

1.2. What is the Legislative Framework?

The Climate Change Act 2008 makes the UK the first country in the world to have a legally-binding long-term framework to cut greenhouse gas emissions and a framework for building the UK's ability to adapt to a changing climate. The strength of the Government's response lies in this dual, 'no regrets' approach. The Act requires:

- A UK-wide **climate change risk assessment** (CCRA) that must take place every five years;
- A **national adaptation programme** (NAP) which must be put in place and reviewed every five years, setting out the Government's objectives, proposals and policies for responding to the risks identified in the CCRA;
- **Adaptation Reporting Powers** (not applicable in Northern Ireland) which enable the Secretary of State to direct "reporting authorities" to prepare climate change adaptation reports.

In addition, the Adaptation Sub-Committee of the Committee on Climate Change, an independent expert body, was set up as required under the Climate Change Act 2008. Its role is to advise on the preparation of the UK CCRA, to report to Parliament on the UK Government's progress in the implementation of the NAP and to provide advice to the Devolved Governments, as required.

The Adaptation Sub-Committee has provided valuable input and advice on the UK CCRA, helping in development of the methodology and in evaluating emerging results from the analysis. We are grateful for their input and support throughout this process.

Climate Change Risk Assessment

The Climate Change Risk Assessment (CCRA) 2012 is the first assessment of its kind for the UK and the first in a five year cycle. This CCRA has assessed (and where possible monetised) the main risks and opportunities in the UK from climate change. This independent analysis provides an overview and assessment of risks in and across sectors, and will enable comparison between different sectors. It provides underpinning evidence that can be used by central Government to help inform priorities for action and appropriate adaptation measures. It also highlights where more work is needed to understand the scale and nature of the risks, and to help us consider what action – if any – we need to take.

The CCRA will be followed by the NAP, which will include appropriate economic analysis to inform Government about the costs and benefits of a number of options for adaptation to climate change.

National Adaptation Programme

The CCRA is the first step towards the delivery of a NAP, providing a key component of the underpinning evidence.

The NAP, like the CCRA, will be reviewed and updated on a five yearly basis. Building on the CCRA and later economic analysis, the aim of the first NAP, which we plan to publish in 2013, will be to articulate the scale and nature of the adaptation challenge, to describe the respective roles of Government, private sector and others in meeting these challenges, and to set out Government's adaptation policies and actions. For Government, the principles for dealing with adaptation will be to act mainly where the market is unlikely to act, to help others make good decisions on climate risks and opportunities (for example from investments in cutting edge science and decision support), and to promote risk-

based decision approaches (for example early action on decisions with long-term consequences, and maintaining flexibility by avoiding technical lock-in).

On the first NAP, the UK Government's intention is to work with others in a collaborative approach to policy making – to co-create with relevant organisations, and seek to achieve a high-degree of consensus on this programme.

Adaptation Reporting Power

The Adaptation Reporting Power (ARP) enables the Secretary of State to direct “reporting authorities” (companies with functions of a public nature such as water and energy utilities) to prepare climate change adaptation reports on how they are assessing and acting on the risks and opportunities from a changing climate. The first round of the ARP has now been concluded and 91 organisations have been directed to report, alongside 14 organisations reporting on a voluntary basis. A summary of the key findings from the first round of the ARP will be published shortly. These reports provide us with further evidence of organisational capacity in areas critical to our national infrastructure, and environment, and will help, alongside the CCRA and other evidence, to inform the development of the NAP.

1.3. What is the CCRA in detail?

The CCRA brings together a wide range of evidence about climate risks including the UK Climate Projections 2009 (UKCP09), stakeholder workshops, the findings from other Government reports, peer-reviewed literature and new analysis completed as part of the CCRA project.

This independent analysis was funded by UK Government and Devolved Governments and has been delivered through a consortium of organisations led by HR Wallingford. The outputs have been extensively peer reviewed by scientific and economics experts, an independent international peer review panel, and have also been scrutinised by the Adaptation Sub-Committee of the Committee on Climate Change.

The methodology is novel in that it has allowed us to compare over 100 risks (prioritised from an initial list of over 700) from a number of disparate sectors, based on the magnitude of the impact and confidence in the evidence base. A key strength of the analysis is using a consistent method and set of climate projections to look at current and future risks and opportunities. Also, the method focuses attention on risks where decisions need to be made in the near future (i.e. in the next five years).

To provide a baseline that can be more easily used to assess the effectiveness of actions or policy interventions, with the exception of a few specific cases, the CCRA does not build in societal change in assessing future risks, either from non-climate related change (e.g. in demographics, technology, economic growth), or responses to climate risks (e.g. Government policy, or private adaptation investment)². For example, the CCRA shows us that without any current or planned action there are significant risks to parts of our infrastructure. However, Government and other key organisations are *already* taking action in many areas to minimise risks: our existing policies on for example flood defence, proposed policies in the Water White Paper, and plans by others, such as the energy generators and water companies to protect key assets such as power stations. Many current Government policies are highlighted in this report.

² See Section 2.1. for more detail and individual Sector reports.

Fundamental change will require fundamental thinking – and this is the start of the process. Government will need to consider the wealth of information and analysis in these and other reports, consider actions and policies already in place where they have deliberately not been considered as part of the CCRA analysis, test the conclusions with a range of organisations throughout the UK, and work with them on understanding where the priorities are for immediate decisions and for further work and research.

This CCRA has mainly examined the risks of a changing climate in the UK – not to the UK from abroad. Given that global climatic events already affect the UK significantly, the future international impacts of climate change may disrupt the UK economy through impacts on traded goods, supply chains, migration and international relations. However, there is very little analysis on the scale and likelihood of such changes. As a starting point, the Foresight Report, *International Dimensions of Climate Change*³, looked at the existing evidence and identified a large number of international risks that could affect the UK, as well as some opportunities. The more recent Met Office report, *Climate: Observations, Projections and Impacts*⁴, funded by DECC, also considered, at a high level, the scale of potential climate threats and opportunities across a number of countries in different regions. Further work needs to be done on international risks to the UK and the NAP will take the state of knowledge on impacts of climate change globally into account.

Government also carries out a number of other types of risk assessment. While the CCRA focuses on risks from climate change and over a long time period (up to 2100), specifically providing underpinning evidence to support short and long term decisions on adaptation policies and actions, other assessments are directed to delivering different information to support Government decisions on specific issues. For example, the National Risk Assessment (NRA) assesses the main threats and hazards to the UK over a five year period, and drives contingency planning for responding to and recovering from civil emergencies; and the National Security Risk Assessment (NSRA) identifies and assesses a wide range of risks to enable Ministers to prioritise the most significant risks which could threaten our national security interests.

3 Foresight International Dimensions of Climate Change Report:
<http://www.bis.gov.uk/assets/bispartners/foresight/docs/international-dimensions/11-1042-international-dimensions-of-climate-change>

4 <http://www.metoffice.gov.uk/media/pdf/t/r/UK.pdf>

2. What is in the Climate Change Risk Assessment?

The CCRA has been an ambitious undertaking – covering analysis of key risks and opportunities across all sectors of our economy at the national level. There is a large amount of material and data, but most organisations will want to access and consider only parts of it that are relevant to them.

The UK Government will be working with stakeholders, in developing the NAP, to help develop an understanding of risks relevant to them, using the CCRA as a starting point for discussions.

The main CCRA reports include:

- The 'UK Climate Change Risk Assessment Evidence Report'
- Reports for each of the eleven sectors
- Reports for Scotland, Wales and Northern Ireland

Evidence for the assessment has been gathered in **eleven sectors**: *Agriculture; Biodiversity & Ecosystem Services; Built Environment; Business, Industry & Services; Energy; Floods & Coastal Erosion; Forestry; Health; Marine & Fisheries; Transport; Water*. The sector reports describe a wide range of potential risks in each sector, followed by a more detailed analysis of selected risks that were judged to be the most important.

The **UK Climate Change Risk Assessment Evidence Report** brings together an overview of climate change risks and opportunities based on the analyses described in the Sector Reports and other sources of information. It is intended to provide information to policy makers on the vulnerability of the UK and future risks and opportunities due to climate change.

The results of the assessment are presented in the UK Climate Change Risk Assessment Evidence Report in five themes:

- Agriculture & Forestry;
- Business;
- Health & Wellbeing;
- Buildings & Infrastructure; and
- Natural Environment.

Climate change risks in each theme are presented in terms of the range of potential magnitude of the risk, how magnitude varies over time and the overall confidence in the findings of the assessment.

The **reports for Scotland, Wales and Northern Ireland** provide an assessment of climate change risks and opportunities in each country. They are based on the UK-wide sector reports but take account of risks that are particular to each country, such as marine water quality in Northern Ireland, changes in the timing of snow melt in Scotland and grassland productivity in Wales.

2.1. What are the Uncertainties in the analysis?

There is strong scientific evidence that climate change will disrupt the global economy, environment and society due to projected warming, sea level rise and changes in global rainfall/snowfall patterns and extreme events. Scientists are confident that average UK temperatures will continue to rise, but it is less clear how other climate variables will change as a result, and therefore the assessment of future climate risks needs to take account of a wide range of outcomes, as well as highlighting those risks which are so uncertain that it isn't possible currently to provide any evidence on the direction or magnitude of change.

The CCRA considered a range of potential changes in climate, informed by the UK Climate Projections 2009 (UKCP09), to provide an indication of these uncertainties. This is reflected in both the magnitude ranges, and how these change with time, as described in the UK CCRA Evidence Report. It is important to acknowledge that changes to climate may occur outside the range considered in this analysis, and that new science may change plausible ranges. The confidence ratings used in the report illustrate the strength of evidence and consensus related to the direction and magnitude of different risks and opportunities.

Although new risks and opportunities may emerge over the next 100 years, there is considerable uncertainty related to when these may occur and therefore the most effective timing of any policy intervention. Continued monitoring of climate risks and opportunities, and future re-assessments of the risks from climate change will provide updated evidence about the timing of important risks and opportunities and the need for adaptation action. This is captured in the five year cycles of the Climate Change Act 2008.

The CCRA used the UK Climate Projections (UKCP09) for three time periods – 30-year periods centred on the 2020s, 2050s and 2080s. These may be interpreted as 'short-term', 'medium-term' and 'long-term' respectively. For the marine environment, UKCP09 projections were only available for a 'medium emissions' scenario, and one future time period (the 2080s).

Many key risks are not caused directly by the climate itself, but by changes in the biophysical impacts of climate change, for example sea level rise and flooding. In addition, many potential risks arise as a result of complex processes in which climate change is just one component. In a few cases the CCRA has considered different rates of population growth, which influence the number of people exposed to hazards like flooding and heatwaves. To minimise analytical complexity, however, with the exception of these few specific cases, the CCRA does not build in societal change in assessing future risks, either from non-climate related change (e.g. in demographics, technology, economic growth), or responses to climate risks (e.g. Government policy, or private adaptation investment)⁵. For example, in the flood risk sector, the assessment assumed that the Government would only continue to maintain existing flood defences, and did not consider any further future flood risk management measures that may be put in place. In the water sector it was only assumed that household demand for water would decline to meet modest water efficiency targets. The analysis then gives us information from which to assess whether specific targeted investment strategies may be able to reduce risks much further.

5 Check individual Sector Reports for details of assumptions.

The cost effectiveness of different adaptation programmes was not assessed as part of the CCRA but the subsequent National Adaptation Programme will assess likely societal changes in order to judge where society will adapt autonomously, and where Government can most usefully act.

The CCRA outputs should be considered as a guide to (a) the possibility of changes in risk over this century, (b) the potential direction and magnitude of these changes and (c) whether risks become significant in the 'short-term' (2020s), 'medium-term' (2050s) or 'long-term' (2080s).

2.2. What are the Strengths and Constraints of the Analysis?

The CCRA, for the first time, uses a consistent method to analyse the magnitude and confidence of a range of risks and opportunities across disparate sectors. This has never been achieved before for the UK. The assessment considered risks across all sectors and involved a high degree of consultation and review. Information from a wide range of sources has been used and analysis has been undertaken by specialists from leading UK institutions. The assessment can therefore be considered to reflect the current state of knowledge on climate risks and opportunities.

The analysis did identify, however, a lack of suitable evidence in many areas. It was not possible to quantify many risks and opportunities and in other cases the analysis was incomplete because of a lack of suitable information. In addition, it was not possible to assess some of the more complex interactions such as the overall risks to ecosystems or to analyse multiplicative effects of several risks occurring together; for example successive droughts followed by floods, or multiple infrastructure failures caused by severe weather events.

2.3. How are Risks Categorised?

The CCRA classifies risks and opportunities into three broad impact classes, 'low', 'medium' and 'high' and also identifies those risks that are highly uncertain and difficult to quantify. In addition, projected ranges of possible climate outcomes are given across the three emission scenarios for each of the three future time periods (2020s, 2050s, and 2080s). These risks are presented in the "summary plots" and "scorecards" provided in the UK CCRA Evidence Report.

2.4. Dealing with Uncertainty – Risk-based Decision Making

The CCRA covers a range of possible future climatic conditions and different rates of population growth. It does not provide forecasts of change, predict the exact timing of the emergence of specific risks and opportunities, or make assumptions about the likelihood of different climate scenarios.

The CCRA provides a high level assessment of potential risks at the national scale. It provides a starting point for considering climate adaptation but more targeted and local studies will be needed to support many adaptation decisions on the ground. Therefore, when using the CCRA, the following approach is recommended:

- Use the CCRA summary plots and scorecards as a guide to the possibility of a risk or opportunity occurring (including the order of magnitude, direction of change and potential timing of when high magnitude risks might occur).
- Use the supporting evidence on specific risks to illustrate possible changes in future, based on the ranges presented but do not focus on central estimates only or use any of the figures as predictions.

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- Consider adaptation actions that recognise the high degree of uncertainty and test adaptation actions against a wide range of future scenarios, including – for decisions where risk appetite is particularly low – scenarios outside of the range presented in the CCRA.
 - For any important investment decisions, complete studies at the appropriate scale (e.g. river catchment), using detailed guidance provided by the relevant organisations, such as Defra for flood and coastal erosion management in England and Wales, and Treasury Green Book methods.
 - For the impacts of greatest concern, and especially where there is low confidence, address gaps in evidence including the establishment of monitoring and further research for both national and local level adaptation.

3. What are the main climate risks and opportunities in the CCRA?

3.1. Agriculture and Forestry

Overview

The Agriculture and Forestry sectors are sensitive to climatic conditions, so any changes in climate can potentially have profound impacts on their productivity and economic viability.

The CCRA analysis has shown that there are implications for both these sectors from climate change, which could impact on the level of productivity and quality of products, and also opportunities, which both industries could potentially exploit.

The Agriculture and Forestry sectors are responsible for managing approximately 90% of UK land; they make an important contribution to the UK economy and deliver a wide range of public goods and services. It is important that Government works with farmers, foresters, land managers and other key organisations to consider the risks highlighted in the CCRA, identify actions to manage risks to the industries and consider how opportunities can be best exploited. Due to the length of time trees and forests take to reach maturity, decisions in some parts of the forestry sector will have implications up to, and beyond, 2050. In agriculture, a shorter crop growth time means that arable farmers and land managers can be more responsive and adaptive to climate change.

In England, Defra leads on agriculture and forestry policies as well as on a range of environmental policies, such as water and flooding, that impact on these industries. Most matters relating to agriculture and forestry policy in Scotland, Wales and Northern Ireland are the responsibility of the Devolved Governments.

The Agriculture and Forestry theme considers the risks and opportunities to the productivity of these two sectors while the Natural Environment theme considers the contribution they make to wider ecosystem services (see section 3.5).

Key Findings

The CCRA identifies that Agriculture and Forestry could be affected by both extreme weather events and gradual climate change, particularly beyond 2050.

The key risks and opportunities identified at UK level are as follows:

Risks	Opportunities
Higher summer soil moisture deficits, increasing demand for irrigation to maintain crop yields and quality.	Increased agricultural yields resulting from longer growing seasons and CO ₂ fertilisation, where water or nutrients are not limiting factors.
Increased competition for water resources in the summer owing to reduced summer rainfall and the need to address unsustainable abstraction.	Opportunities to grow new crops as a result of warmer climate and longer growing seasons.
Crop losses and other impacts on high quality agricultural land due to flooding and agricultural land lost to coastal erosion.	Increased timber yields where water is not limiting to tree growth.
Large areas of forests at increased risk from existing and new tree diseases and insect pests, resulting in reduced timber production, tree mortality and declining woodland condition.	Opportunity to plant a range of timber species previously not considered suitable for forestry in the UK.
Drier conditions and any increase in the frequency of drought will reduce agriculture and timber yield and affect woodland condition.	
Changes in forest productivity with consequences for species selection if timber yields are to be maintained.	
More frequent wildfires due to warmer and drier conditions.	

At a local level, flooding or coastal erosion can be a significant risk to agriculture. In England and Wales, currently around 50,000 hectares are at risk of flooding frequently (i.e. at least once every three years) and this is projected to increase to around 200,000 ha by the 2080s (or 1% of total agricultural land). Agricultural land is also at risk from less frequent flooding (i.e. 1 in 10 year events) and this is projected to increase from around 200,000 ha at present to about 400,000 ha by the 2050s and over 500,000 ha by the 2080s. This is equivalent to about 2% of all agricultural land currently and about 5% by the 2080s. In the longer term this means the farming sector may need to take a more active role in flood risk management or change to more resilient forms of agriculture in high risk areas.

The projected area of agricultural land at risk of loss from coastal erosion is relatively small, representing about 0.06 to 0.09%⁶ (6,500 to 10,000 ha) of the total area of agricultural land (about 11 million ha) in England and Wales in the 2080s. However, as coastal erosion is a natural process, some of this land would be lost even without climate change.

⁶ The range from the low emission p10 projection to the high emissions p90 projection (see Flood Sector Report for details)

In the short term, projected warmer temperatures and CO₂ fertilisation may present some opportunities to improve forestry and agricultural yields, to increase the geographical range of existing crops/tree species and to introduce new crops and tree species, particularly in Southern England. However, these opportunities may be limited by projected low water availability in the summer and increased incidence of flooding.

Implications

Domestic agricultural policy is heavily influenced by EU policy. The Common Agricultural Policy (CAP) provides support to farmers who follow good agricultural practices, and/or offer non-market benefits as well as those prepared to enter into voluntary agri-environment commitments. Regulatory proposals published by the European Commission in October 2011 list 'the sustainable management of natural resources, and climate action' as one of the three objectives for rural development⁷. Other policies, such as the Water Framework Directive⁸, seek to regulate environmental impact and there are a range of EU laws on animal health and welfare and food safety.

There are a number of measures available under the Rural Development Programme for England⁹ to help farmers adapt to climate change. From 1 January 2012, the new Farming Advice Service offers a one-stop-shop to farmers needing advice on a number of subjects, including adaptation to climate change, which will help raise farmers' awareness of the challenges.

Agriculture and Forestry are also influenced by wider policies, for example biomass and biofuels, and by international markets. If international demand for UK production were to increase to meet a growing demand for these products, this could be a significant opportunity but it may also lead to additional pressure on land and water resources in the UK. If international product prices rise, the UK may experience greater pressure on resources as the domestic market becomes more favourably priced in comparison.

A key driver for the UK Agriculture sector is the need to develop its capacity to produce food sustainably. In this context, climate change impacts (e.g. water availability and flooding) are just one of a range of pressures on the sector. In England, the Natural Environment White Paper¹⁰ commits to carrying out a project to look at the challenge of reconciling increased food production whilst enhancing the environment. UK Government is working in close partnership with industry, environmental and consumer organisations towards publishing project conclusions that will help shape future agriculture and food policies. The Business theme (see Section 3.2), highlights the ways in which impacts on the food and beverage sub sector may cascade to the Agricultural sector and vice-versa.

The Natural Environment White Paper also sets the context for Forestry policy, and the Independent Panel on Forestry will report to Government in 2012 with recommendations on the future direction of forestry policy¹¹. Climate change adaptation is one of several key issues the panel are considering. The recently revised 'UK Forestry Standard'¹² and its Guidelines on 'Forests and Climate Change', give a steer on practical measures to consider for adapting forests as a component of sustainable forest management. Such adaptation measures, including species diversification, incorporation of climate change scenarios in road and drainage system specifications and a move to alternative forest management

7 <http://www.defra.gov.uk/food-farm/farm-manage/cap-reform/>

8 <http://www.defra.gov.uk/environment/quality/water/legislation/water-framework-directive/>

9 <http://www.defra.gov.uk/rural/rdpe/>

10 <http://www.defra.gov.uk/environment/natural/whitepaper/>

11 <http://www.defra.gov.uk/rural/forestry/>

12 <http://www.forestry.gov.uk/ukfs>

systems, are the basis of the Climate Change Action Plan for the 258,000 ha Public Forest Estate in England that is now being implemented by the Forestry Commission.

In addition, implementing the commitments outlined in the Water White Paper¹³, published on the 8th December 2011, will impact on agriculture and forestry policies and will set the context within which each Sector will need to adapt. Of particular importance for agriculture is the reform of abstraction licensing which is aimed at providing clearer signals for investment to meet water needs and protect water ecosystems.

Through the development of the National Adaptation Programme, we will work with land owners, farmers and other key organisations, to identify areas for joint action, and develop policies to support sustainable Agriculture and Forestry Sectors.

Devolved Governments

Scotland

As part of Scotland's Climate Change Adaptation Framework, the Scottish Government has published 12 'Sector Action Plans' including one for: Agriculture; Forests and Forestry; and Spatial Planning and Land Use¹⁴. These action plans set out the key climate change issues and challenges for each sector and set out work to strengthen resilience to the impacts of climate change, for example through the Scotland Rural Development Programme. In March 2011 the Scottish Government published '*Getting the best from our land: a land use strategy for Scotland*'¹⁵. The Land Use Strategy is a requirement of the Climate Change (Scotland) Act 2009 and recognises that land-use decisions should be informed by the opportunities and threats from climate change. Implementation of the Strategy will draw on the outputs from the UK CCRA.

Wales

Set within the *Rural Development Plan for Wales, 2007-2013*¹⁶, the Glastir agri-environment scheme is a five-year, whole farm sustainable land management scheme available to farmers and land managers. It is designed to draw together the Welsh Government's commitment to sustainable agricultural development in the context of climate change and is part-funded by the EU. Expected outcomes include better water management, reduced flood risk, and conserved and enhanced biodiversity.

Land managers are expected to be better informed and trained on climate change impacts and possibilities for adaptation thanks to knowledge transfer, advice and skills development through the Farming Connect programme¹⁷.

13 <http://www.defra.gov.uk/environment/quality/water/legislation/whitepaper/>

14 <http://www.scotland.gov.uk/AdaptationSAPs>

15 <http://scotland.gov.uk/Publications/2011/03/17091927/0>

16 <http://wales.gov.uk/topics/environmentcountryside/farmingandcountryside/ruraldevelopment/?lang=en>

17 <http://wales.gov.uk/topics/environmentcountryside/farmingconnect/?lang=en>

'Responding to climate change' is one of the four strategic themes in Wales' forestry strategy, *Woodlands for Wales*¹⁸. This moves Wales towards more mixed and native woodland, and reduces reliance on clear felling regimes. Forestry Commission Wales will develop the Glastir woodland management grant scheme, develop guidance on woodland management and agricultural systems and investigate the benefits of urban tree planting for shade and drainage.

Northern Ireland

The *Northern Ireland Rural Development Plan, 2007-2013*¹⁹, includes delivery of Agri-environment Schemes designed to maintain a high proportion of agriculture land under environmental enhancement agreements. Biodiversity, water quality and climate change objectives are integral to these schemes and are an important contribution to achieve sustainable land management. The NI Sustainable Development Implementation Plan – 'Focus on the Future'²⁰, also includes agriculture related economic and social actions/deliverables in addition to environmental actions/deliverables. The Rural Development Plan also supports woodland creation and the sustainable management of existing forests. Forest Service will promote the recently revised 'Forestry Standard' and its Guidelines on 'Forests and Climate Change', which provide forest managers and owners with a range of practical measures to consider when creating new forests and managing existing forests in the context of climate change.

18 <http://www.forestry.gov.uk/wwstrategy>

19 <http://www.dardni.gov.uk/index/rural-development/nirdp2007-2013.htm>

20 <http://www.sustainableni.org/sustainable-development/the-sd-strategy-2010/implementation-plan-2011-2014/index.php>

3.2. Business

Overview

The CCRA identifies the main climate challenges to businesses, which include: flooding and coastal erosion; increased competition for water, energy and materials; and the disruption of transport networks and communication links. These risks particularly affect activities which:

- rely on large fixed assets (especially near main rivers or the coast)
- have complex supply chains
- rely substantially on natural assets.

The CCRA Business Sector Report looks in detail at the risks and opportunities facing five sub-sectors which meet these criteria, namely: financial services, tourism, food and beverage manufacturing, primary extractives (oil, gas and mining), and chemical manufacturing. Fisheries productivity is considered in the CCRA Marine Sector Report.

Responsibility for adaptation in the Business sector is shared across a number of Government Departments and other bodies, including Defra (flood and coastal erosion, water resources management, biodiversity), Department for Business Innovation and Skills (BIS, supporting business in mainstreaming adaptation, enabling industries to respond to the future needs and opportunities presented), Department of Energy and Climate Change (DECC, energy infrastructure and energy efficiency – including demand for cooling); Communities and Local Government (CLG, planning, housing, urban regeneration, building regulations) and Department of Health (DH, effects of heatwaves on human health). Many policy areas are devolved and are the responsibility of the Devolved Governments in Wales, Scotland and Northern Ireland. HM Treasury leads on financial regulation and on the impacts of climate change for the mortgage and insurance industries.

The Environment Agency (EA) is responsible for implementing flood risk management policy and enforcing other policies in England and Wales; similar responsibilities fall to the Scottish Environment Protection Agency (SEPA) in Scotland and Department of Agriculture and Rural Development Rivers Agency in Northern Ireland.

Heritage bodies (Natural England and English Heritage, the Countryside Council for Wales, Scottish Natural Heritage and the Northern Ireland Environment Agency) have a wide range of responsibilities in relation to environmental protection and play a role in supporting the tourism industry.

Key Findings

The CCRA identifies the main risks and opportunities to the Business sector as being related to flooding, heating and water resources.

The key risks and opportunities identified at UK level were:

Risks	Opportunities
Possible decrease in output for UK businesses due to an increase in supply chain disruption as a result of extreme events.	Possible increase in market opportunities such as tourism and leisure industry.
Risk of increase in monetary losses as a result of interruption to business from flooding.	Delivery of adaptive measures (products and services) as part of the move to a low carbon economy.
Greater variability in the availability of water.	
Potential loss of staff hours due to high internal building temperatures (assessed as being of particular relevance to the health, education and retail sectors, which have large workforces).	

The analysis carried out highlights how inter-connected the Business sector is with other sectors in the CCRA. In particular:

- A significant number of the top risks for business relate to the impacts of flooding.
- The availability of water for industrial and other business use is related to impacts upon, and action taken by, the water supply sector.
- Disruption to transport and energy supplies, and heat-related impacts (on productivity, products and machinery) will all affect the business sector.
- Risks to ecosystem resources and services from the natural environment, such as food, timber, water quality and waste breakdown, will impact on, and be affected by, businesses.
- Impacts on the food and beverage sub-sector will cascade to the agriculture sector and vice versa

Businesses, therefore, need to be aware of these inter-connections and understand how sectoral responses to climate change may lead to changes in the risks that they have to manage.

Implications

Climate change does not necessarily create 'new' risks for the Business sector; rather it represents a change to existing risks, and in some cases opportunities. For example, businesses have already experienced the impacts of severe weather events on the transport infrastructure upon which they heavily rely. With climate change, such events may last longer or become more frequent. Failure to consider climate risk and adaptation in decision-making processes could, therefore, have severe consequences for the UK economy with further impacts felt across all other sectors.

The policy framework for managing the potential future risks of climate change is extremely diverse, reflecting the broad range of risks that the Business sector may face. For example, policy protecting assets from flood risk and coastal erosion, building regulations and planning policy will play a vital role in protecting UK businesses and their supply chains from the negative impacts of climate change. There are a number of pieces of legislation that aim to manage these risks.

As part of the development of the NAP, the UK Government will work with business organisations to identify areas for joint action. Our aim will be to improve awareness and understanding of climate change impacts, so that business can plan and make decisions that build in the management of climate-related risks.

The UK Climate Impacts Programme (UKCIP) have developed a number of tools that help business. UKCIP's Speed Business Areas Climate Assessment Tool (Speed BACLIAT), for example, is a simple checklist that can be used to assess the potential impacts of climate change at an organisational level. In future, the Environment Agency will carry out this advisory role for business and a wide range of other sectors in England and for non-devolved matters.

Given the clear links many UK businesses have to international supply chains, customers etc, the risks and opportunities identified in the CCRA are of course not the only ones that need consideration (for example see Foresight IDCC Report). These wider issues will also be considered in the development of the NAP.

Devolved Governments

Scotland

The Scottish Government has published an adaptation 'Sector Action Plan' for business and industry²¹ which sets out the key climate change issues and challenges and planned work to strengthen resilience of businesses to the impacts of climate change.

Adaptation Scotland provides free advice and support to help business adapt to climate change. Examples of guidance provided by Adaptation Scotland include 'Adapting to Climate Change: A Guide for Businesses in Scotland'²² and a series of information notes to help small businesses²³.

Wales

The Welsh Government business support service can provide advice and support regarding climate change impacts, including via the Business Wales website.²⁴

Tourism is a prominent business sector in Wales, and one that relies heavily on the condition of the environment. A recent study exploring the impacts of climate change on the Welsh visitor economy sets out recommendations to help the tourist industry to adapt to climate change.

Consistent with its central organising principle of sustainable development, the Welsh Government's *Sustainable Tourism Framework*²⁵ highlights adapting to climate change as being of critical importance to the future of sustainable tourism in Wales.

21 <http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationFramework/SAP/BusinessandIndustry>

22 <http://www.adaptationscotland.org.uk/3/82/0/Adapting-to-Climate-Change--A-Guide-for-Businesses-in-Scotland.aspx>

23 <http://www.adaptationscotland.org.uk/3/99/0/SME-Info-Notes--Helping-small-business-meet-its-climate-change-challenge.aspx>

24 <http://business.wales.gov.uk>

25 <http://wales.gov.uk/docs/drah/publications/Tourism/090518stframeeng.pdf>

Northern Ireland

When progressing the Northern Ireland Adaptation Programme, Northern Ireland Government Departments, through the Cross Departmental Working Group on Climate Change, will consider appropriate actions to address climate change risks and opportunities for businesses.

Climate Northern Ireland provides advice and support on the impacts of climate change within Northern Ireland and the adaptation actions necessary to deal with it. Climate Northern Ireland will be publishing guidance in February 2012 on how the business sector can prepare for climate change and this will include information sheets particularly tailored for small and medium enterprises (SMEs).

3.3. Health and Wellbeing (including local resilience and social vulnerability²⁶)

Overview

The CCRA indicates that climate change could have significant implications for the health and wellbeing of the UK population. There are implications for public health, the continuity of health and social care services both within the NHS and beyond, the resilience of local emergency services and the impact on the most socially vulnerable. There are also some potential benefits, for example, a projected reduction in winter mortality and morbidity.

Health and social care are devolved. In England, the DH leads the health and social care sector, which includes the National Health Service (NHS), and associated Arm's Length Bodies (ALBs). In Scotland, the Scottish Government Health Directorate provides the central management of the NHS and oversees the work of 14 NHS boards that plan and deliver health services in their area. The Welsh Government is responsible for the NHS in Wales which delivers services through seven Health Boards and three NHS Trusts. In Northern Ireland, the Department of Health, Social Services and Public Safety leads the health and social care sector, with the delivery of an integrated system through four regional health and social care organisations and 13 other associated ALBs.

Policy governing the role of the emergency services and resilience to the impacts of climate change at the local level is also devolved, although this is not the case for policing in Wales. At the UK level several Government Departments have responsibilities including Cabinet Office, Home Office, DCLG and DH.

Policy and regulation of food safety and food hygiene is devolved across the UK, but with a single body – the Food Standards Agency – acting as the lead department across the UK. FSA is also responsible for food labelling policy in Scotland, Wales and Northern Ireland (with Defra leading in England) and for nutrition policy in Scotland and Northern Ireland (the Department for Health lead for nutrition policy in England, and Welsh Government in Wales).

²⁶ Social Vulnerability is an assessment of the demographic and socioeconomic factors which increase or attenuate the impacts of hazard events on local populations (Tierney et al. 2001, Heinz Centre 2002)

Key Findings

The CCRA indicates that health and wellbeing will be affected by both extreme weather events and long-term gradual change. The main challenges arise from higher temperatures (on land and sea), changing rainfall patterns and rising sea levels.

The CCRA identifies the following key risks and opportunities at the UK level:

Risks	Opportunities
Increased summer temperatures may lead to increased risk of mortality and morbidity due to heat.	Increased winter temperatures may lead to decreased levels of mortality and morbidity due to cold.
Increased flooding would increase the risk of deaths, injuries and people suffering from mental health effects as a result of the impacts of flooding.	Increased summer temperatures combined with increased periods of time spent outdoors could increase vitamin D levels and help to improve physical and mental health of people.
Increased ozone levels by the end of the century could lead to an increased risk of mortality and respiratory hospital admissions	
Increased summer temperatures combined with increased periods of time spent outdoors may lead to an increased risk in the number of skin cancer cases and deaths.	
Increased temperatures and changed rainfall patterns may lead to an increased health risk from water, vector and food borne diseases.	
Increased sea temperatures may lead to increased marine pathogens and harmful algae blooms with a consequent negative effect on human health.	

Risks of summer mortality and morbidity, overheating in hospitals and other buildings, summer air pollution (ozone), and the incidence of some marine and freshwater pathogens are projected to become of increasing significance by the middle of the century. Flooding (both direct impacts and indirect impacts, such as on mental health) is also a risk identified in the CCRA for the Health Sector. An increase in skin cancer cases due to greater sun exposure may occur by the 2080s, particularly in Southern England.

Implications

The risks identified through the CCRA reinforce the importance of a climate resilient health and social care system to minimise the risks of service failure with knock-on impacts for patients, workforce, the wellbeing of the UK population and the wider economy (through the cost of service provision, impact on social cohesion and decline in workforce productivity and wellbeing). There would be added burdens on our emergency services in responding to more frequent flooding, heatwaves and wildfires.

UK Government is working with local communities to build resilience and better prepare for such events, to ensure continuity of high quality health and social care provision, which in turn should reduce the overall costs in the short and long term (financial, social, health, environmental) of the potential risks posed by current and future climate impacts.

Climate resilience is increasingly taken into account in the way that health and social care infrastructure, buildings, facilities and estates are planned, commissioned and maintained. In England, the DH has already considered many of the risks identified in the CCRA through its Climate Change Plan²⁷. The Department together with the Health Protection Agency will shortly update their 2008 report on the Health Effects of Climate Change. England has a Heatwave Plan to manage the impacts of high temperatures on human health.

Within the NHS in England, the Sustainable Development Unit promotes adaptation action across the NHS and is supporting various projects that seek to build adaptive capacity and identify robust adaptive responses²⁸ such as reducing the risk of summer overheating in hospitals. The NHS Carbon Reduction Strategy (2009)²⁹ suggests that NHS organisations establish a Board-approved Sustainable Development Management Plan which includes several adaptation measures such as the promotion of water efficiency.

Most policies relating to air quality (control of ground level ozone) and marine and freshwater quality are addressed at EU level with their implementation devolved across the UK.

Significant improvements have been made in recent years in an effort to reduce risks to human health from consuming contaminated shellfish and from swimming in contaminated bathing waters. Investment in excess of £75 million has been made by Water Utilities in the UK since 2000 on waste water-treatment and infrastructure to improve shellfish water quality. Furthermore, epidemiological surveillance systems are put in place across EU Member States once a pathogen has been included in the European Network for Epidemiologic Surveillance and Control of Communicable Diseases (2119/98/EC and amendments thereafter). There is currently no statutory requirement to monitor incidence and prevalence of non-cholera *Vibrios* and some vector-borne diseases pathogens which are sensitive to environmental temperatures.

Defra will seek to influence evolving EU and international policies to take sufficient account of climate change and relevant risks identified in the CCRA.

Government will look to build the evidence base as to the part climate change might play in increasing the risk of UV exposure and, therefore, the incidence of skin cancer towards the 2080s. Several interacting factors are at play that determine this risk, including the level of projected cloud cover and how people might behave in a warmer, sunnier climate, for example, by taking the necessary protections to minimise exposure to the sun by seeking shade or by applying sunscreen.

27 http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_114929

28 <http://www.sdu.nhs.uk/>. Projects include involvement in DE2RHECC

29 <http://www.sdu.nhs.uk/publications-resources/3/NHS-Carbon-Reduction-Strategy/>

In England, the new partnership approach to funding flood and coastal resilience could potentially make Government funding available to pay for a share of any worthwhile scheme over time. Cost savings and local contributions will mean more communities can benefit from flood and coastal defences; thus reducing the risk of flooding and consequential impacts on public health and the continuity of health and social care services.

Local networks of health and adaptation expertise have been established in several parts of the UK, each driving initiatives that seek to address local climate-related health risks. Ongoing health reforms (for example the role proposed in England for local authority health and wellbeing Boards and Directors of Public Health) will present important opportunities for locally determined action informed by the local assessment of climate risk, reflecting the needs of the local community and delivering solutions which can deliver the greatest co-benefits.

This in turn builds on and links with the close working that already exists at the local level between the health, social care and local emergency planning/resilience networks across the UK established under the Civil Contingencies Act 2004³⁰ (for example local resilience forums in England and Wales and Strategic Co-ordination Groups in Scotland)³¹.

Currently the UK Government has a wide range of policies in place across this sector, some going through some significant reform. As part of the development of the NAP, we will use the outputs from the CCRA to support any further action needed to adapt to risks from a changing climate, promote wider co-benefits linked to adaptation measures and contribute to the wider wellbeing of individuals and communities.

Devolved Governments

Scotland

As part of Scotland's Climate Change Adaptation Framework, the Scottish Government has published 12 'Sector Action Plans', including one on Health and Wellbeing³². This provides an overview of key issues in adapting to the consequences of climate change for the health and wellbeing sector in Scotland. The actions outlined provide an indication of the broad range of work planned over the coming years to strengthen resilience of this sector to the impacts of climate change.

Wales

The Climate Change and Health Working Group has already considered many of the risks identified in the CCRA in its publication, *Tackling the health effects of climate change* (2009)³³. The document recognises that climate change is a significant and emerging threat to public health and wellbeing, and identifies two ways in which climate change will have an impact on the Health Sector:

- directly, as a result of, for example, rising mean temperatures, and flooding
- indirectly, as a result of vector, water and food-borne diseases and air pollution.

30 <http://www.cabinetoffice.gov.uk/content/civil-contingencies-act>

31 <http://www.cabinetoffice.gov.uk/content/local-resilience-forums>

32 <http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationFramework/SAP/Health>

33 <http://wales.gov.uk/topics/health/protection/environmental/publications/climate/?lang=en>

The document also highlights the wider health issues surrounding social welfare and inequality that result from the effects of climate change and provides adaptation priorities and objectives for action.

The *Heatwave Plan for Wales* (2010)³⁴ provides a framework for preparing and responding to heatwaves. It aims to protect health and to reduce harm from extreme heat and heatwaves, including advice for relevant bodies and organisations on the protection of vulnerable people.

Northern Ireland

In Northern Ireland, *Climate Change and Health: Impacts, Inequalities and Action* was published in 2010 by Belfast Healthy Cities in partnership with the Climate Change and Health Group³⁵. This guide for health professionals provides an introduction into the health impacts of climate change and potential directions for health sector action to address impacts on people and places.

34 <http://wales.gov.uk/topics/health/protection/environmental/publications/heatwave/?lang=en>

35 <http://www.belfasthealthycities.com/PDFs/BHCCClimateChange.pdf>

3.4. Buildings and Infrastructure

Overview

Climate change may have significant implications for the built environment, including buildings and energy, transport, water and ICT infrastructure. Infrastructure assets and buildings are in operation or use for many years, which means that decisions made now about their design and construction will have long-term consequences.

The UK Government and the Devolved Governments have a range of responsibilities for the built environment, including policy for the planning system, building regulations and building control, water and transport infrastructure and flood and coastal erosion risk management. Furthermore, new low carbon infrastructure and the 'Green Deal' for homes and businesses will have a crucial role in aiding the transition to a low carbon economy. It will be important to consider climate resilience as part of this process.

Infrastructure UK³⁶ produces the UK Government's Infrastructure Plan, providing a strong focus on the UK's long term infrastructure priorities. Responsibility for the three key infrastructure sectors in England – energy, transport and water – rests with DECC, DfT and Defra respectively, although the sectors range from being Government-led (e.g. Highways Agency), private (e.g. ports), to regulated (e.g. water companies) and unregulated (e.g. airports).

Key Findings

The CCRA analysis indicates that buildings and infrastructure will be affected by both extreme weather events and long-term gradual change in the climate. The challenges arise from higher temperatures and changing rainfall patterns.

The CCRA sets out the following key risks and opportunities for Buildings and Infrastructure at the UK level:

Risks	Opportunities
Energy	
Energy Infrastructure at significant risk of flooding.	Reduced energy demand for heating.
Higher energy demand for cooling.	
Heat damage/disruption to energy infrastructure.	
Increased water demand for energy generation.	
Transport	
Road and railways at significant risk of flooding.	Shorter shipping routes and reduced transportation costs due to less arctic ice.
Scouring of road and rail bridges.	

³⁶ See http://www.hm-treasury.gov.uk/ppp_infrastructureuk.htm for more information.

Water	
Supply-demand deficits.	
Buildings	
Damage to property due to flooding and coastal erosion.	
Overheating in buildings including homes, schools and hospitals.	
Increasing impact from the Urban Heat Island effect.	
Buildings affected by subsidence.	

Flooding is identified as the most significant risk, currently and in the short term, across the UK. Water availability and overheating of buildings are assessed to be increasingly significant by the middle of the century, particularly in England.

Implications

The CCRA reinforces the importance of increasing the climate resilience of our buildings and infrastructure. This has a range of implications for the way that buildings and infrastructure are planned and commissioned, designed, built and maintained, including housing, offices, schools, hospitals and other public buildings, roads, railways and power stations and the part played by water infrastructure in managing the supply/demand balance. Green infrastructure – the living network of green spaces, water and other environmental features in both urban and rural areas – can help to reduce extremes of temperature and manage water flows that affect buildings. In October 2011, the Green Infrastructure Partnership³⁷ was launched, which will provide the opportunity to demonstrate the benefits that well designed high quality green infrastructure can provide.

The UK Government recognises that adapting infrastructure is a priority and in May 2011 *Climate Resilient Infrastructure*³⁸ recommended action to achieve *an infrastructure network that is resilient to today's natural hazards and prepared for the future changing climate*. The Cabinet Office has published guidance on building infrastructure resilience to address the immediate risks³⁹.

The results of the CCRA reinforce the need for Government, businesses, communities and the infrastructure industry to continue to manage the risk of flooding and coastal erosion.

In England the Government expects to invest at least £2.1 billion on flooding and coastal erosion over the next four years. The Environment Agency and the other risk management authorities expect to provide improved protection to at least 145,000 households over this period. The Government also helps infrastructure operators manage their flood risk – for example, through the new Flood Warnings for Infrastructure service provided by the Environment Agency; and collaborative work with critical infrastructure operators on the resilience of critical infrastructure to natural hazards led by the Cabinet Office across the UK.

³⁷ <http://www.defra.gov.uk/environment/natural/green-infrastructure/>

³⁸ <http://www.defra.gov.uk/publications/files/climate-resilient-infrastructure-full.pdf>

³⁹ <http://www.cabinetoffice.gov.uk/infrastructure-resilience>

The Energy National Policy Statements⁴⁰ ensure decisions on development consents for major energy infrastructure are informed by consideration of the impacts of flood risk. They require both assessments of flood risk and proposed mitigation measures to set out how the proposal will take account of the impacts of climate change, using the most recently available UK Climate Projections. As a minimum, this involves using projections based on the emissions scenario that the Independent Committee on Climate Change suggests the world is currently most closely following, but the high emissions scenario (high impact, low likelihood) is used for any safety-critical aspects of the infrastructure.

The draft National Planning Policy Framework⁴¹, which DCLG consulted on from July to October 2011, stated that the Government's objective is that planning should fully support the transition to a low carbon economy in a changing climate, taking full account of flood risk and coastal change. To achieve this objective, the consultation draft said the planning system should aim to:

- Minimise vulnerability and provide resilience to impacts arising from climate change;
- Avoid inappropriate development in areas at risk of flooding by directing development away from areas at highest risk or where development is necessary, making it safe without increasing flood risk elsewhere; and
- Reduce risk from coastal change by avoiding inappropriate development in vulnerable areas or adding to the impacts of physical changes to the coast.

Under the Localism Act 2011, planning authorities and other public bodies in England have a duty to co-operate with each other in relation to planning of strategic cross boundary matters when they are preparing local and marine plans.

To this end, local planning authorities should adopt proactive strategies to mitigate and adapt to climate change.

The Water White Paper¹³ includes a focus on increasing the resilience of our water supplies to future pressures such as climate change. Among the reforms set out were:

- Over the long-term, to introduce a reformed water abstraction regime, as signaled in the Natural Environment White Paper;
- With regulators, to provide clearer guidance to water companies on planning for the long-term, and keeping demand down;
- To consult on the introduction of national standards and a new planning approval system for sustainable drainage.

New systems of marine planning are also currently being introduced across the UK. The Marine Policy Statement (MPS)⁴² was adopted jointly by the Secretary of State, Scottish Ministers, Welsh Ministers and the Department of the Environment in Northern Ireland in March 2011. The MPS provides a framework for marine planning across all UK waters and ensures the sustainable use of marine resources and strategic management of marine activities from renewable energy to nature conservation, fishing, recreation and tourism.

40 http://www.decc.gov.uk/en/content/cms/meeting_energy/consents_planning/nps_en_infra/nps_en_infra.aspx

41 <http://www.communities.gov.uk/planningandbuilding/planningsystem/planningpolicy/planningpolicyframework/>

42 <http://www.defra.gov.uk/publications/2011/09/30/pb13654-marine-policy-statement/>

Building regulations set minimum water efficiency standards for new housing, ensure structural stability and limit heat gain. The recent Housing Strategy (for England)⁴³ emphasises the importance of ensuring that both existing and new homes are sustainable now and in the future, to deliver resilient, adaptable built environments, enhancing the natural environment and people's quality of life.

With increasing temperatures and a higher incidence of summer heatwaves, the risks of overheating are projected to increase for all buildings, and there is evidence that some types of buildings are already vulnerable to summer overheating. CLG is reviewing the evidence in this area and the case for action.

The UK Government has established the Green Construction Board to help ensure that the pursuit of greener construction promotes economic growth. The Board has senior level representation from the construction, property and infrastructure sectors and from Government. This builds on the work of the Low Carbon Construction Innovation and Growth Team in BIS.

In 2008 the Highways Agency published their *Climate Change Adaptation Strategy and Framework*⁴⁴ in which a climate change risk assessment methodology has been developed. This ensures consideration of climate change in design standards and specifications, routine maintenance, operating procedures and contingency planning. Through this process, increases in precipitation and temperature have been highlighted as having the potential to threaten the operation of the network. As a result road surface specifications have been amended to withstand higher temperatures which follow previous alterations to the standards for increased drainage capacity. As these design changes are being made now, the costs will become embedded, so the expectation is that there won't be a sudden requirement for large investment in adaptation measures in the future.

Network Rail has previously carried out climate change risk assessments and research and has weather standards and risk management policies in place. A major research project (*Tomorrow's Railway and Climate Change Adaptation, TRaCCA*) is assessing the risks of temperature (leading to track buckling, staff exposure to heat stress, overhead line sag and overheating of line-side equipment), precipitation (leading to flooding, scour and landslip), wind (leading to trees obstructing railway lines) and sea level rise (leading to overtopping/damage of sea defences at coastal railways). The monitoring of rail buckling is a high priority, as well as flooding and sea level rise. Through established negotiations Network Rail, the Regulator (Office of Rail Regulator (ORR)) and DfT are working to agree adaptation measures which will be implemented during Control Period 5 (2013/14 to 2018/19) and monitored at the highest level. The Initial Industry Plan for this period has concluded that no major additional funding is required during this period as the majority of assets have a relatively short life (in climate change terms), however for some of the assets (in particular bridges) Network Rail has identified that £70 million of additional expenditure is required during Control Period 5 to accommodate climate change.

As part of the development of the National Adaptation Programme, we will work together with key organisations to consider how best to respond to any risks identified in the CCRA where further action is required.

⁴³ <http://www.communities.gov.uk/publications/housing/housingstrategy2011>

⁴⁴ http://www.highways.gov.uk/aboutus/documents/CCAF_Strategy_and_Vol_1_Rev_B_Nov.pdf

Devolved Governments

Scotland

In Scotland, national planning policies are set out in the National Planning Framework and Scottish Planning Policy (SPP)⁴⁵. Both state that climate change adaptation measures need to be considered in development planning.

The Scottish Government has published adaptation 'Sector Action Plans' for the Built Environment, Energy, Transport and Water Environment and Resource⁴⁶. These Actions Plans set out the key climate change issues and challenges and planned work to strengthen resilience.

A National Flood Risk Assessment has been undertaken by the Scottish Environment Protection Agency (SEPA) which provides a detailed picture of flooding impacts across Scotland. The new national assessment has considered main sources of flooding to identify the areas which at present are at the greatest risk of flooding. The National Flood Risk Assessment has identified that in Scotland one in 20 homes and one in 14 businesses are at risk of flooding.

SEPA has undertaken a further assessment of where the impacts of floods are likely to be greatest in future. This allows responsible public bodies to target efforts in a way which will benefit communities, the economy and the environment. These areas are called Potentially Vulnerable Areas. The identification of a Potentially Vulnerable Area has important implications for subsequent efforts to understand and address flood risk. The assessment will also enable national and local government and other organisations with a responsibility for flood risk management, to develop a co-ordinated approach to tackle flooding more effectively.

Wales

The National Strategy for Flood and Coastal Erosion Risk Management was published in November 2011⁴⁷, and the Environment Agency will report on progress annually.

Various Technical Advice Notes (TANs) aid in embedding adaptation into the built environment, and provide supplementary guidance to Planning Policy Wales. With the full devolution of Building Regulations from January 2012, the Welsh Government will be able to set improved standards for all new buildings, for example in ventilation and water efficiency.

The objectives of the *Wales Transport Strategy* (WTS) (2008) are delivered at a national level through the *National Transport Plan* (NTP) (2010)⁴⁸, and at a regional level through the Regional Transport Plans prepared by the Regional Transport Consortia. A transport system that is adapting to the impacts of climate change is a key long-term outcome of the WTS.

The *Strategic Policy Position Statement on Water* (2011)⁴⁹ sets out the Welsh Government's position on aspects of water policy in response to future pressures and challenges, including a range of measures which will help address the impacts of climate change on the availability of water.

45 <http://www.scotland.gov.uk/Publications/2010/02/03132605/0>

46 www.scotland.gov.uk/AdaptationSAPs

47 <http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/flooding/nationalstrategy/?lang=en>

48 <http://wales.gov.uk/topics/transport/publications/ntp/?lang=en>

49 <http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/publications/statement2011/?lang=en>

Northern Ireland

Completion of Northern Ireland's preliminary flood risk assessments, water demand profiling, environmental monitoring together with energy supply, consumption/performance studies have helped to identify, evaluate and plan for flooding, drought, water quality and overheating.

Northern Ireland's overarching Sustainable Development Strategy provides a robust framework for the achievement of sustainable development in Northern Ireland, including the delivery of effective/resilient climate change mitigation and adaption delivery mechanisms. Current planning policy minimises flood risk to property by restricting development in flood plains and in areas of flood.

Northern Ireland's roads authority, Roads Service, has identified "Landslides and Subsidence" as one of the more prevalent risks associated with climate change. Roads Service is actively undertaking extensive research on this topic in an attempt to fully understand the failure mechanisms, mitigate the realisation of failure events and compose an adequate and effective adaption programme.

3.5. Natural Environment

Overview

The Natural Environment theme covers a range of elements across both the physical and biological world: wildlife, rivers and streams, lakes and seas, urban green space and open countryside, forests, fisheries and farmland. It underpins all aspects of our lives. The ecosystem services provided by the natural environment are the foundation of sustained economic growth and personal wellbeing. The recent UK National Ecosystem Assessment (NEA)⁵⁰ provides us with a comprehensive overview of the state of the natural environment in the UK and a new way of estimating our national ecological wealth.

Natural environment and biodiversity policies are devolved. In England, Defra leads overarching policy, with CLG leading on planning policy, DECC on energy policy and DfT on transport policy. All these policy areas impact on the Natural Environment. The Scottish Government, Welsh Government and Northern Ireland Executive are responsible for natural environment and biodiversity policy in Scotland, Wales and Northern Ireland, respectively.

Responsibility for domestic marine and fisheries policy is devolved to the appropriate Government Departments in Scotland, Wales and Northern Ireland. In England, and for negotiations on EU and international policies, Defra has lead responsibility.

UK Government, Scottish Government, Welsh Government and Northern Ireland Executive have a shared vision for clean, healthy, safe, productive and biologically diverse oceans and seas.

The natural environment is vulnerable to both extreme weather events and incremental climate change. It is also an important asset to help society mitigate impacts and to adapt to climate change: managing floods, cooling urban areas and capturing and storing drinking water. CCRA analysis has considered the direct and indirect impacts climate change may have on biodiversity and the consequences to ecosystem services.

The natural environment is already under considerable pressure, as highlighted by the NEA. The CCRA analysis indicates that a changing climate presents both risks and opportunities for the natural environment.

⁵⁰ <http://uknea.unep-wcmc.org/>

Key Findings

The CCRA suggests that, taken collectively, the direct and indirect impacts of climate change on the natural environment could be significant by the 2050s, potentially further exacerbating existing pressures on ecosystems and contributing to the further decline of some species.

The key risks and opportunities identified at the UK level are:

Risks	Opportunities
Low water levels and reduced river flows leading to increased concentration of pollutants from agriculture, sewage and air pollution damaging freshwater habitats and other ecosystem services.	Higher temperatures leading to increase in some provisioning services for example, agriculture and forestry (assuming that water availability is not a constraint).
Soil moisture deficits and erosion impacting biodiversity and soil carbon and increasing risk of wildfires.	Increased habitat range for some generalist species e.g. warm water fish or southerly insects and plants.
Increased prevalence of invasive non-native species, pests and pathogens impacting on animal, plant and human health provisioning services (such as fisheries) and biodiversity.	
Warmer rivers, lakes and seas impacting on biodiversity and the productivity and functioning of aquatic and marine ecosystems.	
Flooding and coastal erosion impacting on key coastal habitats and other ecosystem services (including the extent of beaches and nature sites for tourism).	
Loss of climate space, with species unable to track climate change especially resulting from habitat fragmentation (due to cumulative impact of risks and policy decisions taken in other sectors).	
Possibility of algal blooms, ocean acidification and species range shifts impacting on marine habitats, species and ecosystem services.	
Changes in timing of seasonal events and migration patterns can result in mismatches between species such as predator-prey/host relationships.	

A number of risks and opportunities (such as increased yields, flood risk and plant disease) relate to commercial farming and forestry and are discussed in the Agriculture and Forestry Section (3.1.).

Implications

The importance of ecosystem services and biodiversity is recognised internationally. There are a number of EU Directives that seek to protect and enhance our natural resources, now and in the future, including: the Water Framework Directive, the Floods Directive, the Urban Waste Water and Treatment Directive, the Habitats Directive (currently being reviewed by Defra), the Birds Directive, and the Marine Strategy Framework Directive. Internationally, the UK played a key role in securing the historic global agreement in Nagoya in 2010 to take urgent action to halt the loss of biodiversity⁵¹.

In addition, a wide range of EU programmes, including the Common Agricultural Policy, Cohesion Policy and Common Fisheries Policy support farmers, land managers and fishers to adopt more sustainable approaches and so contribute to the ecosystem services the natural environment provides.

In June 2011 the UK Government published *'The Natural Choice: securing the value of nature'*⁵², the first natural environment White Paper in 20 years, to meet its EU and international commitments and to protect the crucial role ecosystems and biodiversity play in our wellbeing and economic prosperity. The White Paper commits to reversing the historic decline of the natural environment – moving from net biodiversity loss to net gain. Adaptation is a theme that runs throughout the White Paper.

The White Paper also highlights the challenges of protecting and enhancing nature whilst at the same time tackling pressures brought about by climate change on other resources such as water, food production and land and soil erosion. Tough choices may need to be made which the outputs of the CCRA will help inform.

In August 2011, the UK Government published its ambitious new biodiversity strategy *'Biodiversity 2020: A strategy for England's wildlife and ecosystem services'*⁵³, setting out the strategic direction for biodiversity policy for the next decade on land (including rivers and lakes) and at sea. This responds to the challenges laid in the earlier report by Professor Sir John Lawton⁵⁴ which concluded that England's collection of wild areas did not represent a coherent and resilient ecological network capable of responding to climate change and other pressures. Delivery of the Natural Environment White Paper's vision requires action now to support integrated landscape scale approaches and as such will contribute to increased resilience of the natural environment to climate change.

Maritime legislation in general is also strengthening, as evidenced by the UK Marine and Coastal Access Act 2009⁵⁵, the Marine (Scotland) Act 2010⁵⁶, the Northern Ireland Marine Bill⁵⁷ and the EU Marine Strategy Framework Directive⁵⁸. Some unique challenges in the marine environment include ocean acidification and low oxygen zones. The long-term implications of these changes are poorly understood.

51 <http://www.cbd.int/cop10/>

52 <http://www.archive.defra.gov.uk/environment/natural/documents/newp-white-paper-110607.pdf>

53 <http://www.defra.gov.uk/publications/2011/08/19/pb13583-biodiversity-strategy-2020/>

54 <http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf>

55 <http://www.defra.gov.uk/environment/marine/mca/>

56 <http://scotland.gov.uk/Topics/marine/seamanagement/marineact>

57 http://www.doeni.gov.uk/index/protect_the_environment/water/marine_bill_.htm

58 http://ec.europa.eu/environment/water/marine/directive_en.htm

In addition, in 2002, the UK Government and the Devolved Administrations set out a vision of clean, healthy, safe, productive and biologically diverse oceans and seas. Since then, the state of our seas has been monitored and assessed (see Charting Progress 1 and 2 Reports)⁵⁹.

To specifically address climate change implications for our marine environment, the UK Marine Climate Change Impacts Partnership (MCCIP), a partnership between marine scientists and sponsors from the UK and Devolved Governments, their agencies and industry, aims to develop a long-term multi-disciplinary approach to understanding the implications of climate change in our seas. It plays a key role in providing marine climate change expertise for national and international high-level reporting such as Charting Progress 2 and OSPAR's Quality Status Report. MCCIP also provides technical support to help the marine industry to develop their adaptive capabilities to climate change.

More recently, the Centre for Environment, Fisheries & Aquaculture Science (Cefas), through funding from UK Government, has also established a new "Marine Climate Change Centre" to provide a "one-stop-shop" for detailed expert advice on impacts of climate change on the marine environment.

As part of the development of the NAP (2013), we will use the outputs from the CCRA to inform decisions on action needed to improve the resilience of the natural environment.

Devolved Governments

Scotland

Increasing the resilience of the natural systems on which communities depend to the impacts of climate change is part of the aim of Scotland's Climate Change Adaptation Framework⁶⁰. The Framework's principles promote an ecosystem approach which recognises the interdependence between sectors and a healthy environment. Amongst the 12 'Sector Action Plans', those on Biodiversity and Ecosystem Resilience, Water Environment and Resource, Spatial Planning and Land Use, Marine and Fisheries, Agriculture, and Forests and Forestry⁶¹, provide an overview of key issues in adapting to the consequences of climate change for the natural environment in Scotland. The actions outlined provide an indication of the broad range of work planned over the coming years to strengthen resilience to the impacts of climate change.

The 'Scottish Biodiversity Strategy' has identified some actions to assist in adaptation to climate change, and more will be described as understanding of climate change risks and impacts increases. Many actions to assist in adaptation have been identified in the Scottish Natural Heritage publication *Climate change and natural heritage – SNH's approach and action plan*.

The Marine (Scotland) Act 2010 places responsibilities on Scottish Ministers and public authorities regarding the mitigation of and adaptation to climate change including the need to set mitigation and adaptation objectives in a national or regional marine plan.

'*Getting the best from our land: a land use strategy for Scotland*' recognises that land-use decisions should be informed by the opportunities and threats from climate change. Implementation of the Strategy will draw on the outputs from the CCRA.

⁵⁹ <http://chartingprogress.defra.gov.uk/>

⁶⁰ <http://www.scotland.gov.uk/AdaptationFramework>

⁶¹ <http://www.scotland.gov.uk/AdaptationSAPs>

Wales

Through the Natural Environment Framework (NEF)⁶², Wales is developing an ecosystems approach to managing the natural environment. Its guiding principle is to ensure that Wales has increasingly resilient and diverse ecosystems that are managed to deliver economic, social and environmental benefits. Climate change mitigation and adaptation are important elements in this new approach.

Northern Ireland

In Northern Ireland, the river basin management plans, published in 2009, take into account the potential impacts of climate change and set out measures to address the implications for on the water environment. Within the Northern Ireland Rural Development Programme 2007-2013⁶³, the Countryside Management Scheme aims to maintain and enhance biodiversity on farmland whilst also taking account of climate change. Climate change impacts will be considered as part of the review of the Northern Ireland Biodiversity Strategy. A recent consultation on the Alien Invasive Species Strategy sets out a co-ordinated policy and management framework to minimise the risk of invasive species to the economy, environment and society.

⁶² <http://wales.gov.uk/topics/environmentcountryside/consmanagement/nef/sofar/narrative5/?lang=en>

⁶³ <http://www.dardni.gov.uk/index/rural-development/nirdp2007-2013.htm>

4. What will happen next?

First, we need to consider the issues highlighted in the UK CCRA Evidence Report and work with others in the UK to develop a consensus on the analysis. This is part of the process of developing the National Adaptation Programme. We know that there are uncertainties on the scale and impacts of climate change, but we cannot use this as an excuse for inaction: the potential consequences of the risks are too great to be ignored.

Second, the Climate Change Act 2008 requires the UK Climate Change Risk Assessment to be reviewed and updated every five years. A key strength of this first CCRA is its ability to consider the relative urgency around disparate risks, whilst highlighting where more work needs to be done to improve our understanding. In advance of the development of the next CCRA we will be developing our evidence base through a programme of research and close collaborative working with sectors that have been identified for priority action.

Third, looking forward to the National Adaptation Programme, the UK Government will work with the Devolved Governments and Local Government, to ensure that the UK is prepared to manage the risks (and take advantage of the opportunities) presented by a changing climate. It is particularly important for us to develop the NAP with a wide range of organisations and businesses, because:

- Adaptation is context-specific – effective adaptation depends on who is adapting, where they are, their attitude to risk, and how they weigh up other factors in their decisions. The costs and benefits of options vary by location and by the decision-maker, unlike reductions in greenhouse gas emissions which have wider benefits regardless of where the reductions take place;
- Adaptation has no prescribed target and is not a one-off but an on-going process – there is no single metric, like tonnes of carbon emitted, against which to assess decisions;
- Uncertainty about the scale, timing and spatial nature of how the climate might change puts greater weight on flexibility and keeping options open. The benefits of flexibility are harder to evaluate against other, less flexible options that might provide more certain, short-term benefits. But it is important that early action does not lock us into what may become inappropriate adaptation in the future and active monitoring and reviewing progress will be required.

4.1. What is the UK Government's Approach to Developing the National Adaptation Programme?

The Climate Change Act 2008 places a requirement on the Secretary of State to lay a programme of actions before Parliament addressing the risks identified in the CCRA. This should be done 'as soon as reasonably practicable' after the CCRA. In practice, this means during 2013.

This will be the first NAP covering a period of five years (2013-2018). The NAP will be reviewed and a new Programme developed on a five-yearly cycle, following each new CCRA.

The first NAP will be based around the five themes identified in the CCRA. In recognition of the fact that many policy areas relevant to adaptation are devolved to Wales, Scotland and Northern Ireland – where each Government has its own adaptation programme – the NAP will focus on England and reserved, excepted, and non-devolved matters where necessary (for example responsibility for aspects of energy policy and aviation policy lies with the UK Government), in collaboration with Devolved Governments.

The UK economy relies heavily on imports and exports and, therefore, there is high dependency on activities overseas, such as transport and communication and the integrity of supply chains. The World Economic Forum's Global Risk Report⁶⁴ considered climate change as the most important environmental risk and, more importantly, showed how it is inter-related with global food and water security, macro-economic and geopolitical risks. The recent Foresight study on the *International Dimensions of Climate Change* provides an overview of the international climate change risks and how these may affect the UK, and the Met Office Report, '*Climate: Observations, Projections and Impacts*' provides, at a high level, the scale of potential climate threats and opportunities across a number of countries in different regions.

A considerable amount of further work needs to be done on international risks, and the NAP will take the global impacts of climate change into account.

4.2. Content of the National Adaptation Programme

The CCRA identifies a number of risks where decisions are considered 'urgent' i.e. decisions have to be taken by the 2020s. It is therefore the UK Government's intention that, given the 5-year cyclical nature of the adaptation process, these urgent areas will provide the focus for the first National Adaptation Programme.⁶⁵

The UK Government's intention is that the Programme will articulate well developed policy proposals, but also signal areas for future development and consideration. The CCRA has identified a number of key evidence gaps and we will work with Research Councils to develop a programme of work to address the most significant issues.

Although Government will work with partners to set the national framework for adaptation, our response to a changing climate will require action across society – in organisations across sectors, as well as at the more local level, for example by local government, businesses and civil society.

Working with stakeholders it is therefore the UK Government's intention to work with others in a collaborative approach to policy making – to co-create with relevant organisations, and seek to achieve a high degree of consensus on this programme. Beginning this process, alongside the publication of the CCRA, the UK Government is publishing a 'call for views' seeking stakeholders' input on areas where urgent action is required.

⁶⁴ World Economic Forum. 2011. Global Risks 2011. 6th edition. <http://riskreport.weforum.org/>

⁶⁵ As highlighted in the Assessment, a number of the risks examined are potentially very significant but our current level of knowledge means that there are also large uncertainties. This is particularly the case for complex systems such as ecosystems and business networks. Future research will improve the evidence base but it is likely that early action will be needed to deal with both current risks and future risks.

4.3. Next Steps by Devolved Governments

The type, magnitude and urgency of climate change risks vary across the UK. As much policy relevant to adaptation is devolved, the Devolved Governments are developing their own adaptation strategies.

Scottish Government

The Climate Change (Scotland) Act 2009 puts in place parallel arrangements to those set out in the UK Climate Change Act. Specifically, the Scottish Act requires a Scottish Adaptation Programme to be developed to address the risks identified in the CCRA for Scotland.

This will be the first Scottish Adaptation Programme covering a period of five years (2013-2018) and a new Programme will be developed every five years, following each new CCRA.

Scotland's Climate Change Adaptation Framework and the accompanying 12 Sector Action Plans⁶⁶ are a non-statutory forerunner to the Scottish Adaptation Programme.

Welsh Government

The Climate Change Strategy for Wales, published in 2010, sets out the Welsh Government's approach for managing the impacts of climate change. The Adaptation Framework confirmed in the Strategy presents a national, co-ordinated approach to ensure that Wales is well-placed to adapt to a changing climate in a sustainable way. It has three objectives:

- to build the evidence base;
- to embed preparing for a changing climate into decision-making;
- to share information and good practice.

The Adaptation Delivery Plan sits alongside the Climate Change Strategy for Wales and sets out the specific measures being implemented to deliver the Adaptation Framework.

The CCRA provides Wales with an analysis of the key risks and opportunities that climate change presents for Wales, and paves the way for prioritised discussion and action in such areas as infrastructure planning, health planning, eco-system management, economic renewal and community resilience.

Under the Climate Change Act 2008, Welsh Ministers have a duty to report on their objectives, action and priorities in relation to greenhouse gas emissions and the impact of climate change in Wales. The Welsh Government will consider the findings of the CCRA in the first progress report on its Climate Change Strategy, scheduled for March 2012, to fulfil Welsh Ministers' obligations under the Act.

The CCRA will also be used to inform revisions of the Adaptation Delivery Plan, and in developing Sectoral Adaptation Plans for the Natural Environment, Infrastructure, Business and Tourism, Communities, and Health.

⁶⁶ See www.scotland.gov.uk/AdaptationFramework

Northern Ireland Executive

The Northern Ireland Executive is responsible for adaptation to climate change in all transferred policy areas under the Northern Ireland Act 1998 and has given a commitment in its Sustainable Development Implementation Plan to produce a cross-Departmental Climate Change Adaptation Programme.

The UK Climate Change Act 2008 requires Northern Ireland Departments to prepare an adaptation programme to address the climate change risks to Northern Ireland and to review them no later than every five years. Reports on the adaptation programme and subsequent progress are required to be made to the Northern Ireland Assembly.

A Cross-Departmental Working Group on Climate Change (CDWG CC) has been established by the Northern Ireland Executive to support work on climate change. An Adaptation Sub Group has also been convened with responsibility to:

- Support the preparation of an assessment of the risks to the United Kingdom of the current and predicted impact of climate change;
- Support the preparation of an adaptation economic assessment on the key climate change risks to the United Kingdom;
- Evaluate the climate change risks and opportunities for Northern Ireland and prepare and deliver a cross-departmental adaptation programme on climate change;
- Review cross-departmental action on adaptation on an annual basis and report to the CDWG CC on progress; and
- Make recommendations and/or decisions on wider climate change adaptation issues as appropriate.

4.4. Conclusions

The CCRA analysis commissioned by, and delivered to, the UK Government marks a significant step forward in developing our understanding of the potential future impacts of a changing climate – and it also increases understanding of vulnerability to our current weather.

The CCRA will form the core of the evidence base when considering what the national response should be to the projected changes in our climate. We should be in no doubt that whilst these changes are uncertain, many are also potentially significant. Many are irreversible and cannot be ignored. The CCRA is not the last word on analysing climate risk – it is the start of a process.

In many areas Government and other expert organisations will need to consider specific issues and risks, and undertake additional analysis if necessary, before decisions can be made. In other areas, it may be that Government and others are already considering projected climate change in policies and decisions. In some areas of less pressing risks, however, the appropriate response may be to wait, and consider any action only once the underlying climate changes are more certain or their potential impacts more clear.

This risk-based approach, and planning properly for the long term for a range of futures, is a big challenge. Tackling that challenge successfully will allow us to protect and enhance our economy, society and environment both now and for future generations.





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