its National Adaptation Programme 'as soon as is reasonably practicable' following the publication of CCRA2 in January 2017. We expect a new NAP to be published in the next twelve months. We will assess the revised NAP in our next progress report to Parliament in June 2019.

In the meantime the ASC will conduct a number of in-depth studies to supplement the existing evidence base in key areas. We expect to publish a non-statutory report next summer that presents the results of this analysis. We will also seek feedback from a range of stakeholders on the approach we have taken in this and our 2015 report to assessing the National Adaptation Programme, to make sure our analysis and advice is as helpful and effective as possible.

Full list of recommendations

Table 2 provides the full list of recommendations made in this report, in the order they appear in the individual chapters. Priority recommendations are shown in **bold**.

Table 2. Recommendations from the second statutory assessment of the NAP

Recommendation	Owner	Timescale
The National Adaptation Programme (Chapter 2)		
1. To ensure that activity and investments have a significant, cost-effective impact on reducing vulnerabilities, the second NAP should: -- set clear priorities for adaptation; -- ensure objectives are outcome-focused, measurable, time-bound and have clear ownership; -- prioritise the core set of policies and actions that will have the biggest impact; -- build on the breadth of community and business engagement in the first NAP; and -- include effective monitoring and evaluation.	**Defra**	**Next NAP report in 2018**
2. The second NAP should address the important interdependencies between climate change risks and policy responses which fall within and across the remits of different government departments, and national, local and devolved governments, to ensure relevant policies and activity are co-ordinated across the programme.	**Defra**	**Next NAP report in 2018**
3. To ensure continuous improvement in the approach to reducing climate change risks, the second NAP should have a strong focus on evidence and evaluation: -- there is the need and opportunity to work through UK Research and Innovation and the individual research councils to develop the evidence base in time to inform the third UK Climate Change Risk Assessment in 2022, making full use of the new UK Climate Projections in 2018; -- more attention needs to be paid to the evaluation of existing policies and approaches in order to learn lessons for future initiatives; and -- the costs and benefits of more ambitious policy options need to be considered and appraised.	**Defra**	**Next NAP report in 2018**
4. The Government should explore cost-effective ways to communicate the risks from climate change and the actions that can be taken to reduce vulnerabilities. Priorities include: -- engaging vulnerable groups and communities exposed to specific risks such as higher temperatures, coastal change, and increases in flood risk; -- challenging the relevant professional bodies (such as the Landscape Institute, the Royal Town Planning Institute, and the Institution of Civil Engineers), and trade associations (for example the National Federation of Builders), to increase their level of engagement with members regarding climate change, and to improve the training, guidance and professional accreditation they offer; and -- raising awareness amongst the general public including through community groups and national membership organisations such as the National Trust, the Royal Horticultural Society, and the RSPB.	**Defra**	**Next NAP report in 2018**

Table 2. Recommendations from the second statutory assessment of the NAP		
Natural environment (Chapter 3)		
5. A critical part of the next National Adaptation Programme should be a long-term plan for the natural environment that takes climate change into account, builds on the level of ambition of current EU policies, and is consistent with the framework developed by the Natural Capital Committee. In line with the ASC's previous advice, there should be associated targets, actions, and a monitoring and evaluation framework.	**Defra**	**By 2019**
6. Action should be taken to enhance the condition of priority habitats and the abundance and range of priority species. This action should maintain or extend the level of ambition that was included in Biodiversity 2020. An evaluation should be undertaken of Biodiversity 2020, including the extent to which goals have been met and of the implications for resilience to climate change.	Defra	By 2021
7. Research on the risks to the marine food chain and ecosystem from rising sea temperatures, deoxygenation and ocean acidification should be undertaken over the course of the next National Adaptation Programme period, to inform future marine and fisheries policies. The research should assess the extent to which adaptive actions could increase the resilience of marine habitats and species to climate change.	**Defra**	**By 2022**
8. Goals and actions to achieve sustainable yields by 2030 should be included in new policies that will replace the Common Fisheries Policy. Indicators of sustainable management should also be reviewed to ensure they take account of changing distributions of fish species due to climate change.	Defra	By 2019
9. New agricultural land management policies should take account of the need to improve water quality and the condition of habitats and soils, in order to build resilience to climate change. Targets should be set that focus on outcomes, and monitoring undertaken to understand if these targets are being met.	**Defra**	**By 2020**
10. To support adaptation efforts, a plan should be put in place to deliver the aspiration for all soils to be managed sustainably by 2030. The plan should include a scheme to monitor uptake of soil conservation measures, and specific proposals to reverse the ongoing loss of lowland peat soils, in order to provide mitigation and adaptation benefits.	**Defra**	**By 2019**
11. A target for restoring all designated upland blanket bog habitats to favourable condition by 2030 should be adopted in order to contribute to both adaptation and mitigation efforts.	**Defra**	**By 2019**

Table 2. Recommendations from the second statutory assessment of the NAP		
People and the built environment (Chapter 4)		
12. More and better co-ordinated action is needed to manage the lack of capacity within drainage systems to cope with possible increase in the frequency and severity of heavy rainfall. Defra and the National Infrastructure Commission should initiate a comprehensive assessment to quantify the need for investment and other policy actions to manage surface water flood risk, including, but not limited to, retrofitting sustainable drainage systems (SuDS). Urgent investments need to be considered by water companies and Ofwat as part of the 2019 price review, and the comprehensive assessment should be in place to inform local planning policy and major investment decisions in the 2024 price review.	**Ofwat**	**2019 Price Review and 2024 Price Review**
13. Policy is needed urgently to address the outstanding barriers to deliver high quality, effective SuDS in new development that achieve the full range of potential environmental co-benefits. In particular, there is a need for: **-- More comprehensive and ambitious national standards for SuDS.** **-- The automatic right to connect new development to the existing sewerage network to be made conditional on the national SuDS standards being met.** **-- A clear policy on who should maintain and adopt SuDS by default.**	**DCLG**	**2020**
14. Defra should develop a long-term strategy to manage flood risk down to tolerable levels in each part of the country (as we first recommended in 2015), so that as Flood Re is withdrawn properties can remain insurable at reasonable cost. This should include: **-- Monitoring the impact of the actions adopted following the Bonfield Review to achieve, in five years' time, an "environment where it is standard practice for properties at high risk to be made resilient".** **-- Actively communicating the risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s.** **-- Ensuring that Flood Re incentivises households to take up property-level resilience measures, which insurers should allow to be implemented during post-flood repairs.**	**Defra**	**2020**
15. The Environment Agency, with Coastal Groups, should review the ambition within, and progress being made in implementing, Shoreline Management Plans (SMPs), and prepare communities for the coastal adaptation that will need to take place between now and the middle of the century.	EA	2020
16. As recommended in our 2015 report, a standard or regulation should be put in place to reduce the risk of overheating in new homes.	**DCLG**	**2020**
17. Further action should be taken to assess and reduce the risks of overheating in existing buildings, with the priorities being hospitals, schools, care homes and prisons. This could be undertaken for example through the relevant standards agencies such as the Care Quality Commission and Ofsted.	**Department of Health, Department for Education, Department for Justice**	**2020**

Table 2. Recommendations from the second statutory assessment of the NAP		
18. The Cabinet Office should, in consultation with Local Resilience Forums: -- Commission an independent review of the planning scenarios underpinning local Risk Registers to ensure they i) they are consistent with plausible worst case scenarios, and ii) use the results to help LRFs assess the resources needed to manage these events. -- Strengthen the Emergency Planning Guidance to clarify and test responsibilities for coordination amongst Category 1 and Category 2 responders, as well as between neighbouring LRFs.	CO	2020
Infrastructure (Chapter 5)		
19. Defra should review and strengthen its guidance for ARP3 to elicit more comparable data and conclusions about the adaptation of infrastructure. Use of consistent incident reporting and indicators of network resilience will allow performance to be tracked over time. Reporting protocols should be developed in partnership with sector organisations, the Cabinet Office, the National Infrastructure Commission, and the new National Infrastructure Resilience Council.	Defra	2018
20. Defra should ensure that all major infrastructure operators in the digital and ICT sector take part in the third round of the ARP. This will ensure that the sector has considered risks, and that operators, individually and collectively, have developed risk management plans.	Defra	2019
21. To assist with the assessment and management of interdependencies the Cabinet Office should review information sharing arrangements between infrastructure operators, as well as between operators and Local Resilience Forums. Further steps may be necessary to ensure that the legal duties within the Civil Contingencies Act are being fulfilled in practice, including the duty for Category 1 and Category 2 responders to cooperate and share information.	**Cabinet Office**	**2018**
Business (Chapter 6)		
22. The Government should promote voluntary disclosure of climate change risks by both large and small companies, including the risks in relation to supply chains. **-- The investment community should further emphasise the need for meaningful disclosure of how companies assess and manage climate change risks, in line with the recommendations of the Task Force on Climate-related Financial Disclosures.** **-- The Financial Reporting Council's UK Stewardship Code should ask investors to consider company performance and reporting on adapting to climate change.** **-- As a form of disclosure, the Government should promote corporate natural capital accounting and reporting, as recommended by the Natural Capital Committee.**	**Defra/BEIS**	**By 2020**

Table 2. Recommendations from the second statutory assessment of the NAP		
23. The Government should consult on the measures needed in the next NAP to provide appropriate information and advice to support adaptation activity by businesses in England. For example, the Government could work with bodies such as the Confederation of British Industry, the Institute of Directors, the Federation of Small Businesses, Local Enterprise Partnerships, local chambers of commerce, and key individual sector associations, to promote use of the guidance and tools that were developed by the Environment Agency and Climate UK before their closure.	Defra/BEIS	2018
24. The Government should examine how public procurement rules could be used to promote the disclosure and management of climate change risks including within supply chains. For example, the Crown Commercial Service could require companies tendering for contracts to explain how risks have been considered and addressed both within tenders and by their overall business.	Defra/Crown Commercial Service	By 2020
Local government (Chapter 7)		
25. The Government should set out in the next NAP how it will ensure local authorities have access to the technical expertise, guidance, and practical tools they need following the closure of the Environment Agency's Climate Ready Support Service, Climate UK, and Climate Local. There is potential for professional bodies such as the Royal Town Planning Institute and the Chartered Institution of Water and Environmental Management to take a greater role in providing information, training and advice.	Defra/DCLG	2018
26. To stimulate activity and improve monitoring and evaluation, local authorities should be included within the scope of the third round of reporting under the Adaptation Reporting Power. Defra should identify the most efficient and effective means for local authorities to report on the action they are taking and the progress being made to prepare communities for climate change.	**Defra**	**2018**
27. The next NAP should develop stronger sub-national approaches to climate change adaptation that promote business and infrastructure resilience, healthy communities, and investment in natural capital. For example, there is the opportunity to build on current arrangements and work with London and the core city regions, the metro mayors, and the Local Enterprise and Local Nature Partnerships.	Defra	2018
28. The Government should review the effectiveness of the land-use planning system in achieving reductions in greenhouse gas emissions from buildings and transport, and enhancing the resilience of communities and the built environment to the impacts of climate change. The review should consider both strategic and local land-use allocation, and building and infrastructure design.	**DCLG**	**2019**

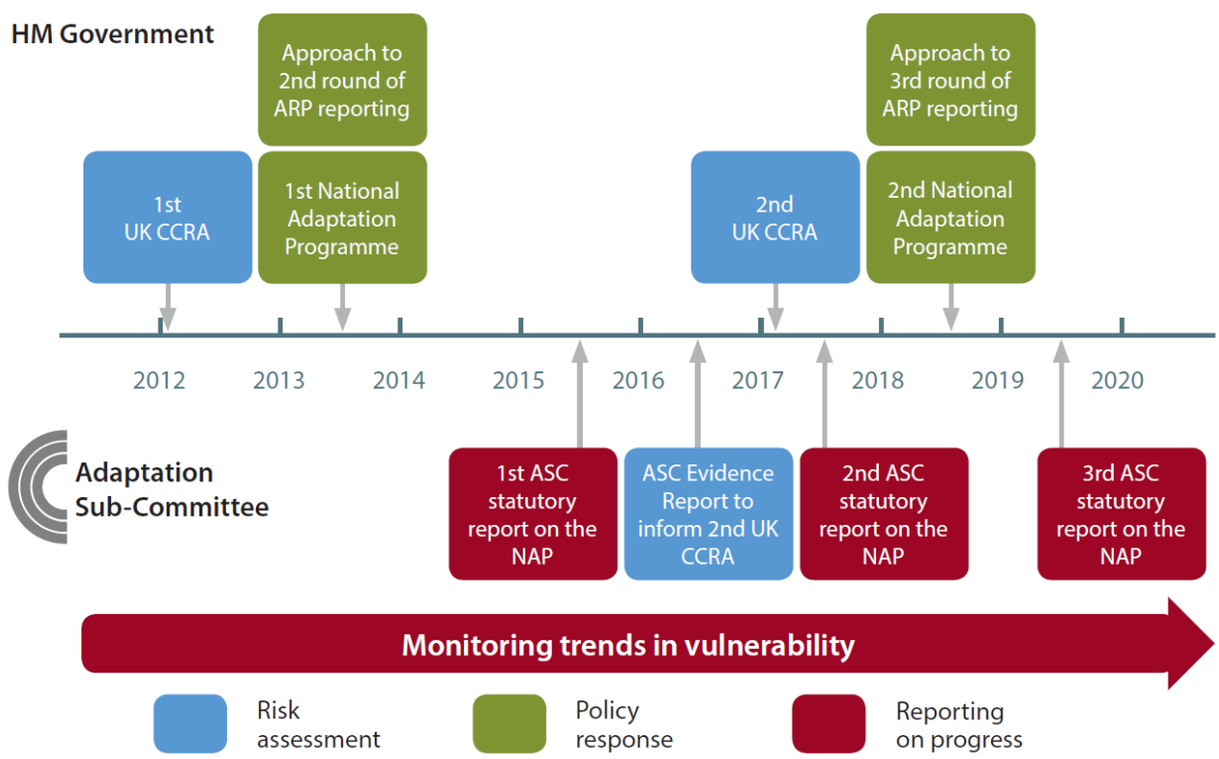
Chapter 1: Introduction

1.1 Purpose of this report

This is the Adaptation Sub-Committee's second biennial assessment of the UK Government's National Adaptation Programme.

In passing the Climate Change Act in 2008, the UK was one of the first countries to create a legal requirement for the risks and opportunities from climate change to be assessed, and for a national programme of adaptation policies to be developed in response (Figure 1.1). The Act also established the Adaptation Sub-Committee of the Committee on Climate Change as the Government's independent, expert advisors on preparing for climate change.

Figure 1.1. The UK adaptation policy cycle within the 2008 Climate Change Act



Source: Climate Change Act 2008, section 56.

- The Act requires the Government to present before Parliament an assessment of the climate change risks and opportunities for the United Kingdom every five years. The first UK Climate Change Risk Assessment (CCRA) was published in January 2012. The second CCRA was presented to Parliament in January 2017 (CCRA2, discussed later in this chapter). The Adaptation Sub-Committee (ASC) has a statutory duty to provide advice on each CCRA, six months in advance of when it is due to be presented to Parliament. The ASC published its Evidence Report to inform CCRA2 in July 2016.[1]

[1] ASC (2016) *UK Climate Change Risk Assessment 2017: Evidence report*, https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/

- Following the publication of each CCRA, the Government must lay out its objectives, policies and proposals to address the climate change risks and opportunities it describes. The National Adaptation Programme (NAP) was published for the first time in July 2013[2] and is now due for renewal. The programme covers devolved policies in England together with reserved policies for the UK as a whole. The ASC is required by the Act to assess the NAP and present a progress report to Parliament by the end of June every other year. The ASC's first assessment was published in June 2015.[3] This report is the second assessment, and is presented alongside the latest report of the Committee on Climate Change (CCC) on reducing UK greenhouse gas emissions. Chapter 2 of this report provides an introduction to the current National Adaptation Programme and a summary of our latest assessment of it.
- The Act requires the Government to respond to each of the ASC's statutory progress reports and present a report to Parliament by 15 October in the same year. The Government's response to the ASC's first progress report on the NAP was published on 15 October 2015.[4]

Box 1.1 summarises the importance of preparing for climate change through the delivery of a national adaptation programme.

The Climate Change Act also includes a power to allow the Secretary of State to direct relevant organisations, such as public bodies and infrastructure providers, to report on the progress being made in adapting to climate change. This Adaptation Reporting Power (ARP) was first used in 2009 and led to 105 organisations publishing an assessment of the climate change risks and opportunities identified and the actions they will take as a result. A second, voluntary, round of ARP reporting (ARP2) was commissioned in 2013. The ASC's evaluation of ARP2 was published in March 2017[5] and is discussed further in Chapter 5: *Infrastructure*.

1.2 Significant events since the ASC's last progress report

A number of significant events, both globally and in the UK, have taken place since the ASC reported to Parliament in 2015. These form an important context for this report, and for the Government as it updates the National Adaptation Programme.

The developments and events summarised below are significant, either in advancing the evidence base for this report and the Government's second NAP, or in providing the policy context within which new adaptation objectives and proposals need to be developed and delivered.

[2] HM Government (2013) *National Adaptation Programme.*
[3] ASC (2015) *Progress in preparing for climate change: 2015 report to Parliament,* https://www.theccc.org.uk/publication/reducing-emissions-and-preparing-for-climate-change-2015-progress-report-to-parliament/
[4] HM Government (2015) *Government response to the Committee on Climate Change.*
[5] ASC(2017) *Adaptation Reporting Power: second round review,* https://www.theccc.org.uk/publication/adaptation-reporting-power-second-round-review/

Box 1.1. What is climate change adaptation and why is it important?

The scientific evidence is clear that the climate is changing due to greenhouse gas emissions from human activity. The warming planet presents a deeply complex, global environmental threat.

Even if the most ambitious emissions reduction efforts are successful, there will still be further changes in climate this century, including in the UK. Changes in seasonal temperatures and rainfall patterns, a warming of and changing chemistry in the oceans, together with sea level rise and more extreme weather, create a series of risks for natural and human systems.

Climate change adaptation is the process by which these risks are assessed and managed. It is not always easy to separate the effects of climate change from other drivers, such as wider trends in economic development and demographic change. It is the combined impact of these effects on future vulnerability to climate hazards that is important to manage and adapt to.

The consequences of not adapting both globally and in the UK are potentially great, leading to larger costs in future and the risk of irreversible damage. In contrast, well-designed adaptation will not only reduce the risks of climate change impacts but also contribute to the delivery of other objectives such as environmental protection, improving air and water quality, and safeguarding the health and wellbeing of the population.

Priorities for adaptation fall in to three broad categories:

- **Low regret adaptation actions** that address existing vulnerabilities to extreme weather. These will provide early, robust benefits and also build resilience to future severe weather events.
- **Factoring climate change into decisions that create 'lock in'**: such decisions are difficult and costly to reverse, such as the location and design of long-lived assets like new housing and infrastructure. These decisions need to take into account projections of the future climate and also the uncertainty associated with these projections. Decisions should remain robust under a range of climate scenarios, and where possible and appropriate, designs should incorporate the flexibility to move or adapt assets should the need arise.
- **Preparing now for options with long lead times**, to start planning for the longer-term climate challenges such as sea level rise and water scarcity. For example it took thirty years to plan, design and build the Thames Barrier after the 1953 floods. Other major infrastructure assets such as large new reservoirs could take many years to deliver. If such assets are needed by mid-century, early planning and investment can ensure options remain open and the information to make timely and robust decisions is gathered.

Source: Adapted from ASC (2010) *How well is the UK prepared for climate change?* and ASC (2016) *UK Climate Change Risk Assessment 2017, Chapter 2: Approach and Context.*

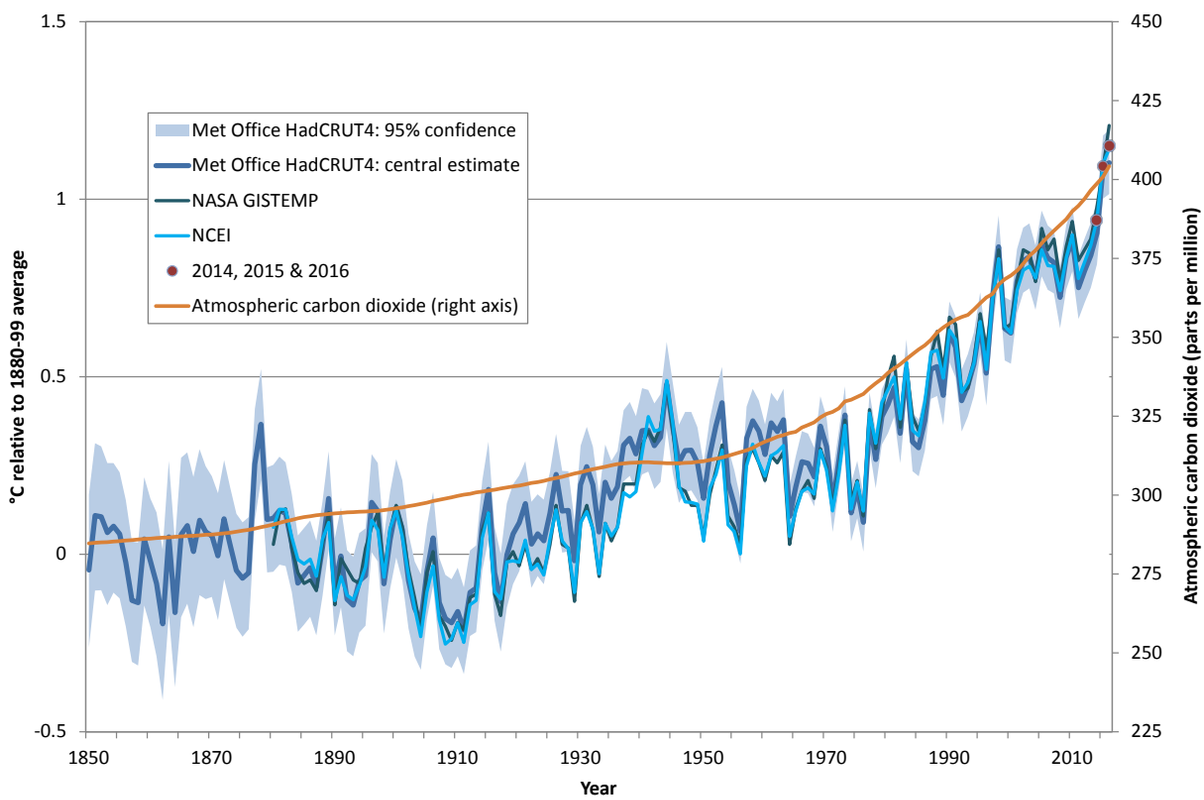
1.2.1 The latest climate science and observations

2016 was the warmest year globally on record, surpassing the previous record highs set in 2014 and again in 2015. Figure 1.2 charts global average surface temperature since records began in 1850 together with the concentration of carbon dioxide in the atmosphere.

The average global surface temperature in 2016 was 1.1°C above the late 19th Century average, with 2014, 2015 and 2016 the three warmest years on record. All ten of the warmest years on record have occurred since 1997, and nine of the ten warmest years have been in the last decade.

There is increasing evidence that the warming to date is changing the pattern of weather systems around the world and leading to more 'persistent extremes' such as flooding, drought and heatwaves.[6] These persistent weather patterns have also been linked with the amplified warming of the Arctic region and loss of polar ice that has been observed in recent decades.[7]

Figure 1.2. Atmospheric carbon dioxide and global average surface temperature



Source: Data from Met Office, NASA and the US National Centres for Environmental Information (NCEI).
Notes: The 1880-1899 period is used as a common 'pre-industrial' baseline to allow the three datasets to be compared. Circles showing the temperatures for 2014, 2015 and 2016 are the average of the three datasets. Atmospheric carbon dioxide before 1958 is from ice core data (Law Dome, East Antarctica), and from 1959 as measured by the National Oceanic and Atmospheric Administration (NOAA) at Mauna Loa, Hawaii.

In 2016, carbon dioxide concentrations in the atmosphere were measured above 400 parts per million in the Antarctic region. Other monitoring stations such as in Hawaii have been measuring CO_2 levels at above 400ppm for several years, increasing at an accelerating rate from pre-industrial CO_2 levels of around 270-280ppm. Data from ice cores and sea sediments suggest CO_2 concentrations have not been as high in the Antarctic region for four million years.[8]

[6] Mann et al. (2017) *Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events*. Nature Scientific Reports.
[7] For example: http://www.nature.com/ngeo/journal/v7/n9/full/ngeo2234.html
[8] See: http://research.noaa.gov/News/NewsArchive/LatestNews/TabId/684/ArtMID/1768/ArticleID/11760/South-Pole-is-the-last-place-on-Earth-to-pass-a-global-warming-milestone.aspx

A series of storms hit the UK in December 2015 and January 2016. Rainfall records across the north of England were broken by storm Desmond on 4th and 5th December 2015, causing widespread flooding and disruption to infrastructure services.

The scale, intensity and duration of storms Desmond, Eva and Frank severely tested local response and mutual aid arrangements. A new UK 24-hour rainfall record was set on 5 December with 341mm falling at Honister Pass, Cumbria. Flood defences were overwhelmed, even those recently constructed[9], and disruption to electricity, communications and the road and rail networks hampered the efforts of the emergency services. The Government initiated two reviews in response to the events, the National Flood Resilience Review and the Cumbria Flood Action Plan. These are discussed further in Chapter 4: *People and the built environment* and Chapter 5: *Infrastructure*.

Whilst it is not possible to attribute any single storm to climate change, an increase in the frequency and severity of heavy rainfall in the UK is projected, as a warmer atmosphere is able to hold more moisture.[10] December 2015 was the warmest as well as the wettest December on record, with the monthly average temperature (of 7.9°C) 4.1°C higher than the long-term average.[11] Daily maximum temperatures reached 14 -16 °C widely across the UK, 7 - 9°C higher than normal.

Climate simulations performed shortly after storm Desmond suggest that the warming of the atmosphere to date has increased the chance of such an exceptional rainfall event by around 40%.[12] The National Flood Resilience Review found that the relatively short rainfall records in the UK understate the potential for high monthly rainfall totals, which could be 20-30% higher than the most extreme on record.[13] The review concluded that there is a reasonable (10%) chance that in any given year, a regional monthly rainfall record will be broken again, even before the effects of further climate change are considered.

The sequence of flood events in England over the past 20 years[14], together with the findings of the National Flood Resilience Review, reinforce the need for national and local government to plan on the basis that a significant flood event will take place somewhere in England most years. According to insurance company data, floods are most likely to occur in December, and in each December there is a near 50% chance of one or more flood events in the UK.[15]

[9] For example in Carlisle, Cockermouth and Keswick.
[10] Blenkinsop et al. (2015) *Temperature influences on intense UK hourly precipitation and dependency on large-scale circulation.* Environmental Research Letters.
[11] See: http://www.metoffice.gov.uk/news/releases/2016/december-records
[12] van Oldenborgh et al. (2015) *Climate change increases the probability of heavy rains like those of storm Desmond in the UK*. Hydrology and Earth System Sciences Discussions.
[13] Cabinet Office, Defra (2016) *National Flood Resilience Review*.
See also: https://blog.metoffice.gov.uk/2016/12/05/storm-desmond-one-year-on/
[14] See: http://www.metoffice.gov.uk/climate/uk/interesting
[15] See: http://www.rms.com/blog/2016/01/14/just-how-unlucky-was-britain-to-suffer-desmond-eva-and-frank-in-a-single-december/

1.2.2 The Paris Agreement

A global agreement to curb greenhouse gas emissions was reached in Paris in December 2015. The Paris Agreement aims to keep the global temperature increase to well below 2°C above pre-industrial levels by the end of this century, whilst pursuing efforts to avoid more than a 1.5°C increase. Current national commitments need to be significantly strengthened, and soon, to avoid more than 2°C of warming occurring this century.

The Paris Agreement calls for a global stocktake of national commitments, termed Nationally Determined Contributions (NDCs), every five years. At present, even full implementation of current NDCs would probably result in a rise in global surface temperature of well above two degrees, with a central estimate of 2.7°C.[16] If NDCs are not fulfilled, global temperatures could rise by more than 4°C by 2100.[17]

The combination of the warming that has taken place, together with the further warming that is already inevitable, means the National Adaptation Programme needs to prepare the country for more significant changes in the UK climate than experienced to date. Even in the best case scenario, of warming limited to 1.5 to 2°C, there are likely to be considerable national as well as global impacts beyond those already observed.

The potential also exists for disruptive shifts in the climate, with an increasing chance of severe, pervasive and irreversible impacts associated with higher magnitudes of warming. Possible abrupt and irreversible changes could include extreme sea level rise as a result of major ice loss from Greenland and Antarctica, changes in ocean currents, and dieback of the Amazon rainforest. Progressive, chronic impacts could include substantial species extinctions, large risks to global and regional food production, and a combination of high temperatures and humidity compromising normal human activity.[18]

This makes it all the more important for the next NAP to consider a range of climate change scenarios, and not just to assume the Paris Agreement will succeed in meeting its aims. Policies and approaches in the NAP need to be stress-tested, using extreme, but plausible, scenarios involving four degrees or more of warming this century. Doing so will identify those policies and actions that deliver benefits in any event, as well as those that might become necessary with higher levels of warming.

1.2.3 Adoption of the fifth carbon budget

The fifth carbon budget at the level recommended by the Committee on Climate Change was set by Parliament in July 2016. This sets maximum emissions at 1,725 $MtCO_2e$ over the five year period from 2028 to 2032.[19] Whilst existing policies and current progress in reducing greenhouse gas emissions suggest the second and third carbon budgets (to 2022) are likely to be met, there is a significant policy gap that needs to be filled as a matter of urgency if the fourth and fifth budgets are to be achieved.

Policies that reduce UK greenhouse gas emissions and those to promote adaptation need to complement each other, to achieve the deep emissions reductions needed whilst also increasing the country's resilience to climate change. If successful, there will be a range of co-benefits for

[16] Gütschow et al. (2015) *INDCs lower projected warming to 2.7℃: significant progress but still above 2℃.*
[17] CCC (2015) *The scientific and international context for the fifth carbon budget*, https://www.theccc.org.uk/publication/the-scientific-and-international-context-for-the-fifth-carbon-budget/
[18] IPCC (2014) *Fifth Assessment Report,* Working Group 1.

the economy, for people and for the natural environment. There are also potential trade-offs that must be born in mind: approaches to emissions reduction should avoid adverse consequences and unnecessary impacts in a changing climate. Synergies and trade-offs between mitigation and adaptation polices include those in the following key areas:

- **Electricity generation.** The UK power sector will have to be largely decarbonised by the end of the 2020s, with around 75% of electricity generation coming from low-carbon sources including renewables, nuclear power and Carbon Capture and Storage (CCS). There is the potential for a decentralised system of energy production to be more resilient to extreme weather, by making improvements to the flexibility of the electricity system and the network of energy assets (including greater use of energy storage and interconnection) in order to deliver increased security of supply and greater reliability.
- **Transport.** During the 2020s there will need to be rapid take-up of electric road vehicles, lower emission conventional vehicles, more trips on public transport or walking and cycling, wider electrification of the rail network, and more efficient freight operations using lower carbon fuels. The reduction in fossil fuel use for transport promises a range of co-benefits in terms of air quality, water quality, and people's health and wellbeing, helping to offset some of the impacts of climate change. Autonomous vehicles, if shared between users, may mean less space is needed in urban areas for parking. This land might be much better used for parks, urban wetlands and other green spaces important for managing climate change risks such as flooding, overheating and water scarcity.
- **Buildings.** Energy efficiency retrofit programmes need to consider the thermal comfort of buildings in both winter and summer. High levels of insulation (including for hot water pipework), and energy efficient lighting and appliances, can help reduce energy use whilst also avoiding homes overheating in the summer months. Schemes also need to consider and promote natural ventilation, and measures that avoid excessive solar gain in summer, such as shutters and heavy curtains, external window shading, and the use of trees and other plants for shade and screening.
- **Land use and agriculture.** Progress in reducing greenhouse gas emissions from agriculture has stalled in recent years, and changes to the land use, land-use change and forestry (LULUCF) inventory will include emissions from UK soils (including peat soils) from 2017. New policies are needed to promote carbon sequestration in the landscape, through greater woodland coverage and better soil management. Such policies will also help counter the risks of climate change for the water cycle, biodiversity and agricultural production. Further sequestration of emissions within the agriculture and land use sectors are likely to be required as part of the UK's contribution towards meeting the goals of the Paris Agreement, helping to offset residual emissions from other sectors such as aviation.

1.2.4 The decision to leave the European Union

Much of the UK's existing environmental legislation arises from our membership of the EU. A wide range of new policies and programmes on the environment and climate change adaptation will be needed to replace those that no longer apply once we have left.

The full implications of leaving the European Union will not be apparent for some time. Statements by ministers since the referendum have indicated that it will not be straightforward to transfer into UK law all the legislation that has governed the use of land and led to improvements in environmental quality over the past four decades. A further complication arises

in that environmental policy is a devolved responsibility, so differences in both the speed of replacement and approach could occur between England, Wales, Scotland and Northern Ireland.

The process of developing equivalent policies, legislation and scrutiny arrangements in UK law creates both risks and opportunities for the National Adaptation Programme. Leaving the EU offers the opportunity to develop new approaches that are more attuned to the UK context than those negotiated collectively with European partners. Replacing the Common Agricultural Policy (CAP) with a system of support that more effectively balances the need to produce food with the need to maintain and enhance natural capital for the benefit of future generations could be the biggest benefit. Improved outcomes from land use policy could include greater storage of carbon in soils and forests, greater extent, condition and connectivity of habitats, and more effective flood risk management at the catchment scale.

There is a risk that the new UK approaches, where they are required, are less ambitious than the EU regulations being replaced, and that this will lead to reverses in the environmental improvements secured over several decades. Even with strong and tailored replacement legislation, questions of monitoring and enforcement remain. Without the European Commission and the Court of Justice of the European Union, the UK Government will be held to account by Parliament and by civil action pursued through the UK courts. It is important that this significant change in the way legislation is monitored and enforced does not undermine the delivery of important outcomes in practice.

The Government proposes a 25-year environment plan in order to achieve an ambition to "be the first generation to leave the environment in a better state than we inherited it". Such a policy framework, if delivered in this Parliament, would need to:

- Be clear about what the meaning of the commitment, how it will be achieved, and how success will be measured.
- Address the legislative impact of leaving the EU.
- Reflect the Paris Agreement goal to achieve net zero greenhouse gas emissions later this century. For the UK this implies a significant reliance on carbon sequestration through improved soil management, expanded forestry, and agriculture systems and practices that emit substantially less methane and nitrous oxide.
- Reflect the changes already underway in the UK's natural systems due to the warming to date, and recognise that further change is inevitable.
- Enable the strengthening of ecosystem resilience to current and future changes by addressing the deep-seated pressures affecting England's semi-natural and farmed landscapes, such as poor air quality, diffuse water pollution, and damaging land management practices.

1.2.5 The second UK Climate Change Risk Assessment

Whilst this progress report reviews the delivery and effectiveness of the current NAP, which was published in 2013, its recommendations will be presented in the context of the latest UK Climate Change Risk Assessment presented to Parliament in January 2017.

The second UK Climate Change Risk Assessment was informed by the ASC's independent Evidence Report, which identified six urgent areas of climate change risk to be tackled as a

priority.[20] These priorities were endorsed by the Government in their formal report to Parliament.[21] The updated NAP, in 2018, should make clear how these risks will be addressed and the means by which progress, in addressing vulnerabilities, will be monitored and evaluated.

- **Flooding and coastal change.** The impacts of flooding and coastal change in the UK are already significant and expected to increase as a result of climate change. Improving protection for some communities will be possible whilst others will face the prospect of significantly increased risks. If unmanaged, risks will affect property values, business revenues and in extreme cases the viability of communities. These potentially severe, localised impacts are not yet being fully planned for. Warming of 4°C or more implies inevitable increases in flood risk across all UK regions, even in the most ambitious adaptation scenarios considered in producing CCRA2.
- **Heat-related health impacts.** The average number of hot days in the UK has been increasing since the 1970s. Temperatures similar to those experienced in the 2003 European heatwave, are expected to become the norm in summer by the 2040s. There are as yet no policies in place to adapt existing buildings and ensure new developments do not overheat in hot weather. Delaying the introduction of legal requirements to ensure homes, hospitals, care facilities, schools and prisons, as well as business premises, are safe and operable in high temperatures will increase risks, lead to longer-term wellbeing impacts, and reduce productivity in hot weather.
- **Water scarcity.** Population growth will increase the demand for water, whilst climate change is projected to make rainfall less dependable. The potential for water shortages is most acute in London and the south east but routine deficits between available water and demand may emerge in northern and western UK areas by mid-century. There is an urgent need for longer-term water resource planning to assess the scale of risks, more co-ordinated action to ensure resilient supplies especially in times of drought, and further steps to achieve the ambitious reductions in water demand and leakage that are likely to be required.
- **Risks to natural capital.** Climate change presents a substantial risk to the UK's native wildlife and to the vital goods and services provided by natural capital, including food, timber and fibre, clean water, and carbon storage. Projected increases in soil aridity and wildfire risks, changes in the availability and temperature of freshwater, and the acidification and warming of UK seas, will exacerbate existing pressures including pollution, habitat loss, threats from invasive species, and the over-exploitation of natural resources. New approaches that safeguard and enhance the natural environment whilst maintaining agricultural production are needed urgently.
- **The international food system.** The UK's imported food comes from relatively few countries and many of these will be significantly impacted by climate change, for example southern France, Spain, the United States, and countries across Africa. Extreme weather events affecting international production, trade, and supply chains, could make food prices more volatile. Longer-term incremental changes in climate are likely to alter the agricultural productivity of regions that are important for global food production. The resilience of the UK food system in the long-term will depend on the stewardship of natural resources here

[20] ASC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report*, https://www.theccc.org.uk/UK-climate-change-risk-assessment-2017/
[21] Defra (2017) *UK Climate Change Risk Assessment 2017*.

and overseas, as well as how international markets respond to the pressures from climate change.

- **New and emerging pests and diseases.** The warmer, wetter conditions expected with climate change will allow some pests and disease vectors to extend their range. Disease outbreaks are difficult to predict, have widespread direct as well as indirect impacts on the environment, communities and economies, and are very expensive to manage once established. There is an urgent need for further research to inform government policy and operational measures, such as additional surveillance of emerging pathogens and monitoring of existing problem species. Nationally and internationally there is a need for more research and collaboration – particularly with other countries in Europe - to understand how pest and disease outbreaks and the spread of invasive non-native species can be contained.

1.3 Structure of this report

The chapters that follow this introduction provide the ASC's second and final assessment of the current NAP. The structure of this report differs slightly from the ASC's first assessment of the NAP in 2015, in order that related climate change risks and policy areas are considered together, as they were in the ASC's evidence report for CCRA2.

The first NAP presented objectives, policies and proposals under six main themes (outlined in Chapter 2). This approach led to some fragmentation of closely related policy areas and outcomes. We have therefore consolidated four of the NAP's themes into two chapters, in line with our approach to CCRA2:

- In the first NAP, actions to promote *healthy and resilient communities* were presented separately from those concerning the *built environment*. Climate change will affect people's health and wellbeing in a number of ways including through the impact of weather events on homes, offices and public buildings, and whether health and social care facilities are able to safeguard patients and vulnerable groups. CCRA2 therefore combined these themes in to a single chapter called *People and the Built Environment*.
- Policy and action on the *natural environment* were separated in the NAP from *agriculture and forestry*. Productive farming, forestry and fishing industries, and a healthy and resilient natural environment, are objectives that need to be pursued together, otherwise one could be achieved at the expense of the other in a way that is not sustainable in the long-term. CCRA2 combined these themes in to a single *Natural Environment and Natural Assets* chapter.

The remainder of this report is structured as follows:

- Chapter 2 presents our overall assessment of the current **National Adaptation Programme** published in 2013, and makes overarching recommendations on how the NAP should be improved in future, based on the experience of progress to date, and in the context of the significant events and developments since our last progress report described at the beginning of this chapter. Recommendations for action in specific risk areas are presented in subsequent chapters.
- Chapter 3 covers our assessment for the **Natural environment**, including commercial land use such as agriculture and forestry. The chapter also includes the marine environment, fisheries and aquaculture.

- Chapter 4 is our combined assessment regarding **People and the built environment**. The chapter focuses on flood risk management, coastal change, emergency planning for severe weather events, as well as wellbeing impacts from overheating, poor air quality, and new and emerging pests and diseases.
- Chapter 5 assesses the resilience of new and existing **Infrastructure**, adopting the same structure as in our 2015 progress report to Parliament.
- Chapter 6 updates our assessment of adaptation action in the **Business** sector.
- Chapter 7 is a cross-cutting chapter on **Local government**, looking at the critical role that local authorities play in enabling, supporting and delivering adaptation within communities.

Chapter 2: The National Adaptation Programme

Key messages

Context

The formal presentation of a new UK Climate Change Risk Assessment to Parliament in January 2017 initiated a second, five-year climate change risk management cycle. To help the Government develop its revised National Adaptation Programme (NAP), due in 2018, this chapter provides an overview of the progress being made by the current NAP and the ASC's overarching advice on how it should be updated and improved. Specific recommendations on individual risks are presented in the subsequent chapters.

Summary of progress

The ASC's first assessment of the NAP in 2015 welcomed its comprehensive nature and the level of stakeholder involvement in its development. However, we noted that the objectives set by the first NAP describe processes rather than outcomes against which progress can be measured. In aiming to be comprehensive and inclusive, the first NAP lacked clear priorities and an overall sense of purpose.

The Government responded to the ASC's first assessment in October 2015. The response supported the majority of recommendations in principle, but in only a third of cases has additional action been taken. Almost all of the original NAP actions are now reported to be complete or 'on track' by those responsible, and there has been a notable drop in NAP-related activity and focus since the ASC's first assessment. With some exceptions, despite progress with NAP actions, in many areas the vulnerability to climate change is not reducing and in some it has increased. It is therefore timely for the National Adaptation Programme to be refreshed and updated.

The Adaptation Sub-Committee looks forward to a more ambitious set of policies and proposals in the second NAP that, when delivered, will reduce demonstrably the country's vulnerability to climate change.

Recommendations for further progress

The chapters that follow make a number of recommendations in specific areas of climate risk. The recommendations below are overarching, relating broadly to the NAP itself.

RECOMMENDATION 1: *To ensure that activity and investments have a significant, cost-effective impact on reducing vulnerabilities, the second NAP should:*

- *set clear priorities for adaptation;*
- *ensure objectives are outcome-focused, measurable, time-bound and have clear ownership;*
- *prioritise the core set of policies and actions that will have the biggest impact;*
- *build on the breadth of community and business engagement in the first NAP; and*
- *include effective monitoring and evaluation.*

RECOMMENDATION 2: *The second NAP should address the important interdependencies between climate change risks and policy responses which fall within and across the remits of different government departments, and national, local and devolved governments, to ensure relevant policies and activity are co-ordinated across the programme.*

RECOMMENDATION 3: *To ensure continuous improvement in the approach to reducing climate change risks, the second NAP should have a strong focus on evidence and evaluation:*

- *there is the need and opportunity to work through UK Research and Innovation and the individual research councils to develop the evidence base in time to inform the third UK Climate Change Risk Assessment in 2022, making full use of the new UK Climate Projections in 2018;*

Key messages

- *more attention needs to be paid to the evaluation of existing policies and approaches in order to learn lessons for future initiatives; and*
- *the costs and benefits of more ambitious policy options need to be considered and appraised.*

RECOMMENDATION 4: *The Government should explore cost-effective ways to communicate the risks from climate change and the actions that can be taken to reduce vulnerabilities. Priorities include:*

- *engaging vulnerable groups and communities exposed to specific risks such as higher temperatures, coastal change, and increases in flood risk;*
- *challenging the relevant professional bodies (such as the Landscape Institute, the Royal Town Planning Institute, and the Institution of Civil Engineers), and trade associations (for example the National Federation of Builders), to increase their level of engagement with members regarding climate change, and to improve the training, guidance and professional accreditation they offer; and*
- *raising awareness amongst the general public including through community groups and national membership organisations such as the National Trust, the Royal Horticultural Society, and the RSPB.*

2.1 The first National Adaptation Programme

2.1.1 Summary of the current National Adaptation Programme

The first National Adaptation Programme was published in July 2013, following a period of extensive consultation with stakeholders across the public, private and third sectors.

Under the 2008 Climate Change 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 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.

The first NAP was structured according to six main themes: *Built Environment, Infrastructure, Healthy & Resilient Communities, Agriculture & Forestry, Natural Environment, and Business*, each forming a chapter. A cross-cutting *Local Government* chapter was also included, to reflect the important role that local authorities play in climate change adaptation across the country.

The requirement of the Act to set out 'policies and proposals for meeting the objectives' was embodied in more than 370 specific actions. The majority of these actions were owned by central Government departments and their agencies. The remaining actions were owned by local government, trade bodies, universities, utility companies, regulators, voluntary groups and environmental charities. This widespread ownership of actions resulted from the co-creation process.

2.1.2 Approach to evaluating the National Adaptation Programme

The ASC has established a method for evaluating progress being made by the NAP in reducing the country's vulnerability to climate change. The method was presented in our first report to Parliament in 2015 and is used again here.

Measuring progress in adapting to climate change can be difficult. Unlike monitoring greenhouse gas emissions, there is no single adaptation metric to track over time. The availability of relevant data can be limited and adaptation is context specific, with risks and opportunities in some parts of the country being much greater than in others.

The statement of the Government's objectives in the first NAP tended to be in the form of activities or processes (for example 'Objective 8: To develop regulatory frameworks to support and promote a resilient and adaptive infrastructure sector') rather than achieving specific adaptation outcomes (such as reducing the vulnerability, in some quantifiable way, of target groups or sectors to the identified risks). There are few stated goals in the current NAP against which progress can be meaningfully measured. Even where the stated objectives are being achieved, vulnerability to climate change impacts may still be increasing.

To enable a robust assessment, the ASC divided each of the main themes of the NAP into specific priority areas that we consider the most important for managing the risks from climate change. For example, adaptation priorities within the natural environment theme include: soil health, water availability and quality, and the condition of important habitat types (for example terrestrial, marine and coastal).

For each adaptation priority, the ASC has considered:

- **Is there a plan?** 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 Statement explicitly considers climate change and provides a framework for planning decisions that take account of flood and coastal erosion risks, in particular.
- **Are actions taking place?** We consider 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, relevant action taking place outside of the NAP or initiated since also forms part of the assessment. Those responsible for the actions listed in the NAP were asked to provide an update to inform this report.
- **Is progress being made in managing vulnerability?** This is our overall evaluation of progress. Even where plans are in place, and actions are being taken, our assessment may conclude that vulnerabilities are still increasing. The assessment takes account of the scale of the current and future risks, the effectiveness of current policies, and the impact of relevant plans and actions. Where possible, the evaluation is based on a suite of indicators that the ASC has developed. These provide information that help show, over time, changes in exposure and vulnerability, and observed climate impacts, within each priority area. Consideration is given to the time that some actions can take to deliver measurable changes in vulnerability.

For each adaptation priority we have assigned a red-amber-green (RAG) score to summarise our evaluation of progress. A 'grey' rating is given where there is insufficient evidence to form a judgement. Annex 2.1 explains the criteria used in arriving at these scores. The results for

individual areas are presented in the chapters that follow. A summary is presented below in Section 2.2.

Before presenting the overall results of the second assessment we describe what has happened since our first report to Parliament in 2015 in terms of:

- the Government's response to the recommendations made by the ASC two years ago; and
- the current status and delivery of the 370+ actions in the original NAP.

2.1.3 The Government's response to our progress report in 2015

The Adaptation Sub-Committee made 36 recommendations to the Government and others in our first progress report on the NAP in 2015. There were 11 priority recommendations on issues where the evidence suggested the country's vulnerability to climate change impacts was increasing. The Government agreed in principle with the majority of the recommendations, but few commitments were made in response to review policies or to take additional action.

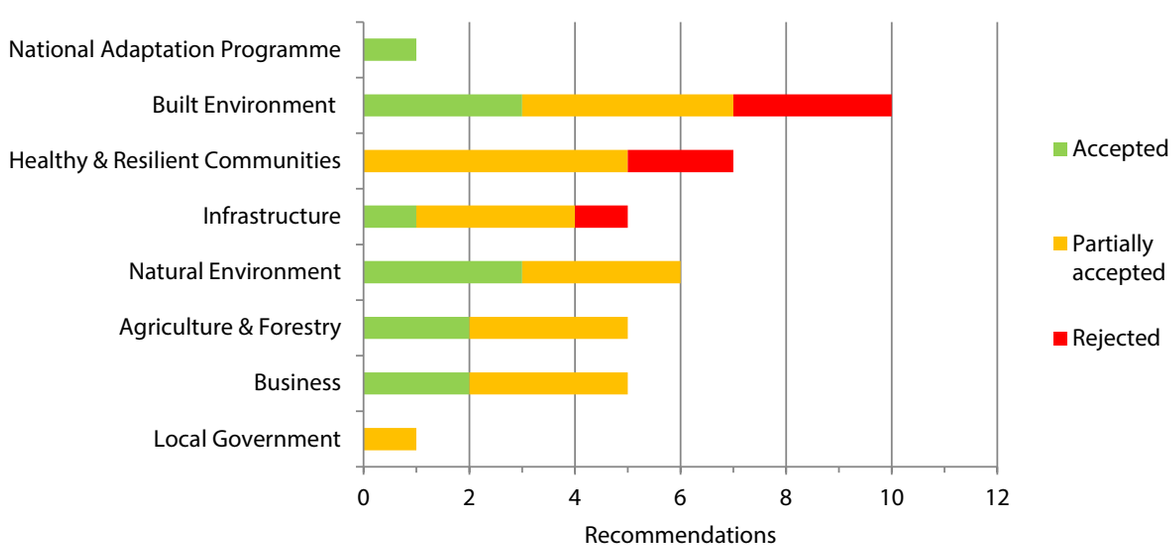
The Government responded to our first progress report on 15 October 2015. Their response considered each of the ASC's recommendations in turn, and responded in one of three general ways (Figure 2.1):

- **The Government agreed with the specific suggestions in nearly a third of the ASC's recommendations**, and committed itself (or has subsequently done so) to changing its approach or to taking additional action. For example, the Government agreed to develop a new national action plan on managing surface water flood risk, subsequently published in February 2017. Also as recommended, there has been an increased emphasis on natural approaches to flood risk management, with £15 million allocated in November 2016 towards new natural flood management demonstration projects. However, this followed the severe storms of winter 2015/16 rather than as an immediate response to our report.
- **For over half of our recommendations the Government considered existing activity to be sufficient to manage the issues highlighted**, even though current policies and activity were taken into account in our assessment. As a result, in some cases, the same or similar recommendations appear in this report. For example, the Government considered existing requirements to share information on infrastructure assets and network vulnerability between operators and Local Resilience Forums (LRFs) to be sufficient. A recent repeat of our 2015 survey of LRF members found access to operators' data on local infrastructure assets continues to be an obstacle to managing the risks of infrastructure failure.
- **In a small number (around 15%) of cases, the Government disagreed with our analysis or considered other priorities to be of overriding importance**. For example, there is a compelling case for new building standards to be set to avoid new homes and other buildings adding to the number that already overheat in warmer weather, and will need to be adapted in future. The Government stated in its response that it was mindful of burdens on developers. This issue is discussed again below.

Of the 11 priority recommendations relating to areas of increasing vulnerability, one was fully accepted by Government: the need for a new surface water action plan, mentioned above. One other recommendation, relating to better reporting of water company activity to prevent sewer flooding, was accepted by Ofwat. Across the remaining recommendations, there were two particular areas of concern regarding the Government's response:

- **Promoting sustainable drainage systems (SuDS) in new development.** The Government rejected a series of priority recommendations in this area, saying it was too soon to judge whether the new policy introduced in April 2015 to promote SuDS through the planning system was having the desired effect. In response to pressure in the House of Lords during the passage of the 2016 Housing and Planning Act, the Government conceded an amendment requiring them to review the impact of the new policy. The Housing Minister subsequently committed, on record, to do so in time to inform this report.[22] The results were due in April 2017 but were not available at the time of writing.
- **Preventing heat-related health impacts.** The Government rejected the ASC's recommendation for a new building standard to avoid new homes overheating, because of being 'mindful of other commitments, for example to reduce net regulation on homebuilders'. The Government also declined to take further steps on two closely-related priority recommendations, to tackle overheating in existing homes, hospitals and care homes, and to act to reverse historic declines in urban greenspace. Instead, the Department for Communities and Local Government commissioned further research on overheating through the Zero Carbon Hub. This was published in March 2016. The Zero Carbon Hub closed at the end of March 2016 as a consequence of the zero carbon homes target being withdrawn.[23]

Figure 2.1. The Government's response to ASC recommendations in 2015



Source: ASC analysis.
Notes: There were 36 recommendations in our 2015 report but some had several elements, making a total of 40 recommendations overall. The forty elements have been categorised as follows:

- **Accepted**: the Government committed to take additional action in its response, or has done so since.
- **Partially accepted**: the Government agreed with the analysis but considered existing activity to be sufficient.
- **Rejected**: the Government disagreed with the analysis, or considered other priorities to be more important.

[22] See Hansard, 27 October 2016, 4pm, Neighbourhood Planning Bill (seventh sitting), column 297.
[23] See: http://www.zerocarbonhub.org/news/zero-carbon-hub-close

2.1.4 Delivery of NAP actions since 2015

Half of the 370+ actions contained in the first NAP are now marked as complete by their owners, with the majority of the remaining actions considered 'on track'. The ongoing actions generally have no timescale for delivery, and few of the completed actions have been replaced by significant new activity. As a result there has been a notable reduction in effort and focus on the National Adaptation Programme since 2015.

Through Defra, the Adaptation Sub-Committee commissioned updates from those identified as responsible for each of the actions in the first NAP. Figure 2.2 shows the status of actions within each of the NAP's themes, for 2015 and 2017. These updates show the following:

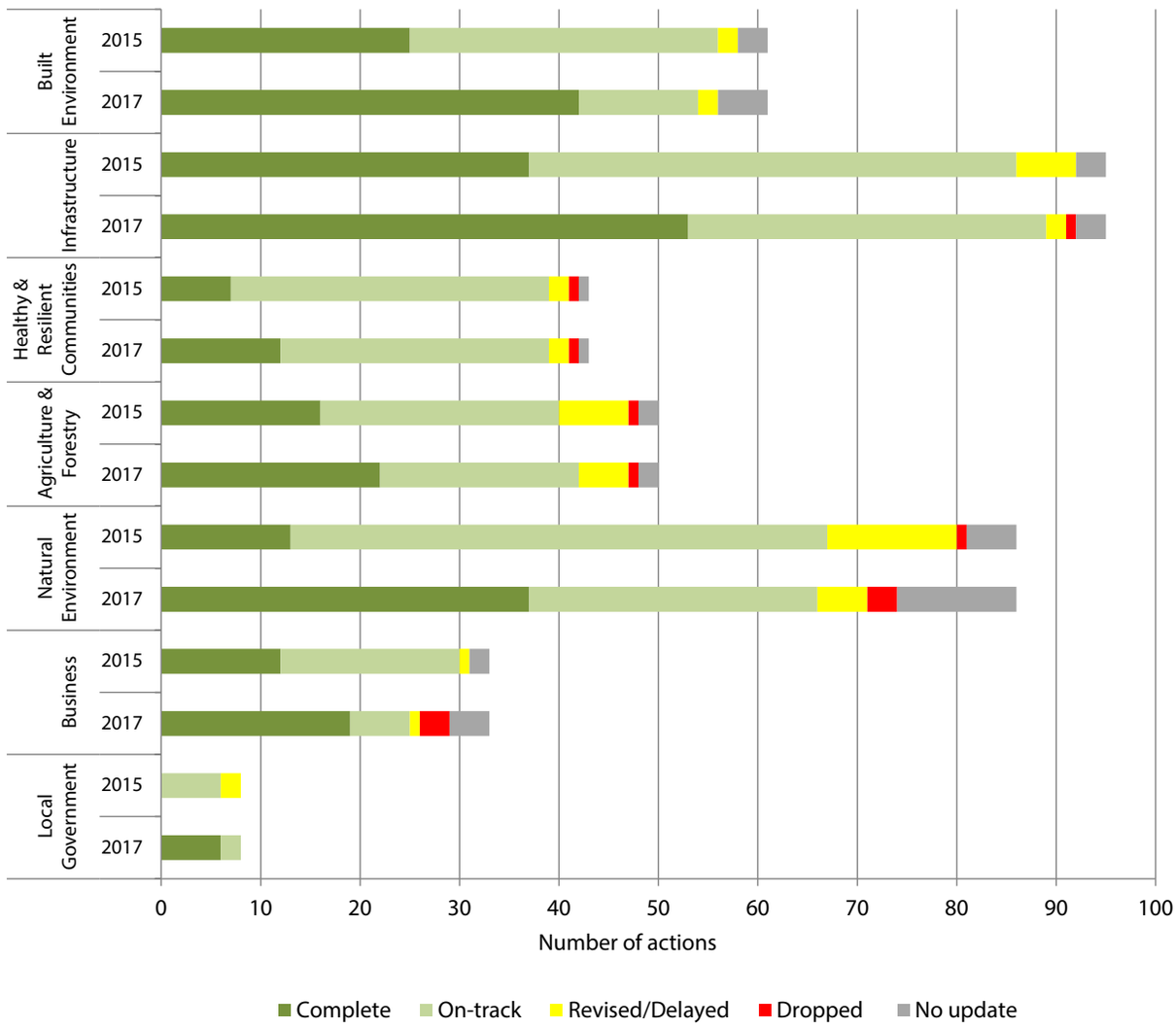
- The proportion of completed NAP actions has risen from 29% in 2015 to 51% in 2017.
- The proportion of actions either complete or on track has remained the same (86%).
- The percentage of actions for which we have not received an update has increased from 4% in 2015 to 7% in 2017.
- The number of actions that have been dropped, revised or delayed has fallen but this may include cases where we have not been given an update. In some instances no update was possible because the organisations or programmes involved no longer exist.

Some actions deemed complete in 2015 have been followed by further action. As a result, some actions have been reclassified from 'complete' to 'on track' by their owners, and in others additional actions have been added.[24] New actions include updating policies, improving communications, and integrating climate change into future plans.

The full text of the updates received is available as an annex to this report available on the CCC website (Annex 1: *Update on NAP actions*).

[24] For example, the number of actions for the infrastructure theme has increased from 91 to 95 since 2015.

Figure 2.2. Status of actions in the current National Adaptation Programme



Source: ASC analysis of returns received from action owners, the majority commissioned through Defra (those relating to government departments and their agencies), with other organisations contacted directly by the ASC.

2.2 Summary of the ASC's second assessment of the NAP

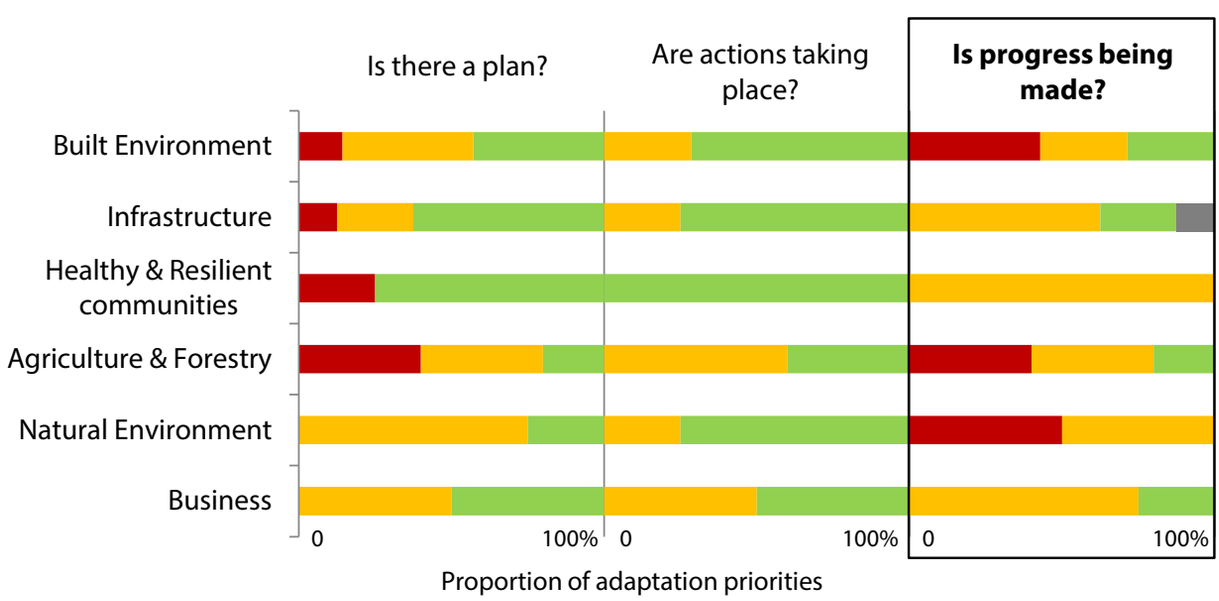
Following the approach presented in Section 2.1.2, the ASC has allocated a RAG score to each of the adaptation priorities considered in this report (Figure 2.3). The number of adaptation priorities given a 'red' rating has increased since our 2015 report.

This second assessment follows the same approach and same criteria to determine RAG scores as in 2015 (Annex 2.1). Combining some of the NAP themes in this assessment has reduced the number of adaptation priorities. As a result, in some areas, the results of this assessment cannot be directly compared with our 2015 report.

Where the results of our 2015 and 2017 assessments can be compared:

- **The number of areas where plans and policies are assessed as 'red' has increased since 2015** (Figure 2.3, 'Is there a plan?'). These include: soil management; fisheries; new development in areas of surface water flood risk; and the resilience of ICT infrastructure.
- **More areas have been assessed as 'red' in terms of trends in vulnerability** (Figure 2.3, 'Is progress being made?'). These include three aspects of flood risk management: surface water risk management, new development in areas of surface water flood risk, property-level flood resilience; and four aspects of the natural environment: the condition of terrestrial habitats, and freshwater habitats, soil health and carbon sequestration, and biodiversity in the farmed countryside.
- **Some areas assessed previously as green have moved to amber, within each of the three components of the assessment.** Some current plans and policies are due to expire, and in a number of important areas action has decreased or has been postponed or cancelled since 2015. For example, the current biodiversity strategy for England expires in three years. The process of public consultation on the proposed 25 year plan for the environment has been delayed. This has affected our assessment of plans and policies in the natural environment chapter.
- **The number of areas assessed as 'grey' has decreased** (where there is insufficient data to form a judgement). Important new data sources include the adaptation reports compiled as part of the second round of ARP reporting, published in 2015 and 2016.

Figure 2.3. Summary of progress by the National Adaptation Programme



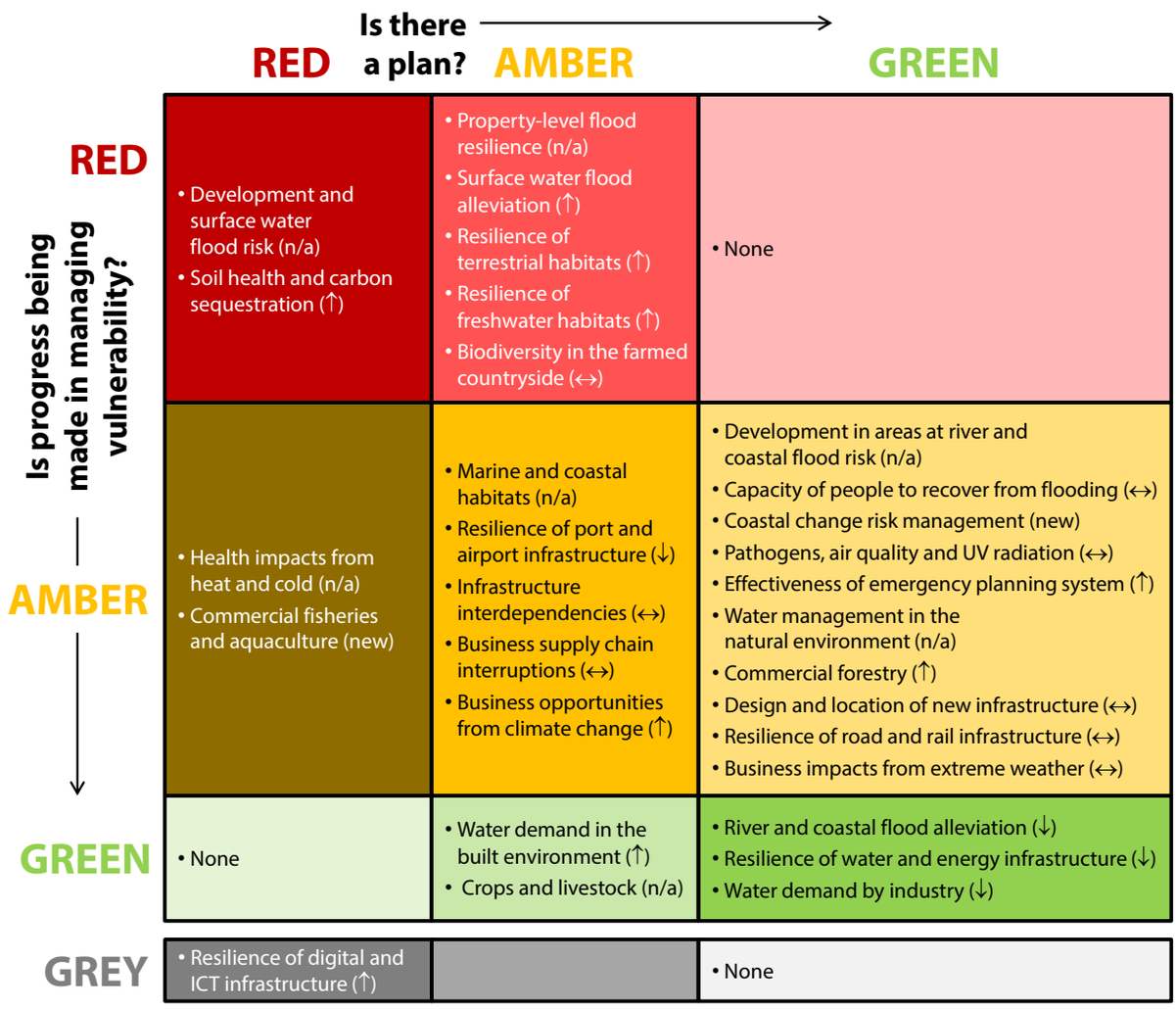
Source: ASC assessment of policies and plans, actions, and progress, for each adaptation priority.
Notes: Adaptation priorities are presented according to the themes in the National Adaptation Programme. The colours depict the proportion of 'adaptation priorities' within each theme, categorised as either:

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

Figure 2.4 presents the results of the assessment, using the first and third components of the assessment: *Is there a plan?* and *Is progress being made in managing vulnerability?* Those adaptation priorities in the top row and left-hand column are the most pressing in terms of the next NAP.

Two priorities have been given a 'double-red' rating (top left-hand corner of Figure 2.4); where the evidence suggests vulnerabilities are increasing and plans and policies that address the risks from climate change are not yet in place.

Figure 2.4. Adaptation priorities: *are plans in place, and is progress being made?*



Source: ASC assessment of policies and plans, and progress, for each adaptation priority.
Notes: Adaptation priorities have been categorised as follows:

- **Red:** plans and policies do not account for climate change risks, 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, indicators of vulnerability are generally falling.
- **Grey**: insufficient evidence to form a judgement.

Key to changes since 2015: ↑ increased concern, ↓ decreased concern, ↔ no change since 2015, **new**: not part of 2015 assessment, **n/a**: scope of assessment changed so comparison with 2015 not possible.

2.3 Advice on the second National Adaptation Programme

2.3.1 Creating a greater sense of purpose and priority

With many of the actions in the first NAP completed and a new CCRA in place, it is timely for the National Adaptation Programme to be refreshed. In doing so the Government has the opportunity to state its objectives, proposals and policies for managing climate change risks, taking on board lessons from the first exercise. Within the broad scope of adaptation requirements, there is a need for the Government to focus its efforts on tackling the most urgent climate change risks and opportunities, and ensure that policies are having the intended effect in reducing vulnerability.

The ASC's first assessment of the NAP in 2015 welcomed its comprehensive nature and the level of stakeholder involvement in its development. However, the objectives set by the first NAP describe processes, rather than outcomes against which progress can meaningfully be assessed. The first NAP, in aiming to be comprehensive and inclusive, lacked clear priorities and an overall sense of purpose. The ASC made a general recommendation in its 2015 report to address this. This second assessment further emphasises the importance of that recommendation, which we repeat, in summary form, as our first overarching recommendation.

RECOMMENDATION 1: *To ensure that activity and investments have a significant, cost-effective impact on reducing vulnerabilities, the second NAP should:*

- *set clear priorities for adaptation;*
- *ensure objectives are outcome-focused, measurable, time-bound and have clear ownership;*
- *prioritise the core set of policies and actions that will have the biggest impact;*
- *build on the breadth of community and business engagement in the first NAP; and*
- *include effective monitoring and evaluation.*

The Government accepted the thrust of this recommendation in its formal response in October 2015 to our first report. The response proposed a two-tier approach to adaptation actions in the next NAP. The first tier would focus on the highest impact and most needed policies and actions with clear timeframes, targets, and monitoring and evaluation. The second tier would capture a summary of much broader activity across the public sector and beyond that supports the Government's adaptation objectives.

2.3.2 The NAP as a programme, greater than the sum of its parts

For the NAP to be successful, it has to do more than just summarise existing policies and programmes. It needs to address the risks of climate change in a strategic and integrated way. It needs to provide a strong message nationally and locally that adaptation is important and should be made a priority.

The National Adaptation Programme has the potential to improve the cost-effectiveness of individual policies, and deliver robust early benefits, as well as reduce the long-term risks from climate change. To be an effective national plan, the second National Adaptation Programme must:

- galvanise, enhance and coordinate the measures being taken by individual parts of government, and the wider public, private and third sectors;

- make sure sufficient financial and other resources are allocated to adaptation activity where there is a clear cost-benefit case and progress would not otherwise occur;
- ensure sufficient evidence is collected and disseminated to guide policy development and continuous learning at the national and local levels; and
- provide the ASC with the data it needs to conduct its assessment and provide robust advice.

The ASC's evidence report for the second UK Climate Change Risk Assessment (CCRA2) highlighted the following six domains where interacting risks, and policies, need to be managed as part of the next National Adaptation programme.[25]

There are also important interdependencies between the six domains that need to be considered when designing policies, so that interventions lead to the desired outcomes in the most cost-effective way.

- **Natural capital.** A healthy natural environment is vital for UK food and water security, economic prosperity and wellbeing. Increases in soil aridity and water scarcity, changes in average and extreme temperatures, the timing of seasonal events and ocean acidification, are the most significant climate change risks to the UK's natural capital.
- **Water security.** Water security encompasses inland and marine water quality, freshwater availability and the management of flood risk. Water security risks interact strongly with those affecting the natural environment (mainly through soil condition and biodiversity). How water is managed in the future will have implications for agricultural production, public health and wellbeing, natural capital and infrastructure service provision.
- **Food security.** Food availability, affordability, safety and nutrition are strongly dependent on environmental conditions in the UK and abroad. UK food security depends on stable international markets and global trade as well as domestic production. Food production in the UK is dependent on natural capital, particularly soils and water, and current deep-seated pressures on the natural environment could limit domestic production in the future.
- **Wellbeing.** Quality of life, material living conditions, and the sustainability of socio-economic and natural environments will be impacted by climate change mainly through flooding, heat risks, and vector-, food- and water-borne diseases. These risks can affect health, life expectancy, living costs, properties and livelihoods, habitats and landscapes, historic places and green spaces. Loss of green space, in turn, exacerbates health risks through its effect on urban temperature and air quality, and by limiting opportunities for recreation and physical exercise.
- **Economic prosperity.** Economic prosperity (encompassing resources, growth, productivity and a skilled and flexible labour market) will be influenced by how businesses adapt to changing climate risks both in the UK and abroad. The level of risk will be to at least some degree outside the control of individual businesses, such as the resilience of key infrastructure where perceptions of risk can affect inward UK investment. Successful management of risks by businesses will help safeguard public health and wellbeing, including of their employees, and the health of the natural assets they rely on.
- **Global security.** Global security encompasses international laws, institutions and values of societies and is the basis for successful international cooperation. Global security is needed to preserve UK economic interests abroad. Climate change compounds economic,

[25] Street, R. et al. (2016) *UK Climate Change Risk Assessment 2017, Chapter 8: Cross-cutting issues.*

environmental and geopolitical pressures, with impacts on populations, economies, livelihoods and natural resources around the world. It will challenge water security, agriculture and transport networks, affecting countries' economies and could exacerbate state fragility in some cases.

RECOMMENDATION 2: *The second NAP should address the important interdependencies between climate change risks and policy responses which fall within and across the remits of different government departments, and national, local and devolved governments, to ensure relevant policies and activity are co-ordinated across the programme.*

A common issue encountered in conducting this assessment is the paucity of robust and relevant evidence, both on the actions being taken and also regarding how policies and activity affect the country's vulnerability to climate change.

This has been particularly evident in the business and local government sectors, but was also apparent in the infrastructure analysis and in respect of public health risks in the built environment. The ASC is heavily reliant on datasets collected for the operational needs of individual organisations, or as required by regulators and government bodies. Data are collected for different purposes, on different timescales, and in different ways. This makes it problematic to compare performance between sectors and organisations, such as between different types of infrastructure, and even, for example, between individual water companies.

The NAP therefore needs to consider how to improve data collection and enhance the evidence base. Gaps in data need to be filled, and existing data sources made more relevant and consistent. This would help inform future Government adaptation programmes and priorities, allow improved performance benchmarking between organisations, and help the ASC to perform its statutory roles. There is a specific need to take forward the research gaps identified during the process of compiling CCRA2 (Box 2.1). We will be reviewing existing data sources and the current indicator set we have developed as we prepare for our next progress report in 2019. We are ready to help the Government consider where improvements in the evidence base would be most valuable as part of the revised NAP.

RECOMMENDATION 3: *To ensure continuous improvement in the approach to reducing climate change risks, the second NAP should have a strong focus on evidence and evaluation:*

- *there is the need and opportunity to work through UK Research and Innovation and the individual research councils to develop the evidence base in time to inform the third UK Climate Change Risk Assessment in 2022, making full use of the new UK Climate Projections in 2018;*
- *more attention needs to be paid to the evaluation of existing policies and approaches in order to learn lessons for future initiatives; and*
- *the costs and benefits of more ambitious policy options need to be considered and appraised.*

Box 2.1. The need for an interdisciplinary research programme to inform CCRA3

Lord Krebs, as outgoing chair of the ASC, wrote in February 2017 to the chief executives of the UK research councils to highlight the significant gaps in the scientific evidence base that were identified by the second UK Climate Change Risk Assessment. CCRA2 identified over 20 cross-cutting research needs as well as around 200 specific evidence gaps within the sectors considered. A full list of the gaps is available on the CCC's website (see link below).

The letter called for the research councils to work together to address these evidence needs in time for future climate change risk assessments, beginning with CCRA3 due to be completed in 2022, and to enable timely and cost-effective actions by a range of stakeholders.

The UK has significant strengths in climate change science and impacts research, but many of the evidence needs are multi-disciplinary and do not fall within the remit of any one research council. There is therefore a need for joint work and coordination relating to economics, behaviour and human health, land use, infrastructure and the built environment, and natural systems.

In particular, the letter proposed an integrated, UK-wide spatial modelling capability that would be able to link climate change processes in the following areas:

- the natural environment (e.g. flooding, droughts and species migration);
- impacts on humans (e.g. health, social, economic and cultural impacts);
- agriculture (e.g. crop productivity, soil condition);
- infrastructure (e.g. energy, transport, water and digital systems); and
- the built environment.

Current science and modelling capability could be brought together and focussed upon evaluating the costs and benefits of adaptation policies and actions in these areas.

Professor Andrew Thompson responded in March 2017 on behalf of the research councils. The letter pledged financial support for CCRA3 from the Natural Environment Research Council (NERC), and suggested the newly formed UK Research and Innovation (UKRI) would be best placed to consider the need for an interdisciplinary research programme. Baroness Brown has begun to discuss this with Professor Sir Mark Walport, appointed as UKRI's first Chief Executive in February 2017.

Source: Both letters and the list of CCRA2 research gaps can be found at: https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/review-and-engagement/research-conference/

2.3.3 The importance of public engagement in the next NAP

In our 2015 report we recommended that the Government should engage the general public about climate change and its consequences for the UK. The Government endorsed the recommendation in principle, but felt it appropriate to continue to focus on individual issues such as flood risk, and provide specific incident-based advice to vulnerable groups, for example during periods of high temperatures. This approach only addresses immediate issues, it does not prepare the country for the inevitable and increasingly severe changes to come.

Despite the scientific consensus on climate change, and the growing evidence of the impacts already being felt in the UK, the National Adaptation Programme does not currently include any element of public engagement. Individual 'present day' hazards are communicated as they arise, led by the relevant departments and agencies (for example, Public Health England regarding

high temperatures during heatwaves). This fragmented approach does not give the public the information they need to make informed long-term choices. Properties will need to be adapted to higher temperatures and heightened flood risks, requiring planning and investment by owners and occupiers, in advance of heatwaves and flooding if health and economic impacts are to be avoided.

Awareness of the expected impacts of climate change enables people to plan for the future and take action for their own benefit. Failure to provide authoritative advice to the general public will leave ministers increasingly exposed to criticism as these impacts become clearer. As with other issues involving complex science, it is important that the public are given robust and unambiguous advice from one or more trusted voices.

Information and advice is especially important in the following areas and for the groups and communities affected:

- **Sea level rise and coastal change.** Sea levels are expected to rise by several metres over the course of the coming centuries. The upper limit of sea level rise projections has increased in recent years as more evidence has been gathered. Sea level rise of more than one metre by the end of this century cannot be ruled out, and this would mean some communities in the UK would no longer be viable. Shoreline Management Plans for the English coastline are in place and help govern long-term coastal management policies, including in those areas where coastlines will have to be allowed to erode or where defences will need to be moved inland. Despite existing engagement effort from the Environment Agency, and Coastal Groups, the affected communities have not yet been engaged in earnest.
- **High temperatures.** The observed trend in rising average temperatures is set to continue, with high confidence that a typical summer will become increasingly uncomfortable and potentially dangerous for the young, the old and the vulnerable. People need advice about how to adapt their homes over time so that internal temperatures remain safe and tolerable in hot weather. Reliance on air conditioning needs to be avoided as far as possible, as air conditioning adds to the urban heat island effect, increases electricity bills, and increases household CO_2 emissions.
- **Severe rainfall and flooding.** Climate models are consistent in projecting more intense rainfall, and higher peak river flows, to varying degrees across the country. The Environment Agency's long-term investment scenarios for flood and coastal risk management suggest that risks will remain or become increasingly severe in many parts of the country despite investment in flood defences. Those communities who are most exposed to rising risks, and unlikely to be protected by community defences, are largely unaware and need time to take appropriate steps. Without additional individual and community-level action the costs of flood insurance will inevitably rise in areas of significant flood risk as the Flood Re subsidised insurance scheme begins to be withdrawn from 2021. Flood Re's value as a transitional measure will be undermined if those householders it has been designed to support do not realise that the scheme is time-limited.

RECOMMENDATION 4: *The Government should explore cost-effective ways to communicate the risks from climate change and the actions that can be taken to reduce vulnerabilities. Priorities include:*

- *engaging vulnerable groups and communities exposed to specific risks such as higher temperatures, coastal change, and increases in flood risk;*

- *challenging the relevant professional bodies (such as the Landscape Institute, the Royal Town Planning Institute, and the Institution of Civil Engineers), and trade associations (for example the National Federation of Builders), to increase their level of engagement with members regarding climate change, and to improve the training, guidance and professional accreditation they offer; and*
- *raising awareness amongst the general public including through community groups and national membership organisations such as the National Trust, the Royal Horticultural Society, and the RSPB.*

Annex 2.1. Criteria for the ASC's Red-Amber-Green assessment of adaptation priorities		
Is there a plan?	Are actions taking place?	Is progress being made in managing vulnerability?
Green: Where needed, plans or policies are in place to fully address the adaptation priority in the context of climate change.	**Green:** All relevant NAP actions are complete or on track, other relevant plans and policies are being implemented.	**Green:** • Indicators suggest vulnerability to climate change impacts is reducing, or stable. • There is a high uptake of low-regret actions. • Long-term decisions are accounting for climate change projections.
Amber: Plans or policies are in place that partially address the adaptation priority.	**Amber:** Not all relevant NAP actions are on track, with partial delivery of other relevant plans and policies.	**Amber:** • Indicators suggest some areas of vulnerability are increasing. • There is scope to increase low-regret actions. • Decisions are partially or inconsistently accounting for climate change.
Red: Policies or plans do not exist or do not address the identified risks.	**Red:** Policies are not being implemented and relevant actions are behind schedule.	**Red:** • Indicators suggest most areas of vulnerability are increasing. • There is minimal uptake of low-regret actions. • Decisions do not take climate change projections in to account.
	Grey: No apparent activity underway.	**Grey:** There is insufficient evidence to make a judgement.
What are we looking for? Statements of government policy (or plans, strategies, etc.) setting out what will be done, how, and when, that will help manage the existing impacts of extreme weather and reduce climate change risks.	**What are we looking for?** That commitments made by the Government or others are being fulfilled. These could be in the form of output and process measures, such as households protected by new flood defences, amounts of money spent, reports published, etc.	**What are we looking for?** • Improvements over time as measured by indicators of exposure or vulnerability to climate impacts, and/or data on impacts from actual weather-related events. • Evidence of whether the Government is on track to meet the goals that have been set in policy announcements or legislation. • Evidence of whether additional cost-effective action could be taken to reduce risks further. • Evidence that robust decisions are being taken that will help manage long-term vulnerabilities.

Chapter 3: Natural environment

Key messages

Context

A well-functioning natural environment is essential for sustaining biodiversity and providing a range of essential goods and services including clean water, food, flood protection, climate regulation and amenity value. Improving the condition, extent and connectivity of the natural environment will help to increase resilience to climate change and has benefits across all of six priority risk areas identified in the ASC's evidence report for the second UK Climate Change Risk Assessment (CCRA2). CCRA2 identified the need for urgent action in the next five years to reduce human pressures on, and improve the condition of semi-natural habitats, soils and water bodies. Taking such action would reduce risks from increasing temperatures and extreme weather events including flooding and water shortages. CCRA2 also identified a need for further research on the risks to wildlife, agriculture and forestry from pests and diseases, the changing suitability of land for different uses, and risks to the marine environment. Climate change could bring opportunities for new species colonisations and improved crop and tree growth, but these opportunities can only be realised if existing pressures on the natural environment are addressed.

Summary of progress

Despite continued action and individual success stories, the vulnerability of the natural environment to climate change, taken as a whole, has not been reduced since our last progress report in 2015 and in some respects has increased.

Most of the current policies and programmes in place to support building the resilience of the natural environment to climate change - such as Biodiversity 2020 - will end in the next five years. Long-term, ambitious plans are therefore needed, with clear objectives, appropriate actions, and a scheme to monitor and evaluate progress over time.

The UK's decision to leave the EU creates further policy uncertainty. The transposition of EU environmental law into domestic legislation and policy will need to at least sustain current levels of protection if further environmental degradation is to be avoided. EU exit presents the opportunity to draw up environmental policies that are tailored specifically to UK requirements and context, and that support adaptation effectively.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	**Is progress being made in managing vulnerability?**
1. Terrestrial habitats	Amber	Amber	Red
2. Freshwater habitats	Amber	Green	Red
3. Marine and coastal habitats	Amber	Green	Amber

Key messages

4. Farmed Countryside	Amber	Green	Red
5. Soil health and carbon sequestration	Red	Green	Red
6. Water management	Green	Green	Amber
7. Crops and livestock	Amber	Amber	Green
8. Commercial forestry	Green	Amber	Amber
9. Commercial fisheries and aquaculture	Red	Amber	Amber

Note: See Annex 2.1 for a description of the criteria used to assign Red-Amber-Green (RAG) scores.

Since our last report, almost all of the actions under the natural environment, agriculture and forestry themes of the National Adaptation Programme have been completed or are ongoing.

There have been some good examples of progress in managing vulnerability to climate change, measured through indicators of habitat condition, species diversity and abundance, and technological capability. These examples all relate to areas with clear plans, actions and accountability. For example:

- 115,000 hectares of new priority habitat has been created since 2011, broadly in line with the Biodiversity 2020 target to create 200,000 hectares of new habitat by 2020.
- 63% of coastal priority habitats are now recorded as being in favourable condition, greater than the 50% target set out in Biodiversity 2020.
- Following a period of stagnation, total factor productivity of UK agriculture - a measure of the technological capability of the sector- rose by 5.5 points between 2013 and 2015.
- The number of different conifer species being planted on the Public Forest Estate has increased from eight to 18 between 2012 and 2015. Increasing the diversity of species planted will help to improve resilience to pests and diseases and changing climatic conditions.

Despite these positive steps, on the whole, vulnerability is not being managed. Most indicators of the condition and extent of habitats, and abundance and diversity of species, are either improving too slowly to meet Government targets, or are declining.

For example:

- Only 25% of terrestrial Sites of Special Scientific Interest (SSSI) habitats are currently in favourable condition compared to the Biodiversity 2020 target of 50% by 2020. Declines in terrestrial species

Key messages

such as woodland birds and butterflies continue to be recorded.

- Farmland species continue to decline in abundance. Butterfly populations have fallen by 27% since 1990. The abundance of farmland pollinator species fell by 32% between 1980 and 2010. Farmland bat species have seen an increase, however.
- The target to plant 5,000 hectares of new woodland every year was missed in 2014, 2015 and 2016.
- Only 20% of water bodies in England are achieving 'good' or 'high' ecological status, down from 23% in 2010.
- The Breeding Wetland Bird Index has dropped to its lowest level since the 1975 starting baseline.
- The proportion of UK fish stocks that are sustainably managed continues to fluctuate around the 30% level.

Recommendations for further progress

The UK's decision to leave the EU affects many of the plans and proposals for managing the natural environment and for building resilience to climate change. In order to ensure that EU-exit benefits adaptation, and does not increase the risks from climate change to the natural environment, long-term goals, policies and enforcement mechanisms are needed. These should as a minimum reflect the level of ambition of current EU policies, and opportunities exist to improve on them. This context applies to all of our recommendations below.

The previous Government's proposed 25-year environment plan would be an appropriate place to articulate outcomes and actions to manage climate risks to the natural environment. A long-term plan needs to be published as soon as possible, and should take account of the need for a step change in measures to improve the resilience of the natural environment to climate change.

RECOMMENDATION 5: *A critical part of the next National Adaptation Programme should be a long-term plan for the natural environment that takes climate change into account, builds on the level of ambition of current EU policies, and is consistent with the framework developed by the Natural Capital Committee. In line with the ASC's previous advice, there should be associated targets, actions, and a monitoring and evaluation framework. (Owner: Defra. Timing: by 2019).*

RECOMMENDATION 6: *Action should be taken to enhance the condition of priority habitats and the abundance and range of priority species. This action should maintain or extend the level of ambition that was included in Biodiversity 2020. An evaluation should be undertaken of Biodiversity 2020, including the extent to which goals have been met and of the implications for resilience to climate change. (Owner: Defra. Timing: by 2021).*

RECOMMENDATION 7: *Research on the risks to the marine food chain and ecosystem from rising sea temperatures, deoxygenation and ocean acidification should be undertaken over the course of the next National Adaptation Programme period, to inform future marine and fisheries policies. The research should assess the extent to which adaptive actions could increase the resilience of marine habitats and species to climate change. (Owner: Defra. Timing: by 2022).*

RECOMMENDATION 8: *Goals and actions to achieve sustainable yields by 2030 should be included in new policies that will replace the Common Fisheries Policy. Indicators of sustainable management should also be reviewed to ensure they take account of changing distributions of fish species due to climate change. (Owner: Defra. Timing: by 2019).*

RECOMMENDATION 9: *New agricultural land management policies should take account of the need to improve water quality and the condition of habitats and soils, in order to build resilience to climate change. Targets should be set that focus on outcomes, and monitoring undertaken to understand if these targets are being met. (Owner: Defra. Timing: by 2020).*

Key messages

RECOMMENDATION 10: *To support adaptation efforts, a plan should be put in place to deliver the aspiration for all soils to be managed sustainably by 2030. The plan should include a scheme to monitor uptake of soil conservation measures, and specific proposals to reverse the ongoing loss of lowland peat soils in order to provide mitigation and adaptation benefits. (Owner: Defra. Timing: by 2019).*

RECOMMENDATON 11: *A target for restoring all designated upland blanket bog habitats to favourable condition by 2030 should be adopted in order to contribute to both adaptation and mitigation efforts. (Owner: Defra. Timing: by 2018).*

3.1 Climate change and the natural environment

Climate change presents a range of risks and some opportunities for biodiversity, the natural environment, and the provision of ecosystem services.

The goods and services provided by biodiversity and the natural environment cut across all of the other chapters of this report and include clean water, hazard regulation (including flooding), climate regulation, and food provision. The ASC's evidence report for CCRA2 identified fourteen specific areas of climate change risk and opportunity for the natural environment (Figure 3.1).

Figure 3.1. Risks and opportunities for the natural environment identified by CCRA2

MORE ACTION NEEDED	RESEARCH PRIORITY	SUSTAIN CURRENT ACTION	WATCHING BRIEF
Ne1: Risks to species and habitats from changing climate space	Ne3: Changes in suitability of land for agriculture & forests	Ne9: Risks to agriculture, forestry, landscapes & wildlife from pathogens pests & invasive species	Ne14: Risks & opportunities from changes in landscape character
Ne2: Opportunities from new species colonisations	Ne7: Risks to freshwater species from high water temperatures	Ne10: Extreme weather/wildfire risks to farming, forestry, wildlife & heritage	
Ne4: Risks to soils from increased seasonal aridity and wetness	Ne13: Ocean acidification & higher water temperature risks for marine species, fisheries and marine heritage	Ne11: Saltwater intrusion risks to aquifers, farmland & habitats	
Ne5: Risks to natural carbon stores & carbon sequestration			
Ne6: Risks to agriculture & wildlife from water scarcity & flooding			
Ne8: Risks of land management practices exacerbating flood risk			
Ne12: Risks to habitats & heritage in coastal zone from sea level rise; loss of natural flood protection			

Source: Brown, I., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 3, Natural Environment and Natural Assets.*
Notes: The urgency associated with each risk and opportunity (shown in top row) was determined by the ASC on the basis of the evidence presented in the CCRA chapter. See Chapter 2 of the CCRA Evidence Report (Warren, R., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 2, Approach and Context)* for a description of the urgency scoring methodology.

This chapter assesses the resilience to climate change of natural capital assets (referring to all aspects of the natural environment including biodiversity) in terms of their condition, extent and provision of ecosystem services.

Following the structure of the CCRA2, this chapter combines the natural environment and agriculture & forestry themes in the current National Adaptation Programme (NAP). Other aspects of natural capital that are more closely linked to the built environment or human health are covered in Chapter 4: *People and the built environment*, including natural flood management, green infrastructure such as sustainable drainage systems (SuDS), urban greenspace, and air quality. The adaptation priorities for this chapter are shown in Table 3.1 below.

Table 3.1. Natural environment adaptation priorities

Natural assets including biodiversity	Regulating services	Provisioning services
Terrestrial habitats Freshwater habitats Marine and coastal habitats Farmed countryside	Soil health and carbon sequestration Water management	Crops and livestock Forestry Fisheries and aquaculture

Notes: The structure of this chapter follows the *Natural environment and natural assets* chapter in the Evidence Report for the 2017 UK Climate Change Risk Assessment. Biodiversity cuts across all aspects of natural capital, but for the purposes of reporting it is included mainly in the natural assets section of this chapter.

Since our last progress report to Parliament in 2015, the policy framework for managing the natural environment in England has changed significantly.

The vote in favour of the UK leaving the European Union has profound implications for the way that the natural environment will be managed post-2019. Many elements of EU legislation that are set out in Directives are already transposed into UK law, and some other regulations will be transferable. However, not all environmental legislation, such as the Common Fisheries Policy can be carried over directly. Many of the domestic regulations that cover EU Directives will also need amending to make sense in a domestic-only context. The Great Repeal Bill aims to preserve all of those rules and laws that are practicable to apply directly to the UK, thus allowing Parliament to consider each piece of legislation separately in the future. The process of leaving the EU also needs to consider how to effectively replace the current level of enforcement delivered by the European Commission and the Court of Justice of the European Union (CJEU).

Numerous reports and position statements have already been published that assess or comment on the risks and opportunities from EU exit for the UK's natural environment.[26] Each section in this chapter considers these risks and opportunities in the context of progress towards different adaptation priorities.

The previous Government made commitments to publish a long-term plan for the environment, and a separate plan for food, farming and fishing. A framework for both plans was originally intended for publication in 2016. It is not yet clear at the time of writing whether one or both

[26] For example, the Lords Energy and Environment Sub-Committee report on the impact of EU exit on Environment and Climate Change; the Environmental Audit Committee report on the future of the natural environment under EU exit, and the All Party Parliamentary Committee report on environmental policy and regulation. Numerous reports and position statements on the implications of EU exit have also been produced by organisations including the IEEP, Soil Association, CIWEM; Green Alliance; and the National Farmers Union.

plans will go ahead. The need for long-term plans is covered in the relevant sections of this chapter.

3.2 Habitats and species

Risks to wildlife and semi-natural habitats were identified as amongst the most urgent to address in the next five years in CCRA2. A number of indicators of habitat condition and extent, and of species abundance point to a continuing increase in vulnerability to climate change.

In order to build resilience, CCRA2 identified that more action was needed to reduce existing pressures, increase the size and improve the condition of habitats, restore degraded ecosystems, and deliver coherent ecological networks. While substantial efforts are being made, there are clear indications that vulnerability to climate change is not yet being reduced. The condition and extent of most habitats is not improving at a rate that is in line with current targets, and species populations continue to decline in many cases.

Terrestrial habitats

Is there a plan?	Amber	The current biodiversity strategy for England (Biodiversity 2020) includes targets for protecting terrestrial habitats and species, and will apply until 2020. The previous Government's proposed 25-year environment plan would offer an opportunity to set out a coherent long term strategy. The timescale for its production is awaited.
Are actions taking place?	Amber	Seven NAP actions specifically relate to terrestrial habitats. Most of these are complete or on track, although some have been dropped or revised. The Government has not yet reported on progress against its target to restore 15% of degraded ecosystems for climate change adaptation and mitigation purposes, though work on a methodology has started.
Is progress being made in managing vulnerability?	Red	**The Biodiversity 2020 goals were intended to improve the condition and increase the extent of terrestrial habitats. Meeting these goals would improve the resilience to climate change. However, at the current rate of progress, the target of 50% of terrestrial SSSI habitats being in favourable condition by 2020 is unlikely to be met.** **Woodland planting rates are below the target set by the Government in 2013 of 5,000 additional hectares per year.**

Is there a plan?

Biodiversity 2020 sets a plan for increasing the resilience of terrestrial habitats and species in the short-term, but long-term plans remain unclear.

The most recent England-specific plan for increasing the resilience of terrestrial habitats and species is Defra's Biodiversity 2020 strategy, published in 2011. The strategy sets out a number of actions to improve the condition, extent and connectivity of habitats. The importance of these

three characteristics of resilience to climate change is explained in the Lawton Review,[27] and in the ASC's 2013 and 2015 progress reports.

Biodiversity 2020 will, as the name suggests, no longer apply after 2020. A long-term plan for the environment is needed that includes proposed outcomes and actions to adapt the natural environment to climate change.

The EU Habitats and Birds Directives are already transposed into UK law. The degree of protection afforded to habitats, sites and species needs to be at least maintained after EU-exit.

The EU Habitats and Birds Directives set out the means by which Member States will meet their international objectives for habitats and species under the Bern Convention. Among other things, the Directives require the UK to take action to maintain and restore natural habitats to 'favourable' status. Both Directives are transposed into a number of UK laws including the 1981 Wildlife and Countryside Act and the Conservation of Habitats and Species Regulations 2010. These laws designate European Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) in the UK. It is not yet clear whether and how these laws will be altered in the light of EU-exit. The Conservation of Habitats and Species Regulations for example contain multiple references to compliance with the Habitats Directive, reporting to European institutions, and provisions for domestic institutions to take account of how SPAs and SACs in England contribute to the overall coherence of the European Natura 2000 network. Any changes to these laws for a UK-only setting will need to ensure the degree of protection currently provided through SPAs and SACs is maintained.

Are actions taking place?

Since our last report, further progress has been made across the seven NAP actions related to terrestrial habitats.

For example:

- Natural England is continuing to use its vulnerability mapping tool to prioritise actions for increasing resilience across its range of work. It is also in the process of updating its adaptation manual to include advice on species of conservation concern.
- In autumn 2016, the Joint Nature Conservation Committee (JNCC) reported to Defra on the sufficiency of the UK SPA network for protecting species listed under the EU Birds Directive, and will undertake further work to assess the changes needed to take account of shifting species distributions due to climate change.[28]
- Defra has published a new biodiversity indicator showing the impact of temperature change on the timing of phenological events such as bud-burst.
- The Ministry of Defence has undertaken climate risk assessments across its priority sites for biodiversity, with over 100 sites now assessed.
- Defra has included consideration of climate change in its review of the Invasive Non-native Species Framework Strategy.

[27] Defra (2010) *Making Space for Nature.*
[28] See: http://jncc.defra.gov.uk/page-7309

- Work is also continuing through the Food and Environment Research Agency (FERA) and the UK Met Office to look at closer integration of weather and plant disease data to help manage plant health risks.

The National Adaptation Programme Biodiversity Working Group continues to review progress across the biodiversity sector, and provide advice to Government. The group provided evidence and other input into CCRA2, and is currently undertaking work to scope out options for biodiversity, agriculture and forestry for the next NAP in 2018.

Some NAP actions are delayed or have been revised.

Outcome 1D of Biodiversity 2020 aims to ensure that 15% of degraded ecosystems important for climate change adaptation and mitigation are being restored. In the Government's response to our 2015 recommendation (no.26[29]), a report on progress was due to be published in 2016.This has yet to be completed though work to identify suitable data has been undertaken.

There was limited take-up of the Countryside Stewardship Woodland Creation Capital Grant in its first year. In March 2017, the Environment, Food and Rural Affairs Committee pointed to a "complex and overly bureaucratic" grant application process as a key barrier.[30] The Government has reported that improvements have been implemented for the 2017 round of grants. These improvements include offering agreements for two year rather than one year periods, providing more information to potential applicants in advance of the scheme opening, and speeding up the processing of applications. The Forestry Commission will evaluate these changes through monitoring applicant numbers for the 2017 scheme.

Is progress being made in managing vulnerability?

In overall terms, the resilience of terrestrial habitats has not improved since the NAP was published in 2013, with most available vulnerability indicators suggesting slow progress or a decline relative to the targets set out in Biodiversity 2020.

Indicators of habitat condition and species abundance have been collected over the past 50 years to assess the changing state of the natural environment. These indicators also provide a useful measure of resilience to climate change, because bigger, coherent habitats in good condition are more likely to be able to withstand pressures from changing external conditions. In the absence of evidence on what an optimal level of habitat condition, extent and species composition would be for resilience to climate change, we use the current Biodiversity 2020 targets as a sensible set of outcomes to aim for.

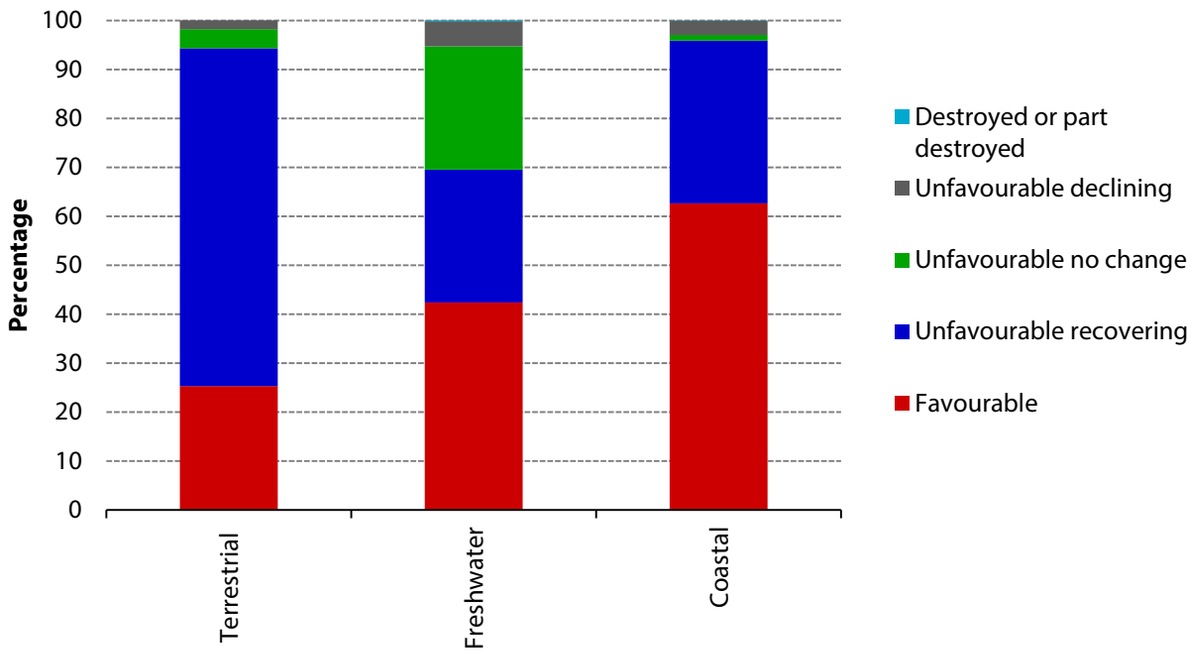
While 94% of all protected terrestrial habitats in England are now classed as in either favourable or unfavourable recovering condition[31], only around 25% of terrestrial SSSIs are currently in favourable condition, which is a lower figure than for freshwater and coastal protected habitats (Figure 3.2). The Biodiversity 2020 target for 50% of SSSI terrestrial habitats to be in favourable condition by 2020 is unlikely to be met on the basis of current trends.

[29] '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: 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'.

[30] See: https://www.publications.parliament.uk/pa/cm201617/cmselect/cmenvfru/619/619.pdf

[31] The definition of 'unfavourable recovering' is that there is a plan in place to restore favourable status. It does not necessarily denote an improvement in condition towards favourable status.

Figure 3.2. Condition of English SSSIs in 2016 by habitat type



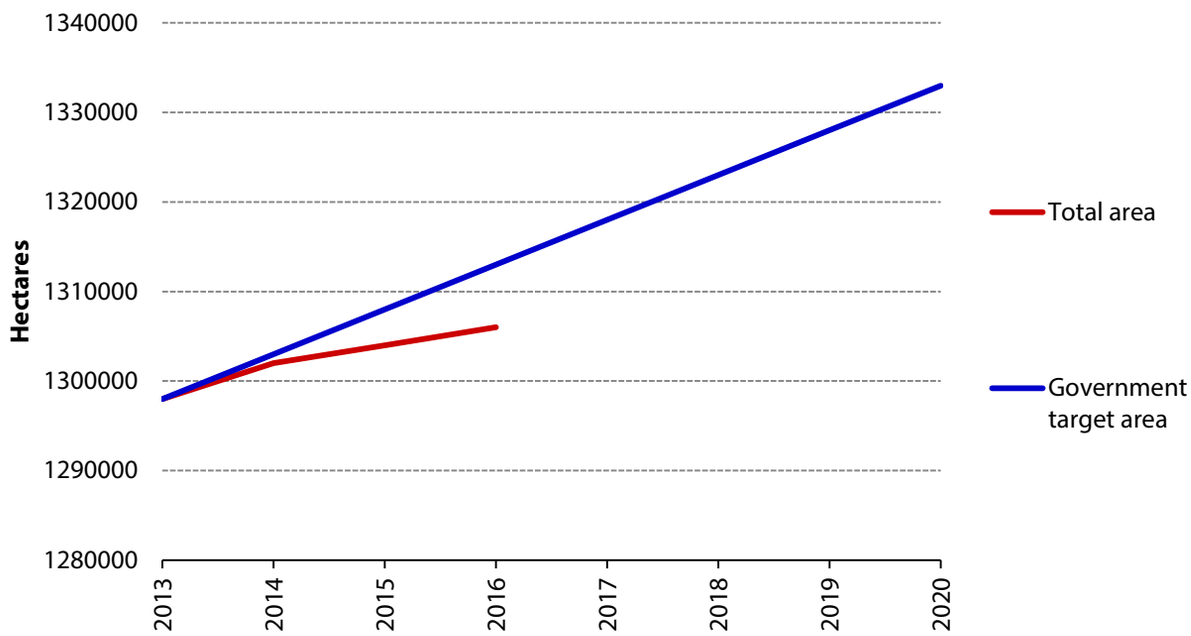
Source: Natural England, see: https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx

According to data collected for the ASC, 115,000 hectares of new priority habitat has been created since 2011.[32] The rate of creation is broadly in line with the Biodiversity 2020 goal to create 200,000 hectares of new habitat by 2020. Neither the habitat types that make up this total nor the condition of these new habitats is currently known. Further work to assess the impact of meeting this goal would be valuable.

To improve the coherence and extent of woodland habitats, in 2013 the Government set an aspiration to increase woodland cover in England to 12% of total land area by 2060, compared to a baseline of around 10% today. To achieve this, a Forestry Policy Statement called for 5,000 hectares of new woodland to be created each year up to 2060. In 2014 some 4,000 additional hectares of woodland (net) were recorded, with figures in 2015 and 2016 dropping to 2,000 hectares (Figure 3.3). The Government has also committed to a short-term goal of planting 11 million trees by 2020, but no data on progress is available.

[32] ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England*.

Figure 3.3. Total area of woodland in England against the target planting rate



Source: Forestry Commission, http://www.forestry.gov.uk/forestry/infd-7aqknx

The area of woodland that is certified as sustainably managed is a useful indicator of the condition of woodland habitats. Woodland certification assesses management practices against agreed environmental standards, including that wood products are harvested legally and sustainably, and that important wildlife habitats are identified and are not negatively impacted by management. The total area certified in England has increased slightly from 23% of all woodland in 2001 to 27% in 2015, but remains lower than the UK average of 44%.

Against a backdrop of slow progress on improving habitat condition and extent compared to targets, indicators for woodland species of conservation importance show continuing declines. Around 25% of woodland bird species in the Woodland Bird Species Index are in long-term decline. Since 1990, woodland butterfly abundance has declined by 48%, reaching a low point in 2012.

More widely, continued monitoring and surveillance is also required to assess how the risks from pests and diseases and invasive non-native species are changing over time. Continued close collaboration with European partners will be needed in the context of EU exit.

RECOMMENDATION 5: *A critical part of the next National Adaptation Programme should be a long-term plan for the natural environment that takes climate change into account, builds on the level of ambition of current EU policies, and is consistent with the framework developed by the Natural Capital Committee. In line with the ASC's previous advice, there should be associated targets, actions, and a monitoring and evaluation framework. (Owner: Defra. Timing: by 2019).*

RECOMMENDATION 6: *Action should be taken to enhance the condition of priority habitats and the abundance and range of priority species. This action should maintain or extend the level of ambition that was included in Biodiversity 2020. An evaluation should be undertaken of Biodiversity*

2020, including the extent to which goals have been met and of the implications for resilience to climate change. (Owner: Defra. Timing: by 2021).

Freshwater habitats

Is there a plan?	Amber	River Basin Management Plans set out how the water environment will be improved between now and 2021. Longer term plans are unclear as the status of requirements under the Water Framework Directive, once the UK leaves the EU, is currently unknown. The Environment Agency monitors water companies' performance in terms of abstraction of water and release of treated water into the environment. Companies can be penalised for over-abstraction and pollution.
Are actions taking place?	Green	The four NAP actions related to improving the resilience of freshwater habitats are complete or on track.
Is progress being made in managing vulnerability?	Red	**Indicators of freshwater habitat condition and species abundance have shown downward trends. Only 20% of water bodies in England are achieving 'good' or 'high' ecological status, down from 23% in 2010.** **The Breeding Wetland Bird Index has dropped to its lowest level since the index began in 1975. An index of wintering wetland birds has shown declines since 2007, though the current level remains above the 1975 starting index level.**

Is there a plan?

River Basin Management Plans set out how to improve the condition of freshwater habitats. These run until 2021. It is not clear what plans will be in place after this date.

The EU Water Framework Directive (WFD) commits Member States to achieving good ecological status in freshwater bodies, through the implementation of River Basin Management Plans (RBMPs). The WFD aimed to achieve 'good status' for all water bodies by 2015, or by the extended deadlines of 2021 and 2027. The current set of River Basin Management Plans in England are due to expire in 2021.

The Government has yet to set out how it plans to maintain the objectives and mechanisms set out in the WFD for protecting water bodies, after the UK leaves the EU. One option is to retain RBMPs in their current form, with their legal status retained through appropriate legislation.

There are checks and balances in place to control water companies' environmental performance, including how much pressure is put on the freshwater environment.

In its 2014 Price Review methodology, Ofwat introduced an abstraction incentive mechanism (AIM), which rewards or penalises water companies depending on their levels of abstraction during times of low flow in environmentally sensitive sites.[33] The Environmental Permitting

[33] See: http://www.ofwat.gov.uk/wp-content/uploads/2015/12/pap_pos201307finalapproach.pdf

Regulations 2010 include provisions to impose fines on water companies for polluting water courses.

The Environment Agency has responsibility for monitoring and reporting on the status of water bodies and the reasons why good ecological status has not been achieved ('reasons for failure'). At present, diffuse and point source pollution make up the majority of recorded reasons for failure (64%), with over-abstraction and flow-related issues accounting for about 5% of failures.[34]

Plans to reform the abstraction licencing system (see Section 3.2) aim to reduce pressures on the freshwater environment, through directing water more efficiently to where it is most needed, and reducing the amount of abstraction that can take place in vulnerable ('enhanced') catchments.

Are actions taking place?

Four NAP actions relate directly to this theme, all of which are on track or complete:

- The second round of river basin management plans were published in 2016.
- The Environment Agency and Natural England are continuing to review and implement Diffuse Water Pollution Plans for Natura 2000 Protected Areas under WFD requirements.
- Work continues on embedding approaches to integrated catchment management. For example, one of the Defra Natural Capital Pioneer projects is focussed on integrated catchment management in Cumbria.
- Defra's ongoing abstraction reform process is seeking to improve environmental flows.

Is progress being made in managing vulnerability?

Indicators showing recent declines in the condition of freshwater habitats point to a lack of progress in managing vulnerability.

As for terrestrial habitats, ensuring that freshwater habitats are in good condition would help to improve resilience to climate change. While 42% of the total unit area of freshwater SSSIs are currently in favourable condition (Figure 3.2), it is not known what percentage of total habitat area these sites make up, as 'freshwater bodies' include rivers, lakes, canals and ponds of a variety of sizes and importance. In 2015, only 20% of all surface water bodies assessed under WFD were classed as having good or high status, compared to 23% in 2013.[35]

Species indices also show negative trends. In 2014, populations of breeding wetland birds in England dropped to their lowest level since the index began in 1975. There was a 10% decline in the index between 2008 and 2013. Wintering wetland birds declined by 5% between 2007/8 and 2012/13, though the index is still above its starting level recorded in 1970.[36]

The lack of significant or sustained improvements in habitat condition and species abundance suggests that persistent and underlying pressures on the freshwater environment are not yet

[34] Suggitt, A., et al. (2015) *Aggregate assessment of climate change impacts on the goods and benefits provided by the UK's natural assets*.
[35] England biodiversity indicators 2015 update, https://www.gov.uk/government/statistics/england-biodiversity-indicators
[36] *Ibid.*

being adequately addressed. This is particularly the case for diffuse pollution from agriculture, which accounts for around one-third of WFD failures but can be technically difficult to manage.[37]

Marine and coastal habitats

Is there a plan?	Amber	Biodiversity 2020 includes goals for coastal and marine habitat protection and creation. There is also a target to achieve good environmental status for marine habitats by 2020 under the EU Marine Strategy Framework Directive. The 2009 Marine and Coastal Access Act provides for setting up and reporting on Marine Conservation Zones (MCZs), and the production of marine plans that must include consideration of adaptation to climate change. Marine Plans take a longer-term focus, looking 20 years ahead, and include sections on climate change adaptation. Those published to date do not include specific proposals to adapt the marine environment to the key risks from rising sea temperatures and changing ocean chemistry.
Are actions taking place?	Green	All relevant NAP actions are complete or on track. Importantly, the number of MCZs across the UK increased from 27 in 2013 to 50 in 2016, with over 1 million hectares (21%) of England's inshore waters now protected, against a Biodiversity 2020 target of 25% by 2020.
Is progress being made in managing vulnerability?	Amber	**Available indicators suggest that progress is being made in improving the condition and extent of marine and coastal habitats. However, exposure to climate risks within the marine food chain is increasing due to changes in ocean biogeochemistry such as rising sea temperatures, deoxygenation and ocean acidification. Our understanding of this process is incomplete and its implications not yet known.**

Is there a plan?

Plans are in place to conserve and improve marine and coastal habitats and to consider how marine planning can take climate change into account.

Improving the condition of the marine environment through the reduction of existing pressures is necessary to give species - including those important for fisheries and aquaculture - the best chance of adapting to changes in water temperature and chemistry.

The current legal framework for the environmental management of UK seas derives from the EU Marine Strategy Framework Directive, which requires Member States to achieve good environmental status by 2020. Biodiversity 2020 contains outcome measures related to improving the condition and extent of coastal priority habitats (Outcomes 1 and 2). These

[37] Brown, I., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 3, Natural Environment and Natural Assets.*

include a 2016 target for 25% of England's waters to be conserved and managed; and targets on improving the condition of priority habitats.

The 2009 Marine and Coastal Access Act initiated the production of Marine Plans, which should include how activities in the marine environment can be made more resilient to climate change. Marine plans for all areas around England should be in place by 2021 and are required to look 20 years ahead. The Act also sets a framework for setting up a network of protected areas called Marine Conservation Zones. Marine Plans do not (yet) include consideration of how to adapt the marine environment to key risks from rising sea temperatures and changing ocean chemistry. Activities could include undertaking further research on how these risks might affect the marine food chain, and consideration of how to build maximum resilience into marine ecosystems through reducing other pressures.

Are actions taking place?

There has been a significant amount of progress against NAP actions related to marine and coastal habitats and species.

The number of MCZs across the UK increased from 27 in 2013 to 50 in 2016, with over 1 million hectares (21%) of England's inshore waters now protected, against a Biodiversity 2020 target of 25% by 2016. Consultation on a third tranche of MCZs is due to take place in 2017.

Defra has published its Marine Strategy (Part 2) required under the Marine Strategy Framework Directive, setting out the monitoring programmes which the UK will use to assess progress towards good environmental status (GES) for the marine environment. The UK is currently carrying out the MSFD Article 8 assessment of UK seas, to update the initial assessment carried out in 2012. The results of this exercise are due to be reported in 2018. Some 50 indicators address the extent to which the UK targets for GES have been achieved, with several indicators (such as sea surface temperature) being directly related to the effects of climate change. However, Defra has indicated that any further cuts to Departmental budgets are likely to result in reduced monitoring programmes in the coming years.

There has been progress through the Marine Management Organisation (MMO) to develop marine plans that include climate change. A plan for the East of England has been published and plans for the south of England are due to be published in 2017. The MMO also produced a report under the second round of reporting under the Adaptation Reporting Power in 2015/16.

The Marine Climate Change Impacts Partnership (MCCIP) is in the process of producing a report card looking in detail at topics highlighted in CCRA2.

The National Coastal Erosion Risk Mapping project has been completed and erosion projections have been published online. In relation to the ASC's 2015 report recommendation no.30,[38] the Environment Agency is working with partners, including Natural England, through the Habitat Creation Programme to identify the potential for new coastal habitats. This includes those created through managed realignment, in line with the strategic direction set out in Shoreline Management Plans.

[38] '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'.

The Marine Biological Association of the UK completed a marine non-native invasive species (NIS) baseline project for Defra in June 2016. This report maps the locations of species that are on the UK marine NIS monitoring list. The report will provide a baseline against which the spread of NIS over time can be monitored.

Is progress being made in managing vulnerability?

Progress is being made in improving the condition of marine and coastal habitats, but there is a potential risk of irreversible changes to the marine environment from rising sea temperatures and changing ocean chemistry.

Compared to terrestrial and freshwater habitats, a larger proportion of coastal SSSI habitats are in favourable condition (63% compared to 25% and 42% respectively - see Figure 3.2). As reported above, substantial progress has been made in designating protected marine areas. In 2014, the breeding seabird index in England was 16% higher than its baseline level in 1986, though with little change since 2008, and against a broader picture of sharp declines in breeding seabird populations around the UK as a whole. The difference between the England and wider UK trend is probably explained by the different mix of species in the two indices.[39]

The input of hazardous substances to the marine environment has also declined significantly since 1990, due to tighter controls on industrial and other sources of pollution and a reduction in industrial production. Inputs of three substances (cadmium, lindane and mercury) declined by more than 75% over this time period, while zinc pollution has declined by 65%, copper by 62% and lead by 53%.[40]

The evidence of potentially irreversible impacts of climate change on marine ecosystems is growing. Studies are beginning to emerge that consider the effects of changes in ocean chemistry (such as deoxygenation and acidification) and temperature on phytoplankton abundance, which underpins the marine food chain. Sea-surface temperatures in UK coastal waters and in the North-east Atlantic have risen by 0.1 - 0.5˚C per decade since the 1980s. During the last 50 years there has been a northward shift in less nutritious warmer water plankton species (by about 10º latitude into the north-east Atlantic), and a similar shift northwards of cold-water plankton species. This equates to a movement by plankton species of 200 - 250km per decade.[41] Full scale of changes in plankton composition and abundance are unlikely to be detected until 2050, by which point it may be too late to put in place effective mitigation measures.[42]

Ocean acidification also carries significant risks to the marine food chain. In general, echinoderms, molluscs, calcareous algae and corals appear to be more sensitive to acidification than crustaceans, fishes and non-calcareous algae. By 2060, over 85% of known deep-sea cold water coral reefs in UK waters could be exposed to waters that are corrosive to them. Many other shell-forming organisms would be similarly vulnerable. Analysis of combined measurements

[39] Species included in the England indicator are gannets (the rising population at Bempton Cliffs has had a significant positive impact), Great Cormorant, European Shag, Common Guillemot (all subsurface feeders), Arctic Tern, Black-legged Kittiwake, Common Tern, Little Tern, Sandwich Tern (all surface feeders), and Northern Fulmars and Herring Gulls (both classed as 'other feeding type'). Across the UK more widely, substantial declines have been observed in populations of puffins, fulmars, and kittiwakes among others.
[40] England biodiversity indicators 2015 update, https://www.gov.uk/government/statistics/england-biodiversity-indicators
[41] Baxter and Laffoley (2016) *Explaining ocean warming*
[42] Deppeler and Davidson (2017) *Southern Ocean Phytoplankton in a changing climate.* Frontiers in marine science, volume 4, article 40.

from different locations shows that the pH in the North Sea has declined by about 0.1 units over the past 30 years. This represents about half of the change expected with global warming of 2ºC above pre-industrial levels.

Long-term monitoring programmes should therefore be put in place as a matter of urgency, and early consideration given to the implications for policy and the management of marine ecosystems.

RECOMMENDATION 7: *Research on the risks to the marine food chain and ecosystem from rising sea temperatures, deoxygenation and ocean acidification should be undertaken over the course of the next National Adaptation Programme period, to inform future marine and fisheries policies. The research should assess the extent to which adaptive actions could increase the resilience of marine habitats and species to climate change. (Owner: Defra. Timing: by 2022).*

Farmed countryside

Is there a plan?	Amber	Agri-environment schemes under the Common Agricultural Policy aim to incentivise activities that protect farmland habitats and wildlife, but they lack explicit goals and targets. Agri-environment schemes are expected to cease to operate in their present form from 2022. Government intentions with regard to a plan for the long-term management of the farmed countryside are unclear.
Are actions taking place?	Green	Only two actions in the NAP relate directly to this adaptation priority, both of which are on track. A number of options under the higher tier Countryside Stewardship scheme include a reference to adaptation. Natural England has also published guidance on how climate change can be considered within Countryside Stewardship.
Is progress being made in managing vulnerability?	Red	**Most of the available indicators for the farmed countryside continue to show long-term declines in species abundance. Only farmland bats show a positive trend.**

Is there a plan?

Agri-environment schemes under Pillar II of the Common Agricultural Policy provide components of a plan to improve the resilience of the farmed countryside to climate change, but have no overarching targets or goals and are likely to cease to operate from 2022.

The Common Agricultural Policy (CAP) has heavily influenced land use and land management by farmers, through Pillar I (direct payments), Pillar II (agri-environment schemes) and other mechanisms. Agri-environment schemes provide payments to land managers for adopting specific environmental measures. Since 2015, the older Environmental Stewardship schemes (Higher Level Stewardship and Entry Level Stewardship) have been subsumed into a new Countryside Stewardship scheme. The new scheme has three levels: higher tier, mid-tier and

capital grants. The application process for Countryside Stewardship is competitive in most cases and scored against specific criteria.

As we reported in 2015, agri-environment schemes incentivise a set of activities that could increase resilience of the farmed countryside, but do not represent a coherent strategy to reduce vulnerability to climate change. In light of the UK's decision to leave the EU, the Government has provided assurances that agri-environment payments to land managers agreed before August 2016 will be honoured up to 'the end of the current Parliament' (which, assuming a five-year term will end in 2022), but what will happen after this time is unclear. Defra are currently working with other Government departments on proposals to replace CAP measures after this time, as part of wider work to develop a new long-term agricultural strategy.

Plans for the long-term management of the farmed countryside have been delayed.

Alongside the 25-year environment plan, the previous Government committed to a 25-year food, farming and fishing plan. The status of this plan under the current Government is unclear at the time of writing.

Are actions taking place?

There are only two actions in the NAP related to improving the condition of the farmed countryside, both of which are on track.

Defra has a NAP action to ensure that climate change is integral to agri-environment schemes. In 2015 its proposals for updating the way agri-environment schemes are delivered through Countryside Stewardship in England were approved. The higher tier options manual sets out which measures can help to deliver climate change adaptation; management and creation of coastal sand dunes, shingle and saltmarsh, creation of intertidal habitat, woodland creation and improvement, management and restoration of wood pasture, and tree planting. The mid-tier options do not include consideration of adaptation.

In 2014, 1.35 million hectares of farmland were covered by Higher Level Stewardship (15% of available farmland) and 6.4 million hectares (72%) by Entry Level Stewardship.[43] Since 2016 both schemes have been closed to new entrants due to the switch to Countryside Stewardship. Data on uptake and coverage under Countryside Stewardship is not yet available.

Natural England has produced climate change guidance for the Countryside Stewardship scheme. Analysis by Natural England shows that the majority of the uptake of restoration and maintenance action under the scheme is on habitats with a medium sensitivity to climate change (~73%). There is significantly less uptake on habitats with high (~9%) and low sensitivities (~5%).

In response to the ASC's recommendation no.29 in 2015,[44] Natural England has conducted a review of how past agri-environment scheme delivery has contributed to climate change adaptation. The study established a monitoring framework and provided a baseline against which future data can be compared. It found that the greatest contribution of agri-environment schemes to adaptation occurs where there is overlap with other objectives, for example the maintenance of existing protected sites. Despite an increase in the amount of priority habitat

[43] England biodiversity indicators 2015 update, https://www.gov.uk/government/statistics/england-biodiversity-indicators

[44] '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'.

being created under the schemes, there has been limited success in addressing habitat fragmentation. The study also found that the majority of blanket peat soils (~73%) are covered by options whilst only 9% of other peat soils are covered by options.

Is progress being made in managing vulnerability?

Key species indicators for the farmed environment continue to show long-term declines.

Farmland birds, butterflies and bats are used by the Government as indicator species to monitor the condition of farmland habitats, as all are sensitive to changes in habitat condition. Breeding birds on farmland have been monitored since 1970 with data on the average population size available for 19 species. The latest data for 2014 show that the population index has fallen by 56% against its 1970 starting value. As we reported in 2015, changes in farming practices such as the loss of mixed farming practices, the move from spring to autumn sowing, and the widespread use of pesticides, have been demonstrated to have had adverse consequences for many species. Impacted species include the skylark and grey partridge, though some 'generalist' species such as the wood pigeon have grown in numbers.

Since 1990, the abundance index for 21 different farmland butterfly species has fallen by 27%, though with some upward movement in 2013 and 2014. An occupancy index for farmland pollinator species fell by 32% between 1980 and 2010. During this time, 27% of pollinator species became more widespread, and 51% became less widespread.

One positive trend associated with the farmed countryside is the index for farmland bat species. Between 1999 and 2013, there was a 20% increase in eight species of bats, though between 2013 and 2014 the index declined slightly. [45]

RECOMMENDATION 9: *New agricultural land management policies should take account of the need to improve water quality and the condition of habitats and soils, in order to build resilience to climate change. Targets should be set that focus on outcomes, and monitoring undertaken to understand if these targets are being met. (Owner: Defra. Timing: by 2020).*

3.3 Soil health and carbon sequestration

CCRA2 identified that improving the condition of soils and degraded peatlands was urgently required in the next five years in order to address the risks to soils from climate change. While actions are underway, there is no overarching plan to improve soil health and the changing condition of soils across England is not routinely monitored.

The way that climate and soils interact is highly complex and the precise impacts of climate change on soil condition and carbon storage are uncertain. Most projections suggest that there is a risk of reductions in soil moisture, and uncertain changes in soil microflora, erosion rates, and carbon content. CCRA2 highlighted the need for more action in the next five years to reduce existing pressures on soils, including through increasing restoration of degraded soils and uptake of soil conservation measures. It also called for more action to restore degraded soil carbon stores, in particular peatlands. Defra's aspiration, included in the Natural Environment White Paper (2011), for all soils to be managed sustainably by 2030 has not yet been translated into a plan, and there has been no national assessment of soil condition since 2007.

[45] England biodiversity indicators 2015 update, https://www.gov.uk/government/statistics/england-biodiversity-indicators

Is there a plan?	Red	Defra set an aspiration in the 2011 Natural Environment White Paper for all soils to be managed sustainably by 2030. This aspiration is reflected in the National Adaptation Programme but there remains no plan in place to achieve it.
Are actions taking place?	Green	All NAP actions related to this theme are on track, including completion of a £3.2 million research programme funded by Defra. Around £14 million was allocated in the 2015 spending review to peatland restoration projects.
Is progress being made in managing vulnerability?	Red	**The percentage of blanket bog SSSIs in good condition declined from 19% to 10% between 2003 and 2016, though the percentage moving from unfavourable to unfavourable recovering condition (i.e. with a restoration plan in place) rose from 16% in 2003 to 87% in 2016.** **The Countryside Survey and National Soil Inventory last reported on soil condition across England in 2007 and 2003 respectively. No further assessment has taken place, so neither the current state nor recent trends in the condition of English soils are known.**

Is there a plan?

Our recommendation in 2015 for an action plan on soil health has not yet been fulfilled.

Our progress report in 2015 stressed the importance of soils in storing carbon and providing a range of other ecosystem services. We recommended that the Government publish an action plan outlining how it would meet its policy aspiration for all soils to be managed sustainably by 2030. We said the plan should include a scheme to monitor soil condition, and proposals to ensure that the ongoing loss of lowland and upland peat soils is reversed. This recommendation was reiterated in the Environmental Audit Committee's 2016 report on soil health.[46]

In response to our recommendations, the previous Government stated that soil protection would be considered as part of the 25-year environment plan, a framework for which has yet to be published. Defra has begun to develop a peatland strategy for England, but work is at an early stage.

Are actions taking place?

All of the NAP actions on soil health and carbon sequestration are ongoing. Most relate to research and guidance.

Under Pillar I of the CAP, new soil protection rules were introduced in 2015 as part of cross compliance. These rules were designed to promote actions to achieve minimum soil cover, limit the risk of erosion, and maintain soil organic matter levels. Defra is responsible for monitoring and evaluating the impact of the new rules, and has stated that it intends to take an outcome-based approach. Details of this monitoring scheme are not yet available.

[46] See: https://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/inquiries/parliament-2015/soil-health/

Defra has a commitment under the Natural Environment White Paper to undertake a research programme to explore how degradation can affect a soil's ability to support vital ecosystem services such as flood mitigation, carbon storage and nutrient cycling; and how best to manage lowland peatlands in a way that supports efforts to tackle climate change. Projects underway include an analysis of what additional measures will be required as a result of climate change to manage risks of soil erosion, changes in soil organic carbon, and the impact of wetter soil conditions. These projects are due to complete in 2017. One of the projects will provide the first full carbon and greenhouse gas budgets for peatland across England and Wales under different management and land uses (e.g. pristine bogs and lands that have been impacted by extraction, grazing and arable production). The results will be used to develop emission factors for each peatland type under a range of baseline management activities. The data derived should help inform how sustainable management practices can reduce degradation of cultivated peatland soils in the lowlands.

NERC and the BBSRC have also begun a Soil Security Research Programme, which is expected to finish in 2019.[47] Projects underway include investigating soil function under land use and climate change, how soil management can mitigate flood risk, and peatland sensitivity to global change.

Upland peat soils are a critical natural asset for climate change adaptation because of the range and scale of ecosystem services they provide, including carbon storage, water storage, and habitat provision. As set out in our 2015 report, Natural England estimates that around half of the 281,000 hectares of blanket bog in England have lost their mossy, peat-forming vegetation and are in a degraded state. The ASC recommended further action in its 2015 report to restore degraded peatlands (recommendation 27).[48] Although the Government declined to produce an action plan as proposed by the ASC, further efforts have been made since our last report to support relevant work. The Spending Review in 2015 announced that £100 million would be invested in a range of projects to support the natural environment. Around £14 million is being allocated to peatland restoration projects, of which £4 million has been spent on projects to date. The remaining £10 million is expected to fund practices such as rewetting and seeding with Sphagnum mosses. The resulting reduction in greenhouse gases is one of the criteria by which bids will be judged.

The Peatland Code has also been developed and deployed via the IUCN website.[49] It is a voluntary standard for restoration projects across England, and signals to potential investors specific projects that include robust restoration actions.

A 2015 review of the policy for reducing the amount of peat used in horticulture has been delayed, in order for it to be aligned with the 25-year environment plan.

Burning of vegetation (heather and grass) on blanket bogs is carried out to create new growth for livestock grazing, and to increase the diversity of the age and structure of heather for game management. A Natural England study from 2013 shows that rotational burning reduces species composition, peat accumulation, and the carbon storage capacity of the soil and increases the amount of dissolved organic carbon in nearby water courses. Burning of vegetation on designated blanket bog sites requires consent from Natural England. It is argued that consenting

[47] See: https://www.soilsecurity.org/research-partners/

[48] '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'.

[49] See: http://www.iucn-uk-peatlandprogramme.org/peatland-code

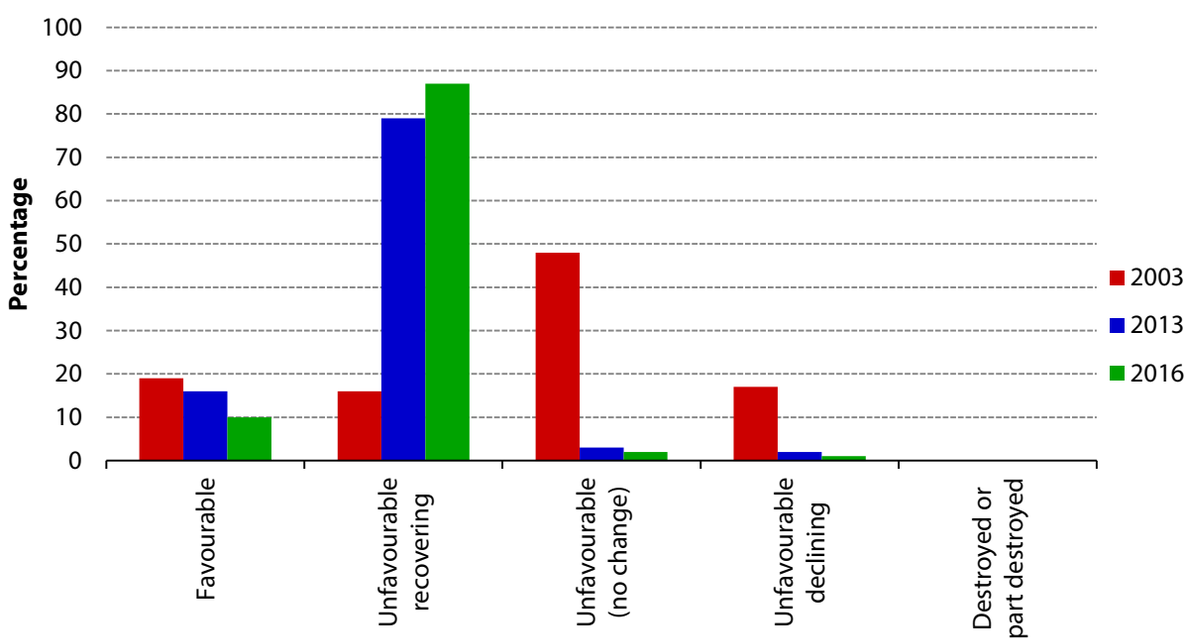
to some burning allows for controls to be put in place and for Natural England to work with landowners on measures to lower the frequency and intensity of burning over time. From an adaptation perspective, the test is how rapidly the extent of burning decreases and stops. The most recent data provided by Natural England indicates that 110,700 hectares (57%) of blanket bog SSSIs (including SAC and SPA) have burning consents in place,[50] against a figure of 160,000 hectares (82%) of such SSSIs with consents in place in 2015. It is not clear what has influenced this decline in area with burning consents in place.

Is progress being made in managing vulnerability?

Only 10% of SSSI blanket bog habitats are in favourable condition.

The condition of upland blanket bog sites is an important indication of the ability of upland peat soils to deliver the ecosystem services described above. Since 2003 there has been a large shift in sites from 'unfavourable' to 'unfavourable recovering' condition (i.e. there is now a restoration plan in place for 87% of sites), but there has been a decline in the area in favourable condition, from 19% in 2003 to 10% in 2016 (Figure 3.4). The area of upland bog in favourable condition also only represents about 6% of the total area of upland peat, as not all areas are protected. Similar data are not available for lowland peat soils.

Figure 3.4. Condition of upland blanket bog SSSIs in England: 2003, 2013 and 2016



Source: For 2016 data - Natural England, https://designatedsites.naturalengland.org.uk/NEInterimReports/ConditionByHabitat.aspx
For 2003 and 2013 data, see ECI (2013) for the ASC, *Assessing preparedness of England's natural resources for a changing climate.*

[50] ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England*. Latest NE data indicates that the total area of SSSI upland blanket bog is 194,000 hectares.

Vulnerability is hard to assess in the absence of routine national monitoring of soil condition in England.

The last national assessment of soil condition in England was published in 2007, as part of the Countryside Survey. The National Soil Inventory also reports on the condition of soils across England, but this has not been conducted since 2003. It is therefore not possible to assess current trends in soil health across England.

RECOMMENDATION 10: *To support adaptation efforts, a plan should be put in place to deliver the aspiration for all soils, to be managed sustainably by 2030. The plan should include a scheme to monitor uptake of soil conservation measures, and specific proposals to reverse the ongoing loss of lowland peat soils, in order to provide mitigation and adaptation benefits. (Owner: Defra. Timing: by 2019).*

RECOMMENDATON 11: *A target for restoring all designated upland blanket bog habitats to favourable condition by 2030 should be adopted in order to contribute to both adaptation and mitigation efforts. (Owner: Defra. Timing: by 2018).*

3.4 Water management

Plans are in place and action is underway to improve water management in the natural environment. It is too early to tell what effect these measures will have on the long-term risks of water scarcity.

CCRA2 identifies urgent risks to agriculture and wildlife from water scarcity. It notes that further steps need to be taken to reduce over-abstraction, and ensure that decisions on water use take into account its availability with climate change. If action is not taken, the majority of catchments in England are projected to have insufficient water to meet demand by the 2050s. Abstraction reform is needed to create a water use system that responds to the changing availability of water over time, directing resources to where they are most needed. Environmental flow indicators will be a useful measure of progress in managing vulnerability as a result of these reforms. Such indicators are currently reported under the Water Framework Directive, and an equivalent process will be needed when the UK leaves the EU.

Flood risk to agricultural land is also highlighted as an urgent risk in CCRA2. Land that is frequently flooded is only capable of supporting lower-value crops, pasture or woodland. Further action is also needed to incentivise land management practices that assist in storing water and reducing runoff rates. Natural flood management is discussed in more detail in Chapter 4: *People and the built environment*.

Is there a plan?	Green	Proposals for abstraction reform legislation should provide a statutory framework for managing water availability in the context of climate change across all sectors. The reforms will need to secure parliamentary time in order to meet the goal for abstraction reform to be introduced by the early 2020s. This will be a challenge given EU-exit and other legislative priorities. Flood risk to agricultural land is covered under the Flood and Coastal Risk Management Strategy for England.

Are actions taking place?	Green	Most of the14 NAP actions on water management in the natural environment are complete or on track. One action, to review guidance and support to farmers in managing their water use, has been delayed until 2018 to coincide with abstraction reform.
Is progress being made in managing vulnerability?	Amber	**Trends in water availability and use are highly variable. Since 1960 there has been no clear trend in summer or winter low flows. There is also no obvious increase or decrease between 2000 and 2014 in water abstraction for agricultural use, spray irrigation, or in crop losses due to drought or flooding.** **Environmental flow indicators will provide a measure of the success of abstraction reform in managing vulnerability in the future, as they will show the amount of stress placed on the natural environment from water scarcity.**

Is there a plan?

Parliamentary time will need to be secured in the coming Parliament for reforms to the water abstraction system to happen as planned from 2021. This may be challenging given pressures on the legislative timetable.

Abstraction reform aims to improve the efficiency of water use, directing it to those who need it most during times of drought and making the system more resilient to climate change. Following a consultation in 2013/14, an impact assessment was published in 2016 and final reform proposals were originally expected in a draft Bill later in 2017, though there is some uncertainty as to whether time can be found in the parliamentary schedule to take this forward. Under the proposals, all abstraction licenses will be re-issued as permits, with reductions in unused abstraction volumes where they pose a risk to the environment if used in the future. The most water-scarce catchments (~30% of the total) will be designated as 'enhanced catchments', with specific rules for environmental controls and trading of permits. Most permits will continue to specify absolute annual and daily constraints on abstractions, but in enhanced catchments, a water share 'accounting' framework will be introduced.

Between now and 2020, the Environment Agency is working to remove unused licences and reduce those that are underused, as well as to bring previously exempt abstractors under regulation. Licences will be moved across into the new system from the early 2020s. If the proposed approach is effective, water should be abstracted and traded in a way that directs it to where it is most needed. An associated aim is to reduce the risks to the natural environment during times of low flows.

Managing flood risk in relation to agriculture, forestry and the natural environment is integrated into the Flood and Coastal Risk Management Strategy for England.

New defences and improvements to existing defences are undertaken to protect agricultural land as part of the wider programme of flood risk management (see Chapter 4). Water level management plans are also prepared by the Environment Agency, Internal Drainage Boards, and some local authorities, depending on who exercises drainage powers in each part of the country.

As well as risks from flooding to agricultural land, opportunities exist for using agricultural land, forestry and natural features to manage flood risk. Natural flood management (NFM) approaches are discussed in Chapter 4.

Are actions taking place?

There are fourteen NAP actions related to water management for the natural environment, agriculture and forestry. Notable actions that have been progressed since our last report include:

- Defra is planning to review and re-issue guidance to farmers in 2018 on managing their water assets, to ensure that guidance is in line with abstraction reform. This responds to the ASC's 2015 report recommendation no.21.[51]
- Measures are continuing to be taken through the Catchment Sensitive Farming programme to incentivise farmers to reduce levels of diffuse pollution into water courses. New measures are being included under the Countryside Stewardship scheme, but no data is available on uptake at present. Defra is also undertaking research to better understand how climate change may impact on the measures included in Catchment Sensitive Farming.
- The Forestry Commission is working with Natural England and the Environment Agency to improve the freshwater environment through woodland creation, and woodland management in flood risk areas through Countryside Stewardship grants.
- Various projects are underway to assess the benefits and feasibility of natural flood risk management. These are reported in Chapter 4.
- The 'Keeping Rivers Cool' project was taken over by the Woodland Trust from the Environment Agency in 2015. Guidance on riparian shading of rivers has been re-issued along with a series of academic papers on cooling, but due to resource constraints the Woodland Trust is now looking for a new partner to lead the programme.
- In relation to the ASC's 2015 report recommendation no.28[52], progress continues to be made under the Environment Agency's Restoring Sustainable Abstraction Programme. To date, changes have been made to 271 licences to reduce pressures on the natural environment, with a further 166 licences remaining to be reviewed. The Environment Agency is also working with local catchment partners, through the Catchment Based Approach, to improve the sharing of evidence on pressures and impacts on the water environment.

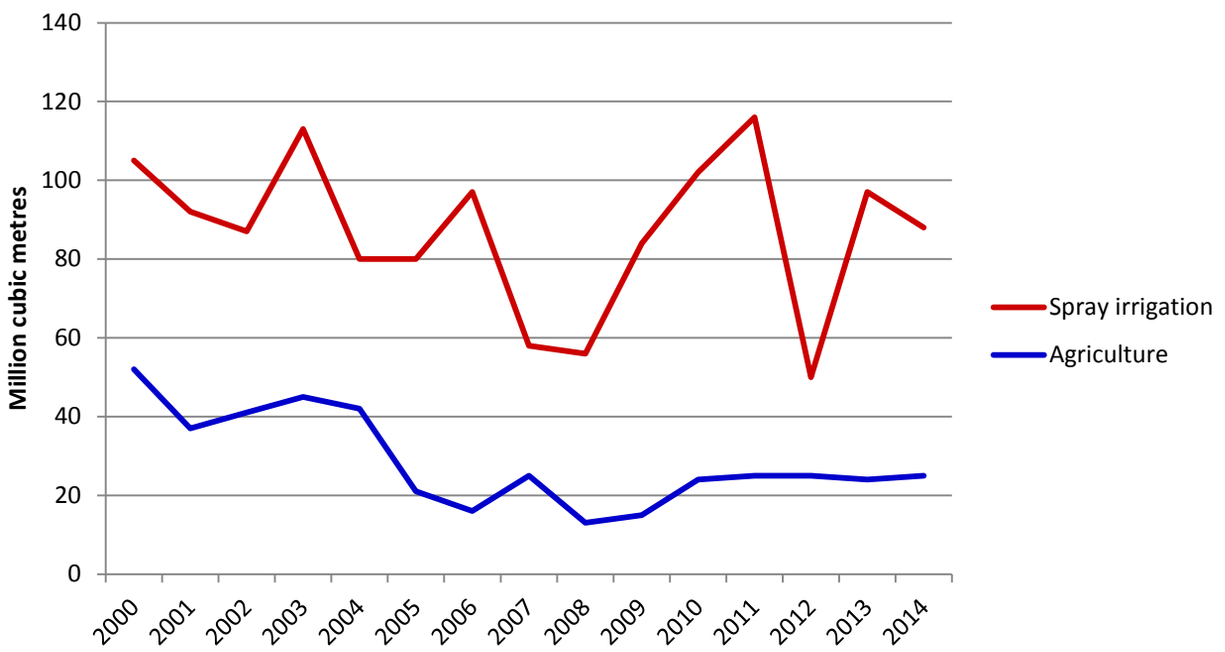
Is progress being made in managing vulnerability?

Trends in river flows, water abstraction, and impacts from droughts and flooding on agricultural activities, show large inter-annual variability with no significant increase or decrease in vulnerability observed to date. Continued monitoring of environmental flows should help to determine whether abstraction reform is reducing vulnerability in the future.

[51] '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'.
[52] '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'.

Long-term trends in river flows are difficult to distinguish from inter-annual variability, and show a high degree of spatial variability. Records since 1960 show no clear pattern in summer or winter low flows.[53] The volume of water abstracted for agriculture and spray irrigation is highly variable and sensitive to annual rainfall fluctuations. There has been a slight downward trend between 2000 and 2014, but the variability between years is high (Figure 3.5). Over the same period, there have been no intense summer droughts, and cereal yields have been affected more by heavy rainfall episodes over this period than by soil moisture deficits.[54]

Figure 3.5. Trends in water abstraction in England for spray irrigation and other agricultural uses



Source: Defra water abstraction statistics, https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables

Environmental flow indicators will help show whether abstraction reform is successful at managing vulnerability in the future, as they will provide a measure of how much pressure is being put on the natural environment from over-abstraction. As discussed in Section 3.2, only 20% of water bodies in England are currently meeting 'good' or 'high' ecological status, with little change since 2009. Over-abstraction currently accounts for 5% of WFD failures in England, though it may contribute to other cases.

[53] Brown, I., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 3, Natural Environment and Natural Assets.*

[54] ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*

3.5 Provisioning services

The capacity for commercial agriculture, forestry, fisheries and aquaculture to adapt to climate change will be greatly reduced if the natural assets and ecosystem services on which they depend remain vulnerable to the climate change risks discussed above. Only if all these risks are managed, can the opportunities from longer growing seasons and higher growth rates of crops and trees in a warmer climate be realised.

The commercial management of land, freshwater and marine resources is dependent on the resilience of underlying natural assets and the ecosystem services they provide. The risks outlined in the sections above are also risks for the production of crops and livestock, and for forestry and fisheries. There are additional climate related risks from pests and diseases and the changing climate suitability of commercial species.

If habitat condition and extent, water quality and availability, and soil health are maintained and enhanced, and resilience thus increased, climate change presents potential opportunities for agriculture and forestry in England from extended growing seasons and faster growth rates. However, risks from pests and diseases and changing climatic suitability for trees, crops and livestock species will remain. There is currently no overarching plan for how the agricultural system in England should respond to climate change. The current Agri-tech strategy[55] provides some components of a plan, but its impact on the long-term productivity and environmental footprint of the sector has not yet been evaluated. There are also wider issues relating to the impacts of climate change on trade, supply chains and food security.

Fisheries and aquaculture were not covered in the first National Adaptation Programme, and there is little information available to monitor vulnerability or assess action to build resilience. New policies will be needed to replace the EU Common Fisheries Policy after 2019, and these should take account of climate change and promote adaptation.

Crops and livestock

Is there a plan?	Amber	The Agri-tech strategy provides a partial plan for increasing the resilience of crops and livestock to climate change as it aims to improve the technological capability of the sector. Overarching plans that identify objectives for crop and livestock production under a changing climate - including consideration of food security issues - do not yet exist.
Are actions taking place?	Amber	All 14 NAP actions relate to providing guidance and research, and most are on track or complete. No updates on progress have been provided for two actions related to the monitoring of pests and diseases.
Is progress being made in managing vulnerability?	Green	**The index of total factor productivity (a measure of the efficiency of the industry) increased by 5.5 points between 2013 and 2015, following a levelling off between 2003 and 2013.**

[55] See: https://www.gov.uk/government/collections/agricultural-technologies-agri-tech-strategy

Is there a plan?

There is no overarching plan that considers the range of risks and opportunities for the agricultural sector in England from climate change.

Habitat condition, soil and water management are central to ensuring that the future production of crops and livestock is resilient to climate change. Relevant plans for managing these aspects of natural capital are discussed above.

The Agri-tech Strategy aims to support the development and deployment of agricultural technologies in the UK, which among other things should help to improve the resilience of the farming sector to climate change through, for example, diversifying the genetic composition of crops grown, and improving control measures for pests and diseases.

However, an overarching plan does not exist that considers how to build resilience of the agricultural sector more widely, taking account of possible broader risks to the food system from climate impacts on supply chains and trade. The previous Government's proposed 25-year food, farming and fishing plan could achieve this, but plans for its publication remain unclear. The Government could also consider the issue in its review of the UK Food Security Assessment (see *Chapter 6: Business*).

Are actions taking place?

All of the actions for this priority in the NAP focus on research and providing support and tools for farmers.

In 2016, 24 new projects worth £16 million were funded under the Agri-tech Catalyst programme, concentrating on food security, weed control and livestock diseases. [56] Five projects will target challenges in developing countries, including improving methods to detect the incidence of carcinogenic mould toxins in food crops, which was identified as a food safety risk in CCRA2. Defra is also continuing to fund research through the Sustainable Intensification Research Platform on improving agricultural practices, supporting decisions at a landscape scale and balancing economic, environmental and social requirements.

Under the ERA-NET Plus action 'Climate Smart Agriculture: Adaptation of agricultural systems in Europe', BBSRC is funding a series of projects to develop resilience in crop and livestock systems.

The Environment Agency and NFU have been collaborating on the development of a Farm Business Resilience Health Check Tool, for farmers to assess their vulnerability to a range of impacts from climate change. Phase 1 of the tool is now complete and work is in progress to roll it out more widely.

A NAP action to promote resilient livestock systems with a focus on dairying has been revised to shift attention to pigs, which are considered more at risk from high temperatures. The 2016 Countryside Productivity Scheme under the English Rural Development Programme is providing grants for farmers to purchase sensors, hardware and associated software to monitor and control temperature, humidity, ventilation and electricity consumption in buildings for housing pigs.

Two actions have not been updated by Defra. One relates to work with the European Commission to monitor new and emerging livestock diseases. The other relates to work by Defra

[56] See: https://www.gov.uk/government/news/16-million-for-new-technologies-to-improve-global-food-production-and-security

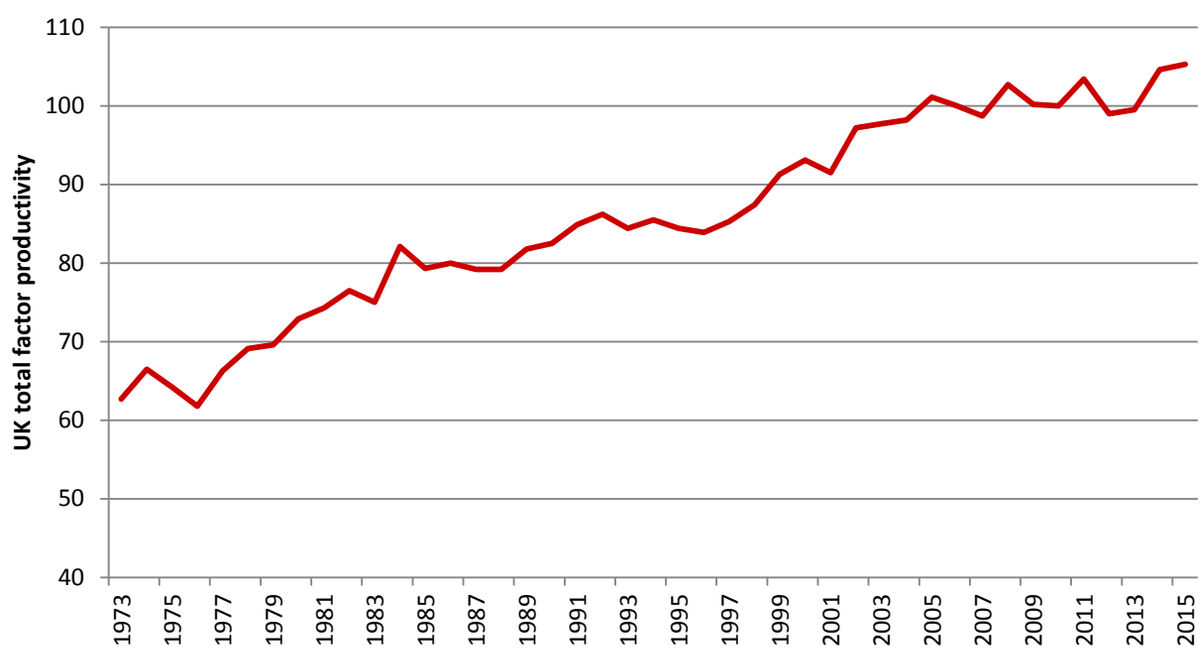
to consider which plant pests and diseases relate to poorly managed adaptation of invasive non-native species.

Is progress being made in managing vulnerability?

Positive recent trends in total factor productivity suggest that the overall efficiency of the UK agricultural system is continuing to increase.

Total factor productivity (TFP) is an important overarching indicator of the level of efficiency of the agricultural sector. A past slowdown in the rate of increase in TFP for the UK agriculture sector has been linked to a levelling-off of expenditure on applied R&D.[57] TFP is used in this report as a proxy indicator for the uptake of research by, and the technological capability of the sector, and thus of vulnerability. Between 1993 and 2003, TFP increased at an annual rate of 1.33 points per annum, before slowing to a rate of 0.18 points per annum between 2003 and 2013. However, it has accelerated again since 2013 (Figure 3.6), and has been increasing at an annual rate of 2.75 points (a total rise of 5.5 points between 2013 and 2015). This may in part be due to the Agri-tech Strategy, although an evaluation of its impact, recommended by the ASC in 2015,[58] has not yet been conducted.

Figure 3.6. UK total factor productivity, 1973 - 2015



Source: Defra agricultural statistics: https://www.gov.uk/government/statistics/total-factor-productivity-of-the-agricultural-industry

The amount of investment in agricultural R&D can be used as another indicator of vulnerability. R&D investment, combined with adequate knowledge transfer can lead to increases in TFP and

[57] Thirtle and Holding (2003). *Productivity of UK agriculture: causes and constraints.*
[58] 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'.

an improved ability to manage pests and diseases, including through changes in species composition of crops and livestock. Data on UK public R&D investment has previously been available through the OECD, but has not been updated since 2015. Some data on private sector R&D for agriculture, hunting, forestry and fish together is available from the Office of National Statistics, and shows high levels of inter-annual variability, though with an increase in spend of about £20 million since 2013 (to £140 million per year).[59] Separately, statistics collected by Defra show for example that, in 2012/13, £320million was estimated to have been invested by the public sector and £496 million by the private sector in agri-tech R&D. The ONS and Defra estimates vary significantly, due to differences in data collection methods, the sectors covered and the time periods considered.

Forestry

Is there a plan?	Green	The Forestry and Woodlands Policy Statement in 2013 committed the Government to work with the forestry sector to improve its resilience to climate change. The Forestry Commission's Climate Change Action Plan for Public Forests has been revised, and should be published shortly.
Are actions taking place?	Amber	Most NAP actions are complete or on track, with some revisions to original objectives. The proportion of forests under active management in England has increased to 58%, although the Forestry Commission's 2018 target of 66% is unlikely to be met. The British Woodland Survey in 2015 showed low take up of adaptation actions by forest managers (<25% were found to be actively taking measures to adapt). Active management of forests is required to reduce their vulnerability to climate change.
Is progress being made in managing vulnerability?	Amber	**While the variety of conifer species being planted on the public forest estate has increased to improve resilience to pests and diseases and changing climatic suitability, this has not been the case for broadleaf species.**

Is there a plan?

Plans are in place to increase the extent of woodland, improve the level of active management, and to enhance the management of pest and disease risks.

The Government's Forestry and Woodlands Policy statement in 2013 included commitments to work with the forestry sector to improve resilience to pests and diseases, and to increase the area of woodland under active management to 66% by 2018. There was also a proposal to increase the total area of woodland in England by 5,000 hectares per year (see Section 3.2).

[59] See: https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/timeseries/ldin/berd

The Forestry Commission's Climate Change Action Plan for Public Forests ended in 2016. It has subsequently been revised and is due to be published shortly.

Are actions taking place?

All eighteen NAP actions related to forestry, comprising a mix of practical action, research and capacity building, are on track. Targets to increase the active management of woodland are likely to be missed.

Since 2011, the percentage of woodland under active management has increased from 52% to 58%, but has remained static over the past 18 months. It is therefore likely that the goal to reach 66% by 2018 will be missed. The Forestry Commission is planning to review progress in 2018.

The England Woodland and Timber Partnership (EWTP) originally had a NAP action to prepare a climate change action plan for privately managed forests. The EWTP was disbanded in 2014, but the Forestry Commission has subsequently worked with over 30 organisations to produce a Climate Change Accord, published in 2015.[60] The British Woodland Survey in 2015 showed that fewer than 25% of land managers were taking measures to adapt to climate change, though the partners involved in the Accord are hoping to increase this number. The Forestry Commission is also reviewing the UK Forestry Standard to improve its usability.

To support efforts to increase tree planting, the Forestry Commission has developed an approach to identifying and mapping areas that are most suitable for large scale woodland creation. The analysis was initially conducted for Northumberland and Cumbria, but is now being rolled out nationally. The analysis reveals that there are ~2 million hectares of land across the country that could be suitable.

The Tree Health and Plant Biosecurity Research Initiative has entered a third phase (2016 - 2020), and is funding projects to investigate the changing risk and possible management of Sudden Oak Death (caused by *Phytophora ramorum*).

Is progress being made in managing vulnerability?

While the diversity of conifer species being planted on the Public Forest Estate has increased, the number of different broadleaf species being planted has remained static.

Increasing the diversity of tree species in new plantings is an important adaptation strategy designed to reduce threats from pests and diseases, and to help manage uncertainties around the suitability of particular species to future climate conditions.

According to the latest data from the Forestry Commission, the number of species of conifer being planted on the Public Forest Estate in England has increased, from eight in 2012/13 to 18 in 2015/16, including 'alternative' species such as Atlas Cedar, Weymouth and Maritime Pine. The same trend has not been observed for broadleaf species. According to the Forestry Commission, this is because of the minimal range of alternative broadleaf species available and a focus on native species to maintain and restore priority habitats. Around 18 broadleaf species have accounted for the great majority of plantings over between 2012/13 and 2015/16, with the percentage of oak and birch increasing from 49% to 61% of total new plantings over this period.[61]

[60] See: https://sylva.org.uk/forestryhorizons/environmental-change
[61] Data provided directly by the Forestry Commission.

Notable changes in planting regimes have been made, however, in response to threats from pests and diseases. Planting of ash has stopped altogether in response to the Chalara outbreak, and Corsican pine has not been planted over this period due to the risk from Dothistroma needle blight. Import notification is also required for some species such as oak, pine, elm, sweet chestnut and Prunus species (cherry, peach, plum) as a result of concerns over pest and disease threats from abroad.

The Forestry Commission in its second report under the Adaptation Reporting Power raised the issue of a lack of clarity on how genetic variation should be factored into decisions on planting broadleaf species. The evidence is to be reviewed, followed by the drafting of a 'policy position statement', to give Forestry Commission England (and Natural England) field staff updated guidance.

Fisheries and aquaculture

Is there a plan?	Red	There is no plan set out in the NAP or elsewhere for improving the resilience of marine fisheries and aquaculture to climate change.
Are actions taking place?	Amber	There are no NAP actions that directly relate to this priority. Seafish (the industry body for the seafood sector) has produced a report under the Adaptation Reporting Power that sets out actions currently being taken by the fishing industry in response to climate change.
Is progress being made in managing vulnerability?	Amber	**The proportion of UK fish stocks that are sustainably managed varies over the long-term but remains low, at about 30%. Other vulnerability indicators would be useful to develop.**

Is there a plan?

There are currently no plans in place that consider how the fishing and aquaculture industries can best adapt to climate change. Replacement policies for the Common Fisheries Policy should include consideration of how to improve the resilience of the fishing sector to climate change.

While plans exist to improve the resilience of marine and coastal habitats and species, there is no specific plan in the NAP or elsewhere that focuses on improving the resilience of commercial fisheries and aquaculture, including fish farming and shellfish production. The previous Government committed to a 25-year food, farming and fishing plan, but its status under this Government is unclear.

The EU Common Fisheries Policy (CFP) is the current overarching policy for the fishing industry in the UK. It aims to achieve sustainable maximum yields across a number of fish species, which if achieved would provide some degree of resilience to climate change. The CFP sets total allowable catches and the allocation of those catches between Member States as well as regulating certain non-quota stocks. Under the CFP, fishing vessels from other EU countries can access UK waters and vice versa. The CFP as such cannot therefore be directly transposed into UK law. Fish species move freely between different countries' waters, and distributions will

change in response to climate change, warming seas and other factors. What happens to fish populations in the seas around Europe will impact UK fisheries. There are a multitude of issues to be considered in working through how UK fisheries policy will operate after the UK leaves the EU.[62] From an adaptation point of view, any new policies will need to achieve at least two key things: sustainable yields for individual species; and flexibility through time in what species are caught, to mirror the changing species diversity and abundance in UK waters as the climate changes.

Are actions taking place?

There are no NAP actions related to improving the resilience of commercial fisheries and aquaculture.

Outside of the NAP, the Seafish Industry Authority (Seafish) has produced a report under the Adaptation Reporting Power. The report outlines a number of actions being taken by the wild-caught fishing industry in response to the risks from climate change, including:

- Setting up fisheries science partnerships to improve dialogue between scientists and industry representatives.
- The inclusion of training modules on environmental awareness within Seafish's 'Introduction to Commercial Fishing' training course.
- Establishing port emergency operating guidelines to deal with severe weather.
- Improving vessel safety for fishermen during severe weather through ensuring appropriate equipment is on board, and training.

Seafish has also developed an action plan for future reporting cycles that aims to improve the state of knowledge on climate change within the industry, further improve port and vessel risk management strategies, and review quota allocations and fishing seasons in response to climate change over the longer-term.

There is no information currently on the adaptation measures being taken by the aquaculture and fish farming industries. Work on this could be conducted as part of the next NAP.

Is progress being made in managing vulnerability?

It is difficult to measure progress in this area as indicators of vulnerability and action within marine fisheries and aquaculture are limited.

Wider indicators of the sustainability of the fishing industry provide a useful insight into resilience to climate change. If fisheries are not resilient to current pressures, they are likely to be vulnerable to the increased pressures expected as a result of climate change. The proportion of UK marine fish stocks that are managed at full reproductive capacity and being harvested sustainably varies over the long-term but is currently at around 30%.[63]

For aquaculture, the amount of freshwater abstracted for fish farming provides a useful indicator, as this represents a significant proportion of non-tidal water abstractions in England. The absolute volume of water abstracted has declined from around 1,700 million cubic metres in 2000 to around 900 million cubic metres in 2014. Abstraction for fish farming has fallen from

[62] For example, see: https://www.instituteforgovernment.org.uk/EU exit-explained/common-fisheries-policy
[63] England biodiversity indicators 2015 update, https://www.gov.uk/government/statistics/england-biodiversity-indicators

14% to 10% of overall freshwater abstraction.[64] It is not clear how much of this water is consumed and how much is returned to the environment.

Further indicators that would be useful to develop include the diversity of fish species caught and sold on the market, and the level of bycatch. It would also be helpful to monitor pest and disease incidence within farmed fish and commercial shell fisheries over time.

RECOMMENDATION 8: *Goals and actions to achieve sustainable yields by 2030 should be included in new policies that will replace the Common Fisheries Policy. Indicators of sustainable management should also be reviewed to ensure they take account of changing distributions of fish species due to climate change. (Owner: Defra. Timing: by 2019).*

3.6 Progress against NAP objectives

Table 3.2 below summarises progress against the objectives listed within the NAP for the Natural Environment, and Agriculture & Forestry themes. In general, the objectives describe a number of processes and list actions that aim to improve the direction of travel in current indicators of vulnerability.

Of the 136 actions in the two relevant themes of the NAP:

- 59 (44%) are complete;
- 49 (36%) are on track;
- 10 (7%) have been revised or delayed, and
- 4 (3%) have been dropped.

Updates were not received on the remaining 14 actions (10%).

93 (68%) of actions in the NAP for these themes are time-bound, with the remaining 43 (32%) classed as 'on-going'.

As set out in our last progress report in 2015, the objectives for the natural environment, agriculture and forestry themes of the NAP focus on reversing historic declines in the direction of travel, i.e. increasing resilience compared to a present-day baseline. Similarly, the ASC's assessment of vulnerability looks at trends for a series of indicators, but unless there are relevant government targets, we do not currently specify recommended outcomes that should be achieved for the natural environment. Further work should be undertaken to consider what outcomes, success measures and indicators would improve the assessment of resilience, to include in future ASC reports and the second National Adaptation Programme.

[64] Defra abstraction statistics, https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables

Table 3.2. NAP objectives for the natural environment, and agriculture and forestry, themes	
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 runoff.	16 NAP actions (12% of the total number included in this chapter) fall under this objective, all of which are on track or complete. Defra and the Environment Agency have focussed on promoting efficient water use through abstraction reform, are undertaking further research to assess the costs and benefits of different water management measures, and are supporting farmers to use water most effectively. In order to measure how resilience is changing, it is necessary to consider overall water use and availability. Since 1960 there has been no clear trend in summer or winter low flows. There is also no obvious increase or decrease between 2000 and 2014 in water abstraction for agricultural use, spray irrigation, or in crop losses due to drought or flooding. Environmental flow indicators will provide a measure of the success of abstraction reform and other activities in managing vulnerability in the future, as they will show the amount of stress placed on the natural environment by water scarcity.
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.	All 12 NAP actions for this objective are complete or on track. The Forestry Commission has worked with a variety of partners to implement actions from the Government's Forestry and Woodlands policy statement, and has placed particular emphasis on increasing the area of woodland being actively managed, in order to support adaptation efforts. The proportion of forests under active management, which now stands at 58%, continues to increase, although the Forestry Commission's 2018 target of 66% is unlikely to be met. The British Woodland Survey in 2015 showed low take up of adaptation actions by forestry managers (<25% are actively taking measures to adapt). The Forestry Commission and other partners are hoping to increase take up through the Climate Change Accord.

Table 3.2. NAP objectives for the natural environment, and agriculture and forestry, themes

NAP objective	Commentary on progress
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.	11 of the 13 NAP actions for this objective are complete or on track. The majority of actions relate to improving the knowledge base of how climate change will affect pest and disease incidence, and embedding environmental change in risk assessments for pests and diseases. No updates have been provided for two NAP actions owned by Defra related to the monitoring of agricultural pests and diseases. Measuring how vulnerability to pests and diseases is changing for biodiversity and agriculture is challenging, due to a lack of suitable vulnerability indicators. Indicators of species diversity in the forestry sector show that the variety of conifer species being planted on the public forest estate has increased (from eight to 18 over the past four years), but this has not been the case for broadleaf species.
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.	All nine NAP actions for this objective are complete or on track, with most of the research highlighted in the NAP action updates due for completion between 2017 and 2019. Research topics under this theme include improving understanding of soil function, valuation of impacts of extreme weather on crop and livestock systems, and how genetic traits in plants and animals can affect resilience to climate change. Evidence is not available on the outcomes of these research programmes in terms of contributing to the development and uptake of climate resilient crops, tree and livestock species. An evaluation of the Agri-tech strategy, which is still outstanding, could seek to derive evidence on the impact of R&D on crop and livestock resilience and use of new technologies. Individual project reviews that look at their impact on decision makers would also be valuable, once the research under this objective is complete.
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.	A large amount of action is underway for this objective, which contains 48 actions covering terrestrial, freshwater, marine and coastal ecosystems. Of these, 44 are complete or on track. Many of the actions relate to producing tools and guidance for land managers, improving site-level assessments of vulnerability, and implementing the actions set out in the Biodiversity 2020 strategy. Four actions have been revised or dropped due to organisational changes, similar work being carried out elsewhere, or a lack of resources. Despite the considerable level of activity, the condition and extent of most habitats is not improving at the rate needed to meet current targets, and species numbers continue to decline in many cases, as set out in detail in this chapter.

Table 3.2. NAP objectives for the natural environment, and agriculture and forestry, themes	
NAP objective	**Commentary on progress**
Objective 20. To take action to help wildlife, habitats and ecosystems accommodate and smoothly transition through inevitable change.	This objective has 11 associated actions, all but one of which are complete or on track. Natural England has focussed on improving its assessment of vulnerable habitats, and undertaken work to consider how to include greater flexibility in site designations to account for climate change. One action for National Parks to update their adaptation reports under the second round of the Adaptation Reporting Power has been revised - not all parks were able to take part in Round 2 due to resource shortages. It is not currently possible to assess how these and other actions have contributed to helping wildlife, habitats and ecosystems to accommodate change. Further work is needed in the future to assess how this can best be measured.
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.	This objective contains 12 actions, nine of which are on track or complete. Actions include work to pilot payments for ecosystem services, efforts to increase the uptake of blue and green infrastructure in urban areas, and to incentivise peatland restoration through the Peatland Code. No updates have been received for three actions related to the work of the Green Infrastructure Partnership, how public bodies are taking into account the need to conserve biodiversity in exercising their functions, and work by the Crown Estate to build resilience to wildfire. It is unclear how far the actions have succeeded in driving a wider uptake of the use of adaptation measures in other sectors, as this has not been reported.
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.	All sixteen NAP actions related to this objective are on track or complete. The vast majority of relevant research projects under this theme have been published, including the Living with Environmental Change (LWEC) climate impact report cards on biodiversity and water, and a 5-year, £14.5 million programme on ocean acidification. As with the other objectives, there is a lack of evidence to assess how these actions have contributed towards achieving the stated objective. Further work to evaluate the outcomes of the various research projects would be valuable.

Chapter 4: People and the built environment

Key messages

Context

The built environment in which people live and work determines, to a large extent, their vulnerability to weather and climate events, such as flooding and increased temperatures. The vast majority of people in England live in built-up areas, with about 91% of the population in cities and towns. Adaptation in the built environment is therefore essential to manage the climate risks to health and wellbeing. The second UK Climate Change Risk Assessment (CCRA2) concluded that urgent action is required to manage risks to people from flooding and higher temperatures. CCRA2 also pointed out that a long-term approach to planning and designing the built environment creates opportunities to manage these risks in a cost-effective way, whilst improving wellbeing. For example, green spaces contribute to reducing surface water flooding and overheating risks, as well as potentially reducing obesity, and improving mental health and air quality. Informed local planning can deliver more resilient communities, whilst also reducing greenhouse gas emissions.

Summary of progress

Since 2015, progress has been made in adapting the built environment to climate change, in particular in managing river and coastal flooding and reducing water use in homes. However, the vulnerability of communities to climate change is still increasing. While there are some examples of good practice, actions to manage surface water flooding are still not commensurate with current, and future, risk. Local planning policies and building regulations are not delivering the resilience to higher temperatures and extreme rainfall that will be needed.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	**Is progress being made in managing vulnerability?**
1. River and coastal flood alleviation	Green	Green	Green
2. Development in areas at risk of river and coastal flooding	Green	Green	Amber
3. Surface water flood alleviation	Amber	Amber	Red
4. Development and surface water flood risk	Red	Amber	Red
5. Property-level flood resilience	Amber	Green	Red

Key messages

6. Capacity of people and communities to recover from flooding	Green	Green	Amber
7. Coastal change risk management	Green	Green	Amber
8. Water demand in the built environment	Amber	Green	Green
9. Health impacts from heat and cold	Red	Green	Amber
10. Pathogens, air quality and UV radiation	Green	Green	Amber
11. Effectiveness of the emergency planning system	Green	Green	Amber

Note: See Annex 2.1 for a description of the criteria used to assign Red-Amber-Green (RAG) scores.

Most of the relevant actions listed in the National Adaptation Programme (NAP) have been completed or are on track. Significant progress is being made in managing river and coastal flooding, and improving water efficiency in homes:

- **Investment in flood alleviation schemes has increased** since 2015, and between now and 2021 is consistent with the most recent assessment of long-term funding needs. Between April 2015 and April 2017, 97,000 homes in England benefited from new or replacement flood defences. Whilst flood defences have required additional maintenance due to damage from recent flood events, the condition of flood defences is, on the whole, improving, with the Environment Agency achieving its target for 97% of 'high consequence' flood defences to be in the required condition by the end of March 2017.
- **A new Property Flood Resilience Action Plan has been developed** as part of a review commissioned by Defra (the 'Bonfield Review'). Within the action plan, Defra has adopted a vision of achieving, in five years' time, an 'environment where it is standard practice for properties at high flood risk to be made resilient'. This is a challenging ambition, yet necessary given that **at least 153,000 households currently at high risk are not cost-beneficial to protect with flood alleviation schemes**, but could potentially benefit from steps to improve their resilience during floods. This number is expected to increase to more than 217,000 households by the time Flood Re is withdrawn in 2039.

Key messages

- **Household water consumption per person has continued to decline** from 155 litres per person per day (l/p/d) in 2003/04 to 139 l/p/d in 2015/16, in line with the target for 2020 of 137 l/p/d. Water companies have implemented a range of actions to reduce household water demand, including encouraging the uptake of water metering. More than 45% of households in England now have water meters installed, compared to 43% in 2013. A recent Water UK assessment highlighted that more ambitious targets to reduce household consumption are needed to manage future risks of water shortages.

However, some of the priority risks identified by CCRA2 are still not being managed at the necessary scale, including those from high temperatures and more intense rainfall.

- While there is extensive guidance, **there remain no legal requirements in place to adapt the built environment** (including homes, hospitals, care homes, schools and prisons) **to mitigate the impact of increasing temperatures**. The absence of building or other regulations that require overheating risk to be addressed by developers is cited by building professionals as one of the main reasons why overheating is not consistently taken into account in new building design.
- **Efforts to address surface water flooding need to increase.** There is evidence that rainfall patterns in the UK are intensifying, with the existing drainage and public sewerage network already under severe pressure in some areas. Responsibility for dealing with this issue is fragmented between water companies and different local authority functions. There are no plans currently in place to prepare for the long-term investment that will be needed.
- **New development is increasing the risk of surface water flooding.** A recent CIWEM survey of 500 industry experts highlighted a lack of confidence in the current policy, and the accompanying non-statutory national standards, that aim to promote sustainable drainage systems (SuDS) in new development. Developers appear to prefer building 'grey' underground systems that are less resilient to future changes in rainfall and do not provide environmental co-benefits. Use of SuDS is also inhibited by the continuing lack of clarity regarding who should be responsible for their adoption and maintenance.
- **Shoreline Management Plans** identify areas where existing defences will become unsustainable or not cost-effective to maintain by the 2030s, 2060s and 2100s. This will have significant implications for some stretches of coastline, but **the affected communities have not yet been seriously engaged in adaptation planning** and need to long before coastal defences become unsustainable.
- Evidence gathered from members of **Local Resilience Forums** (LRFs) suggests that their capacity to respond to emergencies has been severely tested by recent flood events, including Storm Desmond in December 2015. Whilst LRFs say they have made the best use of the resources available to respond to past events, they **are not confident that they could cope with events more severe than those experienced to date**, especially given diminishing resources.

Recommendations for further progress

More ambitious and rigorous policies, plans and implementation activity are needed to manage the increasing risks from surface water flooding and overheating. Stronger action is also needed to help people prepare for coastal change and for the staged withdrawal of the Flood Re subsidised insurance scheme from 2021.

RECOMMENDATION 12: *More and better co-ordinated action is needed to manage the lack of capacity within drainage systems to cope with possible increase in the frequency and severity of heavy rainfall. Defra and the National Infrastructure Commission should initiate a comprehensive assessment to quantify the need for investment and other policy actions to manage surface water flood risk, including, but not limited*

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to, retrofitting SuDS. Urgent investments need to be considered by water companies and Ofwat as part of the 2019 price review, and the comprehensive assessment should be in place to inform local planning policy and major investment decisions in the 2024 price review. (Owner: Defra. Timeline: as above).

RECOMMENDATION 13: *Policy is needed urgently to address the outstanding barriers to deliver high quality, effective SuDS in new development that achieve the full range of potential environmental co-benefits. In particular, there is a need for:*

- *More comprehensive and ambitious national standards for SuDS.*
- *The automatic right to connect new development to the existing sewerage network to be made conditional on the national SuDS standards being met.*
- *A clear policy on who should maintain and adopt SuDS by default.*

(Owner: DCLG. Timing: by 2019).

RECOMMENDATION 14: *Defra should develop a long-term strategy to manage flood risk down to tolerable levels in each part of the country (as we first recommended in 2015), so that as Flood Re is withdrawn properties can remain insurable at reasonable cost. This should include:*

- *Monitoring the impact of the actions adopted following the Bonfield Review to achieve, in five years' time, an 'environment where it is standard practice for properties at high risk to be made resilient'.*
- *Actively communicating the risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s.*
- *Ensuring that Flood Re incentivises households to take up property-level resilience measures, which insurers should allow to be implemented during post-flood repairs.*

(Owner: Defra. Timing: by 2020).

RECOMMENDATION 15: *The Environment Agency, with Coastal Groups, should review the ambition within, and progress being made in implementing, Shoreline Management Plans (SMPs), and prepare communities for the coastal adaptation that will need to take place between now and the middle of the century. (Owner: Environment Agency. Timing: by 2020).*

RECOMMENDATION 16: *As recommended in our 2015 report, a standard or regulation should be put in place to reduce the risk of overheating in new homes. (Owner: DCLG. Timing: by 2020).*

RECOMMENDATION 17: *Further action should be taken to assess and reduce the risks of overheating in existing buildings, with the priorities being hospitals, schools, care homes and prisons. This could be undertaken for example through the relevant standards agencies such as the Care Quality Commission and Ofsted. (Owner: Department of Health, Department for Communities and Local Government, Department for Education, Department for Justice. Timing: by 2020).*

RECOMMENDATION 18: *The Cabinet Office should, in consultation with Local Resilience Forums:*

- *Commission an independent review of the planning scenarios underpinning local Risk Registers to ensure they i) they are consistent with plausible worst case scenarios, and ii) use the results to help LRFs assess the resources needed to manage these events.*
- *Strengthen the Emergency Planning Guidance to clarify and test responsibilities for coordination amongst Category 1 and Category 2 responders, as well as between neighbouring LRFs.*

(Owner: Cabinet Office. Timing: by 2020).

4.1 Climate change and the built environment

The second UK Climate Change Risk Assessment in 2017 (CCRA2) concluded that people's vulnerability to weather and climate events is to a large extent determined by the built environment.

The vast majority of people in England live in built-up areas, with about 91% of the population living in cities and towns.[65] The built environment has a strong influence on how climate change will impact upon people and communities. For example, the level of flood risk to communities depends on whether houses are built in areas vulnerable to flooding, the level of protection provided by flood alleviation schemes, and whether resilience measures are put in place at the individual household level. Housing quality determines whether people live in damp, excessively hot or cold homes, with the health cost to the NHS of poor housing estimated to be £1.4 - 2 billion per year.[66] The extent of permeable surfacing and urban green space impacts on the quantity and quality of water entering drainage networks and being discharged into watercourses. Green spaces also help to mitigate overheating of built up areas.

CCRA2 also presented evidence that adapting the built environment to these risks reduces physical and economic impacts and achieves health and wellbeing co-benefits.

For example, increasing the amount of green space contributes to reducing surface water flooding and overheating risks, and also helps to reduce obesity in children, improve mental health, and improve air quality.[67] Local spatial planning can deliver greater community resilience to severe weather, whilst also reducing greenhouse gas emissions. For example, local planning policies can ensure that energy efficiency measures help to reduce emissions from buildings, which make up 19% of the national total, as well as encourage measures in new homes to protect people from heat and cold. There are many national and international examples of communities that are managing climate change risks, reducing their emissions and increasing the liveability of the built environment (see Box 4.1).These examples show that national and local government are instrumental in making them happen through supportive policies and in some cases funding.

Box 4.1. Examples of climate resilient design contributing to community wellbeing

Amsterdam

In 2015, Amsterdam adopted a comprehensive sustainability agenda to tackle climate change risks, reduce greenhouse gas emissions, improve air quality, and enhance the city's natural resources. The approach defined objectives, with quantitative targets, and the required investments to achieve them.[68] Based on the economic return of these investments, for example through the savings that energy efficiency projects generate or in reducing flood damages, low-interest loan schemes were set up. These loans provided initial capital to projects that would not qualify for traditional financing either by being considered too innovative or because they are too small. This has resulted in more projects

[65] According to Defra's *Official Statistics on Rural population 2014/15* (2016), excluding people living in sparsely populated areas, 83% of the English population lives in cities and urban towns and 9% in rural towns, villages and hamlets.
[66] Select Committee on National Policy for the Built Environment (2016) *Building Better Places*.
[67] Kovats, R.S., Osborn, D., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.
[68] City of Amsterdam (2015) *Sustainable Amsterdam*.

Box 4.1. Examples of climate resilient design contributing to community wellbeing

incorporating adaptation and mitigation being delivered. To qualify for such loans, projects need to demonstrate that they can deliver against specific sustainability outcomes.[69]

North West Bicester 'Eco-town'

The town of Elmsbrook is the first phase of a Masterplan to create up to 6,000 new eco-homes in North West Bicester.[70] These homes are being equipped with measures to reduce surface water runoff and improve water quality, such as green roofs and walls, to achieve water neutrality by collecting and recycling water, and to produce zero net carbon emissions. This development was initially aimed to fulfil the Eco-town Planning Policy Statement, which was withdrawn in 2009. The development was subsequently supported by Government funding of about £13 million.[71]

Stuttgart 'cool city'

Stuttgart is located in a low-lying area between two river valleys, in one of the most important car manufacturing regions in Germany. Overheating and air quality problems were highlighted in the 1930s, and worsened in the 1970s due to industry intensification and the city's growth. To address this issue, a 'climate atlas' was produced in 1992, identifying areas more prone to overheating as well as those that contribute to air circulation - the so-called ventilation corridors. Since then, spatial planning has taken into account the impact that new development has on overheating. For example, local policies do not allow new construction to take place in ventilation corridors, require buildings to be surrounded by green spaces, and provide for interconnected green areas to be created and protected. Passive cooling has also been introduced in public buildings such as the city library and main station. Green roofs are required for all new buildings, and a financial support program for green roofs has been in place since 1989.[72]

Sources: see footnotes.

4.2 Flood risk management and climate change

In 2015, the ASC said a long-term strategy was needed to address the increasing number of homes and other properties expected to be at high flood risk in the coming decades. CCRA2 identified flooding and coastal change as one of the six priority risks for which more action is urgently needed.

Since our last ASC Progress report in 2015, severe flood events have affected the UK. In December 2015 and January 2016, 17,000 properties were flooded as storms Desmond, Eva and Frank passed through the UK. Cumbria was particularly affected. The newly-built flood defences in Carlisle were overtopped, flooding 2,000 homes. In September 2016, widespread thunderstorms and intense bursts of rain caused surface water flooding in Manchester, Cornwall, the Thames Valley, Surrey and Hampshire.[73] In January 2017, severe flood warnings were issued across the East Coast and thousands of residents in Lincolnshire, Norfolk, Suffolk and Essex were asked to evacuate their homes until a life-threatening tidal surge had passed.

[69] C40 Cities (2016) *C40 Cities Good Practice Guide – City Climate Funds*.
[70] See: http://nwbicester.co.uk/
[71] See: http://www.cherwell.gov.uk/index.cfm?articleid=7975
[72] Kazmierczak, A. and Carter, J. (2010) *Adaptation to climate change using blue and green infrastructure – A database of case studies*.
[73] See: http://www.metoffice.gov.uk/climate/uk/summaries/2016/september

The Environment Agency estimates that one in six properties in England is at risk of being flooded from river, coastal and/or surface water. This corresponds to 2.6 million properties at risk of flooding from rivers and the sea, and 3.2 million properties at risk from surface water flooding.[74] About 660,000 properties are at risk from surface water flooding and river or coastal flooding. The annual average damages from flooding are estimated to be about £860 million from rivers and the sea, and £290 million from surface water.[75] CCRA2 estimated that average annual damages would rise by between 22 and 78% by the 2050s, and between 47 and 160% by the 2080s, depending on the climate scenario adopted. These projections assume no population growth and a continuation of current effort in managing flood risk.[76]

Meeting the challenge of increasing river, coastal and surface water flood risk requires a strategic approach that combines catchment management, flood alleviation schemes, development control, and property-level flood resilience.

In 2015, the ASC called for a more integrated, catchment-based approach to managing increasing flood risk. The Environment, Food and Rural Affairs and Environmental Audit Committees have made similar recommendations in response to recent floods. CCRA2 reiterated that more joined-up action is needed to manage flood risks, especially with climate change.

The need for a comprehensive approach to flood risk management was previously identified in the Government's Foresight Flooding report, published in 2004. Following this advice, Defra's Making Space for Water strategy in 2005 sought to integrate a wide range of environmental, social and economic factors to cost-effectively manage flood risk, taking a systems approach. However, the National Flood Resilience Review launched in response to the 2015/16 winter floods focused on what could be done to prepare the country for the following winter, and on improving the understanding of river and coastal flood risk in the current climate.[77] The NFRR did not consider longer-term risks nor cover surface water flooding.

Looking forward, Flood Risk Management Plans for the period 2016-2021, required by the EU Floods Directive,[78] assess the risk of flooding from all sources at the catchment scale and set out how relevant authorities should work together, and with communities, to manage flood and coastal risk. In the context of exiting the European Union, Defra is now considering the approach to the second cycle. Preliminary discussions have identified the potential to develop a more integrated approach in high risk catchments, especially where there are likely to be co-benefits such as carbon storage, water quality and biodiversity benefits.[79] The National Flood and Coastal Erosion Risk Management Strategy is also due to be updated by 2019.

Meeting the challenge of managing flood risk in the context of climate change is particularly important given that Flood Re, the subsidised flood insurance scheme, will begin to be withdrawn from 2021 before ceasing altogether by 2039.

The Government and the insurance industry have an explicit focus on the number of homes in areas with more than a 1% annual chance of flooding. This is because some of these properties

[74] Environment Agency (2016) *Managing flood and coastal erosion risks in England: 1 April 2015 to 31 March 2016*.
[75] Environment Agency (2014) *Flood and coastal erosion risk management - Long-term investment scenarios (LTIS) 2014*.
[76] Sayers, P. B. et al. (2015) for the ASC. *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*. https://www.theccc.org.uk/publication/sayers-for-the-asc-projections-of-future-flood-risk-in-the-uk/
[77] HM Government (2016) *National Flood Resilience Review*.
[78] EU Floods Directive 2007/60/EC
[79] National Adaptation Programme (NAP) action update (2017).

might struggle to access affordable insurance in a free market when Flood Re is withdrawn.[80] Currently there are more than 500,000 homes in this risk band (~2% of homes in England, considering river and coastal flood risk only). This number could increase due to the combined impact of climate change, ongoing building in floodplains, and the deterioration of flood defences. The Environment Agency's Long Term Investment Scenarios show that it will not be cost-effective to build community flood alleviation schemes to protect all of these properties. Thus a wider strategy is needed to reduce the impacts of flooding as Flood Re is withdrawn.

The aim of this section is to assess whether progress has been made in reducing the number of properties in areas at more than a 1% annual chance of flooding through:

- Delivering river, coastal and surface flood alleviation schemes, where it is cost-effective to do so.
- Ensuring that new development is well below this risk threshold now and in the future.
- Implementing property-level resilience in areas where flood alleviation schemes are not cost-effective.
- Assessing whether there are barriers for a prompt and full recovery by those who are affected by flooding.

River and coastal flood alleviation

Is there a plan?	Green	The Environment Agency's latest Long Term Investment Scenarios (LTIS) explored the investment trajectory needed to deliver all cost-effective flood alleviation schemes across England over the next 50 to 100 years. Defra's six-year investment plan sets out what it will achieve by 2021, and forecasts a 5% net reduction in expected annual flood damages by then.
Are actions taking place?	Green	Spending over the 2015-2021 period has increased by £700 million following the 2015/16 floods, although a quarter of this sum has yet to be allocated. There is now a new emphasis on catchment-wide approaches, including initiatives such as the Cumbria Flood Action Plan. £15 million was announced for natural flood management projects in November 2016.
Is progress being made in managing vulnerability?	Green	**Flood risk management authorities delivered new or replacement flood defences for 97,000 homes between 2015 and 2017 and are on course to achieve the 300,000 household target by 2021. The Environment Agency is also on track to achieve its target to maintain 97% of 'high consequence' flood defences in the required condition.**

[80] ABI and the NFF (2012) *Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England*.

Is there a plan?

A six-year plan for investment in flood alleviation schemes in England has been in place since 2015. Plans for the period up to 2021 are consistent with the most recent assessment of long-term investment needs.

The six-year programme of investment in flood alleviation schemes started in 2015. By 2021, the programme should deliver 1,500 schemes that benefit 300,000 households, reducing expected annual flood damages by 5%.[81]

According to the Environment Agency's Long-Term Investment Scenarios, spending £750 to £800 million per year (a total of £4.5 - £4.8 billion) represents the most cost-effective expenditure profile between now and 2021. Defra has allocated £2.5 billion in capital funding and £1.4 billion in revenue funding towards the six-year programme. The rest of the funding is due to be raised from other sources through the 'partnership funding' approach.[82]

Guidelines require that catchment-wide options are considered when designing flood alleviation schemes, with an emphasis on working where possible with natural processes.

The Environment Agency guidance for appraising flood risk management schemes, published in 2010, requires schemes to consider a range of options, including those that work with natural processes.[83] The appraisal of such options should take into account the whole range of co-benefits that each option can provide, as well as whether each option is sustainable in the long term.

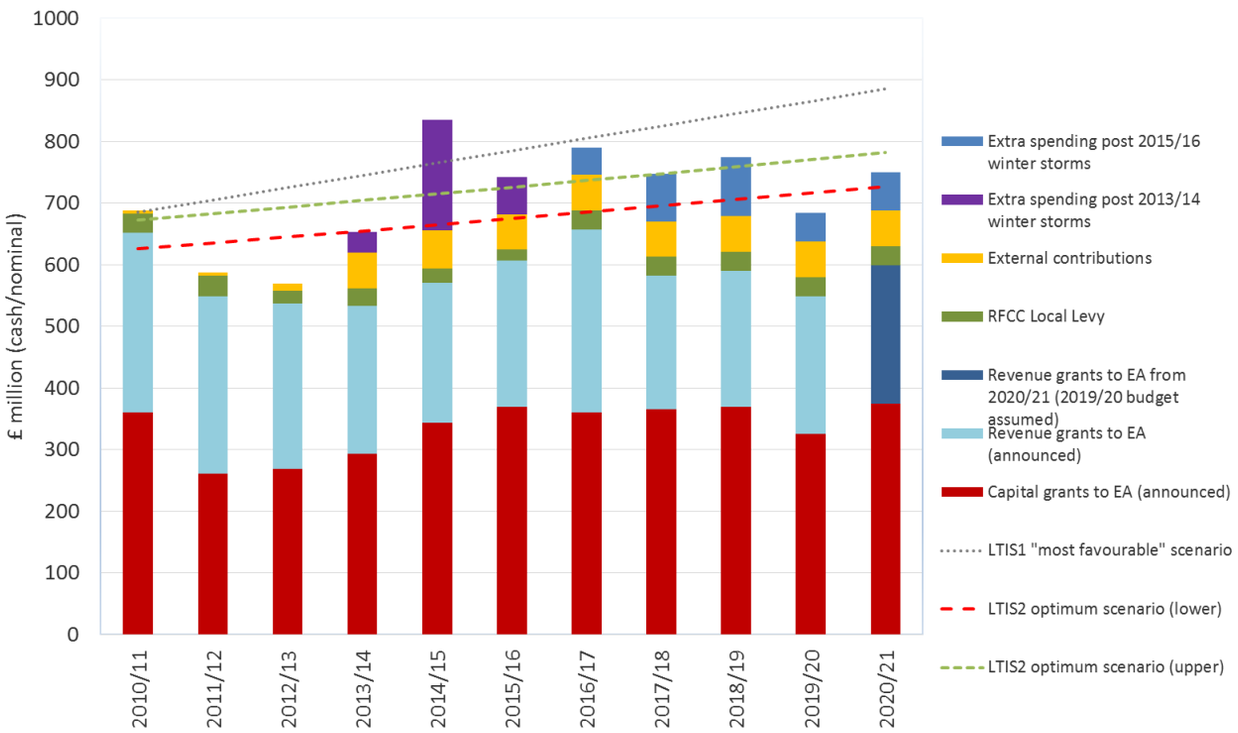
Are actions taking place?

Spending in the six-year programme is now in line with the Government's most cost-effective, long-term investment trajectory (Figure 4.1).

In our previous report[84] we noted that there was underinvestment in flood and coastal defence between 2010 and 2015. In response to flood events in 2013 spending levels were increased. Following the 2015/16 winter flooding, a further £700 million was announced in the 2016 Budget, of which £520 million has been allocated to date.[85]

[81] Environment Agency (2017) *Flood and coastal erosion risk management in England investment programme 2015 to 2021 infographic - updated March 2017*.
[82] See: https://www.gov.uk/government/publications/flood-and-coastal-resilience-partnership-funding-an-introductory-guide
[83] Measures that work with natural process help to manage flood risk whilst improve the environmental condition of rivers, wetlands and coastal areas, both urban and rural. Whilst these measures are not meant to replace traditional schemes, the Environment Agency recommends using them where appropriate as they help achieve wider social and environmental benefits. See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338434/SC130004_R1.pdf
[84] ASC (2015) *Progress on preparing for climate change*, https://www.theccc.org.uk/publication/reducing-emissions-and-preparing-for-climate-change-2015-progress-report-to-parliament/
[85] Communication with the Environment Agency.

Figure 4.1. Spending on flood and coastal erosion risk in England against the long term need



Source: ASC based on Defra (Sept 2016) *Central Government Funding for Flood and Coastal Erosion Risk Management in England*, and Environment Agency (2014) *Long-Term Investment 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 year. 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 lower optimal rate of investment, starting at between £750 million and £800 million in 2014/15.

New or replacement flood alleviation schemes have delivered benefits to 97,000 households since 2015.[86] A large proportion of the investment programme is necessarily focused on replacing existing schemes to maintain current standards of protection, alongside some new schemes in previously undefended areas.

The 97,000 households benefitting from investment since 2015 fall into three main categories:

- Those in previously unprotected areas, now with defences in place for the first time.
- Those already benefiting from defences for which investment was needed or justified to improve the standard of protection.
- Where existing defences were at the end of their service life and needed to be replaced.

[86] Communication with the Environment Agency.

Many of the schemes being delivered, and counted towards the Government's 300,000 'homes better protected' target, will replace or renew ageing defence structures. This is because flood alleviation schemes need periodic upgrades in order to provide a continuing level of protection. During the previous spending period (2011-2015), investment in flood alleviation projects benefitted over 162,000 households.[87] The Environment Agency does not publish a breakdown of this total by the three categories of flood defence project mentioned above.

Is progress being made in managing vulnerability?

The Environment Agency is on course to achieve its target to deliver schemes that benefit 300,000 households by 2021, and to improve the condition of existing flood defence structures so that at least 97% of 'high consequence' assets are in the required condition.

In 2015/16, 111 river and coastal flood alleviation schemes were delivered that benefitted 49,000 households. Two-thirds of these properties were provided with a 1:100 standard of protection or better (39 out of the 111 schemes).[88] A lower standard of protection was provided by 25 schemes (ranging between 1:5 and 1:75). These data show that the residual risk of flooding can be high even for households claimed by the Government as 'better protected'.

The protection provided by the remaining 47 schemes could not be established, as data on the risk of flooding before and after the schemes were built are not available. Without these data it is unclear whether the delivery of flood alleviation schemes by 2021 will achieve the claimed 5% net reduction in expected annual damage.

Climate change was generally factored into the design of recent flood alleviation schemes.

In 2016, the Environment Agency updated the guidelines for designing flood alleviation schemes, reiterating the support for 'managed adaptive approaches'[89] stated in previous guidelines.[90] Almost half (13) of 27 schemes built between 2010 and 2015 reviewed for the ASC incorporated a managed adaptive approach, for example by building larger foundations so defences can be raised in future. Twelve of the schemes adopted precautionary approaches to take into account future climate change. Two of the 27 schemes made no provision for climate change.

The set of options under consideration for large schemes can be narrowed prematurely during the appraisal process, leaving little room for innovative solutions, options that deliver wider co-benefits, or scope to change the risk management approach entirely.

A review by Defra in 2012 found that the final option for two-thirds of flood alleviation schemes was already determined at the start of the appraisal process. In seven of the 27 schemes built between 2010 and 2015 analysed for the ASC, including some large coastal schemes, the choice of the intervention was found to be constrained because the 'new' scheme was an upgrade of a pre-existing scheme. About two thirds of the 27 schemes analysed consisted of a hard engineering structure, four schemes included some element of working with natural processes,

[87] See: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/426724/Agenda_and_papers_for_14_May_2015_board_meeting.pdf

[88] The standard of protection is the annual chance of a flood exceeding the design standard of the flood alleviation scheme, for example by overtopping or breaching a flood defence. An area immediately behind a defence with a 1% standard of protection will have (approximately) a 1% annual chance of being flooded.

[89] Environment Agency (2016) *Adapting to Climate Change: Advice to Flood & Coastal Risk Management Authorities*.

[90] Defra (2009) *Appraisal of flood and coastal erosion risk management: A Defra policy statement*.

and only the remaining six actively worked with natural processes by setting back flood defences, creating salt marshes or lowland fens, and re-connecting floodplains.[91]

Development in areas at risk of river and coastal flooding

Is there a plan?	Green	National planning policy steers development away from flood risk areas. It allows development in flood risk areas only once other alternatives have been considered and then, only by exception**.**
Are actions taking place?	Green	The number of planning applications approved against the Environment Agency's advice remains low.
Is progress being made in managing vulnerability?	Amber	**Development in areas with more than a 1% annual chance of being flooded has increased and there is the potential for 90,000 new homes to be built in the next five years in these areas. Although most of these developments will be in line with the Environment Agency's advice, this level of development will add to future flood risk.**

Is there a plan?

National planning policy steers development away from flood risk areas. It allows development in these areas only once other alternatives have been considered and then, only by exception.

Local Planning Authorities (LPAs, consisting of unitary and district councils) need to identify sufficient development sites to meet local housing requirements. A Strategic Flood Risk Assessment is carried out to assess the flood risk to all the sites that the authority has identified for development, including those brought forward by private landowners.[92] Sites with more than a 1% annual chance of flooding from a river, and more than a 0.5% annual chance of coastal flooding, can be allocated for development only if there are insufficient sites at lower flood risk to meet housing targets (the 'sequential test'). To gain planning permission developers need to demonstrate that occupants of houses built in these areas will be safe during the development's lifetime and that the development does not increase flood risk elsewhere (the 'exception test'). In practice, this means that these houses should be structurally sound, flooding in the area would not pose a risk to inhabitants, and there is a safe means of escape in the event of a flood.[93] The Environment Agency has also developed guidelines to assist developers and Local Planning Authorities to prepare and assess planning applications. These guidelines include specific measures to reduce the risk below the 1% threshold for river flooding, and 0.5% for coastal flooding.[94]

[91] JBA (2017) for the ASC. *Assessment of the impact of recently-built flood alleviation schemes in managing long-term residual flood risk in England.*
[92] DCLG (2014) *Guidance: Housing and economic land availability assessment*.
[93] Based on a 1-in-100 year river flood event (1-in-200 for coastal flooding).
[94] See: https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

In February 2017, the Government published a housing white paper to introduce policies and proposals to address the lack of supply of new homes. The white paper included proposals that could help to clarify some aspects of the NPPF.[95]

It should be noted that new homes built after 1st January 2009 are excluded from Flood Re. This is a useful incentive to ensure new development is located away from flood risk areas or is made sufficiently resilient to be insurable at reasonable cost.

Are actions taking place?

The number of planning applications reported as being approved despite EA objections remains low. However, it is not known if the Environment Agency is consulted on all relevant planning applications. The outcome of about one-third of planning decisions the Environment Agency advises on is also unknown.[96]

Local authorities should consult with the Environment Agency on all planning applications for minor and major developments in areas with at least a 1% annual chance of flooding (0.5% in coastal areas). In 2015/16, the Environment Agency received over 15,700 requests to comment on planning applications, corresponding to about 3% of the planning applications received by Local Authorities over the same year.[97] It is not known whether the Environment Agency is sent all planning applications it should comment on.

Of those received, the EA objected to about 2,600 planning applications on flood risk grounds. It is recommended in planning guidelines that local authorities inform EA of the outcome of applications that it has commented on. Between 2003 and 2015, the Environment Agency was notified of the outcome for two-thirds of the applications it commented on.[98] Of the 2,000 applications for which the outcome is known, 65 (3%) were approved against the Agency's advice. These correspond to less than 200 buildings. The annual percentage of applications going against the Environment Agency's advice has remained around 3% since 2010.

Is progress being made in managing vulnerability?

Development in areas at more than a 1% annual chance of flooding has steadily increased over the last few years. Although it is likely that most of these developments are in line with Environment Agency advice, development at this level of risk should only occur by exception.

The ASC recommended in 2015 that *The Department of Communities and Local Government 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 6). The Government did not agree that such an assessment was needed, quoting the available data at the time that showed 7% of new dwellings in 2013/14 were located in areas with at least a 1%

[95] Proposals include clarifying the NPPF to ensure that: both the Exception Test and Sequential Test need to be passed for an area to be allocated for development; minor developments require both a flood risk assessment and ensure that they do not increase flood risk elsewhere; and that planning policies should consider the cumulative flood risks resulting from separate developments in the same area. See: https://www.gov.uk/government/publications/fixing-our-broken-housing-market

[96] Data from the Environment Agency (2017), see the Technical Annex for this chapter.

[97] DCLG (2016) Planning Applications in England: January to March 2016.

[98] Data from the Environment Agency (2017), see the Technical Annex for this chapter.

annual chance of flooding, lower than the level in 2011.[99] However, in 2015/16 DCLG reported that the percentage had increased to 9%. The Environment Agency has since taken up the ASC's recommendation, and is currently assessing the impact of new development on long-term flood risk as part of work to update their LTIS analysis.

Given the recent rate of development in flood risk areas and the last Government's housing target of building one million new homes, there is the potential for 90,000 new homes to be built in the highest risk parts of the floodplain between 2015 and 2020. The actual level of risk to individual developments will depend on whether defences are in place, the standard of protection they provide, and whether additional resilience measures have been adopted.[100] Flood defences that protect new development will need to be continuously maintained and improved over time if current standards of protection are to be sustained. Even where defences are in place, design standards can be exceeded by extreme weather events.[101] Intensively building behind flood defences means more people and property will be affected by future floods, and increases the exposure of the insurance industry to claims should defences be overwhelmed.[102]

Surface water flood alleviation

Is there a plan?	Amber	Responsibilities and ownership for managing surface water risk remain fragmented, and plans piecemeal: • Lead Local Flood Authorities (LLFAs) are making progress in producing strategies for managing surface water flooding, but 38 out of 152 LLFAs were yet to complete their strategy five years after the requirement was introduced. Defra has published an action plan on surface water management, which focuses on helping LLFAs implement local strategies, but the action plan lacks timescales and resources. • Whilst some water companies have started assessing actions to tackle the lack of capacity of their sewerage networks, it is unclear whether and how this assessment will feed into LLFA strategies.

[99] The percentage of building in the floodplain observed in 2011 is not reported here, as it cannot be directly compared with those observed in 2013, because the two figures were derived using different methods and dataset.
[100] Once flood defences are taken in to account, an estimated 4,600 new homes have been built per year in areas exposed to a 1% or greater annual chance of flooding from river and tidal sources (around 3% of new development in recent years). See our 2015 Progress Report, page 60-66.
[101] For example, recently built flood defences in were overtopped in December 2015, including in Cockermouth and Carlisle.
[102] See: https://www.abi.org.uk/globalassets/sitecore/files/documents/consultation-papers/2004/11/ppg25review.pdf

Are actions taking place?	Amber	Water companies have allocated £6 billion to reduce surface water flood risk over the next five years, and there are many examples of water companies, local councils and transport authorities retrofitting SuDS within the existing built environment to reduce pressure on public sewers. However, the requirements on LLFAs within the Flood and Water Management Act have not yet been fulfilled.
Is progress being made in managing vulnerability?	Red	**Evidence suggests a significant and increasingly severe lack of capacity in the sewer network to deal with heavy rainfall. The scale of the investment to tackle this issue has yet to be assessed.**

Is there a plan?

A recent review carried out by Water UK concluded that responsibilities for managing surface water flood risk need clarifying and that different standards and guidelines need to be aligned.[103]

Responsibilities for managing surface water risk remain fragmented:

- The 2010 Flood and Water Management Act established county and unitary authorities as Lead Local Flood Authorities to take the local leadership role in managing flood risk from surface and ground water, and local watercourses.
- The 1991 Water Industry Act legislated that water companies are responsible for providing, maintaining and operating systems of public sewers and works for the purpose of effectually draining an area. Industry guidance details what 'effectual' drainage means, by defining the minimum capacity of the network.[104]
- The industry regulator (Ofwat) requires water companies to reduce the number of properties with a 10% annual chance of flooding from drains, foul or combined sewer networks.[105] Ofwat also encourages all water companies to charge for surface water drainage services according to impermeable site area.
- Highway authorities are responsible for public drains that collect surface water from local roads.[106]

Lead Local Flood Authorities are responsible for producing strategies for managing surface water and other local flooding, but 38 out of 152 LLFAs had not completed their strategy five years after the requirement was introduced. Defra has published an action plan to help LLFAs implement local strategies, but its expected impact, timeline and resources are not clear.

The Flood and Water Management Act was introduced to implement a number of the key recommendations from the independent Pitt Report on the 2007 floods.[107] One of the

[103] 21st Century Drainage Programme (2016) *Communication document*.
[104] According to this guidance, drainage and combined systems should have the capacity to drain an event with a 3% annual chance of occurring. See: http://sfa.wrcplc.co.uk/
[105] See, for example: Mott MacDonald (2008) *External Review of Sewer Flooding Risk Registers*.
[106] Highways Act 1980.

requirements from the Act was for all LLFAs to produce a local flood risk management strategy. Whilst most of the LLFAs have made progress in implementing the Act, 38 of the 152 LLFAs had not published a strategy by March 2016. Whilst the Act did not specify timescales for compliance, the Government expected local strategies to be produced 'within a reasonable period of time from the commencement of the legislation'.[108] Defra has now said it will consider instructing other risk management authorities to complete the remaining strategies.[109]

The content of the published strategies varies, and in some cases it is not in line with the Act's requirements. For example, 55 of the 90 strategies assessed independently for Defra did not include a cost-benefit assessment of the actions needed to meet the plans' objectives, and 30 included only a partial assessment. 35 out of 90 strategies did not fully specify how and when such actions would be implemented, as is required by the Act.[110]

The ASC's 2015 report recommended that Defra *work*[s] *with local government representatives to improve local flood risk management arrangements (…)* [as] *part of an action plan to tackle surface water flood risk* by the summer of 2016 (Recommendation 3b). Defra accepted this recommendation and in January 2017 published a three-page action plan as an annex to its post-legislative scrutiny report on the Flood and Water Management Act. The action plan focuses on stronger partnership working at the local level, the Environment Agency providing more support to improve the quality of LLFA strategies, and on measures to help identify funding for the projects identified within strategies. The plan does not include a timescale for completion, or the expected impact of improving approaches to manage surface water flood risk.

Whilst some water companies have started assessing actions to tackle the lack of capacity of their sewerage networks, it is unclear whether and how this assessment will feed into LLFA strategies.

Water UK's 21st Century Drainage programme has developed a method to assess actions to tackle the lack of capacity in water company networks. It is not clear whether and how this methodology will be rolled out by water companies or how the outcomes will be fed into local flood risk management strategies.

Are actions taking place?

As well as there being slow progress in producing local flood risk management strategies, other Lead Local Flood Authority duties are also yet to be fulfilled.[111]

When reviewed in 2015, almost half of LLFAs had not yet developed the statutory registers of local flood risk management assets. Knowledge of third-party assets, which could include local SuDS features and water company drainage assets, is particularly important for managing surface water flooding. Some of the registers that had been developed up to 2015 did not include relevant assets owned by third parties.[112]

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[107] Pitt, M. (2008) *The Pitt review: learning lessons from the 2007 floods*.
[108] Defra (2015) Letter from Dan Rogerson to Council Leaders on Local Flood Risk Management Strategies of the 4th March 2015.
[109] Defra (2017) *Flood and Water Management Act 2010: post-legislative scrutiny*.
[110] Maiden, T., Anderson, M. et al. for Defra (2017) *Evaluation of the arrangements for managing local flood risk*.
[111] *Ibid.*
[112] *Ibid.*

The water industry is due to invest £6 billion in improving drainage and combined networks over the current five year asset management period. There are many examples of water companies, local councils and transport authorities retrofitting SuDS within the existing built environment to reduce the amount of water entering the sewer network.

For example, Transport for London has installed green roofs and green walls in some of its stations and depots including Edgware Road, Ruislip and Rotherhithe; is reviewing the drainage in all its road schemes; and trialling permeable asphalt on roads.[113] Thames Water is carrying out a £20 million project to remove around 20 hectares of impermeable paving between 2015 and 2020, and installing rain gardens, swales and other permeable surfaces instead.[114] Sheffield City Council is implementing an EU-funded project to turn 1.3 kilometres of redundant roads into public spaces, including retrofitting rain gardens and a series of interlinked SuDS.[115]

Water companies are also developing Drainage Strategies, in line with guidelines that Ofwat and the Environment Agency issued in 2013.[116] Whilst these strategies focus on company-owned networks, the guidelines require that each water company works with other organisations and contributes to the resolution of wider drainage and surface water flooding issues. However, it is not known how many companies have developed such strategies to date, and what the impact of these strategies will be in managing surface water flooding.

Is progress being made in managing vulnerability?

The available evidence suggests an increasingly severe lack of capacity in the public sewer network. The scale of the investment needed to tackle this issue has yet to be assessed and there is no ownership of the problem.

The Environment Agency reports that 2.5 million households in England are currently in areas at risk of flooding from surface water.[117] On average, surface water flooding accounts for more than £300 million per year in damages to property.[118] Climate change is expected to increase this risk by at least 40% by the 2050s, assuming current approaches to local flood management continue.[119] Much of the public sewer network is 50 or more years old[120] and parts of it are already working at full or beyond capacity.[121]

Even where they exist, it is not clear what the impact of local flood risk management strategies will be in reducing surface water flood risk. Many of these strategies do not report the cost and benefits of proposed actions, and it is unclear whether funding for implementing these strategies is in place. The Environment Agency is due to report on the development and quality of local flood risk management strategies from April 2017.[122] For this reporting mechanism to be

[113] Transport for London (2015) *Providing Transport Services Resilient to Extreme Weather and Climate Change –2015 Update Report following last report to government in 2011*.
[114] Thames Water (2016) *Thames Water's progress in planning for climate change - Climate Change Adaptation Reporting Power*.
[115] See: http://www.greytogreen.org.uk/index.html
[116] Halcrow (2013) for the Environment Agency and Ofwat. *Drainage Strategy Framework For water and sewerage companies to prepare Drainage Strategies - Good practice guidance*.
[117] Environment Agency (2016) *Managing flood and coastal erosion risks in England: 1 April 2015 to 31 March 2016*.
[118] Sayers, P. B. et al. (2015) for the ASC. *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.
[119] *Ibid.*
[120] 21st Century Drainage Programme (2016) *Protecting health, supporting communities, securing the environment now and for the future*.
[121] ASC (2015) *Progress in preparing for climate change*.
[122] Defra (2017) *Flood and Water Management Act 2010: post-legislative scrutiny*.

effective, it should include the expected impact of the strategies in reducing surface water flood risk, an assessment of whether sufficient funding has been identified to support actions, and the progress made toward their implementation.

RECOMMENDATION 12: *More and better co-ordinated action is needed to manage the lack of capacity within drainage systems to cope with possible increase in the frequency and severity of heavy rainfall. Defra and the National Infrastructure Commission should initiate a comprehensive assessment to quantify the need for investment and other policy actions to manage surface water flood risk, including, but not limited to, retrofitting SuDS. Urgent investments need to be considered by water companies and Ofwat as part of the 2019 price review, and the comprehensive assessment should be in place to inform local planning policy and major investment decisions in the 2024 price review. (Owner: Defra. Timeline: as above).*

Development and surface water flood risk

Is there a plan?	Red	Local Planning authorities can only allow development in areas subject to surface water flooding if the development is safe and does not increase the risk elsewhere. However, the standards defining how to discharge this duty in practice are non-statutory, only apply to developments of 10 or more houses, do not promote the benefits of green sustainable drainage systems, and fail to provide clear guidance on responsibilities for adoption and maintenance of SuDS.
Are actions taking place?	Amber	There are many examples of new development that include SuDS. Water companies and Lead Local Flood Authorities also set guidelines detailing the specifications that SuDS should meet in order to be adopted. However, DCLG did not complete its planned review of current SuDS policy in time to inform this report.
Is progress being made in managing vulnerability?	Red	**A comprehensive survey by CIWEM found little confidence that high quality SuDS are being built in the majority of major new developments. In many cases the SuDS being built are below-ground retention systems, rather than 'green' SuDS that deliver a range of benefits and can be more readily adapted to cope with future change. New development is thus highly likely to be adding pressure to existing drainage networks.**

Is there a plan?

Local planning authorities should only allow development in areas subject to surface water flooding if the development is safe and does not increase the risk elsewhere. However, the non-statutory standards defining how to discharge this duty in practice only apply to developments of 10 or more houses, do not promote the benefits of green sustainable drainage systems, and fail to provide clear guidance on responsibilities for adoption and maintenance of SuDS.

New development can be affected by surface water flooding as well as heighten risks in other areas by increasing the flow of water that drains into the sewerage system. The National Planning Policy Framework (NPPF) requires that flood risk is assessed for any development site that might be subject to surface water flooding.[123] These areas should be identified in the Strategic Flood Risk Assessment, for example by using the Environment Agency's surface water flood maps.[124] For developments of ten dwellings or more, the Lead Local Flood Authority should be consulted regarding planning permission in these areas.

The Flood and Water Management Act included provisions to make SuDS the default option for managing surface water in all new development, as recommended in the Pitt Report. However, the relevant clauses in the Act (Schedule 3) were not commenced. Instead, DCLG introduced changes to the planning system to make the use of SuDS an "expectation…wherever this is appropriate" from April 2015 for developments of 10 or more dwellings.[125] Non-statutory technical standards for SuDS were published.[126]

This approach is significantly weaker than that proposed by Sir Michael Pitt.[127] The national standards, even where they are applied, do not mention climate change allowances, and do not recommend ensure that surface water is managed effectively and sustainably, such as by capturing water as close as possible to the source, enabling some of the water to infiltrate into the ground, and using a combination of SuDS to progressively reduce the volume of water running from the source into the final receptor. In contrast, the Welsh non-statutory standards for SuDS, published in 2017, require SuDS being installed in new developments of more than one property. They specify that SuDS as far as possible should capture first 5mm of rainfall, allow it to soak into the ground or evaporate ('interception'), and be located as close to the rainfall source as is feasible. The standards also give specific preference to using SuDS that contribute to improving water quality, biodiversity and amenity value.[128]

Other instruments to ensure that high quality SuDS are delivered in new development have been weakened, namely the pre-commencement conditions that allowed Local Planning Authorities to make approval for planning applications subject to the introduction of SuDS.[129]

To ensure that non-statutory guidelines are implemented at the local level they need to be transposed into Local Plan policies. An analysis of 39 Local Plans showed that 17 (44%) of the plans did not include a specific policy on SuDS and 12 (30%) included policies that were heavily caveated by terms such as 'where viable' or 'feasible'.[130]

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[123] See: https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas
[124] See: https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-be-prepared
[125] See: http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/
[126] See: https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards
[127] See letter from Lord Krebs to the then Environment Secretary shortly after the proposals were announced: https://www.theccc.org.uk/2014/10/28/significant-weakening-of-plans-to-manage-flood-risk-from-new-development/
[128] Welsh Government (2017) *Recommended non-statutory standards for sustainable drainage (SuDS) in Wales*.
[129] The 2017 Neighbourhood Planning Act introduced a clause stating that pre-commencement conditions cannot be applied without a written agreement of the applicant. If a developer disagrees with the proposed conditions, the authority would need to either withdraw the conditions, in which case SuDS would not be implemented, or refuse the application, thus lengthening the planning process.
[130] TCPA (2016) for JRF. *Planning for the climate challenge? Understanding the performance of English local plans.*

Are actions taking place?

There are many examples of new developments implementing SuDS.

Examples include the Sarum Academy in Salisbury, in which surface water runoff is managed through swales and permeable paving, to maximise infiltration;[131] Lamb Drove, Cambridge, a residential development of 35 affordable homes that includes permeable paving, a green roof, swales, detention and wetland basins;[132] the Springhill Co-Housing, Stroud, 34 homes and communal facilities where water collected within the site flows onto a densely planted swale, rills planted by individual house occupants, a wildlife pond and a play area.[133]

Water companies and Lead Local Flood Authorities also set guidelines detailing the specifications that SuDS should meet in order to be adopted.
These guidelines are often more comprehensive than the non-statutory technical standards. For example, Anglian Water has developed a design guide for developers and local authorities and will adopt only those SuDS that meet the standards.[134] These include the requirement for SuDS to intercept the first 5mm of rainfall. Similarly, Cambridge City Council's guidelines state that they will adopt SUDS only if they meet some of the minimum requirements from the SuDS Manual (see below), including the interception of the first 5mm of rainfall.[135] Cambridge City Council is a unitary council, meaning that it is both the LLFA and Local Planning Authority. The Council states that these guidelines might be turned into a Supplementary Planning Document, thus becoming linked to the Local Plan. Staffordshire County Council has also published a SuDS handbook to help the LPAs in Staffordshire ensure that high quality SuDS are included in new developments.[136] The Council is not a unitary authority, therefore for this handbook to be linked to the Local Plan it would need to be translated into a Supplementary Planning Document by each of the nine Staffordshire district councils.

In 2016, CIRIA released an update of the SuDS Manual.[137] The manual aims to assist planning, design, construction, management and maintenance of good SuDS. It provides the evidence and technical guidance needed to deliver surface water attenuation as well as benefits to biodiversity, water quality and amenity.

The Department for Communities and Local Government did not complete its promised review of current SuDS policy in time to inform this report. The findings of the review were originally due in April 2017.

In 2015, the ASC recommended that *DCLG (…) (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 4). The Government initially declined to review the effectiveness of planning policy in delivering SuDS other than to look at the 10 dwelling threshold. However, in response to pressure in the House of Lords during the passage of the

[131] See: www.illman-young.com/images/case-studies/new%20build%20sustainable%20drainage.pdf
[132] See: http://www.susdrain.org/case-studies/case_studies/lamb_drove_residential_suds_scheme_cambourne.html
[133] See: http://www.paving.org.uk/commercial/downloads-registration.php?file=bob_bray_case_study&type=
[134] Anglian Water (date unknown) *Towards sustainable water stewardship - Sustainable drainage systems (SUDS) adoption manual*.
[135] Cambridge City Council (date unknown) *Cambridge sustainable drainage design and adoption guide*.
[136] Staffordshire County Council (2017) *Sustainable Drainage Systems (SuDS) Handbook*.
[137] CIRIA (2016) *The SuDS Manual (C753)* .

2016 Housing and Planning Act, the Government conceded an amendment that required them to review the impact of the new policy. Whilst the Act does not specify a deadline, in October 2016 the then Minister for Communities and Local Government stated that the findings of the review would be available in time to inform this report.[138]

Is progress being made in managing vulnerability?

Survey data suggests there is little confidence that current policies are effective in delivering high quality SuDS. New development is thus likely to be adding further pressure to existing drainage networks

In line with the findings of the Pitt Report, the ASC recommended in 2015 that Defra *amend (…) the 1991 Water Industries Act in order to remove or make conditional the current automatic right to connect new development to public sewers* (Recommendation 3a). Whilst recognising the need to reduce pressures on public sewers, the Government rejected this recommendation stating that they were '*confident that the changes to planning policy put in place by the previous coalition Government to promote sustainable drainage systems as the first option for surface water drainage for new major developments will achieve this'*.

However, practitioners are not confident that SuDS are being implemented. Around 30% of the 500 respondents to a CIWEM survey said that SuDS (of any type) are not used in all major developments, as current guidance requires, and a further 28% do not know whether this is the case.[139] 60% of the responders identified responsibilities for maintenance and adoption not being clearly defined as a significant barrier to the delivery of SuDS in new development. Only 8% of the responders consider current non-statutory guidance effective at driving installation of high quality and effective SuDS.[140]

Green SuDS bring additional benefits over 'proprietary' systems (e.g. underground tanks), including helping to recharge groundwater, improving water quality, and providing and sustaining green spaces. Underground tanks are also less adaptable to changes in extreme rainfall, due to their physically constrained capacity. The capacity of green SuDS can be exceeded during an event without the system failing, and be more easily upgraded.[141] However, 70% of 365 practitioners that took part in a survey in 2016 stated that they did not give priority to green features in SuDS.[142]

There is also evidence of a lack of consideration of the co-benefits of SuDS. While almost 60% those responding to the CIWEM survey consider the cost of SuDS to be more than traditional drainage, 75% said they do not assess the full cost and benefits of SuDS. Underground tanks are also reportedly easier to maintain and more likely to be adopted. These factors are likely to result in green SuDS not being proposed due to the perceived impact on the viability of a development.[143] However, recent research found that SuDS were more cost-effective to fit and maintain than traditional drainage in a range of recent developments.[144]

[138] See: https://www.theyworkforyou.com/pbc/2016-17/Neighbourhood_Planning_Bill/08-0_2016-10-27c.295.4
[139] CIWEM (2016) *A place for SuDS?*
[140] Peter Melville-Shreeve, Ana Arahuetes, Sarah Cotterill, Raziyeh Farmani, Virginia Stovin, Laura Grant and David Butler (in press) *State of SuDS Delivery in the UK*. Water and Environment Journal.
[141] 21st Century Drainage Programme (2017) *Workstream 2: Capacity Management – Executive Summary*.
[142] Engineering Nature's Way (2016) *SuDS: the state of the nation survey*.
[143] CIWEM (2016) *A place for SuDS?*
[144] Environmental Policy Consulting (2017) for the Welsh Government. *Final report: Analysis of evidence including costs and benefits of SuDS construction and adoption*.

RECOMMENDATION 13: *Policy is needed urgently to address the outstanding barriers to deliver high quality, effective SuDS in new development that achieve the full range of potential environmental co-benefits. In particular, there is a need for:*

- *More comprehensive and ambitious national standards for SuDS.*
- *The automatic right to connect new development to the existing sewerage network to be made conditional on the national SuDS standards being met.*
- *A clear policy on who should maintain and adopt SuDS by default.*

(Owner: DCLG. Timing: by 2019).

Property-level flood resilience

Is there a plan?	Amber	The Property Flood Resilience Action Plan published by Defra (following the Bonfield Review in 2016) includes the vision to achieve, within five years, an 'environment where it is standard practice for properties at high flood risk to be made resilient'. However, the Flood Re subsidised insurance scheme largely removes the financial incentive for high risk households to take action to prevent flooding. There is no apparent progress by Flood Re in meeting the commitments made in its transition plan to promote property-level flood resilience (PLR) measures or to share the data it holds on polices and claims in order to help improve risk management approaches in high risk areas.
Are actions taking place?	Green	The Bonfield Review has been published and actions have started to be implemented, including initiating the process to create standards to certify PLR measures. The Government also encouraged the uptake of PLR for households damaged by the winter 2015/16 floods, by making grants of £5,000 available for flood protection measures and resilient repairs.
Is progress being made in managing vulnerability?	Red	**The Government's six-year investment plan includes proposals to protect around 500 households per year using PLR measures.** **At least 153,000 households in England would be cost-effective to protect using PLR measures, and this is expected to increase to more than 217,000 by the time Flood Re is withdrawn. This means that the number of vulnerable properties is increasing five times faster than the rate at which PLR measures are currently being fitted.**

Is there a plan?

Even if all cost-effective community flood alleviation schemes are implemented, there are expected to be more than 217,000 households in areas at a high risk of flooding when Flood Re is withdrawn in 2039. To address the risk to these properties, Defra has adopted

the vision of achieving, within five years, 'an environment in which it is standard practice for properties at high flood risk to be made resilient'.

The Environment Agency's Long Term Investment Scenarios show that there are currently 153,000 households in areas with a 3.3% or greater annual chance of flooding. By the late 2030s, there are projected to be at least 217,000 households in this risk band[145], due to deteriorating defences, climate change, and because it will not be cost-effective to protect them with flood alleviation schemes. The ASC previously found property-level resilience measures can be used to reduce flood risk cost-effectively for properties at this level of risk.[146]

In 2015, the ASC recommended that Defra takes *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* and make *full use […] 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 2). Defra agreed in principle with this recommendation, and later in 2016, commissioned the Building Research Establishment's Chief Executive, Dr Peter Bonfield, to prepare a Property Flood Resilience Action Plan.[147] The plan includes the vision of achieving, in five years' time, an 'environment where it is standard practice for properties at high flood risk to be made resilient'.

The ASC also recommended that *Flood Re's transition plan (…) include[s] clear proposals for how the scheme will promote flood risk alleviation amongst high risk households* (Recommendation 7). The Government agreed that Flood Re should provide the right incentives to households and insurers to put in place resilience measures. In February 2016, Flood Re committed to assessing how the scheme might play a more direct role in incentivising households and insurers to implement property-level resilience measures.[148] However, this assessment is yet to be published.

Flood Re's transition plan also stated 'We will use our database of high flood risk properties and work with others to identify where we believe that spending would be the most effective in cutting the cost of flooding to households and insurers.' The plan committed to work with the Government, the devolved administrations, the Environment Agency, local authorities, and the ASC. Flood Re now holds data on more than 100,000 households in the UK considered by insurance companies to be at the greatest flood risk. The process of releasing data to inform and help target new policies in high risk areas has not yet begun.

Are actions taking place?

Government has encouraged the uptake of PLR amongst households damaged by recent flood events, by making £5,000 'repair and renew' grants available for flood protection measures. However, many insurers do not allow improvements to be made when flooded properties are reinstated, even if paid for by policy holders.

In 2016, Defra published a handbook to help practitioners both select and give better advice to households on low cost flood resilient measures.[149] However, one-third of the insurance brokers interviewed for the Bonfield Review said they would not pay insurance claims if spent on flood

[145] Data from the Environment Agency's LTIS (2014). See the Technical Annex for this chapter.
[146] Royal Haskoning (2012) for the ASC. *Assessing the Economic Case for Property Level Measures in England*.
[147] Defra (2016) *Improving property level flood resilience: Bonfield 2016 action plan*.
[148] Flood Re (2016) *Transitioning to an affordable market for household flood insurance*.
[149] Defra (2016) *Practitioners' Handbook for low cost repairable or resilient reinstatement for surveyors and local authorities*.

resilient or resistant repairs, even if they were cost-neutral. Over half of the brokers said that they would not allow for improvements to be made to a flooded property if they required additional cost, even if this cost were met by the policy holder. The same survey also suggested that fitting resilience and resistance measures do not generally lead to lower insurance premiums.

Actions listed in the Property Flood Resilience Action Plan have started to be implemented.[150]

A Code of Practice for installing PLR measures is being developed as one of the actions listed in the Bonfield Review. The Code will support training and certification in PLR and suggest a single surveyor has overall responsibility for the delivery of PLR measures within a property. BRE is also considering a Certification Scheme for surveyors, supported by training courses that BRE is developing. A new open standard for installers is under development, and the British Standard PAS1188 is being updated.

The six-year investment programme will provide property-level measures to 2,900 of the 153,000 households currently in areas at high risk.[151]

Within the programme of schemes being delivered between 2017 and 2021, the Environment Agency has allocated £5.7 million as grant-in-aid toward property-level flood resilience schemes. This will be matched by £5.3 million in external contributions. Whilst promising, this level of commitment to PLR measures represents around 2% of the properties for which such measures would be cost-beneficial.

Is progress being made in managing vulnerability?

Uptake of property-level resilience measures is far less than is required to manage residual risk for the hundreds of thousands of properties that will not be cost-beneficial to protect by other means.

Between 2008 and 2011, the uptake of PLR was less than 400 properties per year.[152]

In 2015/16, the Environment Agency delivered 24 property flood resilience schemes, installing PLR to 662 properties. These figures only include the schemes that primarily consist on delivering PLR. Further households might have had PLR installed as part other flood alleviation schemes, but these figures are not available. A recent survey among 531 people living in areas at flood risk found that most were not aware of Government schemes to protect their properties, and few had taken up any scheme.[153]

The commitment in the six-year investment plan would result in around 500 properties being fitted with PLR measures per year between 2015 and 2021. At this rate, PLR would be fitted to around 12,000 properties by 2039. By the time Flood Re is withdrawn, it is estimated that 64,000 more properties would be cost-effective to protect using PLR measures in addition to the 153,000 already in this risk band, due to projected increases in flood risk. This means that the number of vulnerable properties is increasing over five times more quickly than the rate at which PLR measures are currently being fitted.

[150] Communication with BRE.
[151] Environment Agency (2017) *Flood and coastal erosion risk management in England investment programme 2015 to 2021 infographic - updated March 2017*.
[152] ASC (2015) *Progress on preparing for climate change*.
[153] Ipsos Mori (2015) for Defra. *Affordability and Availability of Flood Insurance*.

RECOMMENDATION 14: *Defra should develop a long-term strategy to manage flood risk down to tolerable levels in each part of the country (as we first recommended in 2015), so that as Flood Re is withdrawn properties can remain insurable at reasonable cost. This should include:*

- *Monitoring the impact of the actions adopted following the Bonfield Review to achieve, in five years' time, an 'environment where it is standard practice for properties at high risk to be made resilient'.*
- *Actively communicating the risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s.*
- *Ensuring that Flood Re incentivises households to take up property-level resilience measures, which insurers should allow to be implemented during post-flood repairs.*

(Owner: Defra. Timing: by 2020).

Capacity of people and communities to recover from flooding

Is there a plan?	Green	Post-flood recovery is managed through Local Resilience Forum (LRF) recovery plans. Current guidelines state that plans should be developed to manage peoples' physical and psychological recovery from flood events, in the long-term as well as the immediate aftermath.
Are actions taking place?	Green	Repair and renew grants were made available after the 2015/16 winter flooding. National and local flood forums provide assistance to households in processing insurance claims and repairs. Flood Re has begun operation and means almost all households are able to access affordable insurance for the time being. Public Health England has begun to release results from their long-term cohort survey of mental health impacts from flooding.
Is progress being made in managing vulnerability?	Amber	**Insurance uptake remains high and Flood Re was due to support around 130,000 households with subsidised insurance by April 2017, rising to 350,000 by 2020. Even where properties are insured, it normally takes 6 to 12 months for a property to be reinstated, depending on the level of damage. Problems in dealing with loss adjustors are still reported. The PHE study shows that the impacts of flooding on wellbeing are significant, prolonged, and extend beyond those whose homes are directly flooded.**

Is there a plan?

According to the guidance accompanying the 2004 Civil Contingencies Act, Local Resilience Forums have to include recovery in their emergency plans.

Current guidelines state that plans should be developed to manage people's physical and psychological recovery from flood events, in the immediate aftermath as well as in the long

term.[154,155] Recovery plans or recovery sub-groups are in place in all the Local Resilience Forum areas that publish their plans online.[156] Most plans available online acknowledge the long-term psychological impacts of emergencies, and the need for the LRF to support those affected until they recover.

Flood Re has begun operation which means that almost all homes built before 2009 have access to affordable insurance for the time being.

However, by 2021, when the scheme is due to begin being phased out, more action will be needed to ensure that the risks are managed to allow insurance to remain affordable without the need for subsidies (see previous section).

Are actions taking place?

Following the 2015/16 winter floods, the Government provided a series of grants to households and business to aid recovery.

These grants included £500 for emergency assistance to meet immediate costs such as temporary accommodation. Households were also able to apply for £5,000 grants to repair their properties in a flood resilient way (see previous section). Voluntary organisations also provided assistance during the recovery phase. For example, during recent flooding, the flood groups that the National Flood Forum (NFF) has helped set up provided assistance to those affected. The NFF also activated a helpline to assist households in processing their insurance claims. The Association of British Insurers (ABI) has published guidance to help households repair their homes after a flood, and to install property-level protection measures.[157]

Public Health England has published the first results from a cohort study on the mental health impacts of flooding. The study surveyed 2,126 people in neighbourhoods affected by flooding between December 2013 and March 2014, and reported an elevated prevalence of mental health impacts among those affected or disrupted by the floods (see below). In 2014, PHE updated its guidance to help people stay safe and deal with the aftermath of a flood. These guidelines are designed to help prevent the physical health impacts from flooding, but do not cover mental health impacts.

Is progress being made in managing vulnerability?

Even when properties are insured, it normally takes 6 to 12 months for a home to be reinstated, depending on the level of damage. The most effective measure to reduce this is to make properties more resilient before flooding occurs.

Flood Re was on course to support around 130,000 households with subsidised insurance by April 2017, at it is expected to cover 350,000 households by 2020.[158]

Reinstating a property can take a long time, depending on factors such as the property's fabric and the severity of the flooding. ABI reports that, after the 2013/14 flooding, 60% of claims were fully settled within six months, almost three quarters within nine months, but some remained outstanding after one year. After the 2015/16 winter floods, 90% of claims from storms

[154] Cabinet Office (2013) *Emergency Response and Recovery- Non statutory guidance accompanying the Civil Contingencies Act 2004*.
[155] Defra, Environment Agency, Public Health England (2014) *The national flood emergency framework for England.*
[156] ASC analysis of 37 LRF websites.
[157] ABI (2016) *Responding to major floods.*
[158] Communication with ABI.

Desmond, Eva and Frank were fully or partially settled after six months. ABI reports that this length of time is consistent with the repair work that is often needed.[159] However, interviews carried out by the NFF suggest that this time frame is not acceptable for those involved, and difficulties with dealing with loss adjustors and finding independent surveyors have been adding to the time it takes to reinstate a property.[160] In general, it is recognised that the most effective measure to speed up reinstatement is to reduce the likelihood of water entering a property and to use property-level resilience measures, such as water-resilient fittings and materials wherever feasible.[161,162,163]

Successful flood recovery includes dealing with impacts on mental health and wellbeing. These impacts are significant, prolonged, and extend beyond those whose homes are flooded.

The PHE study of households affected by flooding between December 2013 and March 2014 found probable Post-Traumatic Stress Disorder (PTSD), anxiety, and depression, at levels six times higher than amongst those unaffected.[164] 36% of those directly affected by flooding showed probable PTSD, 28% suffered from anxiety, and 20% from depression. Mental health impacts were also recorded amongst those not directly flooded but disrupted by the flood event, for example from power outages, or not being able to get to work.[165] The same study found that mental health impacts might be reduced by limiting flood damage to homes, for example by avoiding water entering living spaces, as well as enabling the affected people to go back to work and school as quickly as possible.

4.3 Coastal change

CCRA2 identified risks to the viability of some exposed communities due to coastal change, as a result of both increased tidal flooding and faster rates of coastal erosion. The assessment concluded that more action is needed to adapt to the anticipated changes.

About one-third of the English coastline is subject to erosion.[166] Over half of the length of the Yorkshire and Humber coastline is receding, together with one-third of the coastline in East of England and 20% of the coastline in North West England.[167] Human intervention can affect the susceptibility of a particular stretch of coast to erosion. For example, coastal structures can reduce the supply of sediment to the shore or exacerbate erosion. About half of the coastline in England is protected by coastal defences or artificial beaches.[168]

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[159] For example, the drying stage can take months, and starting repairs before a property is completely dry would create future problems. Full decontamination is also needed to ensure that the property is safe to occupy.
[160] NFF (2016) *December 2016 Bulletin.*
[161] See: http://www.aviva.co.uk/home/home-advice/extreme-weather-advice/article/getting-back-normal-after-flood/
[162] ABI (date unknown) *A guide to resistant and resilient repair after a flood.*
[163] NFF (2014) *Ready for flooding –Before, during and after.*
[164] Public Health England (2017) *The English National Study for Flooding and Health: First year report.*
[165] Waite, T. D., Chaintarli, K. et al. (2017) *The English national cohort study of flooding and health: cross-sectional analysis of mental health outcomes at year one.* BMC Public Health, 17 (129).
[166] Coastal erosion occurs due to the impact of waves and wind on the coastline. The phenomenon is highly dependent on local factors: the topography and climate of the coastline influence the persistence, height and strength of waves; whilst the geological composition of the coastline determines its erodability.
[167] Masselink, G. and Russell, P. (2013) *Impacts of climate change on coastal erosion,* MCCIP Science Review 2013, 7,1-86.
[168] *Ibid.*

Climate change could increase the risk of coastal erosion due to sea level rise, potentially more frequent coastal storms, and potential changes in wave direction. For levels of sea level rise beyond one metre, which could occur this century, 200km of coastal defences in England are projected to become vulnerable to failure in storm conditions.[169]

This section assesses whether coastal erosion risk is being managed in a cost-effective and sustainable manner by:

- Enhancing the resilience of the coastline by restoring natural processes when possible.
- Protecting economically important infrastructure assets and urban areas.
- Planning ahead for managed realignment or ceasing intervention where maintaining or replacing coastal defences cannot be reasonably justified.

Coastal change risk management

Is there a plan?	Green	Shoreline management plans (SMPs) are currently in place for the whole English coastline. National planning policy states that Local Planning Authorities should not allow new development in areas that they have identified as being subject to coastal change, and must make provisions for development and infrastructure that need to be relocated away from these areas. Whilst there is no compensation available to householders for homes damaged or lost to erosion, grants of up to £6,000 per property are available to pay for demolition and removal.
Are actions taking place?	Green	The Environment Agency provides grants for erosion schemes, helping to protect houses and prevent habitat losses from coastal squeeze. Coastal erosion assistance grants have been paid to a small number of qualifying homes in recent years.
Is progress being made in managing vulnerability?	Amber	**11,000 houses benefitted from coastal erosion schemes between 2010 and 2015, and about 400 hectares of intertidal habitat have been created to offset losses from coastal squeeze. However, the amount of managed realignment of the coastline is still not in line with delivering SMP aspirations for the 2030s. It is not known whether actions in the SMPs constitute a viable approach to coastal adaptation in the long term. Communities likely to be impacted are not yet being engaged in earnest.**

Is there a plan?

Shoreline Management Plans define long term policies for the coastline, developed in consultation with the relevant communities, to adapt to coastal change through to 2100. These policies identify the stretches of coastline that can be defended and those for which managed retreat or no active intervention are likely to be the more sustainable options.

[169] Sayers, P. B. et al. (2015) for the ASC. *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK.*

Shoreline Management Plans are high-level, non-statutory policy documents that help coastal authorities assess and manage the long-term risks of coastal erosion to people and the environment. Coastal authorities have formed voluntary Coastal Groups to bring together interested parties in developing such plans.[170] There are currently 22 different Shoreline Management Plans covering the entire coast of England and Wales.[171]

Each plan includes an assessment of flood and coastal erosion risk for a particular stretch of coastline, and identifies the preferred coastal management policy. These policies determine whether natural processes should be restored, either by not maintaining existing defences once they deteriorate or proactively realigning the coastline; or whether the current coastal defence system should be maintained in the short- (up to 2030), medium- (2060) and long-term (2100). The overall aim of the SMPs is to reduce the number of properties at risk and to realign the coast when protecting it is considered unsustainable.

Currently, 54% of the English coastline is defended. The preferred policy option between now and 2030 is to maintain and increase the protection for 47% of the coastline, whilst actively realigning 5%, and gradually withdrawing from coastal defence for the remaining 2%.[172] These interventions are projected to reduce the number of homes being lost to coastal erosion to about 250, from the 3,400 that might be lost otherwise. To achieve this, about 550 km of coastline needs to be realigned by the 2030s.

Preferred policies in SMPs have helped inform Flood Risk Management Plans, and funding to implement the interventions to protect and realign coastlines are allocated as part of the standard 'partnership funding' formula(see section 4.2). Defra is currently re-evaluating the formula,[173] given that a previous review reported concerns regarding the ability of coastal authorities to secure sufficient external contributions to support coastal erosion schemes.[174]

Coastal Groups work with the Environment Agency to annually monitor progress in implementing individual SMPs. However, as plans describe actions differently, the data collated by different Coastal Groups are not readily comparable in order to draw a national picture of progress.

The National Planning Policy Framework includes provisions to avoid new development in areas at risk of coastal erosion.

The NPPF states that Local Planning Authorities should define areas that are susceptible to coastal change within Local Plans (Coastal Change Management Areas), taking SMPs into account. Local Planning Authorities should also define what type of development is appropriate in these areas whilst making provision for existing development and infrastructure to be relocated away from these areas. Planning applications in these areas can only be granted if development is safe over its lifetime and does not have an 'unacceptable' impact on coastal change.[175] According to the NPPF, it is not appropriate to allocate permanent new residential development within an area susceptible to coastal change. However, a National Trust study found that in 2015 only 29 of England's 94 coastal planning authorities had defined Coastal

[170] Defra (2006) *Shoreline management plan guidance - Volume 1: Aims and requirements.*
[171] Environment Agency (2016) *Managing flood and coastal erosion risks in England: 1 April 2015 to 31 March 2016.*
[172] HR Wallingford (2013) for the ASC. *ASC natural resource indicators - Coastal Research Project* https://www.theccc.org.uk/wp-content/uploads/2013/07/TCCC-ADAPT01-12_Final_Report_Appendices-A-F_29July13.pdf
[173] Communication with the Environment Agency.
[174] Defra (2014) *Flood and Coastal Erosion Resilience Partnership Funding Evaluation, Final report.*
[175] DCLG (2012) *National Planning Policy Framework.*

Change Management Areas, with a further 35 having some form of policy on coastal change. One-third of the coastal planning authorities in England do not have such policies.[176]

Are actions taking place?

Coastal protection and realignment schemes have been delivered, helping to protect houses and compensate for habitat losses from coastal squeeze. Grants have been paid to assist local authorities with removing a small number of homes at immediate erosion risk.

Capital grants for coastal erosion schemes between 2007/08 to 2010/11 averaged £110 million per year,[177] increasing to £125 million per year on average for the period 2013-2016.[178] In 2015/16, 16 coastal erosion projects were delivered.[179]

There is no compensation available to householders for homes damaged or lost to erosion but local authorities can apply for grants toward the cost of demolition and removal, of up to £6,000 per property. Defra allocates £60,000 every year to cover these grants, which are administered by the Environment Agency. Between 2010 and 2017, the Environment Agency provided £273,000 to local authorities to assist with the demolition of 43 properties at immediate risk in Yorkshire, Norfolk and East Sussex. Local authorities are reportedly struggling to meet the criteria to apply for these grants. In particular, properties are eligible only when at imminent risk of loss, which does not allow local authorities to take action proactively. The Environment Agency is currently discussing this issue with Defra to overcome these barriers.[180]

The other two actions related with coastal erosion listed in the NAP have been completed or are on track. A 'light touch' review of the deliverability of SMP policies has taken place and is due to be published by the Environment Agency in summer 2017.[181] In 2009, Defra announced £11 million would be made available to help 15 coastal authorities to engage communities about coastal change and, in some cases, test different approaches to relocating communities. Lessons learnt from this process are being used to develop guidelines that clarify roles and responsibilities, legal and spatial planning frameworks, and the potential funding available to coastal authorities.[182]

Is progress being made in managing vulnerability?

There is no national monitoring of the implementation of the Shoreline Management Plans. The amount of managed realignment of the coastline is still not in line with delivering SMP commitments for the 2030s. It is unclear whether communities are ready for the coastal adaptation that needs to take place between now and mid-century.

Between 2010 and 2015, 11,000 houses benefitted from coast protection schemes, and projects delivered between 2015 and 2016 have reduced coastal erosion risk for a further 5,500 homes. Coastal schemes have created 179 hectares of inter-tidal habitat between 2015 and 2016, and about 400 hectares between 2010 and 2015.[183] Whilst most of the coastal defence projects

[176] National Trust (2015) *Shifting Shores.*
[177] Halcrow (unpublished) for the Environment Agency.
[178] ASC (2015) *Progress on preparing for climate change*.
[179] Environment Agency (2016) *Managing flood and coastal erosion risks in England: 1 April 2015 to 31 March 2016*.
[180] NAP action update (2017).
[181] Communication with the Environment Agency.
[182] *Ibid*.
[183] Environment Agency (2016) *Managing flood and coastal erosion risks in England: 1 April 2015 to 31 March 2016.*

planned for 2015-2021 are in line with the SMP preferred policy options,[184] the rate of implementation is not in line with aspirations within SMPs for 550 km of coastline to be realigned by the 2030s. In 2013, the ASC reported that coastal erosion management projects are realigning the coastline at a rate of 6 km every year. Achieving the goals set out in the SMPs imply realigning around 30 km of coastline every year. This means that the rate of realignment would have to increase five-fold from the current level to deliver the aspiration within SMPs.[185]

No active intervention is planned by 2030 for 2,000 km of the coastline that is not cost-effective to protect, and a further 450 km of coastline will cease to be actively managed or is due to be realigned by 2060. This is likely to have economic and social impacts for the affected communities. Despite existing engagement efforts, CCRA2 concluded that communities are not yet being prepared for the coastal change likely to take place between now and mid-century.

RECOMMENDATION 15: *The Environment Agency, with Coastal Groups, should review the ambition within, and progress being made in implementing, Shoreline Management Plans (SMPs), and prepare communities for the coastal adaptation that will need to take place between now and the middle of the century. (Owner: Environment Agency. Timing: by 2020).*

4.4 Household water use

CCRA2 concluded that whilst significant effort is already underway, additional action is needed to manage the risk of future water supply-demand deficits.

The majority of climate change projections for the UK show a reduction in the amount of water available to people, industry, agriculture and the environment, compounded by increasing demand during the driest months from a growing population. As well as CCRA2, a recent study from Water UK concluded that there is a need to increase action to manage water supplies more efficiently as well as reducing demand.[186]

Water was discussed under several themes of the NAP. Correspondingly:

- Water in the natural environment is discussed in Chapter 3: *Natural environment*.
- Supply-side measures and structural improvements to water company networks to reduce leakage, and be more resilient to severe weather, are covered in Chapter 5: *Infrastructure*.
- Use of water by businesses and industry is covered in Chapter 6: *Business*.

This section discusses progress made in reducing water use by households.

[184] Three coastal defence projects planned for 2015-21 appear to hold the coastline in areas where the SMP policy is to realign or cease active intervention.
[185] ASC (2013) *Managing the land in a changing climate.*
[186] Water UK (2016) *Water resources long-term planning framework.*

Water demand in the built environment

Is there a plan?	Amber	Guidance documents for the industry price review in 2019 emphasise the importance of continued efforts to reduce household water demand. Water UK has identified long-term scenarios for reducing per capita consumption that are more ambitious than those set in current water resource management plans. It is not clear whether these scenarios will be adopted in the next round of plans due from water companies in 2019. DCLG has added an 'optional requirement' for local planning authorities to specify a minimum standard of 110 litres per person per day (l/p/d) in new homes. However, the Code for Sustainable Homes was withdrawn in 2015, which included stronger standards for water efficiency in new homes.
Are actions taking place?	Green	Water companies have implemented a range of actions to reduce household water demand, including programmes to encourage metering, use of water-efficient taps and appliances, and changes in behaviour. Metering of household water consumption has increased from 42% of households in England in 2012/13 to 45.5% in 2015/16.
Is progress being made in managing vulnerability?	Green	**Domestic water consumption has continued to fall from155 l/p/d in 2003/04 to 139 l/p/d in 2015/16, in line with the target for 2020 of 137 l/p/d.** **Data on water consumption in new homes is not available.**

Is there a plan?

Water companies are required by Ofwat to publish water resource management plans (WRMPs) detailing how the companies will manage the balance between available water resources and customer demand over the next 25 years.

WRMPs are updated every five years. The latest set of plans, published in 2014, included the ambition to reduce average consumption per person from 141 l/day in 2014 to around to137 l/day by 2020, and 135 l/p/d by 2040, and proposals to increase the proportion of households with water meters in England and Wales from 48% in 2014 to 61% in 2020.[187]

Defra and the Environment Agency have published guidance for the next round of WRMPs, due from water companies in 2019. These guidelines include a general expectation that demand-side measures will continue to be deployed to reduce per capita consumption, including as a result of more widespread water metering.[188]

Water UK has identified long-term scenarios for reducing per capita consumption that are more ambitious than those set in current water resource management plans. It is not clear whether these will be adopted in the next round of plans.

[187] Ofwat (2014) *Setting price controls for 2015-2020 - Overview.*
[188] NAP action update (2017) and Defra (2016) *Creating a great place for living - Enabling resilience in the water sector.*

Demand-side management will need to play an important role in managing risks to water resources in the future. The scenarios analysed by Water UK include consumption ranging between about 125 l/p/d ('business as usual') and about 115 l/p/d ('extended strategy') in 2040, and between 120 l/p/d and just under 110 l/p/d by 2065. The report concludes that whilst there is only a small increase in cost associated with moving from the 'business as usual' to an 'extended' strategy, the latter would require significant behavioural and policy changes, including interventions such as smart metering and associated tariffs, or increasing requirements for water efficiency in new homes.[189] Previous analysis by the ASC suggests improvements in household water efficiency would be cost-effective and readily achievable, and could reduce consumption to 115 l/p/day.[190]

The NPPF sets a minimum standard of 125 l/p/d in new homes. DCLG has since added an 'optional requirement' that allows local planning authorities to set a 110 l/p/d standard. The Code for Sustainable Homes included various standards for water efficiency, with 105 l/p/d or less required to achieve levels 3-4 of the Code, and less than 80 l/p/d required to achieve levels 5-6. The Code was withdrawn in 2015 as part of a wider simplification of housing standards.[191]

Are actions taking place?

Water companies have implemented a range of actions to reduce household water demand, including programmes to encourage metering, use of water-efficient taps and appliances, and behaviours that help to reduce water consumption.

Water companies have implemented campaigns to encourage the uptake of metering, which has increased from 42% of households in 2012/13 to 45.5% in 2015/16. Current water resource management plans suggest metering should increase to 61% of households nationally by 2020, but some water companies are not on track to deliver their contribution toward this.[192] About 80% of the water companies also provide water efficiency audits or similar services to households.[193] As a result, for example, Southern Water has brought the average water use per person to below 120 l/p/d in some parts of company's catchment, including as a result of metering having reached 90% of customers in the region.[194] Education programmes have also been rolled out, such as Severn Trent Water's school education programme, that reaches more than 45,000 children each year, and site tours at their education centres with 347,941 visits since 2010.[195]

In 2015, Defra reported that a number of manufacturers, retailers and merchants have agreed to use the voluntary European Water Label on all their bathroom appliances. In 2017, the department reported that whilst the adoption of the European Water Label is still low, water companies are now also encouraging manufacturers and retailers to label their products.

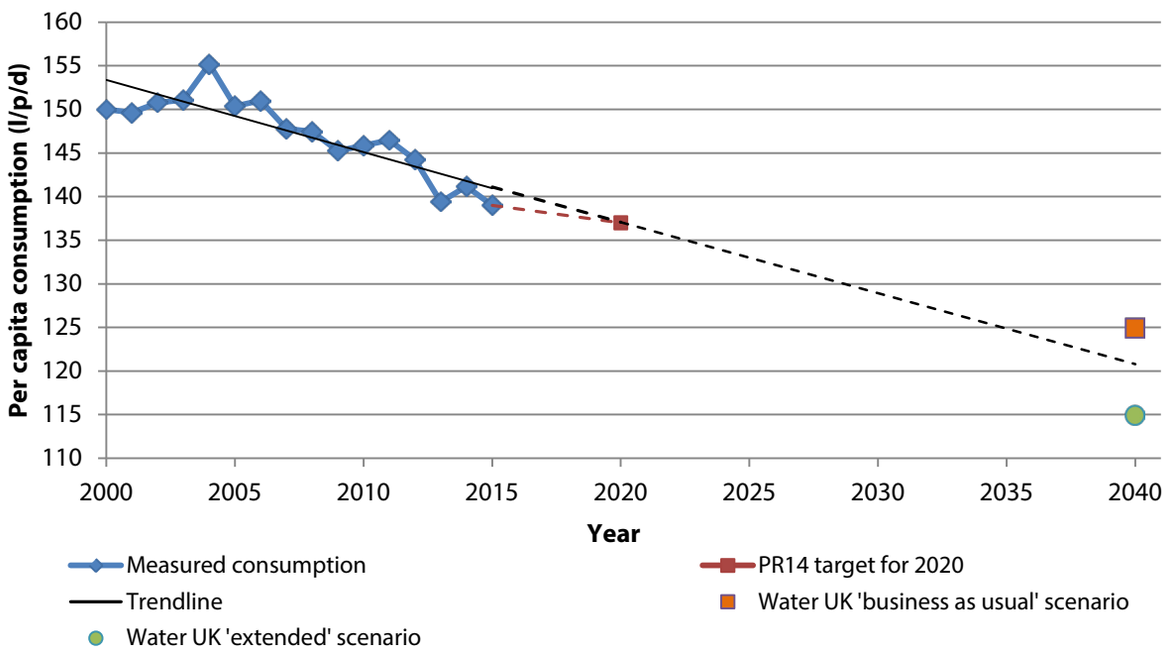
[189] Water UK (2016) *Water resources long-term planning framework.*
[190] ASC (2015) *Progress on preparing for climate change.*
[191] See: https://www.gov.uk/government/publications/2010-to-2015-government-policy-energy-efficiency-in-buildings/2010-to-2015-government-policy-energy-efficiency-in-buildings
[192] ASC analysis of water companies' Annual Performance Reports 2015/16 available on individual companies' websites.
[193] ASC analysis of the PR14 final price control determination notice: company-specific appendices available at http://www.ofwat.gov.uk/regulated-companies/price-review/price-review-2014/final-determinations/
[194] Blueprint for water (2017) *Blueprint for PR19 – Environmental outcomes for the price review.*
[195] Severn Trent Water (2015) *Future proofing: Severn Trent Water's climate change adaptation report.*

Is progress being made in managing vulnerability?

Domestic water consumption has continued to fall from 155 l/p/d in 2003/04 to 139 l/p/d in 2015/16, in line with the target for 2020 of 137 l/p/d.[196]

This trend is consistent with achieving the target of 137 l/p/d in 2020, and on course for Water UK's 'business as usual' scenario for the 2040s (Figure 4.2). Variation from one year to another is due to many factors including annual climate variability, for example; a particularly hot summer would correspond to higher consumption. However, there has been a general downward trend since 2003/04.

Figure 4.2. Domestic water consumption



Source: Measured consumption from the Environment Agency and Ofwat. See Technical Annex for this chapter.
PR14 target for 2040 from Ofwat (2014) *Setting price controls for 2015-2020 – Overview*.
Consumption scenarios for the 2040s from Water UK (2016) *Water resources long-term planning framework.*

4.5 Public health and wellbeing

Managing the risks to health from high temperatures is one of the six priority areas identified for further action in the 2017 UK Climate Change Risk Assessment.

In addition to risks to health from flooding (see section 4.2), climate change is likely to pose risks to public health from excess heat, and potentially from changes in UV radiation, air pollution and new or emerging pathogens. CCRA2 identified a lack of policy instruments in place to manage vulnerability to heat in the built environment, including homes but also other buildings such as hospitals, care homes, schools and prisons. If additional measures are not taken, it is likely that heat-related mortality will increase in the coming decades from a baseline of 2,000 heat-related

[196] Data from the Environment Agency (2017). See the Technical Annex for this chapter.

deaths per year at present. There may also be some benefits of warmer temperatures from increased outdoor activity, for example, but these are not well-quantified.

Cold-related mortality could decline over time as the climate warms, but the overall impact on the number of cold-related deaths per year is projected to be small due to the growing, ageing population.[197] CCRA2 identified the need for more action to reduce exposure to cold and fuel poverty through increased energy efficiency measures in homes. Energy efficiency improvements need to be undertaken in ways that do not increase the risk of overheating.

The contribution of climate change to public health risks from pathogens, air pollution and UV radiation are uncertain. Despite the uncertainty, actions to reduce vulnerability now are important given the size of the present-day risks to health. Air pollution (from all causes) contributes to approximately 40,000 deaths per year in the UK, while around 2,000 deaths per year are attributable to skin cancer, for example.

Health impacts from heat and cold

Is there a plan?	Red	Guidance for managing the risks from heat and cold exists through the Heatwave and Cold Weather Plans for England. The Government's Fuel Poverty strategy has an aspiration to reduce exposure to cold in people's homes. There are no legal safeguards to avoid new homes overheating, and no policies in place to begin the process of adapting the existing building stock to higher temperatures. Policies to address overheating are not generally included in Local Plans, despite a requirement in the National Planning Policy Framework to include climate change adaptation in local authority spatial planning.
Are actions taking place?	Green	The 14 NAP actions related to increasing awareness and undertaking research on risks from heat and cold are complete or on track. The focus for most actions is on providing information and guidance to practitioners, and improving the evidence base.

[197] Kovats, R.S., Osborn, D., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment.*

Is progress being made in managing vulnerability?	Amber	**Daily average and maximum temperatures are increasing over time, which are in turn increasing the exposure of the population to heat. Studies consistently show around 20% of homes already overheat in the current climate. Urban green space, which has a cooling effect, declined between 2001 and 2016 from 63% to 56% of urban areas (though there has been no change between 2011 and 2016). Without further adaptation, the number of heat-related deaths per year is expected to increase from 2,000 to 7,000 by the 2050s, including the effects of population growth.** **The number of people who are vulnerable to cold, measured by the number living in fuel poverty, continues to fluctuate with no obvious downward trend.**

Is there a plan?

The Heatwave and Cold Weather Plans for England provide guidance to health practitioners and the public in order to protect vulnerable people in hot and cold weather. There remain no legal safeguards to protect new development from adding to the number of homes that already overheat in warmer weather. Neither are there policies in place to adapt existing buildings (including homes, hospitals, care homes, schools and prisons) to be safe and habitable in increasing temperatures.

As the ASC reported in detail in its 2014 and 2015 reports, there are no legal requirements in place to ensure that new buildings –homes, hospitals, care homes, schools or prisons – are designed so as to minimise the risk to occupants from increasing temperatures. Regulations exist to ensure that conditions in e.g. hospitals are 'safe'[198], and guidance also exists on performance standards to avoid overheating in schools,[199] and healthcare premises.[200] However, internal temperatures are not routinely monitored, and standards set out in guidance are not enforced.

The National Planning Policy Framework requires local planning authorities to adopt strategies to adapt to climate change, including through the provision and protection of urban green space. However, the NPPF does not mention planning measures to manage risks from heat specifically, and two independent reviews found that this risk is generally not covered in Local Plans.[201]

The Heatwave Plan for England provides guidance to health practitioners and the public in order to protect vulnerable people in hot weather. A heat-health alert service operates across England during June to September. This includes guidance to adapt the built environment year-round and ensure that appropriate measures are put in place when a heatwave does occur. The Cold Weather Plan for England operates in a similar way to the Heatwave Plan, providing guidance on long-term planning and reactive responses to protect people during cold spells.

[198] E.g. http://www.cqc.org.uk/guidance-providers/regulations-enforcement/regulation-12-safe-care-treatment#guidance

[199] Approved document L2 in the Building Regulations.

[200] Department of Health (2015) *Health, Technical Memorandum 07 - 02: EnCO2de 2015 – making energy work in healthcare - Environment and sustainability Part A: Policy and management.*

[201] JBA and LUC (2015) for the ASC. *Local authority action on climate change adaptation, and* TCPA (2016) *Planning for the climate challenge? Understanding the performance of English local plans*

The Zero Carbon Homes target was withdrawn in 2015, with greater emphasis now being put on delivering reductions in fuel poverty through the Energy Company Obligation.

Alongside awareness raising, exposure to cold can be reduced through increasing energy efficiency and the level of insulation in homes. The Government's previous target for all new homes built after 2016 to achieve zero carbon status was dropped in 2015 as part of steps to reduce the regulatory burden on house builders.[202] A target remains in the Fuel Poverty Strategy for as many fuel poor homes 'as reasonably practicable' to achieve an energy efficiency standard of Energy Performance Certificate Band C by 2030. The Energy Company Obligation (ECO) scheme has entered a transition period from April 2017 to September 2018, moving towards a new scheme focused on fuel poverty for 2018-2022.[203] Where insulation schemes are being implemented, there is an opportunity to consider how to retrofit measures at the same time to mitigate the risks from heat. The Government should consider how this could be achieved.

Are actions taking place?

All NAP actions related to heat and cold are completed or on track, but there is limited evidence of the impacts these actions have had on risk.

The majority of NAP actions related to heat and cold aim to increase awareness, provide tools for decision makers, and improve the evidence base. For example:

- Public Health England has included additional information in the Heatwave Plan for local authorities and planners. The Department for Health is funding a review of the effectiveness of the plan, which will report in 2018. This review is investigating whether the Heatwave Plan has contributed to the reduction in mortality observed during the 2013 heatwave compared to the heatwaves of 2003 and 2006.[204]
- The Department for Business, Energy and Industrial Strategy is undertaking a public consultation on the Standard Assessment Procedure (SAP). SAP Appendix P contains a methodology to assess the risk of excessive internal heat gains in new build designs, in order to determine if a building design is compliant with Part L of the Building Regulations. The assessment of overheating risk relates to the need to limit energy use for cooling rather than limit the risks to health. The review by BEIS intends to consider whether revisions are needed to the calculations for internal summer temperatures to better reflect overheating risk.
- In response to the ASC's 2015 recommendation to *introduce a new standard or regulation on reducing the risk of overheating in new homes* (Recommendation 15), the Government stated that it would conduct more research on the costs and benefits of different options to mitigate overheating risk, including drawing on the work of the Zero Carbon Hub. The Hub has now reported its findings to DCLG, but funding for the hub was discontinued following the withdrawal of the Zero Carbon Homes target. Its last report to the Government on how to assess overheating risk recommended a broad, criteria-based standard,[205] in line with the ASC's advice to Government in 2015.

[202] HM Treasury (2015) *Fixing the foundations: Creating a more prosperous nation.*
[203] CCC (2016) *Progress report to Parliament, Chapter 3: Buildings.*
[204] Green, H., Andrews, N., Armstrong, B., Bickler, G. and Pebody, R. (2016) *Mortality during the 2013 heatwave in England – how did it compare to previous studies? A retrospective observational study.* Environmental Research, 147, 343-349.
[205] Zero Carbon Hub (2015) *Next steps in defining overheating.*

- Further work has also been conducted to provide guidance on overheating, green infrastructure, and protecting vulnerable people, by a range of organisations including the Environment Agency, Green Infrastructure Partnership, and the London Climate Change Partnership.

Some evidence is available on the uptake of different cooling measures in cities across England. The uptake of green roofs is most prominent in London, as their installation in new builds is supported by the London Plan.[206] The number and area of green roofs in London have been increasing year on year at a rate of between 15% and 19% annually since 2010, and currently stands at approximately 175,000m^2.[207] Passive cooling measures such as green roofs and passive ventilation systems are a preferable adaptation to air conditioning, which is energy-intensive and expels waste heat into the environment. The 'packaged' air conditioning market – which includes portable units sold to householders – grew by 3% between 2014 and 2015, and is estimated to continue this rate of growth out to 2020.[208]

In relation to risks from cold, an evaluation of the Cold Weather Plan has been completed, which showed that the plan was well regarded by healthcare professionals, but awareness was greater amongst community health practitioners than frontline staff. The review found a lack of evidence to ascertain how far the plan has gone to reducing the risk of cold-related mortality.

Is progress being made in managing vulnerability?

Daily average and maximum temperatures are increasing over time, which are in turn increasing the exposure of the population to heat.

Various indicators of temperature show that average temperatures are increasing over time, as is the frequency of days with high temperatures. The number of days per year in England where the average daily maximum temperature exceeds 25°C has increased from an average of around 5-6 days in the 1880s to 8-9 days in the 2000s. There is no obvious trend in a more extreme indicator of number of days per year where maximum temperatures exceed 30°C, however.

A different type of indicator for extreme temperatures based on the temperature profile across the year has found that the average annual daily maximum temperature in England rose from 11.8ºC in 1961-1990 to 12.8ºC in 1980-2010.[209] CCRA2 noted that in the absence of action, annual UK heat-related mortality is projected to increase from a current baseline of 2,000 heat-related deaths per year to 5,000 per year by 2050 (7,000 per year by 2050 taking account of population growth).

Declines in the area of urban green space observed between 2001 and 2011 have stabilised over the past five years.

Urban green space can help to cool the surrounding area, with studies from cities across the UK showing a reduction in temperatures of several degrees Celsius. One study from Glasgow projected that a 20% increase in green cover could offset 33-50 per cent of the expected extra urban heat island effect in 2050.[210] Urban green space also has other benefits: for mitigating

[206] The London Plan requires all major development proposals to include roof, wall and site planting, especially green roofs and walls where possible, to deliver cooling benefits as an adaptation measure to climate change.
[207] Survey information by Livingroofs Ltd., reported in ADAS (2017) for the ASC(2017) *Research to provide updated indicators of climate change risk and adaptation action in England.*
[208] AMA research limited (2015) *Ventilation and air conditioning market report UK 2015-2019 analysis.*
[209] Kendon, M., McCarthy, M., Jevrejeva, S. and Legg, T. (2016): *State of the UK Climate 2015.*
[210] Emmanuel, R. and Loconsole, A. (2015) *Green infrastructure as an adaptation approach to tackling urban overheating in the Glasgow Clyde Valley Region, UK.* Landscape and Urban Planning, 138(0), 71-86.

surface water flood risk, improving air quality, supporting biodiversity, and providing amenity value to people. The total area of urban green space in England in 2016 declined between 2001 and 2016 from 63% to 56% of urban area, though there has been no change between 2011 and 2016.[211]

Studies based on samples of houses consistently show around 20% of homes overheat in the current climate.

Understanding trends in exposure to heat in buildings is important as people spend on average 90% of their time indoors.[212] Although internal temperatures in buildings across England are not monitored routinely, studies based on samples consistently show around 20% of homes exceed various threshold temperatures for overheating in the current climate.[213] These studies could be routinely updated to establish if overheating is starting to occur more often, or is becoming more severe. Similar studies on large samples of other types of public building are lacking, though there is case study evidence of overheating risk in some types of public buildings (Box 4.2).

Box 4.2. Research on overheating in public buildings

Hospitals

The EPSRC-funded DeDeRHECC project, led by Cambridge University, found that all of the selected buildings across four NHS Trusts monitored between 2009 and 2013 overheated using a 28ºC criteria. Pre-war Nightingale wards were found to be the least likely to overheat, whereas lightweight 1960s designs were shown to be the most vulnerable. As part of the consultation process to improve the scope of data collection, reporting on clinical area overheating incidents is being added to the Estates Returns Information Collection (ERIC) at a Trust level for 2017/18. Under these reforms to the ERIC, Trusts will now be asked to report on a) overheating incidents in wards; b) overheating incidents triggering a risk assessment; and c) percentage of clinical space monitored for temperatures. These changes will allow the health sector to understand the reach of overheating monitoring processes and to measure the risk and risk mitigation of clinical areas overheating across NHS Trusts. This should provide data for an indicator in the future.

Care homes

Gupta et al. (2016) considered four case studies in care homes (two in residential care and two in extra care schemes). The study found that although climate models only predicted a limited risk of overheating in each scheme by the 2050s, empirical monitoring showed overheating across all four schemes during the summer of 2015. There was a general lack of awareness of the impacts of overheating, and the prevalence of the overheating risk both now and in the future across all those involved, from designers to frontline care staff and residents. Currently there is no statutory maximum internal temperature for care schemes. The study found that overheating is a risk in the care sector that is likely to be exacerbated in future due to climate change, yet there is currently little awareness and implementation of suitable and long-term adaptation approaches (such as external shading, and provision of cross-ventilation).

Source: ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*

[211] ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*
[212] Aecom (2012) for DCLG. *Investigation into overheating in homes: literature review.*
[213] ASC (2015) *Progress on preparing for climate change*; Kovats, R.S., Osborn, D., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment.*

Overheating is recognised as an issue in new buildings by 45% of a sample of buildings professionals, who also noted the absence of regulations and appropriate training as a key barrier to further action.

The Building Research Establishment (BRE) conducted a survey for the ASC of building professionals including architects, developers and consultants.[214] Of those surveyed, 45% (33 out of 75 respondents) reported that overheating had been identified as an issue after the completion of new build projects, with 9% reporting it being identified 'often'. A further one third of respondents were unaware of whether there were problems or not in completed projects. Respondents reported that the costs of rectifying overheating issues in completed projects were significantly higher than addressing the issue at the design stage. BRE also assessed the perceived barriers to including overheating measures at the design stage, through a survey, interviews and focus groups. The major barriers reported were:

- The absence of building or other regulations that require overheating risk to be addressed by developers.
- Lack of coverage of climate change adaptation in training for architects and planners.
- The lack of client demand, including both developers and the public.
- The need to promote energy efficiency, resulting in greater air tightness and less natural ventilation in buildings.
- Uncertainty over what future climate conditions to plan for in designs

In 2014 the ASC set out in detail why overheating risk in new homes is unlikely to be tackled through voluntary measures or current planning policy. Given the scale of the current and future risk, we reiterate our recommendation from our last progress report in 2015[215] that a new regulation or other standard should be put in place to manage the risk of overheating in new homes. Such a standard should also be part of a more holistic approach to housing design that takes into account, amongst other things, the need to warm homes affordably in the winter.

In relation to cold, energy efficiency levels are increasing in homes, though levels of fuel poverty have not (yet) declined as a result.

In relation to managing risks to people from cold, there have been positive trends in energy efficiency indicators for buildings. The average SAP (energy efficiency) rating of homes in England in 2014 was 61, up from 45 in 1996.[216] More recent data are not available. There has also been a reduction in the occurrence of damp and mould (which are associated with cold homes), from 12% of homes in 1996 to 4% in 2014.

Although the average energy efficiency rating of homes has increased, levels of fuel poverty in England since 2003 have fluctuated with no obvious upward or downward trend.[217] There are signs that the extra income needed for these households to cross the fuel poverty threshold has reduced, i.e. the degree of fuel poverty in fuel poor households has decreased.[218] Continued monitoring is needed to assess whether fuel poverty rates will decline in the future as a result of

[214] BRE (2017) for the ASC. *Resilience of new developments to high temperatures and flooding*.
[215] Recommendation15.
[216] The Government's Standard Assessment Procedure (SAP) is used to monitor the energy efficiency of homes. It is an index based on calculating annual space and water heating costs for a standard heating regime and is expressed on a scale of 1 (highly inefficient) to 100 (highly efficient), with 100 representing zero energy cost.
[217] BEIS (2016) *Annual fuel poverty statistics report: 2016.*
[218] *Ibid.*

energy efficiency programmes, or other factors such as rising incomes, in order to assess if these programmes are having the desired effect.

RECOMMENDATION 16: *As recommended in our 2015 report, a standard or regulation should be put in place to reduce the risk of overheating in new homes. (Owner: DCLG. Timing: by 2020).*

RECOMMENDATION 17: *Further action should be taken to assess and reduce the risks of overheating in existing buildings, with the priorities being hospitals, schools, care homes and prisons. This could be undertaken for example through the relevant standards agencies such as the Care Quality Commission and Ofsted. (Owner: Department of Health, Department for Communities and Local Government, Department for Education, Department for Justice. Timing: by 2020).*

Pathogens, air quality and UV radiation

Is there a plan?	Green	Targets and monitoring requirements for climate-sensitive air pollutants (ozone and particulate matter) are set through the National Ceiling Limits and Ambient Air Quality Directives. These targets will need to be maintained after the UK leaves the EU. Public Health England and the Food Standards Agency have programmes of research and surveillance for pathogens that pose a risk to public health. The Government has a strategy to reduce levels of skin cancer, and funds public warning systems and awareness raising activities for UV radiation.
Are actions taking place?	Green	All 12 NAP actions related to this adaptation priority are on track or have been completed. These include evidence collection by PHE on the extent and severity of risks from pathogens, air quality and UV radiation.
Is progress being made in managing vulnerability?	Amber	**Although the impacts of climate change on air quality, pathogens and UV radiation are uncertain, it is useful to assess how vulnerability may be changing in the population now.** **The number of people living with or previously diagnosed with chronic pulmonary obstructive disease has risen from 1 million in 2003 to 1.2 million in 2012. Vulnerability to UV radiation may be decreasing as there has been an apparent increase in the number of people taking action to reduce sun exposure. No data is available to assess how vulnerability to pathogens is changing over time.**

Is there a plan?

Plans exist to raise awareness, monitor and lower the present-day risks to health from air pollution, pathogens and UV radiation.

Two types of air pollutant are climate-sensitive and therefore relevant to climate change adaptation: ground level ozone and particulate matter (PM2.5 and PM10). New national ceiling limits and targets for 2030 for particulate matter were set in December 2016 under a new EU

Directive 2016/2284/EU.[219] Targets and limits for ground level ozone and its precursors are set under the Ambient Air Quality Directive 2008/50/EC. The provisions in this Directive are transposed into English law through the Air Quality Standards Regulations 2010.[220] These regulations and national ceiling limits for 2030 will need to be retained in UK law when the UK leaves the EU.

Public Health England's Strategic Plan to 2020 includes an action by 2018 to develop a joint programme of work, and the production of plans, for the public health system's response to high consequence infectious disease incidents. Over the next four years PHE will continue to support research on improving the understanding of the impacts of climate change on health. The Foods Standards Agency Foodborne Diseases Strategy, published in 2011, includes horizon scanning activities to consider future risks from food-borne pathogens. These plans do not include long-term targets or goals in relation to managing the risks from pathogens.

Established monitoring programmes are in place for UV radiation.[221]

Are actions taking place?

All 12 NAP actions related to this priority are complete or on track, many of which relate to increasing the knowledge base on how these risks interact with weather and the level of exposure for different groups of people.

For example:

- PHE are conducting a study to quantify the health impacts from short term exposure to ozone pollution for different regions of England.
- PHE will also be publishing research before the end of the year on improving methods to link infectious disease data to weather patterns.
- Cefas are developing an evidence base on the role of extreme climatic events (in particular heat waves, droughts, precipitation events and storms) in driving waterborne pathogen risk in the UK as well as internationally.
- Bathing and shellfish waters where deterioration has been identified will be prioritised for work in the next water industry asset management programme from 2020.
- PHE has expanded its network of UV monitoring sites, including two new sites on Gibraltar and in Cyprus. A study is also underway to determine peoples' exposure to UV radiation as they go about daily activities, including sport.

Is progress being made in managing vulnerability?

Vulnerability to air pollution, measured by the total number of people living with chronic respiratory conditions, has increased since 2004.

The future impacts of climate change on air pollutants, human pathogens and UV radiation are uncertain, and therefore the future level of risk due to climate change is difficult to predict. However, vulnerability to these risks can be monitored through assessing changes in the vulnerable population over time, for example in the number of people living with chronic respiratory conditions:

[219] See: http://ec.europa.eu/environment/air/pollutants/ceilings.htm
[220] Defra (2016) *Air Pollution in the UK 2015.*
[221] See: https://uk-air.defra.gov.uk/research/ozone-uv/

- Since 2004, the number of people previously diagnosed with or living with asthma has remained steady at 7 - 8 million, though the number of new diagnoses each year has fallen from about 500 per 100,000 people in 2004, to 300 per 100,000 people in 2012.[222]
- The number of people living with or previously diagnosed with chronic obstructive pulmonary disease increased from 1 million to 1.2 million between 2004 and 2012, with a smaller decline in the number of new diagnoses compared to asthma.

Actions taken to reduce exposure to UV radiation are increasing, which should lower impacts over time.

Skin cancer awareness rates can be used as a vulnerability measure for UV radiation, as they give an indication of whether people are aware of the risk and are likely to be protecting themselves. Since 2003, there has been a slight increase in the percentage of people reporting actions to reduce sun exposure in surveys conducted by Cancer Research. Actions include using sunscreen, covering up exposed skin, and being more aware of changes to moles on the skin.[223]

It is not known how the risk to people from human pathogens is changing. There are no indicators that measure trends in the incidence of different disease vectors over time, nor peoples' exposure to different pathogens. However, surveillance systems are in place to monitor vector distribution and abundance, and the incursion on non-native vectors at ports of entry.

4.6 Emergency management

CCRA2 reiterated that emergency preparedness plays a key role in managing current climate risks, such as flooding and overheating, as well as preparing for future extreme weather events in a warmer climate.

An effective emergency response limits damage from any event that poses a serious threat to peoples' wellbeing and the environment.[224] This section discusses whether the emergency planning system in England is effectively managing current weather events, by assessing whether:

- Warning systems exist for the relevant range of climate risks, and are effective in triggering appropriate actions from the public and professional responders.
- Sufficient capability is in place to deal with the range of plausible extreme weather scenarios that can occur under today's climate.

[222] British Lung Foundation, reported in ADAS (2017) for the ASC, *Research to provide updated indicators of climate change risk and adaptation action in England.*
[223] Cancer Research UK (2014) reported in ADAS (2017) for the ASC, *Research to provide updated indicators of climate change risk and adaptation action in England.*
[224] Cabinet Office (2006) *Emergency preparedness.*

Effectiveness of the emergency planning system

Is there a plan?	Green	Warning systems are in place to alert emergency planners and the public in advance of flooding, heavy rainfall, strong winds, and heatwaves. The 2004 Civil Contingencies Act and the associated statutory guidelines define roles, responsibilities and procedures to manage climate and non-climate related emergencies.
Are actions taking place?	Green	Most of the NAP actions on emergency planning have been completed or are on track. The number of households subscribed to receive flood warnings is increasing. A National Capability Assessment for emergency responders is underway. The National Flood Resilience Review provided some additional capability to flood emergency responders through acquiring an additional 32 km of temporary flood barriers.
Is progress being made in managing vulnerability?	Amber	**Recent events have highlighted the need for community flood preparedness to be improved. This is needed because of insufficient flood emergency planning at the community level, people not being signed up to receive warnings, or failing to act upon them when issued.** **Local Resilience Forums report they are not confident that they have the resources to cope with more severe weather events than those experienced to date. Evidence on the effectiveness of the heatwave warning system is being collected.**

Is there a plan?

Warning systems are in place to alert emergency responders and the public in advance of flooding, heavy rainfall, strong winds, and heatwaves.

The Met Office provides weather warnings for heavy rain, severe gales, heavy snow and icy roads. These warnings are communicated to the public using a range of means and channels. Emergency planners and responders can sign up to receive bespoke warnings.

The Heatwave Plan for England sets out guidance on how health practitioners and the public should act during periods of hot weather with a particular focus on protecting vulnerable people (see also Section 4.5). Linked to this plan, the Met Office operates a Heat-Health Watch Service to help healthcare professionals manage periods of extreme temperature. When temperature forecasts exceed a certain threshold, a warning is issued and sent to health professionals and people working in social care.[225]

The Flood Forecasting Centre (FFC) is a partnership between the Environment Agency and the Met Office. The FFC produces daily forecasts up to five days ahead for flooding including from

[225] See: http://www.metoffice.gov.uk/public/weather/heat-health/#?tab=heatHealth

river, surface water, tidal and groundwater sources. The FFC also provides specialised information to emergency planners and responders.[226]

The Civil Contingencies Act provides a framework for local responders to develop appropriate planning arrangements for their area, following the Emergency Planning and the Emergency Response and Recovery guidance.[227, 228]

The Civil Contingencies Act states that emergency planning should involve a number of organisations collaborating across all levels of government. Local authorities, police, fire services, the NHS, the Environment Agency and other key responders are responsible for assessing risks, planning for emergencies, and warning the public. These 'Category 1' responders are organised into Local Resilience Forums (LRFs). According to the Act, utility companies, transport agencies, voluntary and other organisations ('Category 2' responders) are required to co-operate and share relevant information with LRFs.

At the national level, DCLG provides support to LRFs whilst individual government departments lead on national planning for the risks within their remit. Responsibilities are set out in the National Risk Assessment, produced by the Cabinet Office. The Assessment includes weather-related risks such as extreme storms, major coastal and river flooding, droughts, and heatwaves, alongside other non-weather related risks. The Cabinet Office is considering how the National Risk Assessment could take into account the climate change risks identified by CCRA2. The National Risk Assessment forms the basis upon which LRFs produce Local Risk Registers. LRFs must ensure that they have sufficient capability to respond to the risks in their register.

Are actions taking place?

Most of the 21 NAP actions on emergency planning have been completed or are on track, and further actions have been carried out to improve warning systems and increase their uptake. The National Flood Resilience Review provided some additional capability to flood emergency responders through the acquisition of 32 km of temporary flood barriers.

The flood warning service provided by the Environment Agency covers about 83% of properties at a risk of flooding from rivers and the sea. EA aims to extend this to cover 86% of properties by 2017/18 and 100% by 2019/20.[229] Whilst one-third of the remaining properties are expected to be covered by a relatively simple upgrade of the current system, EA estimates that extending the coverage to the remaining two-thirds might require significant investment in infrastructure, data and staff. Two-thirds of the properties covered by the service have subscribed to receive direct flood warnings by text message.[230]

Regarding risks from extreme temperatures, PHE has run a 'Get Ready for Winter' campaign for the last six years, including a dedicated website and proactive communications such as social media activity and press releases.[231] For the last three years, the Met office has also run a similar

[226] See: http://www.ffc-environment-agency.metoffice.gov.uk/
[227] Cabinet Office (2006) *Emergency preparedness.*
[228] Cabinet Office (2013) *Emergency Response and Recovery - Non statutory guidance accompanying the Civil Contingencies Act 2004.*
[229] Communication with the Environment Agency.
[230] These include properties that have been automatically subscribed and have not opted out.
[231] NAP action update (2017).

web-based 'Get Ready for Summer' campaign to raise awareness about warmer weather issues. The Cabinet Office has reviewed and updated the Communities Prepared Hub.[232]

Actions to increase the capability of emergency planners include acquiring 32 Km of temporary flood barriers following the National Flood Resilience Review. Extensive training was carried out to ensure that the military and Environment Agency staff can effectively deploy the barriers.

The Cabinet Office is in the process of conducting a new National Capability Assessment (NCA) at the time of writing this report. However, this assessment focuses on understanding the resources available, rather than those needed, to manage the risks identified in the National Risk Assessment. The results of the NCA are not published.

Is progress being made in managing vulnerability?

Recent events have shown that community flood preparedness needs to be improved. Key issues included insufficient flood emergency planning at the community level, people not being signed up to receive warning messages, or failing to act on warnings when issued. There are no data yet available on the effectiveness of the heat warning system.

A review following storm Desmond in December 2015 concluded that whilst flood warnings were acted upon by most of those that received them, in some places such as Carlisle and Cockermouth the warning reportedly arrived too late and was not sufficiently precise. The review found that some of the affected communities felt unprepared for the event, suggesting they assumed that the physical flood defences in place would never fail to protect them. In some cases no formal or informal flood emergency plans were in place, people were either not registered for Environment Agency flood warnings, or did not give enough credence to them.[233]

The ASC commissioned a survey of experts in Local Resilience Forums to inform this report, with 17 interviews conducted with people working in 14 of the 38 LRFs in England.[234] The majority of the interviewees stated that they are satisfied with the warning services provided by the Met Office and the Environment Agency, although some highlighted that further improvements can be made to the accuracy of the flood forecasting data provided.

Data regarding the effectiveness of warning systems for other weather-related hazards are not available.

Whilst LRFs report that they have made the best use of the available resources in responding to past events, they are not confident that they can cope with future events more severe than those experienced to date. This includes the range of climate-related risks in the National Risk Register.

On Saturday 5 December 2015, Cumbria was hit by storm Desmond (see Section 4.2). Senior responders that provided evidence to the ASC reported that the event was generally perceived as unprecedented and overwhelming, even by people who were experienced and prepared to deal with flooding events. The responders involved in managing the emergency were widely praised for the efforts, resulting in no lives lost. However, the response system was reportedly extremely stretched and this was compounded by severe disruption to infrastructure, in particular electricity, telecommunications and transport services (see Chapter 5 for more details).

[232] See: https://www.gov.uk/government/publications/preparing-for-emergencies/preparing-for-emergencies
[233] JBA Trust, Zurich Insurance (2016) *Flooding after Storm Desmond*.
[234] Jacobs (2017) for the ASC. *Local Resilience Forum 2017 Interviews*.

Almost all the participants in our LRF survey rated their response to past weather emergencies as either 'excellent' or 'good'. However, most interviewees also highlighted limiting factors, stating that plans are constrained by the resources they have available, and would struggle with larger or more prolonged events. Reductions in staff numbers and other resources were reported. Interviewees felt more prepared for events experienced recently, such as flooding, and less prepared for events that are more rarely experienced, such as heatwaves.

The Civil Contingencies Act has improved the capability of the emergency planning system, but further clarity is needed regarding co-ordination and co-operation amongst different agencies as well as between neighbouring LRFs.

In the majority (76%) of the LRF interviews, participants considered the Civil Contingencies Act to be an effective framework for managing emergencies. However, in almost two-thirds of the interviews, responders suggested that there is still room for greater clarity on the definition of responsibilities amongst the various agencies, including the requirements for co-operation and information sharing. Several interviewees also highlighted the need for more regional co-ordination between LRFs, and better co-ordination of the national-level response and resources.[235]

RECOMMENDATION 18: *The Cabinet Office should, in consultation with Local Resilience Forums:*

- *Commission an independent review of the planning scenarios underpinning local Risk Registers to ensure they i) they are consistent with plausible worst case scenarios, and ii) use the results to help LRFs assess the resources needed to manage these events.*
- *Strengthen the Emergency Planning Guidance to clarify and test responsibilities for coordination amongst Category 1 and Category 2 responders, as well as between neighbouring LRFs.*

(Owner: Cabinet Office. Timing: by 2020).

4.7 Conclusions on NAP objectives and actions

Table 4.1 summarises progress against the objectives listed within the NAP for Built Environment theme (objectives 1-6) and the Heathy & Resilient Communities theme (objectives 11-14).

In general, the objectives describe a number of processes and list actions by which the resilience of people and the built environment should be improved.

Of the 104 actions originally listed in these chapters of the NAP:

- 53 (51%) are complete;
- 40 (38%) are on-track; and
- Four (4%) have been revised or delayed.

One action was dropped and updates were not received for the remaining six actions (6%).

43 (42%) of actions in the NAP for these themes are time-bound, with the remaining 60 (58%) classed as 'on going' or do not have an end date.[236]

[235] *Ibid*.
[236] NAP action update (2017).

Table 4.1. NAP objectives and a summary of progress for the built environment and health themes

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.	Of the eleven actions under this objective, seven are complete and four are on-track. Whilst the long term investment need for flood alleviation schemes have been identified and cost-effective schemes are being delivered accordingly, there is little progress toward reducing risks for the 153,000 households that are not cost-beneficial to protect with such schemes. Shoreline Management Plans identify policies to manage coastal change up to 2100, yet the affected communities have not yet been fully engaged in the changes that are likely to occur to coastal management approaches.
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.	Seven out of the eight actions supporting this objective are complete or on track. However, the planning system allows development to continue in areas of flood risk and this will add to the costs of future flood events and increase the need to maintain and improve flood defences. The lack of building standards to avoid overheating means the risk of heat-related deaths is not being managed.
Objective 3. Help businesses and industries in the sector to access skills, training, knowledge and tools to understand and manage climate change risks.	12 of the 16 actions under this objective are complete or on track, one was dropped, and no update was provided for the remaining three actions. Despite these actions, there is still a very low uptake and recognition among building designers and insurers of the need for property-level measures to reduce flood and overheating risks. Climate Ready and the Zero Carbon Hub, which were responsible for delivering four of these actions, have closed.
Objective 4. To ensure that investors and developers have the financial and appraisal decision tools needed to support and promote adaptation to climate change.	All six actions under this objective are complete or on track. Whilst guidelines and tools are now in place promote accounting for climate change when making development decisions, there is no evidence of their impact in practice.
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.	All 14 actions under this objective are complete or on track. These actions aimed to tackle overheating and promote more efficient water use in domestic buildings. Whilst progress has been made in decreasing water consumption in buildings, there remain no plans to address overheating risk in new and existing buildings.

Table 4.1. NAP objectives and a summary of progress for the built environment and health themes

NAP objective	Commentary on progress
Objective 6. To explore and build understanding of the long term implications of climate change for the location and resilience of population centres.	Six actions support this objective, five of which have been completed, whilst one has been revised. The Environment Agency's Long Term Investment Scenarios provide a national assessment of long-term river and coastal flood risk and the degree of investment needed to manage them, but the implications for levels of flood protection and residual risk in different parts of the country are not reported. The scale of the investment needed to tackle the lack of capacity in the public sewer network has yet to be assessed. CCRA2 collated evidence on the expected impacts of a range of climate-related risks to the built environment. The report concluded that more action is needed to address risks from flooding, overheating and water scarcity.
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.	21 out of the 43 NAP actions for the health theme fall under this objective. All but one of the actions are complete or on track. There is an increased understanding of the mental health impact from flooding, and actions are underway that might help to reduce these impacts. It is not known how the NAP actions have helped reduce heat-related mortality, though a review of the Heatwave Plan for England is underway.
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.	All eight actions under this objective are complete or on track. Whilst the Heatwave and Cold Weather Plans for England provide guidance to health practitioners and the public, the impact of these plans in reducing the risk is not known. There remain no requirements in place to ensure that hospitals and care homes do not overheat in high temperatures.
Objective 13. To minimise the impact of climate change on vulnerable groups in society by strengthening their resilience to better prepare for, respond to and recover from future climate risk.	Of the three actions supporting this objective, two are complete and one has been dropped. Whilst progress has been made in increasing the coverage and uptake of flood warnings, there remains scope to improve community-level emergency planning. Data on the effectiveness of the heat warning system are being collected. The level of climate change awareness amongst vulnerable groups is unknown.

Table 4.1. NAP objectives and a summary of progress for the built environment and health themes

NAP objective	Commentary on progress
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&2 Responders of the Local Resilience Forums.	Eight out of 11 actions under this objective are complete or on track, whilst one has been revised, one dropped and no update was provided for the remaining action. Whilst LRFs have made the best use of the resources available to respond to past events, they are not confident that they can cope with events more severe than those experienced to date, especially in the light of diminishing resources. Communication issues amongst Category 1 and 2 Responders are still reported.

Chapter 5: Infrastructure

Key messages

Context

This chapter examines climate change risks to the essential services provided by national and local infrastructure, including water supply, energy, communications and transportation. Weather extremes including flooding, high and low temperatures, droughts, and high winds, can cause infrastructure failures, sometimes with knock-on impacts for other networks and assets. Climate change poses multiple threats to UK infrastructure, making oversight by Government and regulators important because of the potential for systemic impacts. Timely action is required to manage risk in the most cost-effective way.

Summary of progress

Since 2015 significant steps have been taken to improve the resilience of infrastructure systems. Reports under the Adaptation Reporting Power (ARP) have provided evidence of adaptation actions. Most infrastructure operators are aware of risks from climate change and incorporate these in their engineering design and asset management plans. However, although progress has been good, residual risks remain. Recent extreme weather events continue to highlight vulnerabilities, including those resulting from dependence on communication and power networks that were previously considered resilient. There remain limited data at the national level in some sectors to determine whether adaptation actions are reducing vulnerability and managing systemic risks effectively.

Overview of progress

Adaptation priority	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
2a. Energy	Green	Green	Green
2b. Public water supply	Green	Green	Green
2c. Ports and airports	Amber	Green	Amber
2d. Road and rail	Green	Green	Amber

Key messages

2e. Digital and ICT	Red	Amber	Grey
3. Infrastructure interdependencies	Amber	Amber	Amber

Note: See Annex 2.1 for a description of the criteria used to assign Red-Amber-Green (RAG) scores.

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.

Location and design of new infrastructure: Sector-based National Policy Statements (NPSs) are in place. A water supply NPS is being developed for 2017 to guide decisions on the design, location and operation of water supply projects. The National Infrastructure Commission (NIC) was set up in 2016 and will publish a National Infrastructure Assessment (NIA) once every Parliament. The NIA will set out the long-term vision for UK infrastructure. It is intended that the NIA will include the implications of climate projections for infrastructure investment. Adaptation is also being incorporated into some existing project designs (e.g. the High Speed 2 rail link). More broadly, Nationally Significant Infrastructure Projects are taking into account flood risks but less account is taken of other risks such as water scarcity, subsidence, wind, fog, lightning and surface water flooding.

Energy: Ofgem's performance framework for gas and electricity companies incentivises investment in safe and reliable services. The cross-industry ETR 138 standard for network resilience to flooding has been reviewed by the Energy Networks Association and now includes surface water flooding. Roll-out of ETR 138 means that critical substations and other assets are being upgraded. National Grid is initially targeting investment toward assets at highest risk, while providing interim mobile flood defences elsewhere. Electricity generators that need water for cooling are addressing the risk of water scarcity. Good progress is being made in managing vulnerability, but residual risks remain. For example, the flooding of an electricity substation in Lancaster in December 2015 led to the loss of electricity supplies for over 30 hours to approximately 61,000 homes, businesses and local infrastructure. .

Public water supply: The current Asset Management Plan period (AMP6) includes a new outcomes-based performance framework. The framework allows operators the flexibility to deliver resilient services, at least cost. Water companies are looking at least 25 years ahead in their Water Resource Management Plans (WRMPs) and some are developing plans that can cope with the inherent uncertainty in climate change projections and other factors such as population growth. The new 'resilience duty' on Ofwat will take effect in 2019, and this will formalise resilience as an objective for the industry. A new Strategic Policy Statement (SPS) for Ofwat will set out the Government's strategic priorities and objectives for Ofwat's regulation of the water sector in England. Investments in measures to reduce water demand and improve resilience of assets to flooding are taking place. However, there are opportunities to improve resilience further through more ambitious reductions in demand and leakage. Realising these opportunities will require more effort by water companies and regulators.

Ports and airports: The 2014 Transport Resilience Review set out recommendations to improve the resilience of ports and airports. These assets received further attention in the 2016 National Flood Resilience Review. However, performance and resilience standards are largely left to operators to determine. Airports are investing in flood resilience measures. A number of ports have assessed future sea level rise and are implementing improvements, including raising quay heights. Plans to improve flood defences at the Port of Immingham have been approved. Evidence from ARP reports and in

response to recent severe weather events suggests that some actions are beginning to address vulnerabilities, though most actions seem to be in response to events rather than being based on proactive risk management.

Road and rail: The Government provided £150 million to improve transport flood resilience in its 2016 Autumn Statement. Network Rail has published an overarching Weather Resilience and Climate Change Strategy to provide a framework within which all work relating to weather resilience and climate change adaptation is undertaken. Network Rail is analysing risks and undertaking site-specific actions, which have mostly centred on embankments, bridges, and coastal defences. However, ageing railway infrastructure continues to be challenging to adapt. Highways England has addressed high risk and very high risk flooding hotspots and culverts. Fewer weather-related delays have been experienced on England's road and rail networks in recent years, but variability in annual delay data means that it is not yet possible to assess robustly whether this is a result of adaptation actions or other factors.

Digital and ICT: The National Flood Resilience Review identified critical vulnerabilities in digital communications networks and ICT infrastructure. TechUK's ARP report provides an outline of where further scrutiny should be focused, but there do not appear to be systematic industry or Government plans to address these vulnerabilities. The National Adaptation Programme contains no specific actions relating to ICT, despite the sector being recognised as critical to the operation of other infrastructure sectors, as well as the economy in general. There is some evidence of actions taking place (e.g. from ARP reports), in response to recent weather events. However there remains a lack of evidence available to the ASC to assess the resilience of the sector.

Infrastructure interdependencies: The risks from interdependencies between networks have been further emphasised in the second UK Climate Change Risk Assessment. The Cabinet Office annual resilience reviews have identified and considered specific vulnerabilities to interdependent networks. Recent events further highlight vulnerabilities caused by losses in electricity supply and ICT (e.g. the Lancaster floods in 2015). Members of the Infrastructure Operators Adaptation Forum including water companies are working to address the resilience of networks on which they depend, for example, by increasing resilience to power supply outages. Some new infrastructure projects are considering interdependencies (e.g. HS2). However, there is no national assessment of interdependency risk, or of the possible systemic implications of interdependencies. Data are not available to measure progress in reducing vulnerability. There need to be stronger connections between Local Resilience Forums and infrastructure operators to ensure there is a meaningful exchange of information on assets and vulnerabilities, and to enable the collaborative action required to manage interdependency risks.

Recommendations for further progress

More attention needs to be paid to digital and ICT infrastructure, and infrastructure interdependencies, in the second National Adaptation Programme (NAP).

The ASC has limited access to data that the Government holds, which has inhibited our assessment of the NAP. During 2017/18, the ASC will identify the priority data needed to assess England's progress in adapting infrastructure systems.

RECOMMENDATION 19: *Defra should review and strengthen its guidance for ARP3 to elicit more comparable data and conclusions about the adaptation of infrastructure. Use of consistent incident reporting and indicators of network resilience will allow performance to be tracked over time. Reporting protocols should be developed in partnership with sector organisations, the Cabinet Office, the National Infrastructure Commission, and the new National Infrastructure Resilience Council. (Owner: Defra. Timing: 2018).*

RECOMMENDATION 20: *Defra should ensure that all major infrastructure operators in the digital and ICT sector take part in the third round of the ARP. This will ensure that the sector has considered risks, and that*

Key messages

operators, individually and collectively, have developed risk management plans. (Owner: Defra. Timing: 2019).

RECOMMENDATION 21: *To assist with the assessment and management of interdependencies the Cabinet Office should review information sharing arrangements between infrastructure operators, as well as between operators and Local Resilience Forums. Further steps may be necessary to ensure that the legal duties within the Civil Contingencies Act are being fulfilled in practice, including the duty for Category 1 and Category 2 responders to cooperate and share information. (Owner: Cabinet Office. Timing: 2018).*

5.1 Introduction

Climate change poses multiple threats to infrastructure systems, including water supply, energy, communications and transportation. 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 every year.[237]

Infrastructure systems are long-lived, often sensitive to severe weather, and their failure can have knock-on impacts on other networks and assets. All economic activities rely upon infrastructure networks and services, whose quality and resilience are regarded as a pillar of global economic competitiveness. Acting now to improve the current and future climate resilience of our nation's infrastructure makes practical and economic sense.

Infrastructure mostly comprises hard engineering assets and the systems that operate and maintain these assets. Built infrastructure can impact upon the natural environment, and there is growing recognition of the potentially synergistic interplay between "grey" infrastructure and natural capital ("green and blue infrastructure"). For example, enhancing the quality of water in rivers can reduce costs at downstream water treatment works; improving the resilience of intertidal wetlands in estuaries reduces the need for costly sea walls.

5.1.1 Future infrastructure

In 2015 the Government created the National Infrastructure Commission (NIC) (see Section 5.2 for details) to provide expert, independent advice on strategic infrastructure issues. The NIC will produce an in-depth assessment of the UK's major infrastructure needs with a 30-year time horizon, with climate change identified as a key driver. The first National Infrastructure Assessment (NIA) is expected in 2018.

Though the NIA has not yet been published, the latest version of the UK's National Infrastructure Plan[238] sets out over £320 billion planned investment in infrastructure up to 2020/21. Investments in low-carbon and resilient infrastructure projects will be needed to meet domestic climate change obligations at lowest cost, to maintain the competitiveness of UK industry, and to unlock a range of co-benefits such as reducing air and water pollution.

Infrastructure can be built from the outset to be resilient to the anticipated range of future climatic conditions, or designed to allow it to be upgraded cost-effectively as the climate changes (termed a 'managed adaptive' approach).

[237] Data from NaFIRS (2017), Network Rail (2017), Highways England (2017).
[238] HM Treasury (2015) *National Infrastructure Delivery Plan 2016 to 2021*.

5.1.2 Risks to infrastructure from climate change

The Evidence Report for the second UK Climate Change Risk Assessment (CCRA2) identified 14 specific areas of risk and opportunity for infrastructure.[239] Key risks are shown in Figure 5.1.

- Increasing frequency and severity of flooding represents the greatest climate change risk, with the number of assets exposed to significant levels of flood risk potentially doubling by the 2080s.
- Changes in temperature and rainfall will place additional pressure on infrastructure, in particular the rail, road, water and energy sectors, e.g. increased rail buckling with higher temperatures, and the possibility of water demand exceeding the available supply.
- Potential increases in maximum wind speeds experienced during storms would impact infrastructure networks, e.g. electricity transmission cables and overhead power lines for electrified railways, although projections of future wind speeds remain uncertain.
- Infrastructure assets could also become more exposed to subsidence, humidity, fog, storms and lightning, but projections of these risks are uncertain. The National Adaptation Programme (NAP) does not address these issues. The infrastructure chapter within the NAP only considers the key risks highlighted in the first CCRA. These primarily relate to flooding and water scarcity, and their impacts on water, transport and energy sectors.

The NAP sets four objectives for the infrastructure theme. We review progress in delivering the actions in the NAP against each objective in Section 5.5 at the end of this chapter.

The following sections evaluate the extent to which actions and policies in the NAP and elsewhere are addressing the identified climate risks (following the method described in Chapter 2), with a focus on action since 2015. 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.[240]

[239] Dawson, RJ., et al. (2016) *UK Climate Change Risk Assessment Evidence Repor*t: *Chapter 4, Infrastructure.*
[240] See: https://www.theccc.org.uk/publications/

Figure 5.1. Key risks to UK infrastructure

Source: See: https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/ccra-chapters/infrastructure/

5.2 Design and location of new infrastructure

Is there a plan?	Green	A series of sector-based National Policy Statements (NPSs) for energy, transport and waste water require climate change to be taken into account when developing new infrastructure projects. A water supply NPS is being developed. The National Infrastructure Commission, which was formally established in 2017, will publish a National Infrastructure Assessment once every Parliament setting out the vision for UK infrastructure. Resilience to climate change is recognised by the NIC as a driver of need for future infrastructure investment.
Are actions taking place?	Green	Most NAP actions are complete or ongoing. They focus on embedding climate change risks within key policy documents such as the Energy Security Strategy, operator business plans, and the series of NPSs. Environment Agency guidance on building climate resilience into infrastructure (originally due in 2013), was published in November 2015. There is also evidence that engineers are incorporating adaptation into the design of major projects, for example HS2.
Is progress being made in managing vulnerability?	Amber	**Nationally Significant Infrastructure Projects (NSIPs) are taking into account future risks from flooding and sea level rise. Less account appears to be taken of other climate hazards, where the impact of climate change is less certain but could be significant.**

Is there a plan?

The National Infrastructure Commission was formally established in 2017. The Commission will publish a National Infrastructure Assessment every five years, setting out a vision for UK infrastructure for the following 30 years.

The NIC will provide expert, independent advice on strategy, and produce an in-depth assessment of the UK's major infrastructure needs with a 30-year time horizon. NIC's objectives are to:

- Foster long-term and sustainable economic growth across all regions of the UK.
- Improve the UK's international competitiveness.
- Improve the quality of life for those living in the UK.

The NIC will deliver welcome strategic oversight of infrastructure. Resilience to climate change is recognised by the NIC as a driver of need for future investment.

The NIA will look 30 years ahead, but in doing so it is important that climate risks to infrastructure on longer timescales are also considered. The NIC should consider how to build new UK climate projections (due in 2018) into its work plans and ongoing advice. The NIC has published a discussion paper which sets out the framework for consideration of these issues in the NIA.[241]

A series of sector-based National Policy Statements are updated annually. These require climate change projections to be taken into account when developing new infrastructure projects.

Ten National Policy Statements (NPS) have been published since 2011 and cover the energy, transport, and waste water sectors. Since 2015:

- A draft statement for airports[242] was published in February 2017 which considers the implications of climate change and includes requirements for minimising flood risks for new runway capacity and infrastructure at airports in the south-east of England.
- Applicants for new airport infrastructure (e.g. the proposed new runway at Heathrow Airport) must consider climate change when planning the design, build and operation. Any accompanying environmental statements should set out how the proposal will take account of the projected impacts of climate change. Flood risk should be considered as set out in the National Planning Policy Framework.[243]
- A water supply NPS is being developed. This NPS will set out the need for new nationally significant water supply infrastructure projects, with the aim of accelerating the process of providing development consent where necessary.

There is no over-arching NPS to guide the strategic location of important infrastructure assets, so in our 2015 report to Parliament we recommended that *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*

[241] NIC (2017) *The impact of the environment and climate change on future infrastructure supply and demand*.
[242] Department for Transport (2017) *Draft Airports National policy Statement: new runway capacity and infrastructure at airports in the south-east of England*.
[243] Department for Communities and Local Government (2012) *National Planning Policy Framework*.

should then 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 9).

In their response, the Government said it considered existing statutory and policy procedures to be adequate and did not believe an overarching National Policy Statement was necessary. The creation of the NIC now provides the opportunity to analyse systemic risks from a cross-sector perspective. The NIC should include in their assessment interdependencies between sectors, systemic issues, and their implications for infrastructure investment needs, as recommended in the CCC's briefing note to the NIC in March 2017.[244]

Are actions taking place?

Actions within the NAP are mostly complete or ongoing and 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. There is also evidence that engineers are incorporating adaptation into project designs.

One NAP action that had previously been delayed is now complete. Environment Agency guidance due in 2013 on building climate resilience into infrastructure was published in November 2015.[245]

One action remains delayed. BEIS were due to review the adequacy of the NPS to deal with climate change for new energy infrastructure. The combination of shifting priorities and the inception of the NIC resulted in a decision to postpone the review process.

HS2 Ltd has produced a Climate Change Adaptation and Resilience Policy, and is developing a Climate Change Adaptation and Resilience Strategy. These documents set out how the design, construction and operation of the proposed scheme will consider all relevant climate change risks and result in a climate resilient high speed rail network. HS2 is also considering interdependencies and cumulative impacts (see Section 5.4).

Is progress being made in managing vulnerability?

Nationally significant infrastructure projects are taking into account climate change, in particular the risk of flooding. Less account is being taken of other climate hazards.

An ASC commissioned review of Nationally Significant Infrastructure Projects in 2014 found that the primary climate risks that had been assessed were flood risk and sea level rise.[246]

Since August 2010 there have been 75 new infrastructure projects listed on the 'register of applications', with a total of 48 granted in England.[247]

- No project in England was granted planning permission with outstanding objections from the Environment Agency.
- Of the 48 approved, 45 contained details of a Flood Risk Assessment (FRA). The three that did not were offshore developments.

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[244] CCC (2017*) Briefing note: the infrastructure needs of a low-carbon economy prepared for climate change.*
[245] See: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/
[246] HR Wallingford (2014) for the ASC. *An assessment of applications for Nationally Important Infrastructure.*
[247] ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*

- In 39 of the 45 FRAs the Examining Authority's recommendation report includes specific text stating that the EA was satisfied with the method, scope and findings contained within the FRA.
- Evidence of the sequential and exception tests being applied was provided in the majority (33 out of 45) of applications where it was required.[248]

Although flood risk is being taken into account, 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 surface water flooding.

5.3 Resilience of infrastructure services

This section provides an overarching assessment of infrastructure services in England. It covers policies and actions which overlap a number of infrastructure sectors, as well as synthesising our sector-level assessments (see Sections 5.3a to 5.3e).

Is there a plan?	Green	Sector resilience plans, which consider the resilience of the UK's critical infrastructure to a range of weather and non-weather related hazards, continue to be updated each year. The National Flood Resilience Review was published in 2016 and examined the resilience of water, energy and fixed and mobile telecoms. It tested the robustness of Environment Agency flood mapping and gauged the vulnerability of infrastructure assets under an extreme flood scenario. Risks from river and tidal flooding were considered, but not from surface water flooding.
Are actions taking place?	Green	The second round of Adaptation Reporting Power reports (ARP2) provided evidence of risk management actions being taken by organisations. Actions have largely focused on areas where evidence of climate change impacts is strongest, e.g. flooding and sea level rise.

[248] The Sequential Test ensures that the location of a new development is steered toward areas with the lowest probability of flooding. A planning authority should demonstrate, through evidence, that it has considered a range of options in the site allocation process, using the Strategic Flood Risk Assessment to apply the Sequential Test. If the Sequential Test demonstrates that there is no reasonable alternative site for a project in Flood Zones 1 or 2, a project can be located in Flood Zone 3 subject to an Exception Test.

Is progress being made in managing vulnerability?	Amber	**The ASC's review of ARP2 concluded that in some sectors there is a lack of quantified evidence describing how adaptation actions taken have helped to reduce future vulnerability. However, in some sectors such as energy and water, vulnerability is being managed or is reducing.** **The National Flood Resilience Review (NFRR) assessed vulnerabilities across sectors and looked at protection to 1-in-1000 year flood event as a resilience standard. It is not clear to what extent this standard of protection is in place in practice. The ASC has so far not been given access to the data the Government assembled for the NFRR on infrastructure resilience.**

Is there a plan?

Sector resilience plans continue to be updated each year. These consider the resilience of the UK's critical infrastructure to the range of weather and non-weather related hazards set out in the National Risk Assessment.

Resilience plans are updated each year and a public summary produced.[249] The summary highlights:

- Disruption to electricity supplies from flooding, storms and gales is a key risk – the plan prioritises assessment of flood risks to energy assets and flood protection enhancement programmes.
- Disruption to power could result in the loss of mains water and affect the removal and treatment of sewage.
- Priorities in the water sector include building a deeper understanding of the resilience of the water industry against power loss, and building a wider knowledge-base of the resilience of water supply assets to flooding.

National Flood Resilience Review was set up following the severe flooding of winter 2015/16. This tested the robustness of Environment Agency flood mapping and gauged the vulnerability of infrastructure assets within an extreme flood scenario. Risks from river and tidal flooding were considered, but not from surface water flooding.

The NFRR examined the chance of widespread flooding in England, and assessed the exposure and resilience of key local infrastructure assets sited within an extreme flood outline (such as energy, water, transport and communications assets). The review identified 530 assets vulnerable to flooding, but provided no further information on the type or importance of the assets involved. The ASC welcomed publication of the review[250] but also pointed out that the review was limited in its scope:

- It failed to address our recommendation in our 2015 statutory report to Parliament on the UK's National Adaptation Programme – for a new and comprehensive, long-term strategy to address the risk of flooding. This requires a 'systems' approach which considers all sources of

[249] Cabinet Office (2016) *Summary of the 2015-16 Sector Resilience Plans*.

[250] See: https://www.theccc.org.uk/2016/09/08/ccc-welcomes-national-flood-resilience-review-but-says-further-action-needed-to-address-uk-flood-risk/

flooding and the full range of measures that should be used in combination to reduce the probability and consequences of flooding. The remit of the review was to focus on short-term measures that could be taken to improve protection of key infrastructure sites, from river and coastal flooding, before the following winter.

- The review ignored the risks posed by flooding from heavy rainfall overwhelming sewers – linked with the majority of flood damage in some recent events (for example, in 2007).
- The review lacked specific detail about what will be done and by when. This means that it will be difficult to tell in the future whether the review has had any impact.
- The report does not explain how the £700 million extra for flood risk management announced in the 2016 Budget will be spent. Of the £700 million, £350 million was held back to take forward the review's findings. The review only explains how a small proportion of this will be spent - £15 million for additional temporary defences. Following further announcements in the Autumn Statement, around a quarter of the £700 million has yet to be allocated. See Chapter 4: *People and the built environment*.

The Cabinet Office compiled a range of new datasets on the vulnerability of infrastructure assets to flooding as part of the NFRR. In February 2017, Baroness Brown wrote to the Cabinet Office minister to seek a meeting to discuss access to the data for the purposes of preparing this report. The Cabinet Office was unable to offer a meeting in the timeframe required for this report and the data were not provided.

Are actions taking place?

Actions within the NAP aimed at improving infrastructure resilience focus on where the evidence of climate change impacts are strongest. Reports prepared under the Adaptation Reporting Power provide evidence to assess risks and adaptation actions in most (but not all) important infrastructure sectors.

Actions from the NAP are ongoing. These are discussed in more detail in the following sector-specific sub-sections. As reported in 2015, the NAP contains no actions to address risk of shrink/swell subsidence, cold snaps, higher winds, fog and lightning – though some operators are taking these into account (e.g. airports).

In our review of the second round of ARP we found extensive assessment of climate risks and a range of adaptation actions, although the level of evidence included varied across organisations and sectors. All reports from infrastructure operators contained risk management actions. Numerous case studies were provided in the ARP reports, including some data on the costs and benefits of different approaches.[251]

Is progress being made in managing vulnerability?

There remains no published account of what has been achieved in recent years to improve the resilience of infrastructure systems. There is however evidence across some sectors that vulnerability to weather-related hazards is reducing.

Although actions are taking place it is difficult to tell on a national basis to what extent vulnerability is reducing. The ASC's ARP review concluded that there is a general lack of quantified evidence describing how adaptation actions have helped to reduce present and

[251] ASC (2017) *Adaptation Reporting Power: second round review*.

future vulnerability. Actions were not always reported consistently, so that tracking over time was difficult. In our analysis below we find that there is not yet a consistent basis for assessing vulnerability of infrastructure to climate risk. Nonetheless, there is diverse (and often disparate) evidence, concentrated in some sectors such as energy and water supply, indicating that vulnerability is being managed, as discussed in Sections 5.3a and 5.3b.

In 2015 we recommended that *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 report under the third round of the ARP. Reporting as part of the third round of the ARP should be made mandatory* (Recommendation 10).

In their response, the Government agreed to consider incident reporting in the review of the 2015/16 sector resilience plans. The Cabinet Office has said that Lead Government Departments (LGDs) responsible for the UK's 13 critical national infrastructure sectors will produce annual Sector Security Resilience Plans (SSRPs). LGDs are required to provide an assessment of the effects of climate change on infrastructure risks; and are now also required to record incidents that are deemed significant - those which have had an impact on the ability of a sector to deliver essential services.[252] Consultation on ARP3 is due later in 2017.

RECOMMENDATION 19: *Defra should review and strengthen its guidance for ARP3 to elicit more comparable data and conclusions about the adaptation of infrastructure. Use of consistent incident reporting and indicators of network resilience will allow performance to be tracked over time. Reporting protocols should be developed in partnership with sector organisations, the Cabinet Office, the National Infrastructure Commission, and the new National Infrastructure Resilience Council. (Owner: Defra. Timing: 2018).*

As mentioned earlier, the ASC has not been given access to the data that the Cabinet Office collected whilst updating sector resilience plans and in compiling the NFRR. The NFRR assessed vulnerabilities across sectors and looked at vulnerability to a 1-in-1000 year flood event. It is not clear to what extent this standard of protection is in place in practice. The ASC welcomes the de-facto 1-in-1000 year flood protection standard set by the NFRR, which operators should use as a benchmark against which to assess themselves.

The ASC would benefit from being able to see the summary statistics on infrastructure performance and vulnerabilities that the Cabinet Office holds, in order to be confident that progress in reducing vulnerability is being made across sectors.

5.3a Energy generation, transmission and distribution

Is there a plan?	Green	Ofgem's performance framework for gas and electricity companies incentivises investment in safe and reliable services. The Interruption Incentive Scheme (IIS) sets targets for the frequency and duration of both planned and unplanned interruptions (e.g. flooding).

[252] Correspondence with Cabinet Office.

Are actions taking place?	Green	The cross-industry ETR 138 standard for network resilience against flooding has been reviewed by the Energy Networks Association, and now includes surface water flooding. Electricity generation and distribution companies are transparently taking steps to improve resilience to flooding of critical substations, and to water scarcity. National Grid is initially targeting investment to protect assets at highest risk (vulnerable to a 1:100 year flood), and providing interim mobile flood defences. A total investment of £173 million in substation flood protection and resilience measures was approved by Ofgem between 2010 and 2023. By 2015 £73 million had been spent.
Is progress being made in managing vulnerability?	Green	**Progress in implementing flood protection measures appears to be on track with major substations serving 87% of customers due to have site-level protection measures implemented by 2020. However, residual risk will remain and disruption in severe storms and flood events can be expected.**

Is there a plan?

Electricity and gas network performance, including outages related to weather, is regulated by Ofgem. Energy companies are penalised if they fail to meet interruption targets.

Ofgem's performance standard for gas and electricity companies incentivises investment in safe and reliable services. The Interruption Incentive Scheme sets targets for the frequency and duration of both planned and unplanned, including weather-related, interruptions. Distribution Network Operators are rewarded if they meet or exceed these targets and are penalised if they fail to meet them.[253]

The electricity and transmission and distribution companies have agreed business plans with Ofgem to address river and coastal flood risks by the early 2020s.

Are actions taking place?

The electricity network is recognised as being particularly exposed to climate hazards. Steps are being taken to improve levels of flood protection.

Actions from the NAP are on-track or completed. For example, since 2015 the cross-industry ETR138 standard for network resilience for flooding has been reviewed by the Energy Networks Association. The standard now includes surface water flooding.[254]

Energy UK reported in ARP2 that actions are being completed by generating companies.[255] National Grid is investing in flood mitigation work with the support of the regulator, Ofgem:

[253] Ofgem (2017) *RIIO-ED1 Annual Report 2015-16*.
[254] National Adaptation Programme action updates (2017).
[255] Energy UK (2015) *Climate change risks and adaptation responses for UK electricity generation: a sector overview 2015*.

- National Grid is undertaking work to reduce tidal and fluvial flood risk as part of a prioritised investment programme. In their current regulatory price control period (from 2015 to 2023), National Grid has allocated £153 million to network resilience, flooding and physical security. Investment has been initially targeted towards assets at highest risk. Protection for all at-risk sites is planned by 2021. Approximately £3 million has been invested in interim mobile flood defences and supporting equipment.[256]
- A total investment of £173 million in substation flood protection and resilience measures was approved by Ofgem between 2010 and 2023. By 2015 £73 million had been spent.[257]

Electricity generators use large volumes of water for cooling thermo-electric power plants. Abstractions and consumption of freshwater for power generation should fall in the coming decades as inland thermo-electric power plants re decommissioned, but could rise again in the longer-term under some energy-mix scenarios.[258] Individual companies are taking action to improve resilience to future water scarcity.

Higher temperatures coupled with a risk of reduced rainfall in summer months means an increasing risk of water scarcity, and increasing competition with other users for water. Box 5.1 provides an example of the action being taken at one power plant.

Box 5.1. Reducing power sector demand for water - Langage Energy

Langage Energy Centre (owned by Centrica) is a modern Combined Cycle Gas Turbine power station near Plymouth in south-west England. Potential constraints on water availability due to water scarcity were identified as a risk in Centrica's climate adaptation report in 2011. In order to reduce demand for fresh water for steam generation, the Langage Energy Centre has initiated a programme of rainwater recovery using storage facilities on site. Approximately 12,000 m^3 is collected per year and treated before being fed to the boilers. This leads to significant cost savings to the company as well as reducing the demand for fresh water.

Source: Energy UK (2015) *Climate change risks and adaptation responses for UK electricity generation: a sector overview 2015.*

Is progress being made in managing vulnerability?

Flood protection measures are being implemented by electricity supply, transmission and distribution companies over the coming decade, reducing the exposure of customers at risk of interrupted supply.

Most weather-related customer outages are currently caused by high winds affecting distribution lines and substations. Customer minutes lost (CML) from wind-related incidents account for 42% of weather-related CML between 2006 and 2015 (Figure 5.2). Future projections of wind speed and direction are uncertain.

Flooding incidents account for 8% of customer minutes lost. However, flooding is assessed as the greatest risk for transmission and distribution networks because it can affect substations which are generally single points of failure in the system. Moreover, flood events are typically of

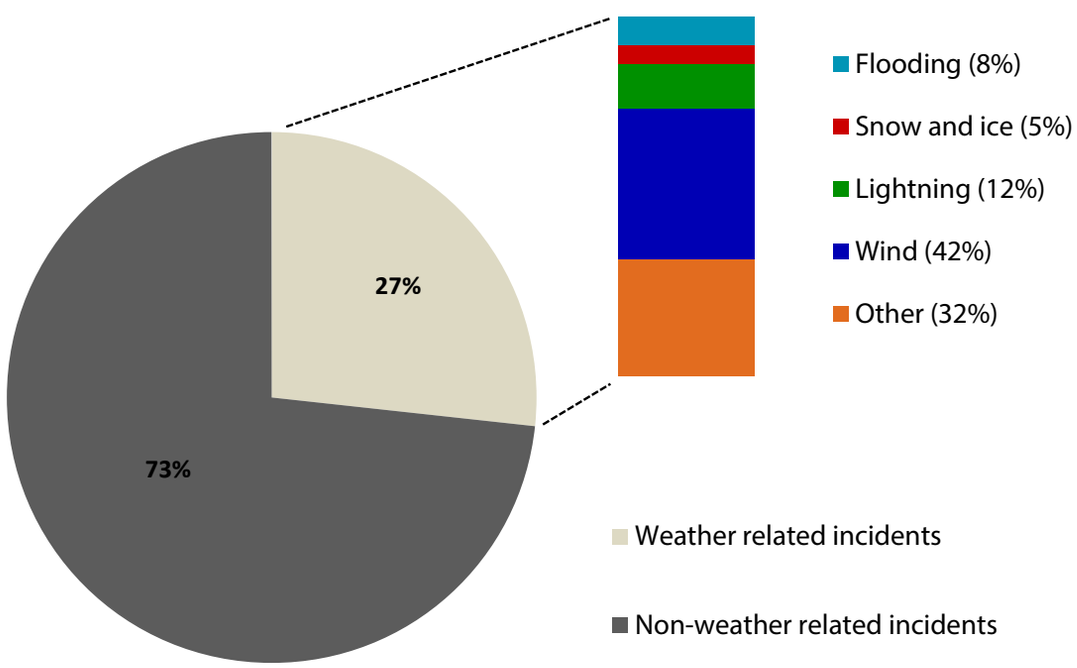
[256] National Grid (2016) *Second round adaptation response: National Grid Electricity Transmission UK.*
[257] ENA (2015) *Climate change adaptation reporting power second round.*
[258] Byers et al. (2014) Electricity generation and cooling water use: UK pathways to 2050. *Global Environmental Change 25: 16 -30.*

longer duration and more difficult to recover from.[259] The majority of investment in actions to address extreme weather impacts is to reduce flood risk.

Electricity substations serving one million customers are due to benefit from flood protection measures by the end of the decade.[260] Progress in implementing flood protection measures, as a result of ETR138 technical standards, generally appears to be on track with nearly 25% of customers reliant on major substations having already benefited since 2012. A further 62% are planned to be protected by 2020. However, by the end of the 2020s, climate change is expected to mean substations serving around half a million customers will fall in the high flood risk category.[261] Further mitigating measures will be needed to keep the level of vulnerability from increasing again.[262]

Residual risk of disruption during periods of severe weather remains. In February 2017 wind from storm Doris cut power to 231,000 homes across the south-east of England due to affected power lines. In December 2015 a major electricity substation flooded in Lancaster which led to power outages for 61,000 homes lasting over two days. The substation had been protected with new defences installed as part of the current upgrade programme, backed up with pumps and sandbags, but these failed to withstand the severe flooding. The absence of electricity led to a series of failures of other infrastructure, causing widespread disruption. Section 5.4 explores this further.

Figure 5.2. Causes of energy customer minutes lost, 2006 - 2015, England and Wales



Source: Data from National Fault and Interruption Reporting Scheme (NaFIRS).
Notes: A total of 10.5 million customer minutes were lost across all incidents between 2006 and 2015.

[259] Correspondence with Energy Networks Association.
[260] Dawson, RJ., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure.*
[261] ASC (2014) *Managing climate risks to well-being and the economy: ASC progress report 2014.*
[262] *Ibid.*

Overall, freshwater abstraction by power plants in England fell between 2000 and 2014.

Over the period investigated, freshwater abstraction for power plants in England rose to a high of 3,499 million cubic meters (M m^3) per year in 2001, falling to 1,085M m^3 in 2006 and 2007 before returning to 2,478M m^3 in 2015.[263] The lack of a detailed breakdown by use category (e.g. hydroelectric) means that these fluctuations cannot be satisfactorily explained.

5.3b Public water supply

Water abstraction sites, treatment works and pumping stations need to be located near to water courses. This means a large proportion of water company assets are in areas at risk of flooding.

CCRA2 projected that by the 2080s the number of water treatment sites in the UK located in areas vulnerable to flooding is expected to rise by 33% from a baseline of 300 sites currently vulnerable, assuming a 4°C rise in global mean temperature.[264]

Is there a plan?	Green	The current Asset Management Plan period (2015 - 2019) includes a new outcomes-based performance framework. The framework should allow operators the flexibility to deliver resilient services, at least cost. The new 'resilience duty' on Ofwat will take effect in 2019, and will formalise resilience as an objective for the industry. Water companies produce Water Resource Management Plans setting out how they will manage supply and demand balances over the next 25 years. In many cases companies are looking beyond this timescale. In March 2017 the Government consulted on a new Strategic Policy Statement (SPS) for Ofwat. This included a strong emphasis on demand management and water supply resilience.
Are actions taking place?	Green	Water companies are taking action to improve the security of water supply and the resilience of assets to flooding. These actions include: sourcing alternative water supplies, drought plans, leakage reduction measures, raising electrical equipment, and providing standby generation for sites most vulnerable to power outage.
Is progress being made in managing vulnerability?	Green	**Measures to reduce water demand are being rolled out and there is evidence of reducing risk of water shortages, for example through improved water efficiency and reducing leakage.** **Individual companies have provided examples of where flood risk has been reduced in their ARP2 reports.**

[263] Data from Defra, see ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*

[264] Dawson, RJ., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure.*

Is there a plan?

A planning framework is in place for Ofwat and the Government to secure long-term resilience in the sector.

In March 2017 the Government consulted on a new Strategic Policy Statement for Ofwat.[265] This draft statement sets out Defra's strategic priorities and objectives for Ofwat's regulation of the water sector in England, and how Ofwat's new primary duty to further resilience, introduced by the 2014 Water Act, will come into effect from 2019.

- The resilience part of the draft SPS mostly addresses drought management, but also looks at the long-term and wider economic, social and environment benefits of water company investment.
- There is also an emphasis on demand management and leakage as a way sustaining water resources and reducing customer bills.
- The draft statement announced that the National Policy Statement on major water infrastructure will go ahead.

The new outcomes-based performance framework and the emphasis on total expenditure ('totex', capital expenditure plus operational expenditure) in this Asset Management Plan (AMP) period (AMP6, 2015-2019) should mean companies have the flexibility to deliver resilient services at least cost to customers. The Outcome Delivery Incentives (ODI) introduced in AMP6 are underpinned by financial penalties and rewards.[266] The majority of ODIs are related to weather either directly or indirectly.[267]

Water companies are required to produce Water Resource Management Plans to set out how they will maintain a balance between water supply and demand over at least the next 25 years.

Water companies include measures to increase the resilience of assets in their business plans. They are required to look at least twenty-five years ahead in their next Water Resource Management Plan (WRMP) (draft versions are due to be released for consultation in early 2018). Some companies are taking the opportunity to look 100 years ahead and develop plans that can be adapted to respond to climate change as it unfolds (e.g. Thames Water, Box 5.2). The WRMP guidance requires companies to identify all the options available to them to meet demand over the long-term and show how they have decided which options to pursue.

[265] Defra (2017) *The government's strategic priorities and objectives for Ofwat*.
[266] See: http://www.pwc.co.uk/industries/water/insights/managing-amp6-incentives-penalties.html
[267] Severn Trent Water (2015) *Future proofing: Severn Trent Water's climate change adaptation report*.

Box 5.2. Thames Water - Water Resource Management Plan 2019

Water companies in England are developing their next Water Resource Management Plans, to be published in 2019, which aim to secure sustainable, affordable and resilient supplies of water for customers for at least the next 25 years. Thames Water's plan includes an 'adaptive pathways' approach to help navigate between the options that could contribute to closing a projected supply-demand gap of over 800 million litres per day by 2100. An adaptive pathways approach helps to cope with the inherent uncertainty in climate change and other factors such as population growth, by building in explicit flexibility and contingencies within long-term plans.

- High, central and low range forecasts for population change, climate change, water demand and water supply are combined to generate a total of 81 different future scenarios.
- An optimised portfolio of water resource options can then be created by testing which combination of options performs best against these future scenarios to 2100.
- As the WRMP and investment plans are updated every five years, Thames Water will be able to regularly assess which of the forecasted scenarios are most likely to materialise and whether the preferred portfolio of options remains appropriate for meeting current and future demands.

Source: Correspondence with Thames Water.

Are actions taking place?

Nearly all actions in the NAP are on track or complete. Water companies have invested in resilience measures in AMP5. The water industry is the first sector to look at developing a comprehensive set of resilience metrics to assess vulnerability.

Three actions have moved from being revised or delayed to being on-track:

- Two drought exercises were conducted in 2016 by Severn Trent Water to test the consequences of an extreme drought.
- New, albeit weak, standards and planning policies to promote sustainable drainage systems (SuDS) came into effect in April 2015 (discussed further in Chapter 4: *People and the built environment*).
- The risks associated with the dependence of water utilities on energy supplies are being assessed. For example, Affinity Water has provided standby generation at the sites most vulnerable to a power outage.

The NAP action that required water companies to form partnerships with Green Deal providers to offer joint energy and water retrofit programmes has been dropped due to cancellation of the Green Deal initiative.[268]

During AMP5 water companies took action to improve the security of water supply and the resilience of assets to flooding. Examples include:

- Improved leakage detection and reduction measures.
- Increased household metering.
- Prioritising investments on assets at higher flood risk.

[268] The Green Deal was set up to help business and home owners employ more green technologies and make energy saving improvements to their properties.

- Raising electrical equipment above predicted flood levels.
- Implementing sustainable drainage systems.

£374 million had been invested in resilience during the period 2008/09 to 2014/15 with Severn Trent accounting for 44% of this, followed by 16% from both Wessex and Anglian Water. Investment has ranged from £35.7 million in 2008/09 to £89.5 million in 2013/14. There was a drop in investment in 2014/15 to £54.9 million. A recent report from Water UK[269] showed a strong rationale for further investment to reduce the risk of drought, which under an extreme scenario could cause billions of pounds in economic damages and unacceptable interruptions of water supply to consumers.

Following a recommendation from Ofwat's Resilience Task and Finish Group,[270] Water UK's Water and Wastewater Resilience Action Group (WWRAG) was set up in December 2016. The group will conduct research and develop metrics for resilience within the water industry.

Is progress being made in managing vulnerability?

Measures to reduce water demand are being rolled out. There is evidence of a reducing risk of water shortages.

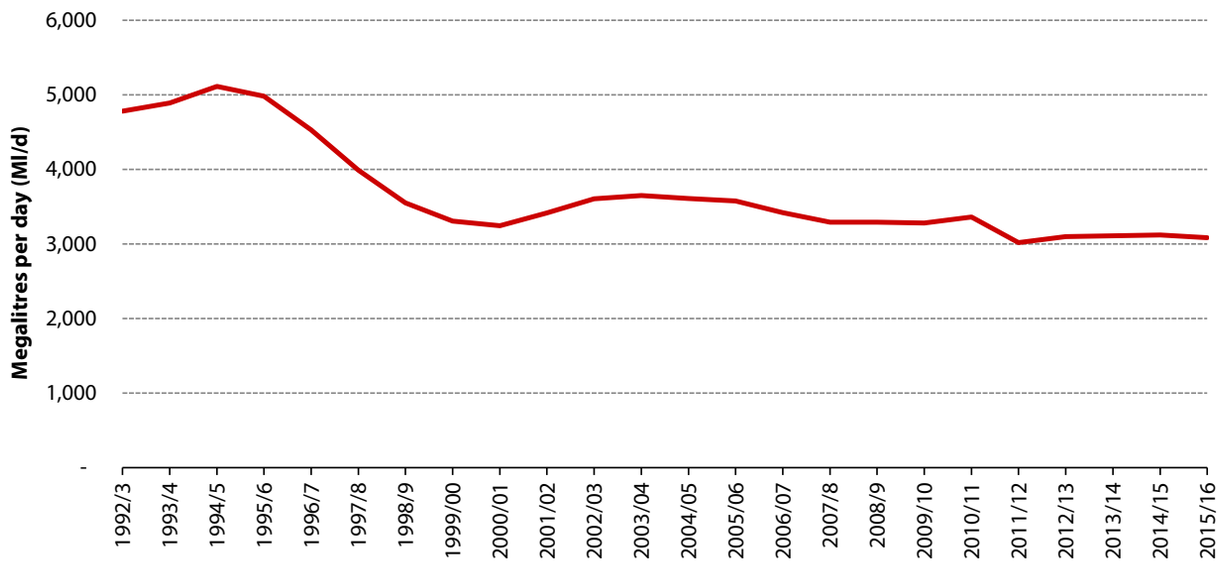
Water companies' business plans in recent AMPs have, in general, increased the emphasis on water efficiency and reducing leakage:

- Installation of water meters is progressing and overall water consumption per person[271] is declining, albeit at a relatively slow pace and against a backdrop of population growth in many water-stressed areas (see Chapter 4: *People and the built environment*).
- Leakage is down about a third from its 1994/95 high, to 3,084 megalitres per day (Figure 5.3). In 2014/15 most (73%) of water companies met or exceeded their leakage targets.[272] However, there has only been a small fall in leakage (0.1% per year on average) since 2012/13 compared to a 10% fall in 2011/12.[273] Ofwat made a commitment in its November 2016 outcomes consultation to set stretching performance targets for reducing leakage further.[274]

The Environment Agency, with support from Ofwat, has committed by 2020 to investigate a number of sites in England and Wales where there is a risk of damage to important conservation sites from over-abstraction of fresh water.[275] Since 2008, 271 licences have been altered in order to preserve water in the natural environment. A plan to address the remaining 166 licences between 2017 and 2020 is in place (see also Chapter 3: *Natural environment*).[276]

[269] Water UK (2016) *Water resources long term planning framework (2015-2065)*.
[270] See: http://www.ofwat.gov.uk/wp-content/uploads/2015/12/rpt_com20151201resiliencetaskfinish.pdf
[271] Correspondence with Environment Agency and Ofwat.
[272] ASC calculations. For data see: http://www.ofwat.gov.uk/regulated-companies/company-obligations/performance/companies-performance-2014-15/
[273] Water companies (2017), see ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*
[274] Ofwat (2016) *A consultation on the outcomes framework for PR19*.
[275] Ofwat (2015) *The case for change - reforming water abstraction management in England*.
[276] Figures as of January 2017.

Figure 5.3. Leakage reported by water companies in England and Wales



Source: Ofwat (2017), see ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*
Notes: As a percentage of distribution input, leakage accounts for approximately 23% of water use, using the latest available data between 2000 and 2012.

A large proportion of water company assets are located in areas at risk of flooding. Several damaging flood incidents have occurred in recent years, though the industry maintains that impacts are rare. Water companies are continuing to invest in measures to improve resilience, as set out in their ARP reports.

Whilst it is not possible to tell on a sector-wide basis whether services are becoming more or less reliable, individual companies have provided examples of where risk has been reduced. For example:

- Yorkshire Water invested £0.5 million to provide flood protection to a critical raw water pumping station near York. This investment proved its worth during the 2015 Boxing Day floods, preventing the site from flooding and thus protecting drinking water supplies to around 500,000 customers.[277]
- Severn Trent is investing £250 million in a scheme to provide Birmingham with an alternative water supply. The current supply from Wales passes through terrain susceptible to landslides and flood-related river scour, both of which are projected to increase over time due to climate change.[278]

5.3c Ports and airports

The ASC acknowledges that the risks to ports and airports from climate change differ, and thus the steps required to adapt to climate change may diverge in the future. At present

[277] National Adaptation Programme action updates (2017).
[278] Severn Trent Water (2015) *Future proofing: Severn Trent Water's climate change adaptation report*.

their progress in adapting to climate change is similar, and as such they are assessed together in this report.

Ports and harbours have a vital economic role, receiving 95% of the UK's imports and exports as well as more than 40 million passenger journeys per year.[279] Half of UK port capacity is located on the east coast, where the risk of tidal surges is greatest. Potential sea level rise of around or beyond 50cm by 2080 is a particular concern, especially for some ageing port infrastructure. Flooding and physical damage to harbour infrastructure and transport connectivity in the hinterland will also become an increasing threat.[280]

CCRA2 reported that the impacts of climate change on UK aviation are expected to be the least significant compared to other transport modes.[281] The greatest challenges are currently due to extreme weather.

The frequency of severe snow and ice is expected to decrease but not disappear altogether with a changing climate. Fog is a perennial issue, but the projections for fog impacts with climate change are limited and have low confidence. Flooding has caused impacts to airports even where they are not in the floodplain because of localised surface water flooding.

Is there a plan?	Amber	The 2014 Transport Resilience Review set out recommendations to improve the resilience of ports and airports. The 2016 National Flood Resilience Review also considered transport infrastructure. However, resilience standards and performance is largely left to port and airport operators to determine. Gatwick and Heathrow Airports must produce operational resilience plans as a requirement of Civil Aviation Authority licence conditions.
Are actions taking place?	Green	Airports are investing in flood resilience measures. A number of ports have assessed future sea level rise and are implementing improvements, including raising quay heights. Plans to improve flood defences at the Port of Immingham have been approved. Regional Port Resilience Groups have been established to promote closer working between ports and Local Resilience Forums.
Is progress being made in managing vulnerability?	Amber	**Evidence in the ARP reports and in responses to recent severe weather events suggest vulnerabilities are beginning to be addressed, though most actions seem to be in response to recent events rather than being based on proactive risk management. Data regarding overall resilience are lacking.**

[279] Department for Transport (2014) *A review of the resilience of the transport network to extreme weather events*.
[280] Dawson, RJ., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure.*
[281] Dawson, RJ., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure.*

Is there a plan?

The Transport Resilience Review (TRR) in 2014 reviewed the impact of the 2013/14 winter storms, including for ports and airports. The 2016 National Flood Resilience Review also considered transport infrastructure. However, resilience standards and performance is, in general, left to individual port and airport operators to determine.

The impacts of severe weather episodes on transport services are well documented, such as the winter storms of 2013/14 that prompted an independent review of road, rail, port and airport infrastructure in England and Wales.[282] The TRR made 63 recommendations, all of which were accepted by the Government.[283] Of the 63 recommendations, six were made directly for ports and airports.

A new national Aviation Strategy (a revision of the 2013 strategy)[284] is due provisionally in summer 2018. Details are still to be determined but it is likely to include consideration of the industry's resilience to climate change. The Department for Transport (DfT) will be engaging with the industry and other partners in the sector around the country. This engagement is likely to include a series of consultations and events over the next 18 months.[285]

Ports and airports are owned and operated by private-sector companies. The Civil Aviation Authority (CAA) regulates the safety of airports but standards for the performance and resilience of port and airport operations are generally left to the operators to determine based on their commercial interests.

However, as of 2014, Gatwick and Heathrow Airports are required by CAA licence conditions to produce operational resilience plans. Heathrow is also finalising a flood plan and surface water management plan, as part of a £16 million investment in surface water drainage.[286]

Are actions taking place?

Airports are investing in flood resilience measures, whilst a number of ports have assessed future sea level rise and are implementing quay improvements.

Completed and ongoing actions in the NAP and TRR include:

- DfT has promoted closer working between ports and Local Resilience Forums to understand risks and identify interdependencies. Regional Ports Resilience Groups have been established, and the port sector has come together to discuss risks and action planning.[287]
- DfT is creating a tidal surge model for major ports, building on its 'Methodology for Assessing Resilience of Seaports' (MARS) port simulation model. At least twenty ports have volunteered to share their flood assessment methodologies. Asset management and business continuity practices have reportedly been updated.

For the second round of ARP, 16 ports and airports submitted reports, although another six declined to participate. These reports received provide an update on actions taken since 2015:

[282] Department for Transport (2014) *A review of the resilience of the transport network to extreme weather events*.
[283] Department for Transport (2014) *Government Response to the Transport Resilience Review*.
[284] Secretary of State for Transport (2013) *Aviation Policy Framework*.
[285] National Adaptation Programme action updates (2017).
[286] Heathrow Airport (2016) *Climate change adaptation and resilience progress report*.
[287] National Adaptation Programme action updates (2017).

- Gatwick airport has invested £20 million in flood resilience measures. Following flood-related disruption in December 2013, the airport commissioned an independent review of its vulnerability to flooding and as a result is investing a further £10 million over the next two years.[288] It has also provided a financial contribution towards the Environment Agency's Upper Mole Flood Alleviation Scheme which benefits both the airport and the surrounding area. Gatwick has also undertaken a Strategic Power Resilience review.
- Heathrow airport has implemented actions to improve resilience to flood risk and snow events.[289] For example, design standards address risks from water ingress and flooding to new buildings. Heathrow's flood plan also addresses risks of groundwater flooding to existing critical assets.
- In February 2017, plans for a £7.4 million scheme to improve flood defences for the Port of Immingham were approved by Lincolnshire County Council. The plans include installing new outer lock gates at the port, replacing flood walls, and increasing the height of the existing defences to 6.1m above sea level. The new defences will significantly reduce the risk of flooding to the port. The Environment Agency is investing £4.5 million in the project.[290]
- Teesport is in the process of renovating its quays. One quay is in the process of being raised by 50cm. The new quay is being built higher in large part to accommodate sea level rise and a potential for greater incidence of storm events. All future Teesport quay upgrades will be built to this standard or reflect best practice guidance at the time.[291]

Is progress being made managing vulnerability?

Vulnerabilities are beginning to be addressed, though most actions seem to be in response to recent events rather than being based on proactive risk management.

The ARP reports show that vulnerabilities are beginning to be addressed. However, data regarding overall resilience are lacking across both the ports and airports sectors. This means it is difficult to tell whether lessons from recent weather events (especially the storms of 2013/14) have now been learned. More data are needed to assess the frequency of disruptions to port and airport operations from severe weather events.

5.3d Roads and the rail network

Is there a plan?	Green	Network Rail has weather and climate resilience plans for each route. As of 2017, it has put in place an overarching weather resilience and climate change strategy to provide a framework for all work relating to weather resilience and climate change adaptation. Highways England reported under the second round of the Adaptation Reporting Power. Their report highlights where climate change will impact operations and networks and how they will address vulnerabilities as part of their 2015-2020 delivery plan.

[288] Cabinet Office (2016) *National Flood Resilience Review*.
[289] Heathrow Airport (2016) *Climate change adaptation and resilience progress report*.
[290] See: http://www.bbc.co.uk/news/uk-england-humber-39141063
[291] PD Teesport Ltd (2015) *PD Teesport Climate Adaptation Assessment Update*.

Are actions taking place?	Green	In the Autumn Statement in 2016 the Chancellor announced £150 million to improve transport flood resilience. Network Rail's adaptation actions have centred on embankment and bridge stability, and coastal defences. Highways England implemented works to reduce flood risk at 124 flooding hotspots and culverts in 2015-16. National Flood Vulnerability Maps were updated in 2015, which has increased Highways England's understanding of risk to the Strategic Road Network from flooding, providing new evidence to inform decision making.
Is progress being made in managing vulnerability?	Amber	**Fewer weather-related delays have been experienced on England's road and rail networks in recent years, but variability in annual delay data means that it is not yet possible to assess robustly whether this is a result of adaptation actions or other factors.**

The ASC acknowledges that the risks to road and rail networks differ and the two sectors face different challenges in adapting their assets. We recognise these differences in our assessment of Britain's land transport systems.

Is there a plan?

Weather resilience and climate change adaptation plans are in place for all of Network Rail's routes. In January 2017, Network Rail published a weather resilience and climate change strategy. The 2014 Transport Resilience Review is also still driving action to manage climate risks to the rail and road sectors.

The Network Rail report for the second round of the Adaptation Reporting Power covered all of its routes. Network Rail's proposed adaptation actions were informed by recommendations from the Transport Resilience Review, and the Tomorrow's Railway and Climate Change Adaptation project (TRaCCA: 2014 - 2016).

In June 2016 an internal audit of weather resilience and climate change activity within Network Rail raised a number of issues regarding ownership and governance. The audit identified the need for strategic targets and standardisation to manage risk, to inform decision making and prioritise work. In January 2017 Network Rail published a weather resilience and climate change strategy for 2017 to 2019. The new strategy aims to provide a framework within which all work relating to weather resilience and climate change adaptation is undertaken across Network Rail's routes. It intends to integrate activities to enhance weather resilience and adapt to future climate change into asset management processes.

Highways England's ARP2 report focusses on steps to address vulnerabilities that form part of their delivery plan for the period 2015-2020.[292][293]

[292] Highways England (2016) *Climate Adaptation Risk Assessment Progress Update - 2016*.
[293] Highways England (2015) *Delivery Plan 2015-2020*.

Are actions taking place?

All actions from the NAP relating to road and rail infrastructure are ongoing or complete. The Government is investing in specific projects to improve the flood resilience of the transport network.

The latest update from DfT regarding implementation of the Transport Resilience Review[294] indicates that implementation actions continue. Many of the review's 16 sector-specific recommendations were dedicated to improving the resilience of the rail network. Actions taking place are discussed below.

In the 2016 Autumn Statement the Chancellor allocated an extra £150 million to improve transport flood resilience. £100 million of this will be invested to make roads more resilient to flooding, including in areas that were affected by flooding in winter 2015/16. £50 million is to be invested in rail resilience projects, including in the Axe Valley and at Dawlish.[295]

Site-specific measures, such as embankment stability and flood resilience, are being incorporated for each of Network Rail's routes and across the London Underground network.

The actions in Network Rail's ARP report centre on embankment and bridge stability, flood resilience, coastal defences and managing lineside vegetation.[296] This includes analysis to understand risk from bridge scour, rail buckling, and flooding of track and equipment, to help prioritise resilience interventions across the network.

Network Rail has worked with the Energy Networks Association to pinpoint the electricity substations that Network Rail relies upon. Single points of failure are being prioritised for attention.

The second phase of the Tomorrow's Railway and Climate Change Adaptation Programme concluded in 2016. The research programme delivered an assessment of climate change risks and developed a suite of decision support tools. Network Rail is working with the Rail Safety and Standards Board (RSSB) to implement the recommendations.

Transport for London's ARP report describes their work to address overheating on the underground network and to reduce the risk of flooding (Box 5.3).

[294] Department for Transport (2014) *A review of the resilience of the transport network to extreme weather events*.

[295] See: https://www.gov.uk/government/publications/autumn-statement-2016-transport-announcements/autumn-statement-2016-transport-projects

[296] See: Network Rail route Weather Resilience and Climate Change Adaptation Plans, https://www.networkrail.co.uk/communities/environment/climate-change-weather-resilience/weather-resilience/

Box 5.3. Adapting London Underground for flooding and higher temperatures

Heat mitigation activities: Temperatures on the London Underground (LU) are projected to continue to increase. LU uses UKCP09 projections for 2030 and 2050 when evaluating cooling requirements during line upgrades. The capacity of ventilation shafts on the Victoria line has recently been increased. LU has installed cooling units and mechanical chillers at two of the busiest stations on the line. LU is also investigating technologies and opportunities to reduce the amount of heat released by trains and to recover energy from braking.

Flood Risk Review: Transport for London's (TfL) Flood Risk Review was prompted by flooding of the Central Line in 2012 and in recognition of the recent impacts of flooding on mass transit systems in global cities, including New York and Paris. The review covered all assets and all sources of flooding:

- Phase 1 of the project identified vulnerable assets including stations, track, shafts, signalling, telecoms and sewers. Sites were categorised, leading to the prioritisation of ten sites. The assessment used the UKCP09 projections.
- In Phase 2, TfL will review cost-effective mitigation options at priority sites, working with the relevant Lead Local Flood Authorities. The project will make recommendations for the optimisation of risk exposure in the future, by providing advice on the steps necessary to manage and mitigate future flood events.

Source: Transport for London (2015) *Climate change adaptation report: second round repor*t. Jenkins et al. (2014) Transportation Research Part D, 30:1-9.

Flood resilience and drainage is being improved on strategic and local roads. The Government has allocated funding to help improve local roads between 2015 and 2021. Additional funds were granted to authorities responsible for roads that were damaged during storms Desmond and Eva in December 2015.

Climate change adaptation is considered as part of current standards, practices and procedures to ensure the resilience of Highways England's network. The Office of Road and Rail (ORR) are assessing Highways England's performance and delivery over the first 'road period' (2015 - 2020).[297] Flood mitigation is included in the performance assessment as an environmental KPI. Highways England addressed more high risk and very high risk flooding hotspots and culverts in 2015/16 than 2014/15 (124 compared to 90).[298]

Actions from the NAP and TRR for Highways England and local authorities are complete or ongoing. Actions have included:

- Highways England conducted a flood risk assessment using updated EA flood risk maps and other data to identify parts of the strategic road network that are at risk. This is supplementing their log of actual flooding events.[299]
- A new methodology for prioritising drainage assets was piloted in 2015. This pilot has now been extended nationally for completion in 2017. Climate change allowances will be factored into future drainage design, to accommodate projected changes in the severity and frequency in rainfall, via updated design manual requirements.

[297] Road Periods and requirements were specified in the Road Investment Strategy. See: https://www.gov.uk/government/collections/road-investment-strategy
[298] ORR (2016) *Annual assessment of Highways England's performance.*
[299] Highways England (2016) *Climate Adaptation Risk Assessment Progress Update - 2016.*

- Local transport agencies and local authorities (e.g. TfL and Newcastle City Council) are mapping risks and starting to use this information for prioritisation.[300] TfL's Surface Highways Asset team is trialling porous asphalts, which can allow the infiltration of surface water, to assess their performance under London's road use conditions.[301]

In the 2014 Autumn Statement the Government confirmed it would provide £6 billion between 2015 and 2021 to improve local roads. The first £75 million from the new Challenge Fund grant was made available for local highway authorities in 2015/16. Successful bids to the Fund included road renewals, upgrades, and analysis of flooding and drainage problems. The Challenge Fund is available again in 2017. An additional £179 million was granted to those authorities with roads most damaged by storms Desmond and Eva. In 2015/16, £4.5 billion was spent on the maintenance of roads in England. Of this, £1 billion was spent on trunk motorways and 'A' roads, and £3.6 billion on local authority managed roads.[302]

Is progress being made in managing vulnerability?

Fewer weather related delays have been experienced on England's road and rail networks in recent years (Figure 5.4), but variability in annual delay data means that it is not yet possible to assess robustly whether this trend will continue and what the causes might be.

There is evidence that when major failures occur Network Rail seeks to improve resilience as part of reinstatement projects. Their Weather Resilience and Climate Change Strategy states that Network Rail is committed to adaptation action at both the construction and asset renewal phase in order to provide resilience in the most cost-effective manner. When weather events cause asset failure, such as the collapse of a sea wall or scour damage to a bridge, Network Rail will commit to 'build back better' rather than replace like for like. The vulnerability of Network Rail's Western route through Dawlish was dramatically highlighted in 2014 when, following heavy storms, the original Brunel seawall was breached. The wall took two months to reinstate, though the risk of failure has not been eliminated. Network Rail has proposed constructing a new wall that would be more resilient. Climate scenarios from UKCP09 have been taken into account in the design.

Although there is evidence of site-specific measures being incorporated for each of Network Rail's eight routes in Great Britain, reductions in vulnerability are not strongly evident across the railway network. There is a large legacy of ageing infrastructure, much of which was not designed to modern engineering standards. Both the industry and the regulator recognise that historic investment has been insufficient to deliver acceptable levels of resilience. There is therefore a backlog that will require sustained investment over several decades to address.

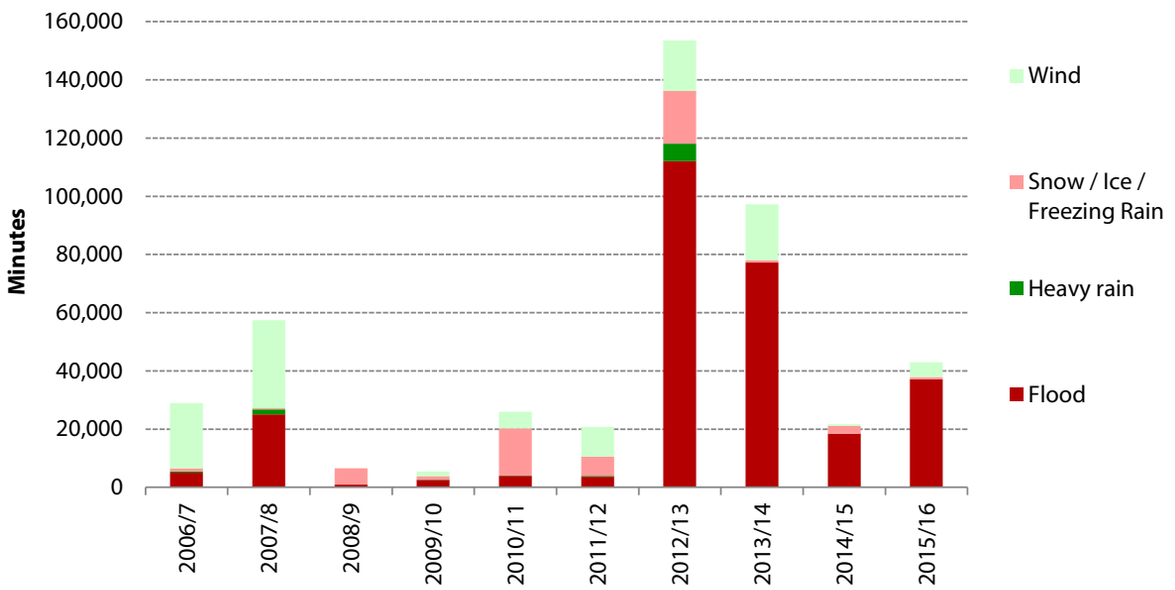
[300] For example Newcastle City Council. See: https://www.newcastle.gov.uk/sites/default/files/wwwfileroot/environment-and-waste/climate-change-and-energy-saving/climate_change_impacts_-_evidence_for_newcastle_upon_tyne.pdf

[301] Transport for London (2015) *Climate change adaptation report: second round report.*

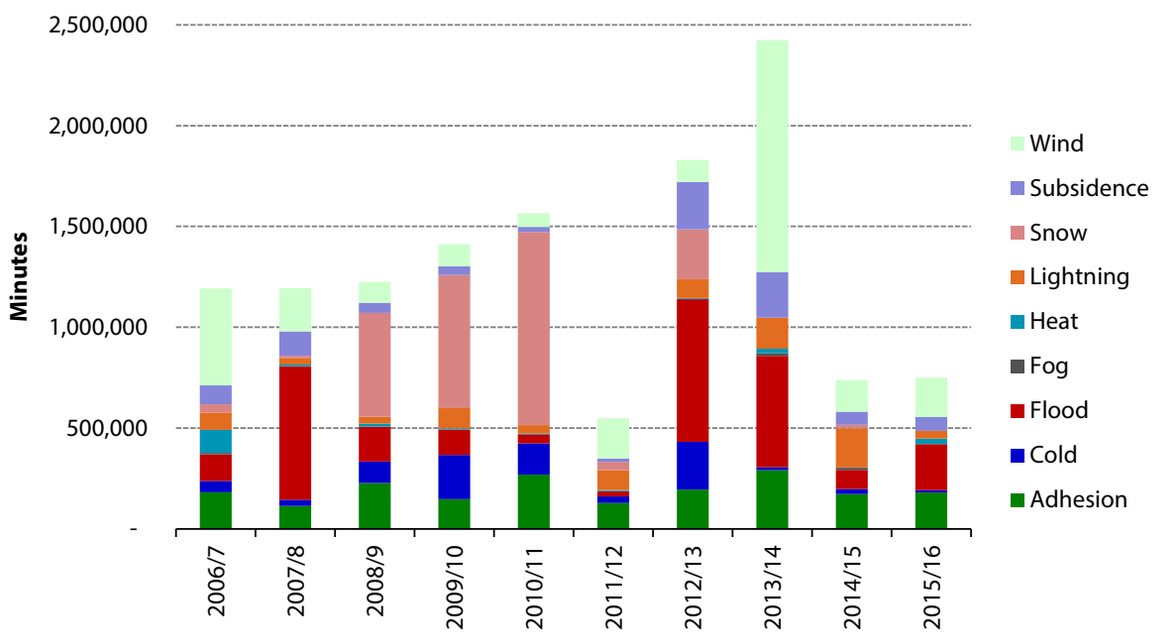
[302] Department for Transport (2017): Road conditions in England: 2016.

Figure 5.4. Annual delays on the strategic road network, and rail network

a) Strategic road network



b) Rail network



Source: Highways Agency and Network Rail (2017), see ADAS (2017) for the ASC. *Research to provide updated indicators of climate change risk and adaptation action in England.*

Notes: Data are for financial years i.e. data begin in April 2006 and end in March 2016. Delays on roads are lane impact durations. A lane impact results from any incident where the capacity (of one or more running lanes) has been reduced or where there is deemed to be a risk to a road user. An impact may or may not result in a full carriageway or motorway closure. A lane impact can relate to a single lane that has been closed for a period of time. A lane impact is recorded as one impact where it affects one or both sides of the carriageway i.e. it is not directional. Network Rail delay data only relate to Network Rail delays not those attributed to other rail organisations.

5.3e Digital and ICT infrastructure

Is there a plan?	Red	The National Flood Resilience Review identified critical vulnerabilities in digital communications networks and ICT infrastructure. TechUK's ARP report provides an outline of where further scrutiny should be focused. There is no apparent plan by industry or Government to address these vulnerabilities.
Are actions taking place?	Amber	The National Adaptation Programme contains no specific actions relating to ICT, despite the sector being recognised at the time as critical to the operation of other infrastructure sectors as well as the economy in general. There is some evidence of actions taking place in response to recent weather events. These have included companies identifying assets at highest risk of flooding, installing flood defences, and engaging with the Cabinet Office-led Electronic Communications Resilience and Response Group (EC-RRG).
Is progress being made in managing vulnerability?	Grey	**Whilst the ASC has extracted some evidence from two ARP reports (techUK and EC-RRG), as in the ASC's 2015 report to Parliament, there is insufficient evidence available from the industry or the Government to assess the resilience of the sector.**

Is there a plan?

The NFRR assessed the vulnerability of digital and ICT infrastructure to flooding and identified some areas of vulnerability. TechUK's ARP report suggests where further scrutiny should be focused. As yet there is no apparent plan by the industry or the Government to address the vulnerabilities found.

TechUK is the UK trade association for the IT, telecoms and electronics industries. Their ARP report explores the climate change readiness of the UK's data centres and also includes their assessment of fixed line and mobile communications. It sets out some of the approaches deployed already within the sector to identify, manage and mitigate risks, details of actions taken following high impact events, and provides an outline of where further scrutiny should be focused, to ascertain potential vulnerabilities and to prioritise action. The Electronic Communications Resilience and Response Group also submitted a report in June 2017 that included plans to enhance flood resilience.[303] However, BT and Ofcom declined to take part in ARP2.

Digital and ICT communications providers compete on the basis of reliability and there are legal requirements for telecoms providers to take steps to protect the security and resilience of their networks and services. Companies appear to be considering climate change and do so as part of managing their own business risks (e.g. Sky plc is investing in the resilience and robustness of

[303] Correspondence with Department for Culture, Media and Sport.

infrastructure;[304] Vodafone Group plc considers climate change in its Sustainable Business Report.[305])

Recent events have shown that the sector can be subject to major disruption and cascading impacts including as a result of failures in other sectors. As yet, there is no evidence that the industry and Government have a plan to assess fully and address these vulnerabilities.

RECOMMENDATION 20: *Defra should ensure that all major infrastructure operators in the digital and ICT sector take part in the third round of ARP. This will ensure that the sector has considered risks, and that operators, individually and collectively have developed risk management plans. (Owner: Defra. Timing: 2019).*

Are actions taking place?

The NAP contains no specific actions relating to digital and ICT, despite the sector being recognised as critical to the operation of other infrastructure sectors, as well as the economy in general. The next NAP should prioritise actions that are needed to enhance the resilience of the sector. Some actions are taking place by individual companies following recent events.

TechUK reported that generally:

- Data centres have back-up generators to mitigate the risk of disruption to mains power.
- Fixed line operators assess risks to masts in high winds and strengthen those at highest risk.
- Mobile networks can be re-routed if flooding or other disruption occurs, provided there is sufficient coverage. However, in some cases there is limited information, even within operators, on where mobile connections are, hindering ability to re-route services effectively.

The EC-RRG is coordinating industry, government and Ofcom activity on infrastructure resilience issues in the telecommunications sector. Their adaptation report for ARP2, compiled in response to an ASC evidence session held with sector representatives, noted that various service providers have reviewed the likelihood of flood damage to critical assets in a 1:1000 year flood event (as specified by the NFRR). EC-RRG reported that temporary defences were in place by end of 2016 and all participating companies have plans in place for permanent defences.

A recent event impacting York and Leeds in December 2015 (Box 5.4) appears to have been a 'wake-up call' for the industry. The event was severe enough to cause three separate outages affecting communications: the Vodafone network, a major BT exchange, and North Yorkshire Police's internal radio network. After the event the following actions took place:

- BT undertook a risk assessment to identify how to protect its flooded exchange in the future.
- BT engaged with the EC-RRG to ensure that lessons from these incidents are applied more widely.
- Vodafone is working closely with EA and Cabinet Office as part of the NFRR, and has carried out a comprehensive assessment of their infrastructure resilience against new EA flood maps.
- In Leeds, Vodafone has spent over £1 million improving the resilience of the site that flooded, including building a flood wall around the perimeter.

[304] Sky plc (2016) *Annual Report 2016 principal risks and uncertainties*.
[305] Vodafone Group Plc (2016) *Sustainable Business Report 2015 -16*.

- Vodafone has also worked closely with the emergency services to make sure engineers can access sites during incidents.

Box 5.4. Severe weather impacts on communications infrastructure - York and Leeds, December 2015

Over the Christmas weekend in 2015 severe flooding affected large parts of the UK, and Yorkshire in particular.

The event was severe enough to cause multiple, concurrent failures:

- In Leeds, flooding affected the Vodafone network and caused intermittent disruption to voice and data services. The flooded site also supported North Yorkshire Police's non-emergency 101 phone line. This was out of action for three hours at the height of the floods. Calls had to be re-routed via an alternative number.
- BT's York exchange was also flooded, which affected landline services, including broadband, in the local area. This exchange had never flooded before and was not considered to be at risk.
- North Yorkshire Police's internal radio network was affected after flooding occurred at several sites. Emergency response vehicles provided a mobile base so that emergency services could communicate with each other.

Source: Tech UK (2016) *The UK's Core Digital Infrastructure: Data Centres Climate Change Adaptation and Resilience.*

Is progress being made in managing vulnerability?

Despite useful information in the two ARP reports from the sector, as in the ASC's 2015 report to Parliament, there is insufficient evidence from the industry or Government with which to assess the resilience of the sector. The observed impacts of Storms Desmond and Eva suggest that vulnerabilities exist, and more action is needed to assess the scale of these vulnerabilities and to put plans in place to address them.

ICT companies have provided information on network vulnerability and remedial action to the Cabinet Office as part of the NFRR. The NFRR assessed the vulnerability of digital and ICT assets to flooding, and committed the sector to develop and implement improvements to resilience in line with actions already taking place in the energy and water sectors. The data collected as part of the NFRR were requested by the ASC to help compile this and other sections of our report, but this request was declined.

Given ICT's pervasive and 'unseen' interdependence with all other infrastructure systems, and its role in underpinning business activities and public safety, it is crucial to assess the vulnerability of the UK's ICT networks and systems, and the interdependencies, particularly with the energy sector in the context of a changing climate.

Tech UK reported[306] that there needs to be:

- More information on interdependencies, in particular the need to consider whether digital communication systems are sufficiently resilient to power failures.
- More data on how often operators reassess flood risks.

[306] Tech UK (2016) *The UK's Core Digital Infrastructure: Data Centres Climate Change Adaptation and Resilience.*

5.4 Infrastructure interdependencies

Is there a plan?	Amber	The Cabinet Office's annual resilience reviews have identified and considered specific vulnerabilities to interdependent networks. However, there is no national assessment of interdependency risk, nor a comprehensive plan to address systemic risks.
Are actions taking place?	Amber	Members of the Infrastructure Operators Adaptation Forum including water companies are working to address the resilience of networks on which they depend, for example, by increasing resilience to power supply outages and the availability of water resources under drought conditions. New infrastructure projects are considering interdependencies. The most comprehensive example is HS2. Local Resilience Forums feel that better engagement is needed, on assets and vulnerabilities, between LRFs and infrastructure operators.
Is progress being made in managing vulnerability?	Amber	**Recent events have further highlighted vulnerabilities caused by losses in electricity and ICT (e.g. the Lancaster floods in 2015).** **The NFRR assessed vulnerabilities across sectors and is looking at protection to a 1-in-1000 year flood event as de-facto standard. However it is not clear to what extent this standard of protection is in place in practice. Information and data to measure progress in addressing vulnerabilities are not available.**

Is there a plan?

The Cabinet Office annual resilience reviews have identified and considered specific vulnerabilities to interdependent networks and have set up the National infrastructure Resilience Council. However, there is no national assessment of interdependency risk, nor a comprehensive plan to address systemic risks.

The Cabinet Office's 'annual resilience review' process has since been subsumed into the SSRP process (see Section 3.2). Three review cycles are now complete. The second review cycle focused on critical interdependencies and the results led to a series of actions and ministerial-level meetings with regulators and operators, although there is no public account of these. The Cabinet Office has said that many of the actions identified in the review have been completed or have been incorporated into other programmes of work.

The Cabinet Office set up the National Infrastructure Resilience Council (NIRC) in January 2017, in response to the NFRR, to enable infrastructure operators and corresponding government departments to fulfil their responsibilities for both planning for and supporting the response to emergencies arising from all risks. The Council has met several times and is chaired on a rotating basis by sector representatives.

Are actions taking place?

Some infrastructure operators are addressing interdependencies, which are also being considered in some infrastructure projects.

The NAP 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. Ten (11%) of the NAP actions for the infrastructure theme support this objective. All actions except one are complete or on track.

- Since 2015 Infrastructure UK has published new guidance on interdependencies and systems thinking.
- Members of the Infrastructure Operators Adaptation Forum (IOAF) are addressing risks associated with interdependencies between infrastructure networks. For example actions are ongoing to increase water company resilience to power supply outages.
- The Climate Ready Support Service, which had responsibility for some of the relevant NAP actions, ended in March 2016. However, some actions are being continued by EA's Climate Adaptation Team in support of their own climate change adaptation commitments. The IOAF working group on interdependencies is aiming to produce guidance on how best to assess the risks of cascading failure, following a review of different approaches that are currently used.
- New infrastructure projects are considering interdependencies. The most comprehensive example is HS2 Ltd. It has assessed the risks faced from climate change impacts on interdependencies, such as the rail network, electricity supply, and ICT. This included an analysis of the locations at highest risk along the HS2 route. Engagement with infrastructure operators helped to identify key interdependencies. Recommendations for the design of HS2 include considering: increased redundancy within the system; collaborative working arrangements with local infrastructure operators; the use of 'what if' scenarios; and the use of common standards across sectors/operators where possible.[307]
- The Department for Transport is working to identify bridges that could fail in a severe flood event and be a single point of failure for other infrastructure networks (for example by carrying telephone or power cables, or gas pipelines).[308]

The ASC's review of ARP2 found that strategic interdependencies were often stated in reports by operators but with little explanation or detail included. Many operators have considered their interdependencies, and continue to take part in cross-sector forums such as the IOAF, but the consequential adaptation actions are not evident.

The National Infrastructure Resilience Council aims to:[309]

- Improve co-operation, co-ordination and information sharing between Government and infrastructure operators and owners.
- Sponsor co-operation and information sharing between sectors.
- Develop cross-sector proposals on infrastructure resilience.
- Examine and document interdependencies between sectors.

[307] Correspondence with HS2 Ltd.
[308] Correspondence with Department for Transport.
[309] Correspondence with Cabinet Office.

We recommended in our review of ARP2 that for ARP3 more advice and support is given to organisations to help them assess, describe and present the risks from interdependencies. Leadership is required to take the necessary cross-sectoral overview. It could be appropriate for either the new National Infrastructure Resilience Council or the Cabinet Office to undertake studies, take an oversight role in relation to the management of interdependencies, and report on progress.

Infrastructure operators and 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.

The UK Regulators Network (UKRN)[310] provides the means to share lessons but could be doing more to drive and co-ordinate action. Our previous recommendation in 2015 was accepted by the UKRN. This was for the UKRN to *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* (Recommendation 13). UKRN produced a questionnaire to gather information on the resilience of assets and the approach to performance penalties, and provided us with the results in June 2017.[311] UKRN members (Ofgem, CAA, Ofwat, Ofcom and ORR) have shared approaches to monitoring and promoting appropriate asset protection and investment policies by regulated utilities. Regulators each have a range of existing monitoring requirements in place to scrutinise the performance of regulated businesses. A more detailed review of incentives has not yet been implemented. However, UKRN has stated that they are committed through their infrastructure and resilience network to continue to share best practice to promote and monitor good asset management.

In 2015 we also recommended that *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 the report's publication. Based on the results, the Cabinet Office should consider introducing in Parliament a legal duty to co-operate and share such information.* (Recommendation 12). This was rejected by Government, who argued that the Civil Contingencies Act places a duty on Category 1 and 2 responders to share information to enhance co-ordination, and the Green Book Guidance provides tools to identify and manage interdependencies that affect resilience in projects.[312]

A survey of 17 Local Resilience Forums (LRF)[313] commissioned by the ASC in March 2017 re-iterated previous findings we presented in our 2014 report.[314] LRF coordinators felt that there was reluctance from some utility and telecommunication providers to share information about their infrastructure due to commercial sensitivities. A few of those interviewed also stated that access to data on Critical National Infrastructure was restricted, and that this was a barrier. Telecommunications were cited by four interviewees, out of the sample of 17, as being particularly challenging to engage with, as they did not prioritise engagement with LRFs. For more results from this survey see Chapter 4: *People and the built environment*.

[310] See: http://www.ukrn.org.uk/
[311] Correspondence with UKRN.
[312] HM Treasury (2015) *Valuing infrastructure spend: Supplementary guidance to the Green Book*.
[313] Jacobs (2017) for the ASC. *Local Resilience Forum 2017 Interviews*.
[314] ASC (2014) *Managing climate risks to well-being and the economy: ASC progress report 2014*.

On the whole, there was a perceived need to develop stronger connections between LRFs and other stakeholders (both public and private) so that there is a meaningful engagement and exchange of information.

This exchange should not be limited to LRFs. It is important that information sharing and engagement occurs between infrastructure operators with co-dependent networks.

RECOMMENDATION 21: *To assist with the assessment and management of interdependencies the Cabinet Office should review information sharing arrangements between infrastructure operators, as well as between operators and Local Resilience Forums. Further steps may be necessary to ensure that the legal duties within the Civil Contingencies Act are being fulfilled in practice, including the duty for Category 1 and Category 2 responders to cooperate and share information. (Owner: Cabinet Office. Timing: 2018).*

Is progress being made in managing vulnerability?

Recent events have further highlighted vulnerabilities caused by losses in electricity and ICT. The Cabinet Office annual resilience reviews have identified and considered specific vulnerabilities to interdependent networks. The NFRR assessed vulnerabilities across sectors using 1-in-1000 year flood event as de-facto standard. It is not clear to what extent this standard of protection is in place. Data to measure progress in addressing vulnerabilities are not available.

Common standards of resilience would help with investment planning, and help emergency planners better understand the potential for service disruption arising from assets in an area.

The Cabinet Office rejected our 2015 recommendation *to 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 they are implemented. This process should inform the 2016 round of sector resilience planning.* (Recommendation 11). Nonetheless, the NFRR assessed vulnerabilities across sectors and looked at a 1-in-1000 year flood event as de facto standard of protection.

It is not clear however, if this standard of protection in place. Data to measure progress are not available and recent events, such as flooding in Lancaster in December 2015 (Box 5.5), have shown that cascading failures of infrastructure can occur in practice.

Box 5.5. Collapse of Lancaster's critical infrastructure networks

In December 2015 intense rainfall caused flooding in many parts of Lancaster when surface drainage networks, including new underground storm water drains, were overwhelmed. This led initially to flooded roads, bridges, homes and businesses. The most devastating impact however was when floodwater entered a major electricity substation, despite pumps, sandbags, extra emergency pumps, and new defences built in 2007 that were designed to withstand a 1-in-100 year flood event. Electricity supplies were lost for over 30 hours in approximately 61,000 homes in Lancaster and the neighbouring towns of Carnforth and Morecombe. This led to secondary infrastructure failures and widespread disruption across Lancaster and the surrounding areas, including:

- Failure of home broadband and public internet services.
- Mobile phones were inoperable.

Box 5.5. Collapse of Lancaster's critical infrastructure networks

- Roads which were unaffected by flooding had no streetlights or traffic lights.
- Petrol stations ran out of fuel.
- Trains were delayed or cancelled.
- Problems occurred with drinking water supplies.
- Outpatient and non-emergency appointments at the hospital were cancelled with military and mountain rescue teams helping to transport medical staff to and from work.
- Lancaster University and local schools had to close temporarily.

Source: Weather magazine (January 2017) *A perfect storm? The collapse of Lancaster's critical infrastructure networks following intense rainfall on 4/5 December 2015.*

5.5 Conclusions on NAP objectives and actions

Table 5.1 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.

In 2017 we received updates on 95 actions, including four new actions since 2015:[315]

- A further 17 (18%) of actions are now complete, bringing the total to 56%.
- The majority (69%) of the remaining actions are not time-bound.
- An action relating to the Green Deal has now been dropped after the Green Deal was cancelled.

Table 5.1. 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.	60 (62%) of the NAP actions for the Infrastructure theme fall under this objective. All but two of the actions are complete or on track. 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 surface water flooding.

[315] An annex to this report presents the current status of each action, see https://www.theccc.org.uk/publications/

Table 5.1. NAP objectives and a summary of progress for the infrastructure theme	
NAP objective	**Commentary on progress**
Objective 8. To develop regulatory frameworks to support and promote a resilient and adaptive infrastructure sector.	13 (14%) of the NAP actions for the theme support this objective, all of which are complete or on track. 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 is continuing to work with the water companies and Water UK is looking to develop resilience metrics. DfT continues to discuss the Office of Rail and Road's role in monitoring climate change resilience for rail's Control Period 6 (2019-2024).
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.	12 (13%) of the NAP actions fall under this objective, all of which are complete or on track. The use of SuDs in new development is a material consideration as part of a revised planning policy, which came into effect in April 2015 (discussed further in Chapter 4). The primary focus to date has been on improving understanding of climate change, and the resilience of critical national infrastructure. The Environment Agency's Climate Ready Support Service ended in March 2016.
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.	Ten (11%) of the NAP actions support this objective. All actions except one are complete or on track. Since 2015 Infrastructure UK has published new guidance on interdependencies and systems thinking. The Infrastructure Operators Adaptation Forum continues to share good practice between sectors and is working on addressing risks arising from interdependencies between infrastructure networks. The one action which has been revised and delayed is for Climate UK to address interdependencies via regional or sub-regional analysis, knowledge sharing, and via capacity building activity. Six out of nine Climate UK regional partnerships closed in 2016 when funding from central Government came to an end. Whilst Climate UK is no longer working on this, it is still a priority for the IOAF.

Chapter 6: Business

Key messages

Context

Climate change risks are increasing for business and industry in England, with flooding and extreme weather events likely to pose the greatest challenge. Through international supply chains, distribution networks and global markets, businesses are also exposed to risks from extreme weather, flooding and water shortages around the world. Climate change presents opportunities to business through increases in demand for some existing goods and services, including those specifically related to adaptation, and the emergence of opportunities for new products and services. Risks caused by disruption to national and local infrastructure services are discussed in Chapter 5.

Summary of progress

The environmental, social and governance (ESG) performance of listed companies is becoming a mainstream concern within the investment community and many leading companies now report on their assessment of climate change risks and opportunities. Yet action to reduce the direct impacts of extreme weather is less apparent, as is the management of climate risks within supply chains, especially amongst small and medium sized enterprises. The next NAP needs to restate the Government's objectives and priorities for adaptation within the business sector in light of the support programmes that were in place, such as the Environment Agency's Climate Ready Support Service, coming to an end in 2016.

Overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	**Is progress being made in managing vulnerability?**
1. Business impacts from extreme weather	Green	Amber	Amber
2. Supply chain interruptions	Amber	Amber	Amber
3. Water demand by industry	Green	Green	Green
4. Business opportunities from climate change	Amber	Green	Amber

Note: See Annex 2.1 for a description of the criteria used to assign Red-Amber-Green (RAG) scores.

There have been some positive developments in the business sector that could in time make a difference:

- **New initiatives to support the uptake of property-level flood resilience (PLR) measures by businesses are underway** in response to the severe weather events in December 2015 and

Key messages

January 2016. Actions include the development of recognised standards and certification for PLR products and services.

- In December 2016, the British Insurance Brokers' Association (BIBA) launched a **new flood insurance scheme for SMEs** to help more businesses obtain affordable flood insurance, including those affected by recent flood events. Unlike Flood Re - the subsidised flood insurance scheme for households - pricing and terms under the BIBA scheme encourage investment in resilience measures and will allow the costs of flood resilient repairs to be included in claims. This is a welcome development that should be mirrored by Flood Re in the household sector.
- The UK introduced **new Non-Financial Reporting Regulations in December 2016**, requiring large companies to report from next year on the materiality of non-financial risks. A **Task Force on Climate-related Financial Disclosures**, reporting to the Financial Stability Board, has also consulted on a series of recommendations that aim to encourage meaningful, voluntary reporting on actions to cut greenhouse gas emissions and to reduce exposure to climate change risks. These developments will add to existing voluntary and market reporting initiatives aimed at the investment community.
- **Retail competition in the water sector for non-domestic customers in England began in April 2017**, and this is expected to increase the focus by businesses on water efficiency. The reforms allow many companies to choose for the first time who supplies their water and wastewater services. Some water retailers may look to differentiate their offering through value-added services such as water efficiency audits, better information on consumption and leakage, and tariffs that incentivise water conservation.

Since the ASC last reported to Parliament in 2015 there has been a notable reduction in NAP-related activity in the business sector. It is therefore timely for the Government to reassess its priorities and policies for enabling and encouraging adaptation by businesses and industry.

- **The Environment Agency's Climate Ready Support Service ('Climate Ready') has closed** after Defra decided it was no longer a priority for funding. Climate Ready was the lead national adaptation support service for businesses, as well as other sectors, and was responsible for a large number of actions in the National Adaptation Programme. The funding also supported Climate UK's network of regional climate change partnerships, more than half of which have since closed. This puts at risk the legacy of information, tools and guidance developed over the last decade.
- **There is limited evidence to indicate that businesses are taking steps to reduce the physical risks of climate change impacts**, including from flooding and arising within supply chains. The uptake of property-level flood resilience measures to date has been low, even though grants have been made available. There are only individual examples of companies actively identifying and managing climate change risks in their supply chains.

Recommendations for further progress

While each business is responsible for their own adaptation to climate change, there is the potential for the Government to work through existing business networks, processes and initiatives to provide businesses with information and advice, and to promote and embed climate change risk management as part of standard business practice.

RECOMMENDATION 22: *The Government should promote voluntary disclosure of climate change risks by both large and small companies, including the risks in relation to supply chains.*

- *The investment community should further emphasise the need for meaningful disclosure of how companies assess and manage climate change risks, in line with the recommendations of the Task Force on Climate-related Financial Disclosures.*

Key messages

- *The Financial Reporting Council's UK Stewardship Code should ask investors to consider company performance and reporting on adapting to climate change.*
- *As a form of disclosure, the Government should promote corporate natural capital accounting and reporting, as recommended by the Natural Capital Committee.*

(Owner: Defra/BEIS. Timing: by 2020).

RECOMMENDATION 23: *The Government should consult on the measures needed in the next NAP to provide appropriate information and advice to support adaptation activity by businesses in England. For example, the Government could work with bodies such as the Confederation of British Industry, the Institute of Directors, the Federation of Small Businesses, Local Enterprise Partnerships, local chambers of commerce, and key individual sector associations, to promote use of the guidance and tools that were developed by the Environment Agency and Climate UK before their closure. (Owner: Defra/BEIS. Timing: by 2018).*

RECOMMENDATION 24: *The Government should examine how public procurement rules could be used to promote the disclosure and management of climate change risks including within supply chains. For example, the Crown Commercial Service could require companies tendering for contracts to explain how risks have been considered and addressed both within tenders and by their overall business. (Owner: Defra/Crown Commercial Service. Timing: by 2020).*

6.1 Climate change risks to business

Businesses are exposed to physical, financial, and reputational risks from climate change, affecting their operations in the UK and abroad. These include the risks of direct physical damage to business assets, and changes to the price and availability of materials, ingredients and other inputs sourced locally and overseas. Whilst it is ultimately for each business to determine their strategy for adapting to climate change, the Government has a role in enabling and promoting private sector adaptation.[316]

Severe weather events have caused significant costs to businesses in recent years. Flooding has in particular caused damage and the loss of business activity in affected regions. Smaller businesses may take several years to recover from serious flooding incidents, with some never reopening. Business impacts can be felt far beyond the areas directly affected, including as a result of the loss of road, rail, energy and communications infrastructure (discussed further in Chapter 5). Flooding and storms also incur high costs to the insurance industry, and to the Government through demands for grants and support packages to help businesses to recover.

The interconnected nature of global supply chains means businesses in the England (the scope of this report) can be exposed to climatic events around the world. As extreme weather events become more frequent, building resilient supply chains will become increasingly important and could give some businesses a competitive advantage.

There will also be opportunities arising for businesses that anticipate how climate change will affect the demand for certain goods and services, and where and how they are produced in this country and around the world. Climate change is likely to alter global patterns of food production and other climate-sensitive raw materials, and increase the demand for adaptation-

[316] Surminski, S. et al. (2016) *UK Climate Change Risk Assessment 2017, Chapter 6: Business and industry.*

related goods and services such as flood alleviation, drought management and climate change risk advice.

Since 2015 there have been significant developments within the investment community regarding listed businesses and their assessment and disclosure of climate change risks. But climate change has to compete with other issues, such as EU exit, for board-level attention.

Companies' environmental and sustainability performance has progressed in recent years from a niche topic to a mainstream subject within the investment community. Listed companies are now expected to address an array of social, economic and ecological challenges, including emissions reduction and climate change risk management. This trend is likely to continue, with investors placing increasing pressure on companies to disclose how their assets and liabilities could be affected by climate change, and expecting greater maturity in the assessment of risks and the adaptation actions being taken.

However, the risks and opportunities that will arise from the process of the UK leaving the European Union is likely to feature highly in company risk registers and to some extent will dominate board-level discussions for some time. The consideration and management of climate change risks and opportunities is likely to have been deprioritised as a result.

The ASC's evidence report for the 2017 UK Climate Change Risk Assessment identified seven specific areas of risk and opportunity for businesses in the changing climate. Figure 6.1 summarises the results of the assessment for the business sector.

The results reinforce the need for further action to help businesses manage their exposure to flood damage, and for more research to support future policies and proposals on coastal change. The impacts of higher temperatures on employee well-being and productivity were also highlighted as an area for further exploration.

Figure 6.1. Risks to business identified by the UK Climate Change Risk Assessment 2017

MORE ACTION NEEDED	RESEARCH PRIORITY	SUSTAIN CURRENT ACTION	WATCHING BRIEF
Bu1: Risks to business sites from flooding	Bu2: Risks to business from loss of coastal locations & infrastructure	Bu3: Risks to business operations from water scarcity	Bu4: Risks to business from reduced access to capital
	Bu5: Employee productivity impacts in heatwaves and from severe weather infrastructure disruption	Bu6: Risks to business from disruption to supply chains	Bu7: Business risks /opportunities from changing demand for goods & services

Source: Surminski, S. et al. (2016).
Notes: The urgency associated with each risk and opportunity (shown in top row) was determined by the ASC on the basis of the evidence presented in the CCRA chapter. See Chapter 2 of the CCRA Evidence Report for a description of the urgency scoring methodology.

The risks highlighted above are discussed in this chapter under the headings of the four priority areas for business activity presented in the ASC's first progress report to Parliament in 2015:

- Business impacts from extreme weather.

- Supply chain interruptions.
- Water demand by industry.
- Business opportunities from climate change.

The final section of this chapter summarises progress against each of the objectives for the business sector set within the current National Adaptation Programme.

6.2 Business impacts from extreme weather

Is there a plan?	Green	Defra's six-year flood defence investment plan aims to achieve a 5% net reduction in expected annual flood damages by 2021. The National Flood Resilience Review assessed the vulnerability of local infrastructure and committed to consider options to improve flood resilience in the six core city regions in England to levels equivalent to London, beginning in Sheffield in 2017.
Are actions taking place?	Amber	Most actions in the NAP are now complete or are considered ongoing by their owners. Outside of the NAP, developments since 2015 include the Bonfield Review of property-level flood resilience, and BIBA's new flood insurance scheme for businesses. There are also a number of new initiatives that aim to promote company disclosure of climate change risks. The Environment Agency's Climate Ready Support Service closed in April 2016, with consequential closures of Climate UK and most of the regional climate change partnerships in England.
Is progress being made in managing vulnerability?	Amber	**Investment in flood defence projects, actions arising from the Bonfield Review, and BIBA's flood insurance scheme, are all positive developments but there is little evidence of action being taken more generally to identify and reduce business exposure to extreme weather.** **Where action is taking place by businesses it focuses primarily on flood risk management, not other extreme weather risks, such as from heatwaves and drought.**

Is there a plan?

Flooding continues to be the most prominent weather-related risk to business operations, causing severe and enduring impacts. Other extreme weather events, such as high winds, heavy snow or heatwaves, have a lower risk of causing lasting physical damage to assets but still need to be considered in order to safeguard staff and ensure continuity of operations.

Flooding imposes significant costs on businesses, causing disruption to business activity and damage to assets.

- An economic analysis of the winter 2013/14 floods, published in 2016, estimated that costs to businesses in England were £270 million, with this representing 21% of the £1.3 billion total costs caused by the event. More than 3,000 businesses were impacted with an average of £82,000 in losses per business. The majority of damage to businesses over that winter was in coastal areas, including as a result of the period of surge tides along the east coast of England between 4th and 8th December 2013.[317]
- More recently, in the winter of 2015/16, there were a number of extreme flood events caused by storms Desmond, Eva and Frank. Lancashire, Yorkshire and Cumbria were particularly affected. The Association of British Insurers reported shortly after the event that their members were dealing with more than 5,000 insurance claims from businesses, with claims overall (from business, residential and motor policies) expected to total £1.3 billion.[318]

The majority of businesses (74%) responding to a survey conducted in Cumbria after the December 2015 flooding identified indirect effects such as reductions in trade as the most significant cost to their business.[319] SMEs were disproportionately impacted by the storms. In the Calder Valley in Yorkshire, which experienced severe flooding in 2012 as well as in 2015, an economic assessment found that damages to SMEs were much higher as a proportion of their turnover than for larger businesses (Box 6.1).[320]

Box 6.1. The impact of recent flooding on small businesses in the Calder Valley

Flooding caused significant damage to businesses in Borough of Calderdale and the Upper Calder Valley on Boxing Day 2015. Over 1,600 businesses suffered losses in a region that was affected by serious floods only three years before. In March 2016, four months after the onset of the flooding, the damage to the local economy was estimated at £47 million. A year after the floods, the estimate had risen to £177 million and for many businesses the recovery process is still ongoing.

A survey conducted immediately after the flood found that 45% of the surveyed businesses suffered structural damage to buildings, 75% lost stock, and 46% lost office equipment. Relative to income, damages were significantly higher in smaller businesses. Whilst businesses with more than 20 employees experienced higher losses in total, damages for companies with less than four employees were twice as costly relative to their income.

Around (60% of businesses had at least one type of flood insurance, with business equipment, stock, and business interruption the most commonly insured. Of those businesses that were insured, 14% reported that they did not make a claim as the excess was too high. Of those without insurance, 65% reported this was because they could not find any insurers willing to cover them, while 21% reported that the insurance premiums they were quoted were unaffordable. The ability to obtain affordable insurance in the future was an overriding concern for many businesses surveyed.

The survey found high uptake of the government recovery funds of £2,500 per affected business that were made available. Around 900 businesses applied for the grant in the three months following the event. Grants of £5,000 were also made available for investment in property-level flood resilience measures. The uptake of these was much lower, reportedly due to a complex application process and a

[317] Environment Agency (2017) *The costs and impacts of the winter 2013 to 2014 floods*.
[318] See: https://www.abi.org.uk/News/News-releases/2016/01/New-figures-reveal-scale-of-insurance-response-after-recent-floods
[319] BMG (2016) for Cumbria Local Enterprise Partnership, *Cumbria Business Survey 2015/16 Flood Impact Report*.
[320] Paola, S., Holdsworth, A., & Curry. S. (2016) *Economic Impact Assessment of the Boxing Day Floods (2015) on SMEs in the Borough of Calderdale*. University of Leeds, Calderdale Council, Upper Calder Valley Renaissance.

Box 6.1. The impact of recent flooding on small businesses in the Calder Valley

narrow application window.

Despite these challenges, there are examples of local businesses successfully installing resilience measures. Where properties cannot be prevented from flooding, simple measures like installing shelves to allow stock and essential equipment to be raised above flood levels can help reduce damage costs and allow companies to begin trading again more quickly.

The Upper Calder Valley Renaissance (UCVR), a community based social enterprise, led a valley-wide initiative that supported local businesses in their recovery. UCVR highlight that as well as improving physical flood protection measures, providing support to adapt business models can be just as important. For the communities in Calder Valley, heavily reliant on retail and tourism, an example of this is to grow online revenues so trading can continue even if local premises are disrupted.

Source: Paola, S., Holdsworth, A., & Curry. S. (2016) *Economic Impact Assessment of the Boxing Day Floods in 2015 on SMEs in the Borough of Calderdale.* University of Leeds, Calderdale Council, Upper Calder Valley Renaissance.

Current Government policies in this area focus on flood risk management, and providing protection to businesses through national investment in flood alleviation schemes. The National Flood Resilience Review also included a commitment to consider how to provide improved standards of protection within the core cities. National plans and policies to help businesses prepare for extreme weather - beyond flood risk management - are limited.

Overall, Defra's six-year investment plan for flood and coastal defence aims to achieve a 5% net reduction in expected annual flood damages between 2015 and 2021.[321] 300,000 households will benefit from new or renewed flood and coastal defences (see Chapter 5: *People and the built environment*). Protecting businesses is a stated aim of the programme but this is given less emphasis than protecting households when it comes to allocating limited national funding, given the scope for larger businesses in particular to invest in their own resilience or contribute towards the costs of community-level schemes in their area. Consequently, there is no national target for protecting businesses but many will nevertheless benefit from the 1,500 flood and coastal schemes beginning construction in England between 2015 and 2021.

Aside from managing their own assets, businesses are also vulnerable to disruption from flooding caused by the loss of local infrastructure networks, such as electricity, roads, rail and telecommunications. The National Flood Resilience Review, published in September 2016, identified more than 500 vulnerable infrastructure assets in areas of flood risk (discussed further in Chapter 5: *Infrastructure*). The report also committed to review current standards of flood protection within the English core cities, given their relative vulnerability to flooding in comparison with London. A pilot in Sheffield is underway, looking at how self-financing options for urban development could also deliver flood resilience benefits. If successful, work with other cities could follow in 2018.

[321] Defra (2014) *Reducing the risks of flooding and coastal erosion: an investment plan 2014.*

Are actions taking place?

Significant developments since 2015 include the Bonfield Review of property-level flood resilience,[322] and the launch of a new flood insurance scheme for businesses.

- In our 2015 report we recommended that *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* (Recommendation 32). In response to this, the Government said that learning from past grant schemes would be applied to relevant future policy. Lessons were subsequently considered by the Bonfield Review (see Box 6.2, and discussed further in Chapter 4: *People and the built environment*).
- A new flood insurance scheme targeted at SMEs was launched by the British Insurance Brokers' Association in December 2016 (also discussed in Box 6.2). The scheme aims to increase the availability of insurance products to SMEs including through the use of more detailed, property-level flood risk information, than is typically used by insurers. The scheme is industry-led, and operates without government involvement or public subsidy. Such an approach could become applicable in the household insurance market as Flood Re begins to be withdrawn from 2021. Flood Re is discussed further in Chapter 4.

Box 6.2. A review of property-level resilience, and a new flood insurance scheme for businesses

A survey of insurance brokers completed as part of the Bonfield Review explored the relationship between property-level flood protection and the availability and affordability of insurance. Key findings included:

- There is currently limited recognition of resilience measures by insurers, in terms of an increased ability to quote or to offer improved terms.
- Making internal improvements to buildings that might reduce the cost of a claim is the measure most likely to be recognised by insurers, while signing up to Environment Agency flood alerts is one of the least recognised.
- There is no industry-recognised certification or standard for flood protection products, resilience measures, or installation firms.
- Many insurers highlight the difficulty in making buildings more resilient following a claim, with 28% of brokers reporting that their insurers would not make resilient repairs even if cost neutral, and 52% stating that their insurer would not allow more expensive, resilient repairs, even if the customer made up the additional cost.

BIBA's new flood insurance scheme for businesses, launched in December 2016, seeks to address some of these issues. The scheme has the following features:

- A more detailed appraisal of risk due to higher resolution risk mapping. This assesses the risk for individual properties rather than applying the same risk profile to all properties in the same postcode.
- Assessment of risk from multiple flooding sources: fluvial, coastal, surface water, groundwater and from sewers.
- Incentives for the use of property-level flood protection, signing up to flood alerts, and installing

[322] Defra (2016) *Improving property level flood resilience: Bonfield 2016 action plan*.

Box 6.2. A review of property-level resilience, and a new flood insurance scheme for businesses

resilience measures, in order to lower premiums or make an 'unacceptable' risk become acceptable and therefore insurable.

- Flexibility in the level of excess, which can result in reduced premiums, allowing businesses to vary the degree of risk they are willing to take.
- Allowing resilient repairs as part of the costs of claims.

Whilst the scheme's detailed flood modelling will avoid lower risk properties being incorrectly classified as high risk, there will still be some very high risk businesses that are uninsurable under the scheme. Unlike Flood Re, the scheme does not involve public subsidies, and therefore those properties identified as being at particularly high risk or with a history of claims may still struggle to find affordable cover. In the long-term such price signals from the insurance market are helpful to encourage vulnerable businesses to adapt or relocate to lower risk areas.

No statistics are yet available on the uptake of the scheme, and it may take several years to assess how effective it is in improving SME flood insurance uptake or stimulating business investment in resilience measures.

Source: Communication with the British Insurance Brokers' Association. For more information see: https://www.biba.org.uk/current-issues/flood-insurance/

More generally, and encouragingly, there is an increasing onus at least on larger listed businesses to assess and disclose non-financial risks including as a result of climate change.

We recommended in 2015 that *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* (Recommendation 33). The Government's response said that it is for investors to hold directors to account for the management of risks to listed companies. There have since been a number of useful developments in this area (Box 6.3), and there is value in the Government promoting these initiatives as part of a specific focus on the investment community in the next NAP.

Box 6.3. Company disclosure of climate change risks and opportunities

Some companies report on their exposure to climate change risks and the management and mitigation plans they have in place. This is done predominantly by publicly listed companies as part of corporate sustainability reports. Because reporting is normally completed on a voluntary basis, compliance is far from uniform and standards of reporting vary between organisations. Companies understandably choose to highlight their best practice examples, which may not be representative of normal practice. Despite these caveats, voluntary disclosure is an important means of gauging performance across the business community and driving improved performance.

Corporate sustainability reports focus more on carbon reduction than climate change adaptation. However, market disclosure initiatives such as the Global Reporting Index (GRI) and CDP (formerly the Carbon Disclosure Project) have categories relevant to climate change adaptation, such as evaluating climate change risks and opportunities, levels of water consumption, and supply chain risk management. London-based company CarbonClear publishes an analysis of FTSE100 sustainability reports on an annual basis, including company performance in relation to greenhouse gas emissions

Box 6.3. Company disclosure of climate change risks and opportunities

reduction and climate change adaptation (see Figure 6.2 for example).

Since 2015 there have been two key developments regarding company disclosure that are relevant to climate change adaptation.

- **Non-Financial Reporting Regulations** were brought into UK law in December 2016. These regulations require companies with 500 employees or more to consider and report on environmental and other non-financial risks as part of their financial reports. This will apply to financial years commencing after 1st January 2017. The regulations require financial reports to contain sufficient information to understand the company's development, performance and position and the impact of its activity relating to environmental matters (including the impact of the company's business on the environment). However, the regulations are no more prescriptive than this, so the degree to which they will result in companies reporting on climate change risks remains to be seen.
- A more prescriptive and ambitious set of recommendations have been made by the **Task Force on Climate-related Financial Disclosures** (TCFD) on behalf of the Financial Stability Board (FSB). The FSB is an international body that monitors and makes recommendations about the global financial system and is currently chaired by Mark Carney, the Governor of the Bank of England. As requested by the G20, the FSB set up the TCFD to develop climate-related disclosures that "could promote more informed investment, credit [or lending], and insurance underwriting decisions" which, in turn, "would enable stakeholders to understand better the concentrations of carbon-related assets in the financial sector and the financial system's exposures to climate-related risks". The task force has divided climate risks into two major categories: risks related to the transition to a lower-carbon economy; and risks related to the physical impacts of climate change. These physical impacts include acute risks, such as extreme weather events, and chronic risks which refer to longer term shifts in climate patterns.

Whilst voluntary, the TCFD aims for their recommendations to be adoptable by all organisations. CDP have announced that they intend to align with the TCFD's recommendations from next year.

Sources: Global Reporting Index (2017) see: https://www.globalreporting.org/Pages/default.aspx
Carbon Clear (2016) *Sustainability reporting performance of the FTSE 100.*
HM Government (2016) *The Companies, Partnerships and Groups (Accounts and Non-Financial Reporting) Regulations 2016, No. 1245.*
TFCD (2016) *Recommendation of the Task Force on Climate-related Financial Disclosures.*
CDP (2017) *Invitation to provide feedback on CDP's Reimagining Disclosure Initiative.*

One of the weaknesses in current disclosure requirements is that they only apply to public listed companies. However, a green paper in 2016 sought views on strengthening corporate governance for the largest private companies.[323] The BEIS Select Committee recently recommended that private companies, beginning with those with over 2,000 employees, should be subject to similar reporting requirements to public companies.[324]

The Government has not yet published a summary of stakeholder feedback on the green paper nor responded to the Select Committee's report.

The BEIS Select Committee's recommendation is for a light touch approach focusing on revenues, company structure, executive pay, numbers of employees, and pension scheme

[323] BEIS (2016) *Corporate governance reform: green paper.*
[324] BEIS Select Committee (2017) *Corporate Governance: Third Report of Session 2016-17.*

contributions. The scope of the recommendation also includes those areas covered by section 172 of the Companies Act. This places an obligation on company directors to have regard for the 'impact of the company's operations on the community and the environment'. Reporting would be on a 'comply or explain' basis, as for listed companies. The Financial Reporting Council has offered to develop and oversee a new governance code for private companies.

RECOMMENDATION 22: *The Government should promote voluntary disclosure of climate change risks by both large and small companies, including the risks in relation to supply chains.*

- *The investment community should further emphasise the need for meaningful disclosure of how companies assess and manage climate change risks, in line with the recommendations of the Task Force on Climate-related Financial Disclosures.*
- *The Financial Reporting Council's UK Stewardship Code should ask investors to consider company performance and reporting on adapting to climate change.*
- *As a form of disclosure, the Government should promote corporate natural capital accounting and reporting, as recommended by the Natural Capital Committee.*

(Owner: Defra/BEIS. Timing: by 2020).

Developments since 2015 also include the closure of the Environment Agency's Climate Ready Support Service ('Climate Ready'). Climate UK and most of its regional climate change partnerships have also closed as a consequence of Environment Agency funding coming to an end.

Climate Ready, and Climate UK, were responsible for a large number of actions within the National Adaptation Programme (see Section 6.6). Whilst many of these actions are now complete, it means that publicly-funded support for adaptation activity in the business sector has largely ceased, the tools that have been developed are not being maintained and promoted, and there is no longer the machinery that was in place to help the Government deliver new business-related actions in the next NAP.

In our 2015 progress report we recommended that *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 31).

Following an internal review conducted by Defra, as part of the 2015 cross-government spending review, the decision was taken to no longer make Climate Ready a priority for funding. The service closed at the end of March 2016, leaving no centrally-coordinated adaptation service provider to businesses. To illustrate the kind of activity no longer being funded, Box 6.4 provides examples of activity in support of adaptation in the business sector.

Box 6.4. The Climate Ready Support Service: support for business-sector adaptation

The Environment Agency's Climate Ready Support Service was launched in October 2011 to support the process of preparing and adapting communities, businesses and infrastructure services within England. Climate Ready worked with partners to provide targeted advice to help key sectors increase their resilience. The following are some examples of what was achieved by engaging with businesses:

- A 'Climate Adaptation Framework' was developed with the retailer Asda, which claims to be the

Box 6.4. The Climate Ready Support Service: support for business-sector adaptation

'UK's broadest study on the future impacts of climate change on a multinational supply chain'. Climate Ready also engaged with suppliers to M&S and Sainsbury's, to help them produce extreme weather plans and flood risk assessments.

- Various tools and guidance documents were developed including 'Assessing and managing climate change risks in supply chains' (still available as an online resource), and the Business Areas Climate Impacts Assessment Tool (BACLIAT). This provides a simple process for organisations to assess the potential impacts of climate change on their business.
- The Business Resilience Healthcheck tool is a free online service that can be used to gain an insight into potential risks and receive practical advice on how to prepare for extreme weather. The tool has been accessed by more than 8,000 businesses so far. The tool is now hosted on the Climate UK website but is no longer maintained and was not working at the time of writing.
- A Good Practice Guide for Local Enterprise Partnerships (LEPs) was developed, in partnership with Sustainability West Midlands, to integrate climate adaptation and the low carbon economy into regional economic strategies.
- A series of workshops, training and other events were organised, such as for company sustainability managers, and local authority officers.

Source: Environment Agency Climate Ready Programme Board papers (unpublished).

Relevant tools and guidance have also been developed by others to build awareness of risks and promote adaptation action. For example, the 'Know Your Flood Risk' campaign has published a Flood Guide for Business, providing advice on where to find information and how to increase the resilience of small business premises.[325] The guide was updated and re-released following the winter 2015/16 floods. The private sector also provides a range of goods and services to businesses, such as consultancy, technical guidance and products, both flooding-focussed and related to adaptation more broadly. At this stage, it is not clear whether others can and will step up to fill the gaps left by Climate Ready and Climate UK and how many businesses will value this kind of advice enough to pay for it.

RECOMMENDATION 23: *The Government should consult on the measures needed in the next NAP to provide appropriate information and advice to support adaptation activity by businesses in England. For example, the Government could work with bodies such as the Confederation of British Industry, the Institute of Directors, the Federation of Small Businesses, Local Enterprise Partnerships, local chambers of commerce, and key individual sector associations, to promote use of the guidance and tools that were developed by the Environment Agency and Climate UK before their closure. (Owner: Defra/BEIS. Timing: by 2018).*

Another means to embed climate change risk management within the business community would be to use public sector procurement rules.

The 2012 Public Services (Social Value) Act requires buyers of public sector services to consider "how what is proposed to be procured might improve the economic, social and environmental well-being of the relevant area". The Crown Commercial Service is the UK's public procurement organisation, spending almost £13 billion in the 2016/17 financial year on behalf of 17,000

[325] See: http://www.knowyourfloodrisk.co.uk/sites/default/files/FloodGuide_ForBusinesses.pdf

public sector organisations. As well as directly managing procurement projects, the Crown Commercial Service works to improve supplier and contract management across government.[326]

In April 2017, the Crown Commercial Service published a statement outlining how it will support public bodies to deliver more 'social value' through their procurement activity.[327] Planned activities include the development of tools and guidance to build social value into contracts and to evaluate the social value of bids received. Such tools and guidance could have a particular focus on climate change adaptation.

RECOMMENDATION 24: *The Government should examine how public procurement rules could be used to promote the disclosure and management of climate change risks including within supply chains. For example, the Crown Commercial Service could require companies tendering for contracts to explain how risks have been considered and addressed both within tenders and by their overall business. (Owner: Defra/Crown Commercial Service. Timing: by 2020).*

Is progress being made in managing vulnerability?

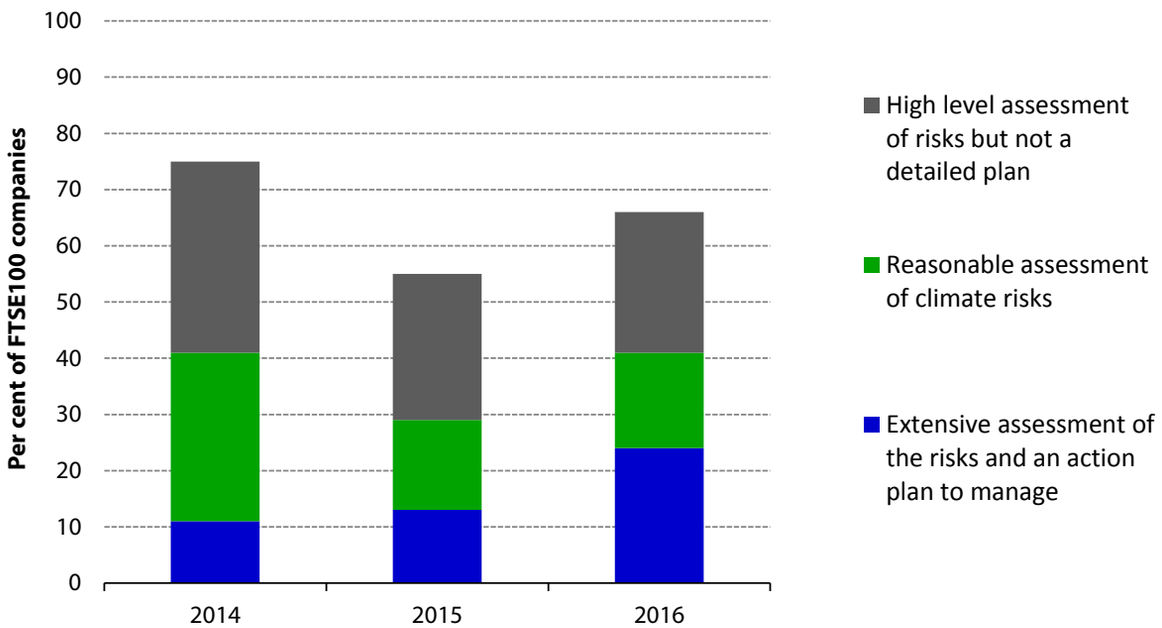
There is limited quantitative data to indicate how prepared businesses are for the risks associated with extreme weather.

A range of indicators were used in our 2015 report to assess how prepared businesses were for extreme events. These included survey results of businesses showing how many had business continuity plans in place, plus Environment Agency metrics on the number of businesses at risk of flooding and the rate of new non-residential development in areas of flood risk. These datasets have not been updated since 2015 but should continue to be monitored in future updates.

A more recent dataset that is available analyses what FTSE100 companies publish in their sustainability reports. While this data has some drawbacks, highlighted in Box 6.3, it is a useful indicator of company and shareholder priorities. Figure 6.2 shows the proportion of FTSE100 companies completing a materiality assessment of climate change risks over the last three years. While the overall number of companies completing a materiality assessment has decreased slightly, the number making a more extensive assessment of risks and putting management plans in place, rather than just undertaking a high level assessment, has increased. This suggests that at least some leading companies are taking more action to manage climate change risks.

[326] See: https://www.gov.uk/government/organisations/crown-commercial-service/about
[327] Crown Commercial Service (2017) *CCS Social Value Policy*.

Figure 6.2. FTSE100 company assessments of climate change risks in sustainability reports



Source: Data provided by CarbonClear (unpublished).
Notes: The quality of reporting by FTSE100 companies varies considerably. Feedback from CarbonClear suggests that outside the top 15-20 companies the quality of reporting drops off notably. Membership of the FTSE100 changes from year to year which may explain some of the fluctuation in the results.

6.3 Supply chain interruptions

Is there a plan?	Amber	Introduction of the Non-Financial Reporting Regulations may encourage greater consideration of supply chain resilience in company reporting. The green paper on the UK's Industrial Strategy emphasises the importance of 'strong' supply chains but not their resilience. The UK Food Security Assessment is due to be reviewed by 2020 in light of the ASC's evidence report for the second UK Climate Change Risk Assessment.
Are actions taking place?	Amber	A Business Resilience Healthcheck tool was developed by the Environment Agency Climate Ready Support Service before it closed in April 2016. The tool helps companies think about supply chain risks but will no longer be maintained and promoted.

Is progress being made in managing vulnerability?	Amber	**Around a quarter of FTSE100 companies mention supply chain resilience or adaptation in their sustainability reports, with this proportion at similar levels over the past five years.** **There is a range of initiatives underway to promote company disclosure of climate change risks, including in supply chains, but it is too soon to evaluate the impact these might have.**

Is there a plan?

Extreme weather impacts and market forces, including from the investment community, are currently more influential on supply chain risk management than government policy. However, the new regulations in place to promote disclosure of non-financial risks are likely to achieve some consequential benefit in terms of the visibility and management of supply chains.

Through their supply chains, distribution networks and participation in global markets, businesses are exposed to risks from extreme weather elsewhere in the UK and around the world. The risks relate to, in particular, supply chains and distribution networks that involve more vulnerable countries, such as in south and south-east Asia, and in sub-Saharan Africa.[328]

Greater connectivity and interdependencies across markets mean that whilst in the past an event may have only affected one or two companies, today losses have the potential to impact entire regions or market sectors. Flooding continues to be the major business risk associated with climate change in England, but around the globe this is not necessarily the case. Sensitivity to climate hazards will differ depending on the sector, with our non-statutory progress report in 2014 highlighting the types of primary industry and raw materials most at risk.[329] The extent to which weather events in other continents can have long lasting consequential effects on multiple business sectors was highlighted by the Thailand floods in 2011 (see Box 6.5).

Box 6.5. Supply chain impacts from the Thailand floods

The Thailand floods of 2011 represent the insurance industry's highest recorded flood loss event, with disruption to over 14,000 companies worldwide. The World Bank estimates the total damage and economic losses resulting from the floods at around $45 billion, including the impact on international supply chains. 70% of this loss is estimated to have been borne by the manufacturing industry due to the flooding of several industrial estates. The Lloyds of London insurance market alone incurred $2.2 billion in claims from the Thailand floods.

The floods were reported to have disrupted international supplies of motor and consumer electronic parts. In the UK, Honda cut production at its Swindon plant by 50% and delayed the launch of a new model. The floods in Thailand also raised the issue of reliance on 'clustered' industries where similar types of suppliers are grouped in the same region.

[328] ASC (2016) *UK Climate Change Risk Assessment 2017: Synthesis Report.*
[329] See Section 4.4 of ASC (2014) *Managing climate risks to well-being and the economy*, https://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/

Box 6.5. Supply chain impacts from the Thailand floods

The impact on the global hard-drive disk (HDD) market was pronounced. Before the 2011 floods, Thailand produced approximately 43% of the world's HDDs. Production of HDDs is concentrated between four major manufacturers, two of which had key facilities inundated during the floods. Western Digital Corporation has one third of the global HDD market and the company lost 45% of its global production due to a single facility flooding. Toshiba also had flooding at a key facility. The other two significant manufacturers (Samsung and Seagate) did not suffer direct impacts, but still had to drop production as they relied on parts from facilities that were affected. Globally the prices of desktop HDDs increased by 80–190% and mobile HDDs by 80–150%, with price impacts lasting for around six months and consequences for many other markets and products.

This example demonstrates the interconnectedness of global supply chain networks and how the indirect damage of regional disasters can affect consumer markets globally. The companies and sectors involved will have learnt from the Thailand floods and put in place plans to ensure greater business continuity in similar future events. However, the degree to which they, and the wider business community, are prepared for other climate related events in different locations is less clear.

Sources: Savitz, E. (2011) *Long after the floods recede, supply chains feel the pain.*
Lloyd's Global Underinsurance Research (Date unknown) *Thailand Flooding 2011.*
Haraguchi, M, Lall, U. (2014) *Flood risk and impacts: A case study of Thailand's floods in 2011 and research questions for supply chain decision making.*

The Industrial Strategy green paper published in January 2017[330] makes reference to developing strong UK supply chains, although this focuses on achieving economic rather than climate resilience. In the future, regulatory changes such as Non-Financial Risk Reporting, and initiatives such as the Task Force on Climate-related Financial Disclosures (Box 6.3) may begin to shift businesses to more actively assess and report on climate change risks in their supply chains.

The ASC's Evidence Report for the 2017 UK Climate Change Risk Assessment highlighted supply chain risks from disruption to international food production and trade as part of a wider concern about future food security.[331] In presenting the Government's CCRA report to Parliament in January 2017, Defra committed to review the UK Food Security Risk Assessment.

The ASC's Evidence Report concluded that access to safe, nutritious and affordable food was one of six priority areas of climate change risk for the UK that needs to be addressed as a matter of urgency in the next National Adaptation Programme. About 40% of UK food is imported, with some crops coming from a limited number of trading partners. Individual UK businesses are heavily reliant on imported ingredients, such as cereals, vegetables, oil crops, and sugar.[332] The food supply chain in the UK contributes £100 billion to the economy and employs 4 million people.[333]

An increasing risk of extreme weather events abroad will affect overseas production and supply chains, and potentially disrupt global markets. Incremental changes in temperature, rainfall

[330] HM Government (2017) *Building our Industrial Strategy– green paper.*
[331] Challinor, A., Adger, W. N., et al. (2016) *UK Climate Change Risk Assessment 2017, Chapter 7: International dimensions.*
[332] De Ruiter et al. (2016) *Global cropland and greenhouse gas impacts of UK food supply are increasingly located overseas*.
[333] See: https://www.fdf.org.uk/publicgeneral/stats-2017.pdf

patterns and ocean acidification are likely to shift the global pattern of food production posing risks to the UK's trading partners and the price of food here in the UK. In our evidence report we called for a greater focus on the UK food system from the perspective of climate change. Relevant policies in the next NAP would include the effective management of natural resources (both here and overseas), and understanding and managing the response of international markets to climate risks.

Are actions taking place?

The Business Continuity Institute (BCI) undertakes a supply chain survey amongst businesses around the world on an annual basis. Participation is voluntary, so is not necessarily representative, but provides some insight into action on global supply chain issues.

Surveyed businesses were asked how severely their supply chain had been affected over the last 12 months.[334] From a list of 23 potential responses, adverse weather was consistently cited as one of the top six sources of disruption. The BCI report suggests supply chain visibility remains one of the biggest challenges for businesses.

In the 2016 BCI survey, 61% of large businesses and 37% of SMEs reported that they insure against supply chain losses. The ability, particularly for larger businesses with complex supply chains, to insure against supply chain disruption may be why many businesses do not appear to be actively managing supply chain risks (see 'progress' section).

Passing the financial risks of supply chain disruption to the insurance industry will be an appropriate and cost-effective strategy for many businesses. The risk of insurance companies defaulting due to the potential scale of extreme weather claims has been reviewed by the Prudential Regulation Authority (PRA).[335] The report concluded that at least in the near term, insurance firms are 'reasonably well equipped' to manage the potential for damages including as a result of disruption to supply chains.

Other parts of the finance sector could also be exposed to climate change, but this has yet to be considered in detail. In our 2015 progress report we recommended that *the Bank of England should undertake research to better understand the potential systemic risks from climate change to the finance sector,* building on the PRA's report regarding the UK insurance industry, and that *the third round of ARP reporting should be extended to cover all areas of the finance sector* (Recommendation 34). In response the Government said that the Bank of England and PRA will continue to undertake further analysis and research, with the initial phase to be completed in time to inform the next National Adaptation Programme due in 2018. Further research has yet to be published.

The impact of climate change on overseas production facilities and supply chains is a subject of increasing interest within the investment community. Tools are now available that allow investors to assess the financial exposure of businesses to water scarcity in vulnerable regions.

The abstraction and use of freshwater in many parts of the world is currently unregulated. The price of water, and restrictions on its use, are likely to increase as resources become scarce and less dependable, and countries are forced to intervene. This will have implications for water-

[334] Business Continuity Institute (2016) *Supply Chain Resilience Report*.
[335] PRA (2015) *The impact of climate change on the UK insurance sector,* http://www.bankofengland.co.uk/pra/Documents/supervision/activities/pradefra0915.pdf

intensive industries operating in vulnerable regions, and as a result, the risk-adjusted returns expected by investors.

One tool now available to investors is the Water Risk Valuation tool developed by Bloomberg LP, the Natural Capital Declaration, and the UN Environment Programme Finance Initiative (Box 6.6).

The Environment Agency's Climate Ready Support Service provided supply chain guidance and advisory services, working with a number of individual businesses. The Environment Agency's supply chain guidance sets out a methodology for analysing and managing supply chain climate risk and includes case studies on a variety of businesses, including textile producers, flower growers, and timber and coffee bean importers. As discussed earlier, Climate Ready was discontinued in early 2016 and is therefore no longer able to offer businesses practical support.[336] This means businesses seeking advice on supply chain risk management will now likely need to pay for it. This will restrict the uptake and application of such advice.

Box 6.6. A shadow price for water in vulnerable regions and its implications for investors

Water is under-priced in many parts of the world and at best reflects the long-term costs of investing in water and waste water management infrastructure. The premium for increasing scarcity or increasing unpredictability of supply is rarely reflected in prices. If it was many companies' costs would increase, profitability would decrease, and they would become less attractive to investors.

The Water Risk Valuation tool was created to model the potential impact of water scarcity on earnings, and hence the profitability and share price of businesses. The tool is open-source and freely available.

The tool provides a standard methodology for incorporating the risk of water shortages and price effects into the financial valuations of companies. The tool calculates a 'shadow price' of water in each region based on a range of factors, including the value of water to other users. The difference between the shadow price and the market price in a region provides a measure of the financial risk that companies are exposed to. The tool has been applied globally to mining, utilities and beverage producing companies.

Source: Bloomberg LP, Natural Capital Declaration, see: http://www.naturalcapitaldeclaration.org/bonds-water-scarcity/ and https://www.environmentalleader.com/products/bloomberg-lp-the-water-risk-valuation-tool/

Is progress being made in reducing vulnerability?

It is in businesses' own interests to ensure their supply chains are robust and resilient. However, while businesses are experienced at driving down costs in supply chains, there is less evidence to show that resilience to climate change is yet a consideration. Where companies do report on supply chains, much greater emphasis is placed upon ensuring compliance with ethical and sustainability principles, rather than looking at the potential for disruptions in supply.

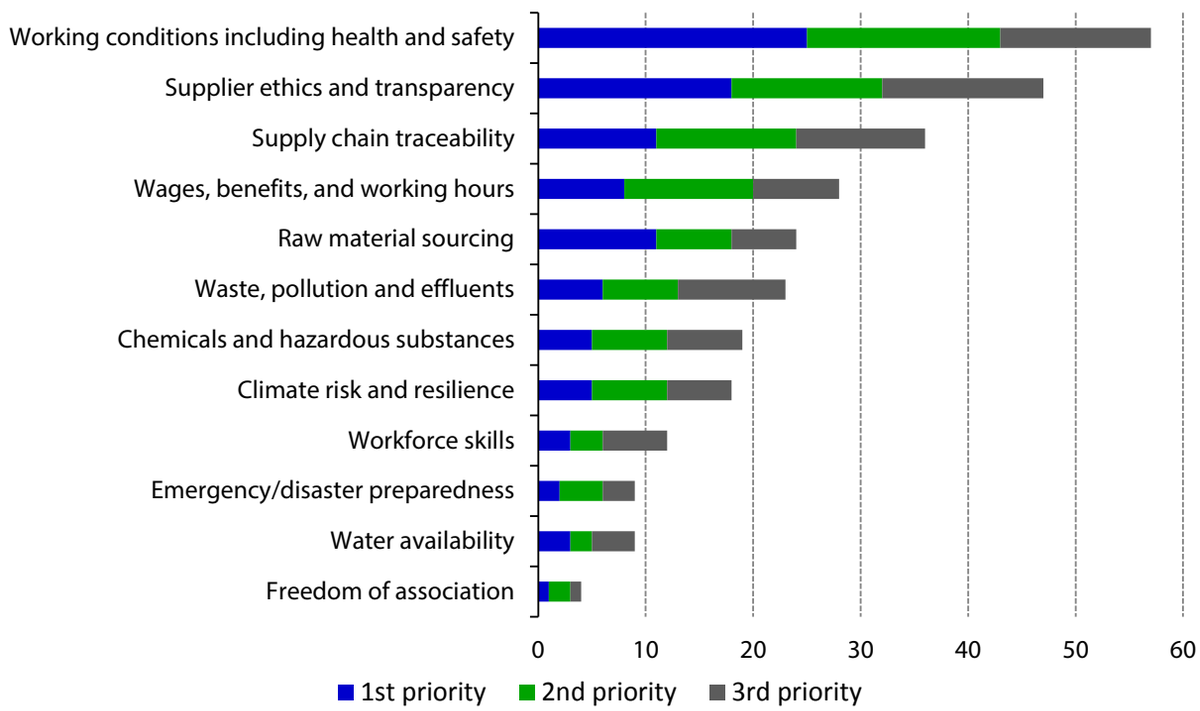
Climate change risks within supply chains do not feature prominently in listed companies' sustainability reports. Figure 6.3 shows that for most global businesses participating in a recent survey, non-climate related issues were considered greater priorities for supply chain assessment and risk management. Climate risk and resilience was 8th, water availability 10th, and emergency/disaster preparedness 11th, behind a range of ethical, social and environmental

[336] Environment Agency (2013) *Climate Ready: Assessing and managing climate change risks in supply chains.*

issues.[337] Perhaps unsurprisingly, the issues at the top of the list are those that are subject to regulatory standards, and those where a lack of supervision and control could lead to reputation damage.

Analysis of FTSE100 sustainability reports also suggests that supply chain assessment of climate risk is not a priority for many companies. Around a quarter of FTSE100 companies mentioned business or supply chain resilience or adaptation to risks in their most recent reports.[338] This proportion has remained relatively stable over the last five years. Amongst other industry leaders, supply chain assessment may be considered unnecessary, too challenging, or not a priority for sustainability reporting.

Figure 6.3. Relative importance of different 'sustainability' issues within company supply chains



Source: BSR (2016) *The State of Sustainable Business 2016*.
Notes: Companies were asked "What do you believe are the three most important sustainability issues in your supply chain?" Companies were provided with a list to choose from and asked to rank their top three issues.

[337] BSR (2016) *The State of Sustainable Business 2016: Results of the 8th Annual Survey of Sustainable Business Leaders.*
[338] Based on data from CarbonClear (unpublished).

6.4 Water demand by industry

Is there a plan?	Green	The introduction of retail competition for non-domestic customers from April 2017 could increase the focus on water audits and leakage reduction as part of value-added services on offer to businesses. The 2014 Water Act commits the Government to provide an update to Parliament in 2019 on progress in reforming the system of abstraction licences, to improve the allocation and efficiency of water use including by businesses.
Are actions taking place?	Green	Some Food and drink manufacturing sites claim to have achieved 30% reductions in water use. WRAP's Rippleffect scheme is no longer active but a new 'Courtauld 2025' commitment is being developed. This includes an aim to encourage companies to commit to reducing water use in supply chains.
Is progress being made in managing vulnerability?	Green	**Direct abstraction of freshwater by industry has been declining, as has non-domestic use of public water supplies. However, water shortages and restrictions can still be expected from time to time and action to reduce water use by businesses should continue as part of national efforts to tackle the long-term risks of water scarcity.**

Is there a plan?

Many businesses that use large volumes of water are located in areas that are already water stressed. Climate change is projected to reduce the reliability of water resources whilst the growing population will create additional demand.[339]

Companies reliant on plentiful, and cheap, water need to plan for potential reductions in water availability but also the opportunities that could arise from more water trading. All businesses need to manage water more efficiently as part of a national effort to improve the resilience of long-term water supplies.[340]

The most significant policy development since 2015 is the introduction of water retail competition for non-domestic customers in England. Retail competition allows businesses to choose who supplies their water and wastewater services, an option that was previously only available for consumers using in excess of five million litres of water per year.[341] Retail competition began in April 2017, enabling an additional 1.2 million businesses to choose their supplier.

The focus on water efficiency is expected to increase as a result of retail competition. Businesses will be able to bring together separate contracts with suppliers across the country into a single bill. This will allow much easier benchmarking of water efficiency across different sites, including

[339] ASC (2016) *UK Climate Change Risk Assessment 2017: Synthesis Report.*
[340] ASC (2016) *UK Climate Change Risk Assessment 2017: Synthesis Report.*
[341] See: http://www.open-water.org.uk/about-open-water/how-it-works/

through smart metering and online reporting. Competing suppliers may offer pricing structures that incentivise reduced water consumption. Customers will also be able to access tailored services such as advice on water efficiency, leakage and waste reduction.[342]

As the market has only recently been opened in England, it is not yet possible to assess how effective it will be in reducing water demand. However, a water retail market has been operating in Scotland for almost a decade and has delivered some promising results (Box 6.7).

Box 6.7. The impact of water retail competition in Scotland

Businesses in Scotland have been able to choose their supplier for water and sewerage services since 2008. In the five years to 2013, while only 5% of businesses changed their supplier, around 50% of businesses renegotiated their terms. The retail company Scottish Water Business Stream claims to have helped customers save 16 billion litres of water over this period.

For retailers to differentiate themselves and win business they need to offer added value, which may be in the form of improved customer services, billing and reporting, or tailored advice such as on water efficiency and leakage reduction.

Publicised examples of project successes in Scotland include five schools that were able to reduce their water use by 44% (31 million litres per year), with their chosen retailer helping by benchmarking consumption in 50 schools against national standards, repairing leaks at five schools with excessively high usage, and installing smart meters. This led to a reduction in water and wastewater charges in excess of £56,000 a year. In another example a water supplier in Scotland helped a caravan park reduce their metered consumption by 20% through installing rainwater harvesting for services that can use untreated water, such as toilet flushing.

Source: Water Commission (2010) *Competition in the Scottish water industry*, blog post on www.financingsustainablewater.org (June 2015) *Lessons from the UK on water efficiency through retail competition for water services.*

Reforms to the system of water abstraction licencing are due in England by the early 2020s.[343] The existing system, in place since the 1960s, allows many companies to continue to take water from the environment even when water levels are low. Abstraction reform is important to help manage water resources sustainably and allocate it between users more efficiently.

Abstraction reform is intended to increase the efficiency of water allocation and use in order to protect the environment, particularly recognising the need to limit abstraction during times of water scarcity. Proposals for abstraction reform include a specific licencing regime in the most water-stressed catchments (called 'enhanced catchments'), and for licence holders to be able to trade water more easily.[344] Abstraction reform is therefore important to create the conditions for water-intensive businesses to take water efficiency measures more seriously, and to encourage users to more actively participate in drought response management.[345]

[342] See: http://www.open-water.org.uk/about-open-water/the-benefits/
[343] Defra (2016) *UK Government response to consultation on reforming the Water Abstraction Management System*.
[344] Water UK (2016) *Water resources long term planning framework (2015-2065)*.
[345] Defra (2016) *Water Abstraction management reform in England – What would reform mean for abstractors?*

Are actions taking place?

There are many initiatives underway across and within sectors, including commitments made by individual companies, to reduce water consumption.

- Aside from water companies and regulators, others active in promoting water efficiency include: the UK Water Partnership, a private-public model focussing on innovation established in 2015[346]; Waterwise[347]; sector-specific industry bodies such as the Food and Drink Federation[348]; and a range of NGOs. These organisations publish guidance and advice, but do not have the resources to offer direct support to individual businesses. The Waste and Resources Action Programme (WRAP) Rippleffect[349] website has an archive of guidance available, but is no longer active in providing direct support. There are also a few examples of multi-sectoral regional partnerships where stakeholders from industry, the water sector, and regulators, collaborate on water resource issues.[350]
- There are also examples of industry-wide initiatives. The Federation House Commitment for food and drink manufacturers ran from 2008 to 2014 and aimed to contribute towards the UK Food and Drink industry target of reducing water use by 20% by 2020.[351] The scheme was administered by WRAP in partnership with the Food and Drink Federation (FDF) and Dairy UK, with support from Defra and the Environment Agency. By 2014 its participants had together reduced their water consumption by 15% (excluding water embedded in final products). Although the original Federation House Commitment is no longer monitored, the Food and Drink Federation continues to encourage signatories to report their water consumption. Data submitted by 56 companies with 223 sites show water consumption in 2015 was 30.1% less than in 2007.[352]
- Some companies voluntarily set themselves water reduction targets, as evidenced within FTSE100 sustainability reports. In 2016, 39% of FTSE100 companies reported a water reduction target. This compares to 70% of companies with a carbon reduction target, indicating that for many, addressing water efficiency is a lower order priority.[353]

The fact that some businesses voluntarily set and report against water reduction targets is a positive step. However, examples of best practice by industry leaders, or those at greater risk from water scarcity, are not necessarily representative of businesses as a whole. Managing water consumption and planning for a future involving potentially scarce water resources does not appear to be a high priority when compared with more immediate business needs.

Is progress being made in reducing vulnerability?

Overall, industry use of water represents a relatively small proportion of total abstraction (9%) and has been on a downward trend. Business use of public water supplies has also been declining. This reduces the general likelihood that businesses will be disrupted during times of water scarcity, but this national picture masks the continuing risk of

[346] See: https://theukwaterpartnership.org/
[347] See: http://www.waterwise.org.uk/
[348] See: https://www.fdf.org.uk/home.aspx
[349] See: http://www.wrap.org.uk/content/rippleffect
[350] For example see: http://waterresourceseast.com/about-water-resources-east/
[351] See: http://www.wrap.org.uk/content/federation-house-commitment
[352] Food and Drink Federation (2016) *Environmental Ambition: Progress Report*.
[353] Carbon Clear (2016) *Sustainability reporting performance of the FTSE100.*

severe water shortages and restrictions being imposed within individual catchments from time to time.

In 2014, water abstraction by industry from freshwater sources was 848 million cubic meters. This is a 37% decrease from abstraction levels in 2000 (of 1,357 million cubic meters), an annual decrease of over 44 million cubic metres.[354] There could be a number of possible drivers for this including changes in the economic activity of water intensive industries, improved water efficiency, or changes to abstraction licence conditions.

In our 2015 report we recommended that *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* (Recommendation 35). In response to this, the Government highlighted a number of initiatives already in place which will allow industry to improve its water efficiency, such as the Enhanced Capital Allowance for water efficiency investments[355], the recently formed UK Water Partnership, and the expected savings in water from the introduction of retail competition.

Major changes in the water sector, such as the introduction of retail competition and abstraction reform, provide an opportunity to make further improvements to water efficiency amongst businesses and industry. This should be monitored closely, together with levels of production from manufacturing, mining and quarrying, and other water-intensive industries in the UK, as patterns of production change. Further intervention, beyond that already planned, may become necessary to ensure that water use by industry continues to contribute towards national water resource management efforts.

6.5 Business opportunities from climate change

Is there a plan?	Amber	The Government is no longer looking to promote the potential economic opportunities for the UK from climate change. The Industrial Strategy green paper makes no mention of climate change adaptation or those sectors that could see growing economic activity in the changing climate.
Are actions taking place?	Green	The Bonfield Review led to a number of initiatives to promote property-level flood resilience products and services, with the potential for positive consequences for this nascent UK industry. Innovate UK, Climate-KIC and the UK Water Partnership are encouraging investment in adaptation and resilience-related business opportunities. Climate UK's engagement with Local Enterprise Partnerships' growth strategies has been affected by funding cuts.

[354] ADAS (2017) for the ASC, *Research to provide updated indicators of climate change risk and adaptation action in England.*
[355] Defra (2016) *Water efficient enhanced capital allowances*.

Is progress being made in managing vulnerability?	Amber	**Adaptation goods and services are difficult to define and value but the available evidence suggests the changing climate is not yet driving significant investment in new markets and technologies that could contribute towards GDP growth.**

Is there a plan?

Climate change will affect the production costs and demand for certain goods and services. Businesses that anticipate these changing markets may be able to gain an advantage. Specific adaptation-related goods and services include water engineering, climate risk insurance, finance for adaptation projects, and precision farming technologies.[356] Businesses can be expected to respond to market signals and exploit these opportunities as they arise. There is a role for Government to make sure that companies are aware of the potential opportunities and have information that will help them to make sound investment decisions.

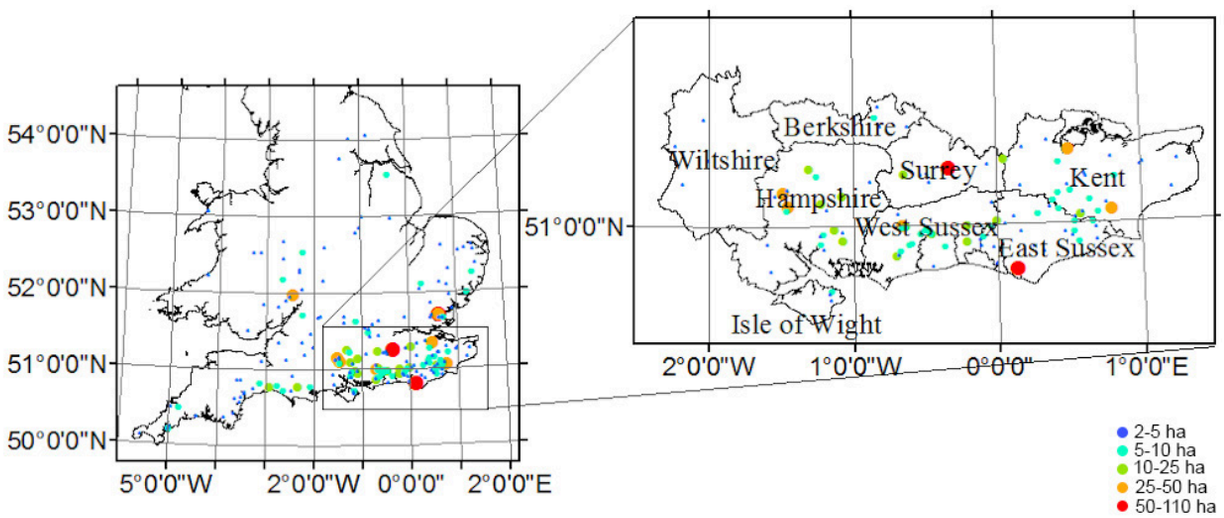
Business opportunities from climate change mitigation (low carbon) activities are not considered in this section, which instead focuses on how climate change globally could increase the demand for certain adaptation-related goods and services, and as a result create new market and export opportunities for UK companies.

In addition, climate change in the UK may have some beneficial effects for certain industries, such as agriculture, horticulture, forestry and tourism, due to more favourable conditions emerging relative to other parts of the world. Evidence of this to date is difficult to find but one example is the UK wine industry, which could benefit from warmer weather and longer growing seasons. The world's total vineyard surface area has been decreasing since 2000, mainly due to the reduction in area of European vineyards. Over this period the area of vineyards in England and Wales has doubled (albeit from a low base), from around 800 hectares in 2000 to almost 1,900 hectares in 2015.[357] This may be due to more suitable climatic conditions, but other factors will also be in play. Farmers and other land owners may be responding to wider market signals and looking to diversify.[358]

Figure 6.5 shows the size and geographic spread of vineyards in England and Wales. The concentration of major wine producers in the south east of England is a natural consequence of the climate and soil conditions, but is also where water and soils may become under particular stress. Climate change therefore poses risks as well as opportunities to wine growers.

[356] Surminski, S. et al. (2016) *UK Climate Change Risk Assessment 2017, Chapter 6: Business and industry.*
[357] UK vineyards statistics, reported in ADAS (2017) for the ASC, *Research to provide updated indicators of climate change risk and adaptation action in England.*
[358] For example, declining interest in golf has led one course in Surrey to convert nine of their 36 holes to vineyards, see: http://www.todaysgolfer.co.uk/news-and-events/general-news/2016/september/mannings-heath-to-be-uks-first-golf-club--wine-estate/

Figure 6.5. Location of wine-producing vineyards in England and Wales



Source: Nesbitt, A. et al. (2016) *Impact of recent climate change and weather variability on the viability of UK viticulture – combining weather and climate records with producers' perspectives.* Australian Journal of Grape and Wine Research, 22, 324–335.
Notes: The majority of commercial vineyards are situated in south east England with approximately 1,186 hectares under vine in Kent, East and West Sussex, Surrey, Hampshire, and the Isle of Wight. There were approximately 235 hectares in the South West (Cornwall, Devon, Dorset, Somerset Wiltshire and Gloucestershire).

The adaptation-related goods and services offered by businesses in England include science, engineering, insurance, and finance. These are areas where the UK has a competitive advantage and there could be justification for giving these markets greater emphasis.

The UK leaving the European Union may mean there is a need to develop new trading partners, so in this context there may be additional value and urgency in promoting adaptation-related goods and services as one potential area of export growth.

The Prudential Regulation Authority completed a review of the insurance sector and highlighted several climate change-related opportunities for insurance firms. These include new sources of premium growth, such as supporting resilience to climate change through risk awareness and risk transfer, investments in 'green bonds', and providing financial sector leadership on climate change.[359]

Defra's property-level flood resilience action plan includes a series of measures to promote flood protection products and services in areas at high flood risk. The recommendations include the development of independent standards with certification processes, such as the new BSi Kitemark scheme for measures meeting the PAS1188 standard.[360] The development of a trusted certification scheme is considered to be advantageous for growing this market as a business opportunity both in the UK and overseas.

[359] Prudential Regulation Authority (2015) *The Impact of climate change on the UK Insurance sector*.
[360] See: https://www.bsigroup.com/en-GB/our-services/product-certification/industry-sector-schemes/construction/flood-protection-and-waterproofing-materials/

In Scotland, Adaptation Scotland and Sniffer give the adaptation market a particular emphasis, and the Netherlands successfully markets and exports its expertise in flood and water management. There is no equivalent approach in England.

The National Adaptation Programme includes an objective to raise awareness and understanding amongst businesses about domestic and international adaptation opportunities (Objective 25). The relevant actions in this area are now complete or ongoing (see Section 6.6), with no further activity planned at the current time.

Are actions taking place?

There are examples of innovation and investment in adaptation-related goods and services, such as those funded and coordinated through Climate-KIC and Innovate UK (Box 6.8). The UK Water Partnership[361] is also active in promoting water sector innovation - aiming to develop, implement and commercialise new technologies and approaches.

Box 6.8. Initiatives underway to promote adaptation-related goods, services and expertise in England

Innovate UK is the UK's innovation agency, formerly known as the Technology Strategy Board. Since 2007 Innovate UK has run a number of competitions that have supported projects relevant to adaptation:

Solving business problems with environmental data: This competition provided 33 feasibility studies with a total of £4 million. Relevant projects that were funded include:

- Agriculture and food examples: Crop pest and disease warning system for food security in the developing world, crop forecasting, incorporation of satellite-based data into weather index-based insurance and adaptation, management and mitigation of sustainability and climate change issues within grocery supply chains.
- Energy generation and supply: Forecasting climate change impacts on electricity distribution loads at the network asset level, and improving African dust storm forecasts for oil and gas operations.
- Infrastructure: Near real-time assessments of flood impact for the insurance and civil contingencies sectors, and a groundwater modelling service for flood and drought decision support.

Design for Future Climate: The competition looked at climate change considerations in the design of construction and building refurbishment projects in the UK. It ran over two phases between 2010 and 2014 and granted £5 million to 45 projects. The 240 companies working on this programme were tasked with developing adaptation strategies for their building projects over the course of the 21st century.

Climate-KIC is a public-private partnership created in 2010 by the European Institute of Innovation and Technology. The UK branch of Climate-KIC is working with Innovate UK to establish a Resilience Innovation for Growth programme to support start-ups and other businesses that are developing innovative climate- and disaster-related products and services. The programme has four key themes:

- Delivering education and professional training through a network of associated higher education and professional development courses.
- Growing resilience innovation by working with businesses in the climate and disaster management fields and offering small grants to establish pathfinder projects, promote them and strengthen

[361] See: https://theukwaterpartnership.org/

Box 6.8. Initiatives underway to promote adaptation-related goods, services and expertise in England

investment networks.

- Strengthening the market for resilience goods, by completing market research and developing demand side innovation challenges based on real world issues and drawing in investment.
- Bringing together a resilience innovation community, creating learning and sharing environments and fostering a sense of business community through resilience trade shows.

Source: Innovate UK (date unknown) *Directory of Projects*. Innovate UK (2017) *Design for Future Climate*.

Is progress being made?

Defining and measuring the size of the market related to climate change adaptation is difficult. The best data currently available suggest UK companies are behind their overseas competitors in exploiting this new market opportunity.[362] However, there is at least some evidence that a growing proportion of large companies are becoming aware of the opportunities that could arise in the changing climate, which may be particularly important to specific UK regions where there is already expertise (Box 6.9).

Understanding the size of the adaptation market opportunity is challenging for several reasons. There are very few companies that solely focus on adaptation-related goods and services, with these normally part of a wider and more general offering. Attributing market- and company-level activity to climate change adaptation is therefore difficult.

Box 6.9. Regional expertise in climate change adaptation and environmental risk management

South West England and South East Wales was one of five regional science and innovation audits completed in 2016, in the first wave of audits completed by the Department for Business, Energy and Industrial Strategy. Expertise related to innovation in resilience, environment and sustainability was found to be strong in the region, with the presence of the Met Office, other world leading research institutions, and a significant business community. The audit estimated that the environmental goods and services sector in the region comprises 25,000 companies providing 153,000 jobs, and has grown 16 times faster than other sectors in the region. The audit identified two areas where the region has the potential to be globally competitive: environmental risk and data innovation, and sustainable technologies and development. Relevant sites in the region include the Global Environmental Futures campus at Exeter Science Park, catalysed in-part by the presence of the Met Office; the South West Satellite Applications Catapult Centre of Excellence, based at Goonhilly Earth Station in Cornwall; the Rural Innovation Centre and Berkeley Science and Technology Park in Gloucestershire; and the Porton Science Campus in Wiltshire. The market opportunity to utilise environmental data to tackle the risks from natural hazards and protect the resilience of socio-economic systems was highlighted in the audit as an urgent priority.

Source: BEIS (2016) *South West England and South East Wales Science and Innovation Audit*.

[362] ASC (2015) *Progress on preparing for climate change*. See p217.

In 2016, 43% of FTSE 100 companies reported that they had assessed future climate change opportunities for their business, up from 25% in 2015.[363] This will not be representative of the business sector as a whole, and the proportion of businesses that actively follow up to respond to climate opportunities will be a smaller number. However, the results do indicate that a greater number of companies are aware of the business opportunities that could arise.

6.6 Conclusions on NAP objectives and actions

Table 6.1 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:

- 19 (58%) are complete;
- 6 (18%) are on-track;
- 1 (3%) has been revised; and
- 3 (9%) have been dropped.

Updates were not received on the remaining 4 actions (12%).

17 (51%) of actions in the NAP for the business theme are time-bound, with the remaining 16 (49%) classed as 'ongoing'.

Table 6.1. 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, which focus on raising awareness and capacity through guidance, tools, training and professional standards. Three actions were completed before the 2015 update and two more have been completed since. Of the remaining four actions, two actions are on track, one has been revised, and we've not received an update on the final action. While it is positive that five actions have been completed and that guidance documents produced are in the main still available as a business resource, there is a risk that progress on this objective is losing momentum without ongoing support to promote the guidance and engage with businesses. Six of the nine actions were owned by EA Climate Ready and/or Climate UK, funding for which has been discontinued with no equivalent organisation to replace them. The degree to which other forms of business support (e.g. from the private sector) are fulfilling these functions is unclear.

[363] CarbonClear (unpublished).

Table 6.1. NAP objectives and a summary of progress for the business theme	
NAP objective	**Commentary on progress**
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.	There are eight actions for this objective, which are similar to those listed under Objective 23. Three actions were completed before the 2015 update, one more has been completed since and two actions have been dropped. One of the remaining actions is on-track, which is to increase the number of businesses using management standards to manage climate risks. We did not receive an update on the final action, which is for the Health and Safety Executive to review their guidance regarding work place temperatures following a consultation. Similarly to Objective 23, while actions have been completed and some progress made, there is a potential lack of ongoing activity. Three of the eight actions for this objective were owned by Climate Ready and/or Climate UK, which are no longer active, and the two dropped actions relating to water efficiency were owned by the WRAP Rippleffect service which has also closed. There are signs that the need to demonstrate climate resilience to company shareholders may be becoming increasingly important, although as yet there is little evidence that it is having a significant impact on business risk management decisions. For SMEs at risk of flooding there remain barriers to uptake of resilience and resistance measures, such as property level protection. Recommendations from the Bonfield Review are underway in an attempt to address these barriers.
Objective 25. To raise awareness and understanding amongst businesses about domestic and international adaptation opportunities.	There are ten actions for this objective, one of which was completed before the 2015 update and two more have been completed since. Three further actions are on-track, one has been dropped, while three actions have had no new updates provided. The actions for this objective relate to raising awareness of markets for adaptation goods and services and providing practical support in growing these markets and enabling business opportunities. Several agencies (e.g. Innovate UK, DfID, Climate-KIC UK) are supporting businesses offering adaptation goods and services, but the market is diffuse and not well understood or promoted, and does not have a strong business support community around it. As the UK is leaving the EU, nurturing export market opportunities for these types of services may become a greater priority.

Table 6.1. NAP objectives and a summary of progress for the business theme	
NAP objective	**Commentary on progress**
Objective 26. To help businesses better understand and manage climate risks to their supply chains.	There are four actions for this objective, three of which were completed prior to our 2015 report and the remaining one has been completed since. Three of the actions relate to EA guidance on supply chain resilience, which has been produced and is available online. There were a few examples where businesses collaborated with Climate Ready to investigate and manage climate risks in their supply chain before the support service was discontinued. The other actions relate to the UK Industrial Strategy. The last Government published an Industrial Strategy green paper, seeking to grow UK based supply chains but it did not make any explicit reference to climate resilience. Supply chain management from a climate risk perspective is on the whole not widely understood by businesses. In 2016, only 25% of FTSE 100 companies reported on supply chain adaptation or climate risk in their annual sustainability reports. The introduction of Non-Financial Reporting Regulations and initiatives, such as the Task Force on Climate-related Financial Disclosures, may begin to shift businesses to report more actively on climate change risks, including those related to 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.	There are two actions for this objective, which focus on better understanding of the risks to finance and the insurance sector and the links between adaptation and growth. Both actions were reported as being complete prior to our 2015 progress report. Since our 2015 Progress Report, the Prudential Regulation Authority published its review into the robustness of the UK insurance market to climate risks, and the Government has acknowledged that ongoing research in this area is necessary prior to the next NAP update.

Chapter 7: Local government

Key messages

Context

Local authorities are key partners in delivering many aspects of the National Adaptation Programme (NAP) discussed in the previous chapters, such as to manage flood risks and to respond to severe weather emergencies. To avoid duplication, in this chapter we review the progress being made by local authorities in assessing and strategically planning for climate change risks and opportunities, and in delivering key climate-sensitive functions that are important for adaptation such as spatial planning and public health.

Summary of progress

Local authorities have a critical role to facilitate and deliver adaptation action to address the specific needs, risks and opportunities faced by individual communities. Although the technical understanding of climate change amongst local authority officers has continued to improve, the resources and importance attached to local adaptation - including by central Government - have diminished since our last progress report in 2015. The evidence of progress being made by local authorities is limited and momentum in the sector is at risk of stalling.

Officers have shifted from talking about climate change and adaptation to "community resilience" and "service continuity". This has the potential benefit of embedding climate change risks within corporate plans and risk registers. However, the pressures on local budgets, and lack of statutory requirements other than in relation to flood risk management, mean that the focus of resilience projects tends to be on addressing immediate issues, such as individual vulnerabilities highlighted by recent severe weather events. Evidence of strategic planning for longer-term risks from climate change is limited.

For most local authorities there continues to be a focus on assessing and planning for flood risk, and responding to weather-related emergencies, with little attention paid to other aspects of adaptation.

The current and future outlook for local government funding remains extremely challenging. In addition, the central government funding that was in place to engage and support local authorities on climate change adaptation has come to an end. This has resulted in the closure of the Environment Agency's Climate Ready Support Service, the Local Government Association's 'Climate Local' initiative, Climate UK, and more than half of Climate UK's regional climate change partnerships in England. The Local Adaptation Advisory Panel remains in place but the limited resources now active in the sector mean it is has restricted its activity toward informing the next NAP.

Recommendations for further progress

The completion of specific NAP-related activity, combined with a general lack of resources, has had a notable impact on momentum over the past two years. The lack of a requirement for authorities to monitor and report on the steps they are taking to adapt to climate change means there is little evidence at the national level to assess the level of progress being made.

RECOMMENDATION 25: *The Government should set out in the next NAP how it will ensure local authorities have access to the technical expertise, guidance, and practical tools they need following the closure of the Environment Agency's Climate Ready Support Service, Climate UK, and Climate Local. There is potential for professional bodies such as the Royal Town Planning Institute and the Chartered Institution of Water and Environmental Management to take a greater role in providing information, training and advice. (Owner: Defra/DCLG. Timing: next NAP report in 2018).*

RECOMMENDATION 26: *To stimulate activity and improve monitoring and evaluation, local authorities should be included within the scope of the third round of reporting under the Adaptation Reporting Power. Defra should identify the most efficient and effective means for local authorities to report on the action they are taking and the progress being made to prepare communities for climate change. (Owner: Defra. Timing: 2018).*

Key messages

The devolution of powers to core city regions and elected mayors, and the associated changes in the way services can be funded and prioritised locally, provides an opportunity to tackle vulnerabilities. The emphasis on partnership working within the core cities and Local Enterprise Partnerships is well aligned with, and at an appropriate scale for, addressing climate change risks. Collaboration between Local Enterprise Partnerships and Local Nature Partnerships should be encouraged so that investments in natural capital and climate change adaptation are integral to regional economic growth plans.

RECOMMENDATION 27: *The next NAP should develop stronger sub-national approaches to climate change adaptation that promote business and infrastructure resilience, healthy communities, and investment in natural capital. For example, there is the opportunity to build on current arrangements and work with London and the core city regions, the metro mayors, and the Local Enterprise and Local Nature Partnerships. (Owner: Defra. Timing: 2018).*

Local authority land-use planning and building control functions are crucial in shaping local adaptation to climate change as well as in promoting policies that reduce greenhouse gas emissions. There is evidence that climate change has in effect been de-prioritised in the land-use planning system.

RECOMMENDATION 28: *The Government should review the effectiveness of the land-use planning system in achieving reductions in greenhouse gas emissions from buildings and transport, and enhancing the resilience of communities and the built environment to the impacts of climate change. The review should consider both strategic and local land-use allocation, and building and infrastructure design. (Owner: DCLG, Timing: By 2020).*

Many of the recommendations in previous chapters are also relevant to local authorities, including:

- **Recommendation 12:** More and better co-ordinated action is needed to manage the lack of capacity within drainage systems to cope with increases in heavy rainfall.
- **Recommendation 13:** Policy is needed urgently to address the outstanding barriers to deliver high quality, effective sustainable urban drainage systems (SuDS) in new development.
- **Recommendation 14:** Defra should develop a long-term strategy to manage flood risk down to tolerable levels in each part of the country.
- **Recommendation 15:** The Environment Agency, with coastal groups and relevant authorities, should review the progress being made in implementing Shoreline Management Plans and preparing communities for the coastal adaptation that will need to take place by the 2050s.
- **Recommendation 16**: A standard or regulation should be put in place to reduce the risk of overheating in new homes.
- **Recommendation 17:** Action should be taken to assess and reduce the risks of overheating in existing buildings, such as hospitals, schools, care homes and prisons.
- **Recommendation 18:** The Cabinet Office should, in consultation with Local Resilience Forums (LRFs), (a) commission an independent review of the planning scenarios underpinning local Risk Registers and use the results to help LRFs assess the resources needed to manage these events, and (b) strengthen the Emergency Planning Guidance to clarify and test responsibilities for co-ordination amongst Category 1 and Category 2 responders, as well as between neighbouring LRFs.
- **Recommendation 21:** The Cabinet Office should review information sharing arrangements between Local Resilience Forums and relevant infrastructure operators.
- **Recommendation 24:** The Government should examine the use of public procurement rules to promote the management and disclosure of climate change risks and adaptation measures.

7.1 Local government action on climate change adaptation

Local councils have a critical role to play in climate change adaptation. Local authorities are well placed to understand the short and longer term risks faced by their communities, and to lead and facilitate action to address them. This includes preparing for the opportunities which could arise from a changing climate.

The important role that local authorities play in managing climate change risks has already been discussed in the previous chapters of this report. Local authorities hold important policy levers, such as local spatial planning and the enforcement of building regulations, and are responsible for the delivery of a range of relevant services such as local flood risk management, public health and social care, and emergency planning. This chapter therefore considers whether local authorities are using local policies and plans, and the delivery of important functions and services, to manage the risks and realise the opportunities from the changing climate for the benefit of local communities.

Although the role of local authorities continues to be crucial to addressing local vulnerabilities, their capacity to respond is limited by budgetary pressures and the relative importance of other, often more immediate, local priorities.[364]

Since 2010, councils have had to manage a 37 per cent real terms reduction to their core government grant and meet any funding gaps through council tax income, savings and efficiencies.[365] Alongside this there have been escalating resource demands in other key services, in particular social care, meaning that councils are diverting funds from discretionary budgets such as climate change adaptation.[366] This has resulted in reduced resources not only in dedicated climate change roles, but also within core functions discussed later in this chapter as being 'climate sensitive'.[367] In addition, the decision to leave the European Union will impact local authorities' access to EU funding sources and networks, such as the European Structural and Investment Funds (ESIF). The last government committed to maintain funding to ESIF projects signed before the UK leaves the EU. It is not yet clear what domestic measures, if any, will replace ESIF in the longer-term.

Key elements of the current National Adaptation Programme in the local government sector have come to an end since our last progress report in 2015.

The Environment Agency's Climate Ready Support Service ('Climate Ready') was set up in October 2011 initially for a period of three years with a budget of £2 million per year.[368] Climate Ready supported adaptation activity across the NAP's themes, including initiatives focused on enabling and supporting local authority adaptation activity. The Environment Agency also helped fund the regional Climate Change Partnerships (CCPs), coordinated by Climate UK, and the Climate Local programme run by the Local Government Association (LGA). Following an internal review in late 2015, ministers decided that Climate Ready was no longer a priority for funding and the programme closed in March 2016.

[364] JRF (2015) *The Cost of the Cuts: The Impact on Local Government and Poorer Communities*.
[365] National Audit Office (2014) *The Impact of Funding Reductions on Local Authorities*.
[366] Local Government Association (2016) *Adult social care funding: 2016 state of the nation report.*
[367] Based on a series of discussions with local government representatives.
[368] The Climate Ready programme began midway in 2011/12 with a budget of £1 million for the first six months. The budget was reduced to £1.6 million per year from 2013/14. In 2015/16 the budget was reduced further to around £1.3 million following an in-year savings exercise.

Climate Local and six of Climate UK's nine regional climate change partnerships in England closed in 2016. Three partnerships continue at a much reduced scale, utilising funding from other sources. Climate UK itself is in the process of being wound down and is expected to cease trading this summer. Alongside the direct impact of these closures, the change in funding has been perceived within the sector as a signal from central government that local adaptation is considered to be a low priority.

RECOMMENDATION 25: *The Government should set out in the next NAP how it will ensure local authorities have access to the technical expertise, guidance, and practical tools they need following the closure of the Environment Agency's Climate Ready Support Service, Climate UK, and Climate Local. There is potential for professional bodies such as the Royal Town Planning Institute and the Chartered Institution of Water and Environmental Management to take a greater role in providing information, training and advice. (Owner: Defra/DCLG. Timing: next NAP report in 2018).*

Alongside this reduction in funding and support for adaptation, there continues to be no obligation for local authorities to monitor and report their progress in managing climate change risks and opportunities.

The limited requirement to report on adaptation activity under the Local Government National Performance Framework (specifically national indicator NI188) was withdrawn in 2010 and has not been replaced. The level of activity in voluntary action plans, progress reports and updates coordinated through Climate Ready and the Climate Local initiative has also dwindled over the past two years. The lack of data collection and reporting of local authority action makes it difficult to assess to what extent progress is being made. A lack of evidence will also hamper the ability to design and justify new initiatives.

In our 2015 progress report to Parliament, we recommended that *Defra and DCLG should introduce a cost effective and proportionate way of assessing the progress being made by local authorities, potentially by including local authorities in the next round of the Adaptation Reporting Power* (Recommendation 36). The Government's response implied that options involving local authorities could be part of the public consultation exercise that will inform the approach to the third round of ARP reporting. The ASC's review of ARP Round 2 repeated the call for local authorities to be considered for inclusion in ARP3.[369]

RECOMMENDATION 26: *To stimulate activity and improve monitoring and evaluation, local authorities should be included within the scope of the third round of reporting under the Adaptation Reporting Power. Defra should identify the most efficient and effective means for local authorities to report on the action they are taking and the progress being made to prepare communities for climate change. (Owner: Defra. Timing: 2018).*

The remainder of this chapter is structured as follows:

- Section 7.2 reviews the general progress being made by local authorities to assess and strategically plan for climate change risks.
- Section 7.3 discusses the progress being made by local authorities in delivering climate-sensitive functions such as spatial planning and local flood risk management.
- Section 7.4 considers progress in relation to the four objectives set within the NAP for the local government sector.

[369] ASC (2017) *Adaptation Reporting Power: second round review,* https://www.theccc.org.uk/publication/adaptation-reporting-power-second-round-review/

7.2 Progress in assessing and strategically planning for climate change

There are a number of good examples where local authorities are proactively assessing, strategically planning for, and taking action to address, climate change risks. However, this is not consistent across all local authorities and, in particular, monitoring and reporting activities appear to have lost focus and have diminished overall.

Although some authorities continue to make progress, and individual actions established within local authority action plans are being implemented, the overall momentum for assessing and planning for climate change risks has diminished. A survey of local authority progress in 2016 identified that most participating councils were planning and implementing climate change adaptation and resilience measures, either through a dedicated climate change strategy or identified within other council plans and strategies.[370] However authorities were not typically revisiting and updating risk assessments nor were they monitoring and reporting on their progress.

There is evidence that technical capability and understanding of climate change has improved over recent years, including within the climate-sensitive functions of local authorities. At the same time, the impact of budget constraints and other pressures mean local authorities have a reduced capacity to take action on climate change risks.

Technical understanding of climate change within authorities appears to be improving. Officers involved in adaptation say there is a greater awareness of climate change risks across most key services and functions. For some authorities, for example Gloucestershire County Council, adaptation is an integral part of the risk management framework to be considered by all heads of services within their business continuity plans.[371]

While there may be a greater proportion of planners, engineers and other officers who understand climate change risks and impacts, there is within councils an overall reduction in capacity and ability to respond. This means that achieving progress in adaptation can be dependent on informed and committed individuals and these people being in a role where they are able to influence funding and priorities. A Local Government Association survey of local authority progress highlighted that, for some councils, "climate change adaptation is a peripheral interest" due to the prioritisation of other core services.[372] The LGA report also notes that the low response rate to the survey (20% of the 353 councils in England responded) means that the results may not be representative and that the response rate in itself could be an indicator of the importance and resources allocated to climate change adaptation. A survey of climate change adaptation resources and priorities commissioned by the Local Adaptation Advisory Panel in March 2017 received responses from only 32 local authorities in England.[373]

[370] LGA (2016) *Climate Local adaptation survey*.
[371] Based on discussions with council officers.
[372] LGA (2016) *Climate Local adaptation survey*.
[373] Online survey sent to local authority members of the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), and the Association for Public Service Excellence (APSE).

Since the previous report there has been a change in the language used around climate change adaptation. The most significant is a general shift in focus from 'adaptation' as a primarily environmental issue towards discussing 'resilience' from a broader, economic and social perspective.

In some cases this has been a conscious decision, to reposition the agenda and find 'hooks' for engagement which can be more easily aligned with the priorities of councils and other local partners.[374] This has had a positive impact on the ability to embed climate change risks into local authority corporate plans and risk registers, and to secure funding for projects.

A related change has been an increased focus on 'service continuity' as a driver for progress in addressing climate change risks. Climate-related disruption to services and the financial consequences of this are problematic especially where resources and budgets are already under pressure. A Severe Weather Impacts Monitoring System (SWIMS) tool developed by Kent County Council enables local authorities to monitor the financial impacts of severe weather events in order to help support the financial case for improved resilience.[375]

The extent to which longer-term implications of climate change risks are being considered is less certain. In addition, there is a risk that accountability for adaptation or resilience sits with no single council department or individual; with examples of initiatives being driven by environmental, land-use planning or, as is increasingly the case, within emergency planning functions.

The devolution of powers and budgets to core city regions has changed the way that services can be funded and how needs can be prioritised by the local government sector. Provided that this is combined with a strong focus on partnership working, devolution presents an opportunity for tackling regional climate change vulnerabilities.

Under the 2011 Localism Act, the 'Core Cities amendment' allowed for decentralisation of decision-making and budgetary control for core cities, bringing enhanced powers and establishing combined authorities in some cases. There are now eight cities within England (and 10 across the UK) which have been designated as 'Core Cities': Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle, Nottingham, and Sheffield.

Devolution means that prioritisation can be more readily influenced by the specific vulnerabilities of the region.[376] The election of 'metro mayors' for six combined authorities in May 2017 offers further opportunities for local leadership on climate change risk management as part of policies that promote regional growth and investment in housing and transport, and in some cases also public health and social care.[377]

The advantage of working with London and the core cities is that together they account for approximately a quarter of England's population and have established partnership arrangements in place at an appropriate scale for managing climate change risks and opportunities. London and the core cities, due to their staff numbers and connections, have the

[374] For example, the LGIU initiated dialogue with officers around 'resilience' and 'business continuity' to reposition adaptation and facilitate continued progress.
[375] Currently hosted by Climate UK at http://climateuk.net/resource/severe-weather-impacts-monitoring-system-swims
[376] See: www.gov.uk/government/news/bringing-our-country-together-cities-towns-and-counties-to-get-stronger-powers
[377] The six metro mayors elected in May 2017 are for: Cambridgeshire and Peterborough; Greater Manchester; Liverpool City Region; Tees Valley; West Midlands; and the West of England. The Sheffield City Region is due to elect a metro mayor in May 2018.

capacity and breadth to consider strategic issues in a way which smaller public authorities are less able to. In addition, the core cities' approach to 'sustainable development' is long established and provides a strong context for officers to address the adaptation and resilience agenda. The London Climate Change Partnership continues to be active, together with the Core Cities Climate Resilience and Adaptation Working Group. The core cities working group meets quarterly to provide a platform for sharing and support between cities on a range of climate adaptation areas, both within and beyond those set out within the Core Cities Commitment in the current NAP.

RECOMMENDATION 27: *The next NAP should develop stronger sub-national approaches to climate change adaptation that promote business and infrastructure resilience, healthy communities, and investment in natural capital. For example, there is the opportunity to build on current arrangements and work with London and the core city regions, the metro mayors, and the Local Enterprise and Local Nature Partnerships. (Owner: Defra. Timing: 2018).*

7.3 Progress in relation to 'climate sensitive' functions

7.3.1 Land use planning and building control

Local authority land-use planning and building control functions are crucial in shaping how local communities adapt to climate change as they develop and grow. The importance stems from the long life span of buildings and developments, and the infrastructure that serves them.

Planning decisions have a direct influence on action to address climate change risk and to improve the resilience of communities. Decision-making which is misinformed, or with inadequate consideration of longer term implications, can exacerbate the potential risks for communities now and in the future. By demonstrating leadership in the development of planning policy, local authorities can:

- **Minimise flood and coastal erosion risk.** In line with the National Planning Policy Framework (NPPF), local authorities should avoid inappropriate development in areas at risk of flooding and coastal change. Where such development is unavoidable, it should be delivered in a way which does not increase the risk of flooding elsewhere. The NPPF also requires local authorities to prioritise the use of sustainable drainage systems (SuDS) in developments.
- **Retain and enhance green infrastructure.** The NPPF advises local authorities to take a strategic approach to planning for the creation and protection of green spaces. This can include measures such as green roofs, targeted urban tree planting, and constructed wetlands. Such measures can help to keep urban areas cool in summer and manage storm water in periods of heavy rainfall.
- **Address overheating risk.** Local planning policies can reinforce the need for new developments to be planned and designed to manage internal temperatures. Factors such as solar gain and how this could be influenced by orientation, shading, window size and design, as well as ventilation and internal insulation, are all important for thermal performance.
- **Deliver resilient infrastructure.** Local Planning Authorities (LPAs) need to make sure that new infrastructure is designed and appropriately located to take current and future climate change risks into account.

Addressing climate change is a key component of delivering sustainable development and is a strategic priority in the NPPF.[378] Making progress in assessing and planning strategically for these risks often requires collaborative approaches that cross authority boundaries. The duty placed on LPAs to cooperate with their neighbouring authorities provides an opportunity for achieving coordinated progress in addressing climate risks at an appropriate spatial scale.

A recently published study by the Town & Country Planning Association (TCPA) concluded that local authorities are not using planning policy, as they are required to by law, to make progress on adaptation. Failure to use the full potential of the planning system will lead to avoidable impacts on local communities and the economy in the longer term.

TCPA's assessment of 64 Local Plans published since the NPPF was introduced in 2012 highlighted a "large-scale failure" to implement the requirements of national planning policy, and specifically the policy requirements underpinned by the 2008 Climate Change Act.[379]

The report found a wide variety of practice but concluded that climate change has been de-prioritised as a policy objective in the spatial planning system. In contrast, the TCPA report highlights the "overwhelming' priority" being given to the allocation of housing land within the planning system. The report also highlights the reduced capacity within the local authority planning service[380], which hinders effective local policy-making, as well as a reduced capacity within the Environment Agency to support the development of local plans.

Consideration of climate change within planning policy is centred on current flood risks.

The Local Plans which do contain policy relating to climate change adaptation focus largely on current flood risks. Although heat stress was identified as a risk factor by almost half of the LPAs responding to the TCPA's online survey, the assessment of Local Plans found only 15% to include policy wording on overheating or heat stress. Specific policies in favour of sustainable drainage systems was found in 56% of the local plans assessed but most policies were qualified with a 'where possible' caveat. The TCPA study found that the climate resilience of locations was often not prioritised above other factors such as landscape and local infrastructure when considering land use options.[381]

Although some authorities, particularly those in urban areas, are proactively planning to increase the use of green infrastructure, approaches and their impact are variable.

There appears to be confusion among planners about what constitutes green infrastructure and how this differs to green space more broadly.[382] It is important to consider not only the provision of individual green spaces, but how the network of trees, parks, green spaces, canals and rivers work together to deliver benefits to the community including in terms of climate resilience.

RECOMMENDATION 28: *The Government should review the effectiveness of the land-use planning system in achieving reductions in greenhouse gas emissions from buildings and transport, and enhancing the resilience of communities and the built environment to the impacts of climate change. The review should consider both strategic and local land-use allocation, and building and infrastructure design. (Owner: DCLG, Timing: By 2020).*

[378] DCLG (2014) *Climate Change Planning Practice Guidance.*
[379] TCPA (2016) *Planning for the Climate Challenge? Understanding the Performance of English Local Plans.*
[380] On average there has been between a 35% and 45% reduction in capacity within planning departments.
[381] TCPA (2016) *Planning for the Climate Challenge? Understanding the Performance of English Local Plans.*
[382] Matthews, T, Lo, A.Y. and Byrne, J.A. (2015) *Reconceptualising Green Infrastructure for climate change adaptation: barriers to adoption and drivers for uptake by spatial planners*. Landscape and Urban Planning Vol 138, p155 -63.

7.3.2 Flood risk management

The obligations on county and unitary authorities as Lead Local Flood Authorities (LLFAs), along with the impacts of recent flood events, has kept flood risk management high on local agendas. Despite this, progress in delivering on the requirements of the 2010 Flood and Water Management Act has been slow. Actions to tackle problems appear to be largely reactive. Vulnerability to damage from localised flooding remains significant and is likely to be growing.

The Flood and Water Management Act requires unitary and county councils to take the leadership role on local flood risks and prepare a local flood risk management strategy. Further statutory obligations to prepare a register of key flood management assets, and investigate flood incidents, were also set. These obligations, along with the direct community and economic impacts of recent storms, mean local authorities place greater emphasis on assessing and planning for flood risk over other aspects of adaptation. These two factors have also assisted in justifying resources.[383]

As of March 2016 only 114 out of the 152 LLFAs in England had completed and published their strategy.[384] The Act requires strategies to include a cost-benefit assessment of the actions needed to meet the plans' objectives. Only five out of the 90 strategies independently evaluated for Defra in 2015 met this requirement, with a further 30 strategies including a partial assessment.[385] Most strategies did not specify how and when such actions would be implemented, again a legal requirement in the Act. Almost half of LLFAs had not developed a register of relevant flood risk management assets, and some of the registers that had been developed did not include assets owned by third parties. Knowledge of third-party assets, which could include local sustainable drainage features and water company drainage assets, is particularly important for managing surface water flooding.

The impact of development on local drainage infrastructure is of particular, ongoing concern. A recent survey of relevant professionals found little confidence that efficient, high quality sustainable drainage systems are being included as part of new developments.[386]

The Pitt Review in 2008[387] identified two fundamental barriers to the widespread uptake of SuDS in new development. These were the automatic right developers have to connect developments to the existing drainage network, and difficulties agreeing who should be responsible for maintaining SuDS once constructed. As discussed in Chapter 4: *People and the built environment*, these barriers remain unaddressed. Where SuDS are included in new development the evidence suggests they tend to consist of 'grey' underground retention systems that do not deliver the full range of environmental co-benefits that are important for climate change adaptation.

[383] CAG Consultants (2017) *Evaluation of the arrangements for managing local flood risk.*
[384] Environment Agency (2016) *Managing flood and coastal erosion risks in England, 1 April 2015 to 31 March 2016.*
[385] CAG Consultants (2017) *Evaluation of the arrangements for managing local flood risk.*
[386] CIWEM (2017) *A Place for SuDS?*
[387] Pitt, M. (2008) *The Pitt review: learning lessons from the 2007 floods*.

There are a number of examples of flood management measures which have successfully alleviated the impact of severe weather. Other examples of partnership and collaborative working on a regional level also provide useful models which could be replicated elsewhere.

Although the pace of delivering the requirements of the Flood and Water Management Act may be slower than anticipated, there are some good examples of action that will help address climate-related vulnerability. After the widespread flooding in 2007, Gloucestershire County Council embarked on a programme of flood alleviation and management initiatives in partnership with a utilities provider and other agencies. There have been three severe weather events since 2012, considered by council officers to be of a similar scale to those in 2007, but with far less impact and the measures taken deemed effective. According to the officers, recent storms in Gloucestershire have affected tens of properties rather than hundreds or even thousands, as was the case in 2007.

After the severe winter flooding on the Somerset levels and moors in 2013/14, a partnership between relevant organisations was created to improve the assessment and management of local flood risk. The establishment of the Somerset Rivers Authority (SRA) as a statutory body could also provide a useful model for other areas (Box 7.1).

Box 7.1. A model partnership on local flood risk management? The Somerset Rivers Authority

The Somerset Rivers Authority (SRA) was launched in 2015 as a response to the floods which occurred in the winters of 2013 and 2014, and the significant impacts of these events on local communities. Establishing the SRA was a key action of the Somerset Levels and Moors Flood Action Plan, developed at the Government's request to provide greater control of and responsibility for work to maintain and improve water management in the area.

The SRA's purpose is to deliver higher standards of flood protection than can be funded from existing budgets and to create better protection and resilience against further flooding through the joint planning and delivery of projects. This is in addition to the partners' existing flood risk management responsibilities.

Established with interim funding of £2.7 million in the 2015/16 financial year (£1.9 million from Defra, £600,000 from Somerset County Council, and £200,000 in total from the county's five district councils and the Somerset Drainage Boards Consortium), the SRA has a commitment from the Government to be established as a statutory body with the power to raise income. In the interim, in 2016/17, DCLG gave Somerset County Council and the five district councils the power to raise a shadow precept on council tax of up to 1.25%, for the purpose of funding the SRA's business plan. This provided almost £3 million towards its £12 million budget last year and gives confidence that funds will continue to be available in future years.

Source: Somerset Rivers Authority.

7.3.3 Highways and local transport

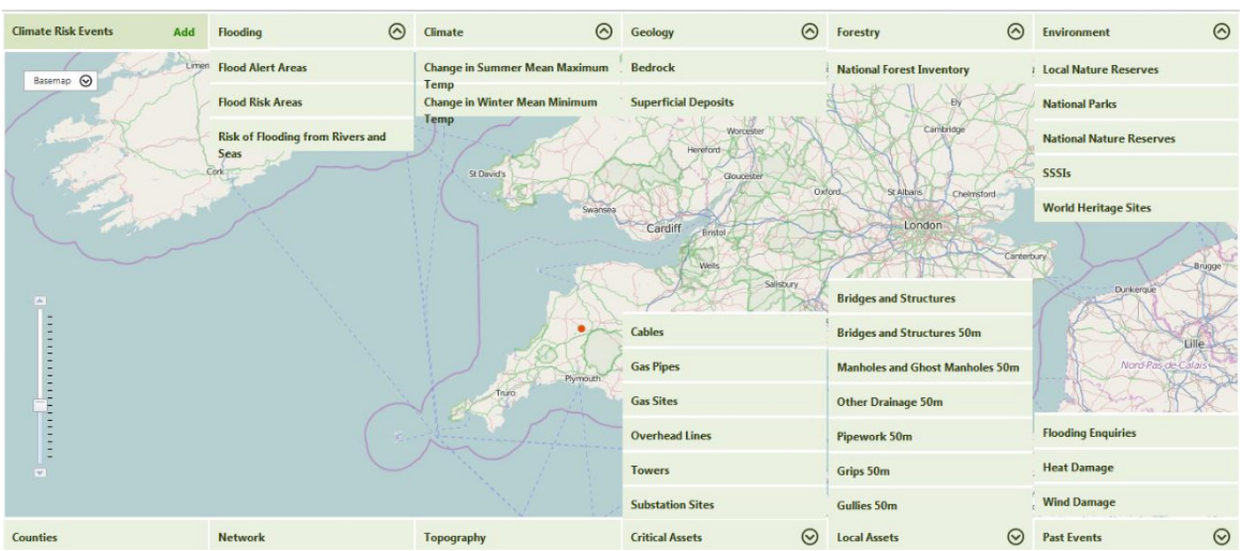
Recent severe weather events have highlighted the consequences for local communities of disruption to roads and other transport infrastructure. An increase in strategic planning and investment in resilience by local authorities has begun in some regions (Box 7.2).

Flooding is the most significant climate change risk to transport infrastructure in England, along with the impact of storm surges and erosion in coastal regions. The issue of vulnerability is not

limited to the roads themselves.[388] Failure of key infrastructure components such as bridges, or landslides that block important transport corridors, can significantly increase travel times or can isolate local communities completely. For example, there was a significant impact for residents of Tadcaster, North Yorkshire, following storm Desmond in December 2015. This resulted in the loss of the only direct vehicular route over the river between the two parts of the town. Repairs took around 400 days, with the only access during this time being a temporary footbridge or a lengthy detour.[389]

Box 7.2. HIRAM, the Highways Infrastructure Resilience Assessment Modelling tool

Developed by the Southwest Highways Alliance (SWHA), HIRAM is a web-based application that enables authorities to assess resilience risks within the road network. It provides a network view of resilience risk and costs on an asset or weather event basis and as such supports an asset management approach to managing highways. It brings together individual authorities' knowledge and enables a collective understanding of the costs likely to be associated with dealing with events affecting the highways network and the estimated benefits of building in resilience.



Authorities plot resilience risk locations on a plan, and then enter details on the potential impacts. HIRAM analyses these data so authorities can see which events are more likely to happen and what disruption would be caused. HIRAM provides financial outputs which can be used directly in business cases as well as other details to support effective decision making.

The South-West Highways Alliance invested £35,000 to establish the tool, with start-up funding of £25,000 from the Environment Agency's Climate Ready Support Service. The result is an improved picture of resilience across the whole of the South West to help understand the resilience risks and costs on a regional level, at minimal annual cost to the authorities (~£3,000). HIRAM continues to expand its coverage with the eleven authorities of the Eastern Highways Alliance recently joining.

Source: South West Highways Alliance.

[388] ASC (2016) *UK Climate Change Risk Assessment 2017: Synthesis Report,* https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/

[389] See: www.bbc.co.uk/news/uk-england-york-north-yorkshire-38852930

In Cumbria, storm Desmond caused three river systems to flood simultaneously. Dozens of bridges, many of which had stood for more than a hundred years, were damaged, swept away or undermined. Some bridges carry not only road and rail traffic but other vital services such a gas and water pipes, electricity cables, and digital networks. The loss of a bridge can lead to significant knock-on consequences. It is important for local authorities, in conjunction with utilities providers, to gain a better understanding of the consequences of common infrastructure such as bridges being lost, particularly for remote and vulnerable populations.[390]

7.3.4 Public health and social care

Under the 2012 Health and Social Care Act each county and unitary authority in England has a duty to take steps to improve the health and wellbeing of people in its area.

Local authorities are responsible for commissioning services and initiatives which manage health protection incidents, disease outbreaks and emergencies, and reduce the public health impacts of environmental risks.

There are examples of climate change risks to health being acknowledged within Joint Strategic Needs Assessments (JSNAs) produced by local authorities. There are fewer examples of these risks being reflected in the associated Joint Health and Wellbeing Strategies (JHWSs).[391] Although there is no statutory requirement to consider climate change within these documents, authorities are encouraged to do so and the Environment Agency's Under the Weather toolkit[392] and Public Health England's Public Health Outcomes Framework (PHOF) support this. Funding and resource reductions have led local authorities to focus on a narrower group of public health priorities, such as their statutory obligations on adult social care. Where relevant action is being taken, this is being driven by immediate objectives relating to flood risk management, fuel poverty and promoting active travel.

Over the past two years there has been some work to assess overheating risks, particularly relating to vulnerable populations such as within care homes and other social care facilities.

For example, the London Borough of Islington has a dedicated Seasonal Health and Affordable Warmth (SHAW) team, which sits within its environment department. As well as tackling fuel poverty, the SHAW team has also examined the effects of summer heat on health and wellbeing. A study of high-rise social housing in Islington surveyed 450 vulnerable households and provided support to help residents be better prepared for hot weather.[393]

A study for the Joseph Rowntree Foundation reviewed the extent to which existing care homes and other care provision facilities are prepared for a hotter climate.[394] The study found that summertime overheating is already a risk in care facilities but there is limited awareness and appropriate adaptation strategies to address the risks. Approaches could include both the design of facilities, and their day-to-day operation, particularly the control of heating systems. Building designs rarely consider overheating, or it is given a low priority within the design brief. Measures included in designs are sometimes later removed as part of 'value engineering' attempts to cut costs. Although there is an increased focus on understanding heat-related risk,

[390] Dawson, R.J et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 4, Infrastructure*.
[391] JRF (2016) *Public health in a changing climate.*
[392] Department of Health, SDU, PHE, EA (2014) *Under the Weather: Improving Health, Wellbeing and Resilience in a Changing Climate.*
[393] See: https://iris.ucl.ac.uk/iris/browse/researchActivity/6573
[394] JRF (2016) *Care provision fit for a future climate.*

progress in addressing it remains limited. There continues to be a perception that older people benefit from warmer conditions, with a more limited understanding of the potential health risks of excessive heat.

7.3.5 Emergency planning and response

Local authorities have a duty to cooperate with other key responders to plan and manage emergencies, including those from extreme weather events. Whist local authorities have improved their understanding of weather-related risks, they have concerns about capacity and resources to respond to such events.

The 2004 Civil Contingencies Act requires local authorities, police, fire services, the NHS, the Environment Agency and other key responders in England and Wales to assess risks, plan for emergencies, and warn the public. These responders are organised in Local Resilience Forums (LRFs), established according to police force boundaries.

Under the Act, local authorities have a specific responsibility to provide advice and assistance to business and voluntary organisations. All local authorities are also expected to have an emergency plan in place, including for severe weather, and to implement these as required. However, local authority responders interviewed by the ASC expressed concerns about decreasing resources to plan and respond to emergencies.[395]

Recent events have shown that the effectiveness of community flood planning needs to be improved (see Chapter 4: *People and the built environment*). A review of storm Desmond found that the people affected felt unprepared for the event, suggesting they assumed that the physical flood defences in place would never fail to protect them. In many cases no formal or informal community-level flood emergency plans were in place, and people were either not registered for Environment Agency flood warnings or did not give enough credence to them.[396] The Cumbria Flood Action Plan commissioned after storm Desmond identifies actions to strengthen the approach to emergency planning and the responsiveness of agencies, together with actions to support communities in building their own resilience.[397]

Although there has been an increased focus on understanding trends and impacts by some local authorities, supported by tools such as SWIMS, the extent to which this is used to look ahead and consider the longer term risks and vulnerabilities is less certain. LRFs say they feel prepared to deal with the events to which they have responded before, such as flooding, but less prepared for events that are more rarely experienced, such as heatwaves.[398]

[395] Jacobs (2017) for the ASC, *Local Resilience Forum 2017 Interviews*.
[396] JBA Trust, Zurich Insurance (2016) *Flooding after storm Desmond*.
[397] Cumbrian Floods Partnership (2016) *Reducing flood risk from source to sea.*
[398] Jacobs (2017) for the ASC.

7.3.6 Promoting local biodiversity and other natural capital assets

As public authorities, councils have a duty to protect and enhance the biodiversity in their area.[399] Local authorities also have responsibilities for managing parks, public gardens and other green spaces.

Local authorities are able to use their functions to:

- Improve and extend ecological networks to allow species to adapt and migrate as conditions alter with climate change. The resilience of green spaces can also be enhanced by choosing species suitable for the future climate.
- Alleviate flood risk through the integration of green infrastructure in new developments and the protection of existing green spaces, which will help to manage surface water run-off. The incorporation of space for water within green spaces will also assist in managing drainage and flood risk issues.

An assessment of the most recent Climate Local action plans identifies a number of actions related to both climate resilience and the natural environment.[400]

For example, Climate Local action plans included commitments to:

- use the planning system to promote biodiversity and create and protect networks of biodiversity and green infrastructure (including blue and green infrastructure mapping);
- develop specific green infrastructure delivery plans;
- explore ways to protect trees and plant new trees;
- consider the impact of climate change on native wildlife and develop plans to address this (including alternative management regimes which may be required);
- develop wildflower planting schemes;
- review the parks and open space strategy; and
- further enhance green spaces on housing estates.

Natural England's national biodiversity climate change vulnerability (NBCCV) assessment tool[401] has been developed to enable the assessment of priority habitats for overall vulnerability to climate change.

The tool analyses both sensitivity to climate change and the adaptive capacity of specific habitats. Local authorities are able to incorporate the outputs within their spatial planning to help protect and enhance biodiversity. The extent to which local authorities are aware of and using this tool is not known.

The National Planning Policy Framework states that existing open spaces in developed areas should not be built upon unless the open space has been shown to be surplus to requirements; equivalent open space can be provided elsewhere, or the development provides alternative sports or recreation facilities. The last Government's housing white paper[402] proposes to relax standards to protect open space, if there is deemed to be 'adequate provision' in the wider area, but gives no details on how this might be calculated.

[399] See Natural Environment and Rural Communities Act 2006, Section 40.
[400] LGA (2016) *Climate Local Annual Report 2015/16*.
[401] Natural England (2015) *Natural England's climate change risk assessment and adaptation plan (NE318)*
[402] DCLG (2017) *Fixing our broken housing market.*

There are no statutory requirements related to the maintenance of urban greenspaces, which leaves their management at risk from budget reductions. There is some anecdotal evidence that local authorities are removing trees from urban areas in order to reduce maintenance costs, including those which result from root damage to highways.[403]

Recognising green infrastructure as a natural capital asset rather than a liability could help local authorities prioritise measures to protect and enhance their value, including in terms of improving human health and wellbeing, providing habitats, and contributing to adaptation.

In other words, investments in green infrastructure can help local authorities deliver their statutory services as well as non-statutory ones.

A key challenge for local authorities is how green infrastructure and other natural capital assets are accounted for on the balance sheet. At the moment the maintenance of such assets is considered a cost or liability. The 'value' of the asset is often taken as zero or given a nominal value because the accounting rules value assets at their resale value and community green spaces and natural infrastructure cannot be sold. It is important that the value of these assets is properly accounted for, recognising the range of benefits they deliver for the local community. This is beginning to happen with some local authorities taking better account of the environmental, economic and social benefits of green infrastructure, including how it can help reduce the burden on other services such as public health.

7.4 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. Of the eight actions relating to the local government theme,[404] six are considered complete, with the remaining two identified as on track.

The updates provided by the owners of these actions are presented in an annex to this report available on the CCC website.

The responses from the owners of the actions demonstrate that the level of action seen in the period to 2015 has not been maintained due to resourcing pressures and the withdrawal of funding for the relevant national and regional support programmes. It is clear from the updates from action owners that there has been a need to refocus and reprioritise efforts. Commentary on progress in relation to each objective is summarised in Table 7.1.

[403] For example in Sheffield, see: http://www.bbc.co.uk/news/uk-england-south-yorkshire-38024846
[404] Noting that there are a further 48 actions relevant to local government which are cross-referenced in the register of NAP actions.

Table 7.1. Summary of progress for the Local Government actions and objectives 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.	The NAP has two actions against this objective, both owned by the Local Adaptation Advisory Panel (LAAP). The LAAP was established to support the local government sector, working closely with the Environment Agency's Climate Ready Support Service, the Local Government Association, and Climate UK. Both actions are considered complete. In the period to 2015 the LAAP, working in collaboration with the EA and the LGA, helped to produce a number of outputs designed to raise awareness of climate risks and actions that can be taken by local government.[405] For our 2015 report, the LAAP indicated that the actions set out in the NAP needed to be reviewed and made more challenging. In the subsequent period to 2017, in the context of reduced budgets and the closure of adaptation support services, the LAAP work programme has been reprioritised, from supporting local action, to focus on informing policy, in particular to feed into and prepare for the next NAP.
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.	The single action against this objective is considered complete, and refers to EA Climate Ready tools and guidance being developed and made available and accessible to all local authorities. In the period to 2015 Climate Ready, Climate Local, Climate UK and the Core Cities Group worked together to develop a business case for managing the impacts of severe weather and climate change. The guidance was launched at two regional seminars held in Birmingham and Warrington in the summer of 2015. It was circulated across a range of local government networks and received positive feedback from the sector. EA and the LGA also ran a webinar in the autumn of 2015, to raise awareness of the report and in particular the work that can be done to address surface water flood risk. No further work is planned. The action also included the rollout of the Severe Weather Impacts Monitoring System (SWIMS) developed by Kent County Council. Although the SWIMS system is now available via the Climate UK website, no update was provided on how widely this is now in use. Only three of the nine Climate UK branches in England remain active, with significantly reduced capacity, after their funding from central government came to an end in April 2016.

[405] See: http://www.local.gov.uk/web/guest/climate-local/-/journal_content/56/10180/5832192/ARTICLE

Table 7.1. Summary of progress for the Local Government actions and objectives in the NAP	
NAP Objective	**Commentary on progress**
Objective 30. To ensure the policy framework for local government supports councils to increase community resilience in partnership with local and regional players.	The single action in this area is a general one for the Government to ensure policy and programmes are joined up, to enable and support local authorities to build resilience to the impacts of climate change. It is considered on track but with no specific further work planned. The update from the Government mentions a Cabinet Office initiative to develop and roll out a programme on community resilience in partnership with other government departments and relevant public agencies. This will include engaging local authorities and Local Resilience Forums, but with no further details provided.
Objective 31. To support sector-led activities, which allow councils to make local commitments to address their own unique challenges and opportunities arising from a changing climate.	The four actions against this objective refer to various local initiatives such as Climate Local, the Core Cities Group, and the Climate Ready Support Service. Three of the four actions are considered complete. There is limited progress on the remaining action, relating to the Core Cities Commitment. The Core Cities Climate Resilience and Adaptation Working Group continues to meet but reports that its activity has been constrained by resources and the loss of knowledge due to the movement of staff. The Working Group says these issues present a challenge to the Core Cities in continuing to make progress against this objective, including into the next NAP period.

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