Managing the environment in a changing climate

A report to Defra and the Welsh Assembly Government in response to a direction to report under the Climate Change Act 2008

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Executive summary

The climate is changing and will continue to do so even if greenhouse gas emissions reduce. Understanding of the nature, timing and scale of these changes is imperfect but we know enough to assess the likely implications for what we do. This report sets out the Environment Agency's climate change risks and our plans to address them. It has been written in response to a direction to report from the UK and Welsh Assembly Governments under the Climate Change Act 2008.

The Environment Agency's core business involves protecting and improving the environment of England and Wales for people and wildlife and contributing to sustainable development. It is important that we understand and respond to the factors that impact on these outcomes. Weather conditions are already a central consideration for us. Heavy rain, for example, washes chemicals and nutrients off farmland into rivers in addition to contributing to flooding by swelling streams and rivers. Temperature changes can have significant impacts on wildlife and people. A changing climate therefore represents a major challenge to the environment and our work. We take this challenge seriously and have been responding to it for a number of years.

As we write this report, the first UK climate change risk assessment is being prepared. Government Departments are implementing their own adaptation plans and a number of organisations are preparing reports like this one. Others will be starting to consider what they need to do differently as the climate changes. We hope that our approach is useful to others. It involves assessing the risks that climate change poses for each of our strategic objectives, focusing on the importance of the impacts, when they might occur, when we need to start taking action, how much effort we need to put in to adapt and then prioritising them. We have set out the actions we will take, building on our existing plans.

Our priorities are to address the risks that climate change poses to our work on flooding, coastal erosion, water resources, water quality, wildlife and habitats. We have used the outputs of the UK Climate Impacts Programme (UKCIP) to understand climate change hazards. We have used our own evidence in combination with UKCIP output to understand the impacts on the issues that are most important to our responsibilities. We are most concerned about the impacts arising from changes to rainfall, sea-levels and temperature.

The work of UKCIP indicates that rainfall patterns will change with more rain during the winter and more of it falling in short and heavy bursts. There may be less total rain in the summer but with heavy downpours. Our modelling shows that this will translate into large decreases in river levels in the summer and autumn months coupled with higher flows in the winter. We expect inland flood risk to increase as a result in both urban areas and in the countryside, but the effects will vary across England and Wales. Droughts may also become more common.

All these changes will influence water quality and will add to the pressures that habitat loss and invasive non-native species are already having on wildlife which will be further affected by rising temperatures. Rising sea-levels will increase the frequency and height of extreme high tides and increase the likelihood of coastal

flooding, especially on the east and south-east coasts of England. Sea-level rise will also lead to greater wave attack on coastal cliffs whose stability will be further affected by changes to rainfall.

In addition to our top priority risks our assessment has identified a number of other risks that we need to manage. These are described in the report and include risks to the buildings and equipment that we use and the systems and processes that allow us to operate.

The actions we plan to take fall into a number of categories, reflecting our regulatory, operational and advisory roles and include:

- Working with a wide range of partners to ensure that a sound evidence base underpins our own decisions and the advice we give to others. This will involve both research and analysis, including using the latest set of UK climate projections to characterise changes to river flows and to help us improve our knowledge of coastal processes;
- Providing advice, guidance and data to others to help them play their part in adapting to climate change. We have developed guidance for organisations directed or invited to report under the Climate Change Act, which focuses on flooding, coastal change and water resources. It is available on our website.
- Ensuring that climate change is considered in everything we do. We are ensuring that the further development of River Basin Management Plans under the Water Framework Directive takes account of climate change. Because of the inherent uncertainties in this work we take a flexible approach wherever we can so that we can adjust as we go. For example, our approach to the management of flood risk incorporates the flexibility to adapt to future changes in a timely way but not prematurely.

We are already taking action to adapt to climate change. Going forward we will prioritise our efforts to address our priority risks. We will monitor the changes to these risks over time and modify our action plans as appropriate. We will continue to develop our evidence base with others; identify and share good practice approaches to managing climate risks; and ensure that our staff and partners have the knowledge, skills and tools they need to act.

1 Introduction

The Climate Change Act

The Climate Change Act 2008 gives Government the power to direct certain public bodies to report on their climate risks and adaptation plans.

We received a joint direction to report from the Secretary of State for Environment, Food and Rural Affairs and the Welsh Ministers in March 2010.

Our direction asks us to provide:

- a summary of our statutory and other duties;
- the method used to assess current and projected climate impacts on these;
- a statement of the policies and proposals we will pursue in response;
- our plans and timescales to implement these proposals.

This report sets out the risks and our adaptation plans for England and Wales. We have made it clear where risks or plans differ between the two countries, for example due to devolved policy.

Who we are and what we do

The Environment Agency of England and Wales (The Environment Agency) is established under the Environment Act 1995 to protect or enhance the environment and to contribute to sustainable development.

We are responsible to the Secretary of State for Environment, Food and Rural Affairs (Defra) and are an Assembly Government Sponsored Body responsible to Welsh Ministers. We have staff based across England and Wales and work actively with local communities. We have regulatory, operational and advisory roles in:

- flood and coastal risk management
- water quality and resources
- conservation and ecology
- regulation of major industry
- waste management
- agriculture
- navigation
- fisheries
- contaminated land
- climate change and energy

We have specific statutory and non-statutory responsibilities in all of these areas.

Climate change is a priority for us

The climate is changing and will continue to do so – even if greenhouse gas emissions reduce. We know that the environment is fundamentally affected by climate and that even relatively small changes in rainfall or temperature can have large impacts on people and wildlife. Climate change is therefore central to our work and we recognise that adaptation is essential for a healthy and safe environment. We also know we need to work with communities and partners in industry and government in this area.

We published our first adaptation plan in 2005 and updated it in 2008. We have been taking actions for a number of years to both improve our understanding of the effects that climate change will have on our work and to address climate risks. Annex 2 lists actions that we have already taken.

The Environment Agency Board has endorsed the following commitment to managing climate change:

- We will help England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts.
- We will help people and wildlife adapt to climate change and reduce its adverse impacts.
- We will put climate change at the heart of everything that we do.

Our approach

To assess risks and develop adaptation plans, we have:

- systematically identified the activities undertaken by all our business functions;
- identified those activities which are sensitive to climate change;
- reviewed our evidence to understand how climate change will affect these activities;
- prioritised between them;
- developed action plans for all our risks.

Annex 1 explains our methodology in full and Annex 2 sets out our assessment of risks and our plans to manage them.

Our risk assessment approach describes potential climate impacts on our objectives against four characteristics:

- Importance – how much the impact matters to us.
- Proximity – when our objectives, resources or delivery will need to change in response to climate change.
- Inertia – how quickly we can adapt.
- Resources – the effort we need to make to adapt.

We have compared risks using these characteristics to understand our priorities, which are shown below in Table 1. Annex 3 gives a full explanation of how we have prioritised our risks.

Our priority risks	Rationale
Inland flooding Coastal flooding and erosion Wildlife and habitats	These risks are likely to increase with climate change. We are already factoring climate change into our flood risk management approaches. Funding levels will need to increase in the future to maintain current levels of protection.
Water resources and quality	Climate change poses significant risks to water resources and quality. While we are already addressing them, our current approach might not be sufficient in the future.

Table 1 – Our priority risks

Our analysis shows that our ability to deliver many objectives is not at risk from climate change but we may need to change the way we work to achieve the same results. A good example of this is where we give technical advice to our partners, such as advice on flood risk to local authorities. Our ability to offer such advice is not itself at risk from climate change but we may need to change the advice we offer to reflect the potential impacts of climate change.

The rest of this report explains how we are managing our climate risks:

- Chapter 2 sets out the climate impacts we expect to see;
- Chapter 3 explains how we will adapt to our priority risks;
- Chapter 4 explains how climate change affects our other activities, and especially how we will respond in our climate-influenced work;
- Chapter 5 explains how our adaptation programme will drive activity.

The annexes that support this report give more detail on our risks and our adaptation plans for the next five years. The actions and risks set out in this report reflect our current duties and ways of working. Our risks and adaptation plans may change with:

- Government policy and legislation;
- Our resources and remit.

We will review our assessment and adaptation plans on a regular basis and update them when appropriate.

2 Present and future climate

Here we summarise the potential impact of climate change on the environment of England and Wales, paying special attention to the areas covered by the Environment Agency's responsibilities. We look first at the evidence for the current impact of climate change, and then review the projected change over the 21st century.

Climate change impacts in England and Wales

Climate change is already happening. Global average temperatures have risen by 0.8^{o}C since the late 19th century, with a more rapid increase over the last three decades. It is very likely that human emissions of greenhouse gases caused most of this increase. Atmospheric concentrations of carbon dioxide are now 388 parts per million (ppm), up from a pre-industrial level of about 280 ppm.

The climate system is very complicated, with many different factors affecting the weather at any location. This means, for example, that it is possible to have an unusually cold winter in the UK while mean global temperatures are high: globally, the first six months of 2010 were the warmest on record. This climatic variability means that it is more difficult to detect and attribute change to local climate trends than global trends. Despite this, we can see recent trends in the climate of England and Wales that affect the natural environment.

Central England temperature has risen by about 1^{o}C since 1970. Average sea surface temperatures in UK coastal waters have risen in the last three decades by about 0.7 ºC. Our monitoring data suggest that river water temperatures in England and Wales warmed at an average rate of 0.3 ºC per decade between 1990 and 2007.

Sea levels have risen globally through the thermal expansion of water and ice melt. Changes in UK sea level are consistent with global observations. Average sea level around the UK rose by about 1mm/yr in the 20th century, corrected for land movement.

Rainfall is highly variable from month to month and season to season, and there is not yet evidence that UK rainfall is changing in response to climate change

Similarly, there is no evidence yet of a change in the frequency or duration of droughts in England and Wales. There were a number of significant droughts in the 20th century, but some droughts in the 19th century were longer and had a greater impact.

It is also not possible to say whether climate change is contributing to increased river flooding. There is some evidence of a trend towards increasing flows over the last thirty to forty years in northern and western areas, but in records over a longer timescale there is less evidence of any trends.

Animal and plant species are moving and changing in response to increasing temperatures. These changes are clearest in marine and coastal environments. In terrestrial and freshwater habitats the inability of species to move far, coupled with

the influence of land and water management, tends to obscure trends. There is some evidence that animals living in both terrestrial and freshwater environments have extended their range northwards and upwards. Natural events – like leafing and spawning – appear to be happening earlier in the season.

Projections of future change and impacts

We base our assessments of further climate change on the work of the UK Climate Impacts Programme, including the latest climate projections known as UKCP09. There is considerable uncertainty around future climate projections. This uncertainty arises partly because it is not clear how greenhouse gas emissions will change this century, but also because the climate system is complicated and some aspects are poorly understood. For the UK, there is confidence that temperatures will rise, but changes in rainfall patterns and volumes are much less certain. This uncertainty means that we prefer flexible and robust adaptation options that can cope with a wide range of future climates, as we set out in this report.

Over the rest of the century, temperatures are expected to rise everywhere, with the greatest increases in southern England. There may be little change in average annual rainfall, but more rain may fall in winter, with less rain in summer, particularly in the south of England. Coupled with increased temperatures, this may lead to much lower average summer river flows, but there may also be a significantly increased risk of flooding as more rain comes down in heavier bursts. River and lake water temperatures are likely to continue to increase broadly in line with air temperatures.

Sea level rise will increase coastal flooding and erosion. Under current projections of sea level rise, the coastal floodplains of the south-east and east coast of England would experience the greatest increased probability of flooding. There is a huge diversity of coastal environments and morphology, which will lead to very local variations in coastal change, but climate change is very likely to increase erosion rates with the most severe erosion occurring in the east of England.

By the late 21st century, the potential range of many European plant species may shift several hundred kilometres north. Freshwater and marine ecosystems will change in response to climate change, but there is still much to learn about how individual species and ecosystems will change.

3 Managing our priority risks

Our risk assessment shows that three areas of our work are particularly at risk from climate change and need to be priorities for our adaptation programme:

- flooding and coastal erosion
- water resources and quality
- wildlife and habitats.

This chapter sets out our objectives and adaptation plans in these areas. Annex 2 gives more detail on these risks and plans.

Flooding and coastal erosion

Our responsibilities

The Environment Agency has had a strategic overview role in England for all sources of flooding since 2008. We lead, advise on and coordinate planning and management to address all sources of flood risk and have an overview role for coastal erosion. The Welsh Assembly Government has overall responsibility for managing flood and coastal erosion risk in Wales with the Environment Agency responsible for managing flooding from inland main rivers and the sea.

The Flood and Water Management Act 2010 has come into force and is expected to be fully implemented by 2012. It gives the Environment Agency responsibility for managing main river and sea flooding while local authorities will be responsible for managing surface water, groundwater and ordinary water course flooding on a local basis, along with coastal erosion.

In managing flood risk, our objectives are to:

- work with our professional partners and the public to manage risk and reduce the probability of flooding;
- reduce the consequences of flooding;
- make sure that we, our professional partners and the public understand flood risk;
- provide environmental benefits through our flood management programme.

Climate risks to our flood and coastal erosion objectives are priorities for our adaptation programme. We need to continue to build on the actions we have already taken to manage them effectively.

Inland flooding

Flooding is one of the most visible and destructive effects of extreme weather. It can have devastating consequences, threatening people's lives, homes, possessions, businesses, the wider economy, utilities, transport and the natural environment. We expect inland flood risk to increase throughout the century as climate change influences rainfall patterns. We expect significantly more rain to fall in the winter and more of it to fall in short and heavy bursts. Heavier downpours are also likely in the

summer. These changes may increase both the frequency and duration of river flooding, leading to more severe impacts.

The impacts of river flooding depend on the vulnerability of people, properties, infrastructure and the environment. Our recent assessments of flood risk from rivers and the sea in England and Wales have documented that important infrastructure and public services are currently in flood risk areas:

- Water and wastewater treatment works and pumping stations are particularly at risk, since they tend to be located near rivers. We estimate that over 55 per cent of these sites in England and 80 per cent in Wales are in flood risk areas.
- About 7,000 electricity infrastructure sites, some 14 per cent of all in England, are also at flood risk. In Wales, the figure is 800 sites (22 per cent).
- We estimate that 10 per cent of main roads in England are at flood risk and 11 per cent in Wales. For railways the figures are 21 per cent and 33 per cent respectively.

The risks on the coast

The coastline of England and Wales is continually changing, with cliffs, sand dunes and mudflats shifting. Through our strategic overview role in England we aim to join up coastal management activities to ensure effective management of flooding and erosion risk. Large parts of the coast are at risk:

- England has approximately 4,500km of coastline, of which 60 per cent is at risk of flooding and 40 per cent at risk of erosion
- Wales has approximately 1,500km of coastline, of which 51 per cent is at risk of flooding and 49 per cent at risk from erosion
- Across England and Wales, 91 per cent of the coastline at risk of flooding has flood (sea) defences that reduce the frequency of flooding (mostly protecting land against a 1 in 200 year event)
- Most of the undefended flood plain is made up of saltmarsh or other land that benefits from flooding and also provides a buffer for coastal processes.

The latest science indicates that sea levels will continue to rise as a result of thermal expansion of the oceans, increasing the frequency and height of extreme high tides. Changes to storm surge magnitude and frequency may play a part although Met Office models do not suggest this at this time.

Sea level rise will increase coastal flooding and erosion and changes in rainfall will have an impact on cliff stability. Under current projections of sea level rise, the coastal floodplains of the south-east and east coasts of England would experience the greatest increased probability of flooding. Sea level rise also leads to greater wave energy incident on the coasts, potentially increasing erosion. Coastal environments and morphology are diverse and we expect climate-related changes such as sea level rise and increased winter rainfall to increase cliff erosion and instability with the most severe erosion occurring in the east of England.

Climate changes may also impact on the way we construct and maintain our flood and erosion defences. In particular, increased coastal erosion and wave action may disrupt our asset maintenance and construction programmes.

The action we are taking

We are taking action to ensure we have a sound evidence base and that the latest research and engineering evidence is available. We make sure that that we use this evidence to inform our decisions, actions and our work with all our partners. We are:

- using the latest set of climate projections to understand how river flows may change;
- monitoring changes in river flows to compare the trends observed by our river gauges with our predictions;
- improving our ability to differentiate the effects of climate change from natural variations in rainfall and river flows;
- improving our understanding of the processes that influence coastal erosion and coastal flooding by undertaking research and modelling, including using the UKCP09 projections where appropriate;
- assessing the impact of climate change on reservoir safety.

On a day to day basis we will:

- continue to advise against inappropriate developments in areas at risk of flooding now and in the future. We are working with others to ensure that spatial planning guidance and practice fully address flood risk;
- continue to work with others to increase resilience to flooding;
- seek to understand the implications of climate change on our current estimates of future flood risk from rivers and reconsider our current management approach;
- continue to work with natural processes to tackle flood risk where it is appropriate and cost-effective to do so. This includes creating new wetlands and habitats that are resilient to climate change and can help to convey flood water away from people and properties;
- create new habitats to compensate for those lost as a result of sea level rise, coastal squeeze and erosion of the coast, where legally required. This also increases the potential for intertidal storage for estuary flood management and helps to dissipate wave energy;
- take a flexible approach in the development and implementation of flood risk management approaches including new defences and maintenance of existing ones to help us address uncertainties about the effects of climate change and appropriate responses. Action can be brought forward or put back depending on what actually occurs in practice compared with projections;
- take account of Government guidance when making allowances for future climate change in the design of structures and schemes;
- ensure that we consider the implications of changes to river flows and sea levels when designing new schemes and maintaining and modifying existing structures, including allowing for increased disruption to our construction and maintenance programmes;
- ensure that our incident management response standards and planning assumptions are kept under review to account for changes in climate;
- consider what additional funding may be needed to maintain and improve flood defence assets to cope with climate change

- consider the aesthetic acceptability of flood defences to communities in particular locations.

We work with a wide range of partners including Government departments, local authorities, land owners and managers and the owners, operators and occupants of commercial and residential property. We have a wealth of technical knowledge, practical experience and data and an important role to help others play their part in managing flood and coastal erosion risk.

- We will continue to raise awareness of all sources of flood and coastal erosion risk, including the implications of climate change, by working closely with those affected and those in a position to act.
- In Wales we have embarked on the "Flood Awareness Wales" community engagement programme. This represents a key strand of the Welsh Assembly Government's approach to managing flood risk through developing greater community resilience.
- In England, the Floodwise flood warning programme and coastal engagement projects seek to increase public understanding of participation in, and action on flood and erosion risk management.
- We will provide data, guidance and technical advice to:
    - inform the development and implementation of legislation including the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009;
    - enable our partners and those we regulate to consider the implications of climate change for flood risk, both inland and from the sea and for coastal erosion.

We have published guidance for the organisations that have been directed or invited to submit adaptation reports by Defra, using its powers under the Climate Change Act 2008. And we will continue to work closely with our professional partners (including local authorities) to implement Catchment Flood Management Plans and Shoreline Management Plans and coordinate local planning and delivery. We have developed coastal erosion information by assessing the impact of sea level rise and changes to winter rainfall using the UKCP09 projections.

Water

Our responsibilities

We are the lead government body for securing the proper use of water resources and enhancing and maintaining the quality of waterbodies in England and Wales. We:

- aim to ensure that the abstraction and return of water have no unacceptable impact on the environment or water users;
- aim to ensure that there is enough good quality water for people, businesses, industry and agriculture most of the time;
- publish information on the demand for water and available resources;
- aim to ensure that water is used properly and efficiently;
- ensure discharges from sewage treatment works, industry and businesses are of an appropriate quality;

- ensure that surface water, groundwater and coastal waters (up to three miles from the coast) are of an appropriate quality;
- implement EU Directives such as the Water Framework Directive by developing and implementing river basin management plans, and ensuring that all relevant water quality objectives and standards are met.

The risks we face

Water bodies are under pressure from population growth, urban development and land-use change. We expect climate change to increase the pressure by altering the frequency and distribution of rainfall, increasing temperatures and increasing the frequency and severity of extreme weather events. Higher temperatures will also increase evaporation and the demand for water. These effects are likely to be most severe where rivers are fed primarily by surface run-off rather than groundwater and therefore rise and fall rapidly in response to rainfall, as in much of Wales.

Climate change will therefore affect the demand for water as well as its availability and quality. Working at the catchment level we have assessed the implications of climate change for river flows using the 2002 climate projections from UKCIP. We are now working with Defra and WAG to update our approach. Our modelling suggests that, on average, natural annual flows could decrease, with large decreases in many rivers during summer and autumn months coupled with higher flows in the winter. These changes may put substantial pressure on surface and groundwater supplies and quality. Other research suggests that the frequency of severe droughts could increase and restrict the water available for wildlife, people, industry and agriculture.

Heavier rainfall and potentially increased storminess could increase runoff from agricultural land and urban areas and increase discharges from combined sewer overflows. Climate change, coupled with changes to land management activities and land use, could increase soil erosion, pesticide and fertiliser run-off and urban run-off, resulting in pollution of surface waters. In areas such as the South Wales Valleys where the underlying geology causes rapid runoff to waterbodies, we anticipate more acute pollution incidents during intense rainfall events.

Climate change is a priority risk to our objectives for ensuring secure, safe and sustainable water supplies and healthy waterbodies. We need to continue to act, including building on the actions we have already taken, to ensure we manage the risks effectively.

The action we are taking

As with flood risk, our actions to address the impacts of climate change on water fall under three broad headings: ensuring we have a sound evidence base; using it to change the way we do things; and sharing it with others.

In order to continue to develop our understanding of the implications of climate change and ensure that we have a robust evidence base we will:

- improve our understanding of the impact of climate change on the availability of, and demand for, water;

- work with others to assess how climate change will impact on the frequency and intensity of drought and security of water supplies;
- improve our understanding of how wildlife responds to changes in water flow and seasonal variations;
- model future flows to the 2050s, using UKCP09, to ensure consistent application in impacts assessments by us and our partners;
- monitor the effects of climate change and continue to review our monitoring networks to ensure that they are fit for purpose;
- understand greenhouse gas emissions in abstraction and wastewater collection and treatment and gather baseline energy/water-use data for agriculture, industry, power generation and other sectors;
- understand the benefits of retrofitting sustainable drainage systems (SuDS) to existing sewerage systems, where practicable;
- understand the implications of climate change on sewerage and wastewater treatment.

In managing access to water and safeguarding water quality we will:

- ensure that the appraisal process used for River Basin Management Plans under the Water Framework Directive considers climate change and that these plans are considered in water company Water Resources Management plans;
- continue to look at whole river catchments to determine how much water is available for people and the environment and in our work to maintain and enhance the ecological status of waterbodies;
- continue to manage access to water through abstraction and discharge permits to ensure that the environment is not being harmed;
- work with Defra and the Welsh Assembly Government to review our licensing regime to ensure it is adaptable to climate change;
- promote guidance on the construction and development of suitable new resource solutions and water efficiency;
- work with Defra and the Welsh Assembly Government to use current controls to tackle diffuse pollution effectively and propose new approaches where necessary;
- target our farm inspections and our range of regulatory interventions to tackle pollution;
- advise on flexible adaptation strategies for water resources infrastructure and water resources management.

Noting the many uncertainties relevant to our roles we will work closely with a range of partners to plan for the future. In particular we will:

- work with Defra, the Welsh Assembly Government and Ofwat to develop and evaluate options for future access to and allocation of water;
- advise and provide evidence to government departments, the Welsh Assembly Government, regulators and abstractors on how to improve water efficiency;
- update our guidance to water companies to reflect the pressures from climate change;
- advise large water users in industry, agriculture and the energy sector on ways to reduce water use. We will work with them to understand the impacts from

climate change, and develop sector-specific adaptation actions to minimise risks;
- work with the Energy Saving Trust to ensure that water and energy efficiency are considered together in future programmes;
- advise on water supply resilience and identify areas to improve the connectivity and integration of supplies;
- identify actions to increase the resilience of supplies that underpin food and energy security;
- advise on the need to change our regulatory approach where existing approaches fail to deliver the changes needed;
- review and modify our approaches to reduce the energy used to supply and treat water and to reduce greenhouse gas emissions.

Wildlife and habitats

Our responsibilities

We have wide ranging responsibilities for wildlife and habitats, although we are generally not the lead body for them. Our functions include:

- contributing to the UK Biodiversity Action Plan, the England Biodiversity Strategy, the Wales Environment Strategy, the Wales Fisheries Strategy and leading on some actions;
- conserving Sites of Special Scientific Interest and enhancing the biodiversity, cultural and recreational potential of land we own;
- assessing new permits we issue under the Habitats and Birds directives to check for impacts on Special Protection Areas, Special Areas of Conservation and Ramsar sites;
- implementing the EU Water Framework Directive to achieve good ecological status and conserving freshwater and migratory fish and their habitats;
- enhancing the economic potential and social value of migratory and freshwater fishing.

The risks we face

Biodiversity is already declining in the UK due to habitat loss and the impact of invasive non-native species. Climate change will put even more pressure on wildlife. Some species will be unable to survive in their current location and there will be limits on how much they can adapt by themselves. This will make it difficult or impossible for us to achieve our wildlife objectives.

Aquatic systems are likely to be amongst the most sensitive to a changing climate as drought, periods of high temperatures, floods and extreme rainfall are predicted to occur with greater frequency and severity. Low river flows and high temperatures during summer droughts could have particularly heavy impacts on fish populations.

The vulnerability of fish species to climate change depends on their habitat and life cycle. We expect coldwater and migratory species such as trout and salmon to be particularly affected. In some parts of the UK, we have already seen changes in water temperature lead to increased trout and salmon mortality and changes in their life-cycle, such as the size of fish and the timing of their migration. In the long term, it

may not be possible to conserve trout and salmon in all places. Eel populations have also declined in the last thirty years and it is possible that climate change is a contributory factor.

We expect that climate impacts on coarse fish such as bream and carp will be less severe. However, their ability to adapt depends on the speed of climate change and the robustness of their habitats. It will be more difficult for them to adapt if their habitats become fragmented or degraded by other pressures.

Non-native species may become invasive under climate change, which could further impact on the diversity and vulnerability of native freshwater fish.

The effect of these changes on angling is complex. Although we do not expect to see the sport decline as a whole, we may see significant impacts on trout and salmon fisheries. These have significant socio-economic and historical value in Wales and South East England in particular. We may also see a shift in the species that anglers fish for, as native species migrate and non-native species become established.

Climate risks to our wildlife and fisheries objectives are priorities for our adaptation programme and need urgent attention.

The action we are taking

Reducing pressures such as pollution is key to maintaining functioning ecosystems as the climate changes. The fewer pressures that plants, animals and habitats have to deal with the more resistant and resilient they will be. We will develop a landscape management approach to reduce pressures. We will:

- reduce temperature in selected rivers by working with our partners to increase bank-side shade (for example, by allowing trees to recolonise);
- work with others to achieve the best outcomes for river basins that we can;
- set temperature standards for coastal waters and estuaries to manage the impact of cooling water from power stations;
- contribute to early response and monitoring plans for non-native species;
- make space for the natural development of rivers and coasts;
- ensure that wildlife adaptation needs are addressed in permits;
- help fish migrate by tackling barriers and building fish passes into flood defence, hydropower and water pumping schemes;
- develop tools and guidance for conservation managers, including a tool for wetland managers to help them factor climate change into their work
- continue to work with natural processes to tackle flood risk where it is appropriate and cost-effective to do so. This includes creating new wetlands and habitats that are resilient to climate change and can help to convey flood water away from people and properties;
- create new habitats to compensate for those lost as a result of sea level rise, coastal squeeze and erosion of the coast, where legally required. This also increases the potential for intertidal storage for estuary flood management and helps to dissipate wave energy.

We will need to work closely with our partners to help wildlife adapt. In particular, we will need to work with government and conservation agencies to decide if our species, habitats and fisheries objectives should change with the climate. We will:

- work with conservation agencies to review and, if necessary, revise objectives for species and habitats to allow for inevitable climate impacts;
- explore how we can help freshwater species with poor dispersal capabilities reach alternative habitats (e.g. fish such as vendace and schelly);
- promote biodiversity adaptation measures to our customers and partners to aid the achievement of the Water Framework Directive objectives and those of the Habitats and Birds Directive and related legislation;
- work with customers and third sector organisations who share our goals to reduce pressures on wildlife and habitats and increase their resistance and resilience to climate change;
- continue to monitor fish stocks to identify changes in species health and composition (including invasive species) that may happen with climate change;
- assess the value of commercial and recreational fisheries as species composition changes, and monitor effects on angling and rod licence sales.

We may sometimes see periods of the summer where high temperatures and low rainfall lead to low river flows and warmer water temperatures. In such conditions oxygen levels in the water can fall and it may be necessary to rescue fish or oxygenate the water to help them survive. We may also need to reintroduce species to recolonise stretches where fish have died.

Where climate change could lead to the permanent loss of a habitat, we may need to consider relocating species that we are responsible for. We are exploring moving vendace and schelly from the Lake District to more suitable northerly locations in England and Scotland to ensure that the species do not become extinct and are more able to adapt to climate change.

One problem we face in helping wildlife adapt is that the evidence on impacts and adaptation measures is often uncertain. We will need to improve this evidence base to make sure that we are addressing problems effectively. We will work flexibly so that we can adjust adaptation measures if we need to. We will:

- adopt an adaptive management approach, where we implement flexible measures, monitor their effectiveness and adjust them as needed, including testing experimental approaches and through action-learning research;
- review good adaptation practice, external research and emerging literature;
- assess the vulnerability of species and habitats to help us target adaptation measures, particularly for salmonid fisheries.

4 Managing our other climate risks

Our risk assessment shows that parts of our business do not face significant risks but will need to adapt to achieve the same results they do now. These are:

- Regulating business and waste
- Land quality
- Recreation and navigation
- Sustainable places
- Maintaining business continuity
- Reducing our own carbon emissions

This chapter explains how we are responding to climate change in these areas of our business. Annex 2 gives more detail on the climate impacts we expect and our plans to respond to them.

Regulating business and waste

Our responsibilities

We work with local government and businesses to regulate activities with the potential to harm the environment:

- We ensure that waste is recovered or disposed of safely.
- We help local government develop and monitor sustainable waste plans.
- We issue environmental permits to help industry and businesses operate in ways that do not cause harm to people or the environment.
- We check to ensure that industry and businesses comply with their permits.
- We regulate radioactive discharges and disposals of radioactive waste.

The risks we face

Climate change should not directly affect our regulatory, advisory and support roles for industry and waste management, however it will influence how we carry out these duties.

We know that climate change is likely to affect the frequency and severity of extreme weather events, sea level rise, flooding and low river flows, as well as increasing temperatures. These impacts may increase the vulnerability of regulated sites and their emissions to the environment.

The action we are taking

We need to understand how climate change could affect regulated businesses and waste management sites and adjust our approach accordingly. We will:

- investigate the risks to regulated sites and their increasing vulnerability;

- assess the implications of the adaptation reports submitted by other reporting bodies, including utilities and public service providers;
- examine how we record information and monitor compliance to ensure that we can clearly identify any causal link between climate change and permit breaches or pollution incidents;
- investigate how improved site management can help to reduce vulnerability to climate change impacts.

We will ensure that the sites we regulate manage their climate risks by:

- considering climate change when reviewing permits, assessing operator compliance and issuing guidance to our staff and operators;
- ensuring approaches such as Best Available Techniques (BAT) take account of climate change;
- revising guidance on flood risk and environmental permitting regulations;
- investigating levels of awareness of risks and working with regulated businesses to help them adapt.

In May 2011 we will receive a revised safety case for the Low Level Radioactive Waste Repository. We have asked that climate change impacts on sites are addressed in the safety case and we will carefully review these.

Land quality

Our responsibilities

- We support Government policies and strategies on land resource protection such as Defra's Soil Strategy for England and the Welsh Assembly Government's Environment Strategy.
- We have regulatory duties for contaminated land, sewage sludge, nitrate vulnerable zones, silage and slurry.
- We use catchment-based approaches to tackle diffuse pollution and improve water quality and environmental objectives specified by the Water Framework Directive (see Chapter 3).

The risks we face

Climate change may increase pesticide and fertiliser run-off in agricultural catchments, affecting the quality of water bodies (see Chapter 3). Higher temperatures and lower rainfall in the summer may affect soil structure and moisture content, increasing the potential risk of sediment run off into rivers and other water bodies.

Climate change will not directly affect our ability to deliver our other regulatory, advisory and support roles for land quality.

The action we are taking

We will work closely with our partners to adapt land management by:

- advising government, trade organisations and other government agencies on ways to promote and enhance adaptation as part of the Common Agricultural

Policy, Rural Development Programme, Sludge Regulations, Biowaste Directive and Nitrates Directive;
- pursuing sustainable urban drainage systems under the provisions of the Water Framework Directive and the Flood and Water Management Act 2010;
- supporting the Rural Climate Change Forum;
- advising government on the need for regulations to allow for increased winter rainfall associated with the storage of slurry and dirty water, for example the Silage, Slurry and Agricultural Fuel Oil Regulations 2010.

And we will further develop our evidence base by:

- working with others to review climate projections and identify future impacts on water and land;
- using monitoring frameworks and research programmes to detect climate change impacts on water and land.

In the longer term, we may need to work with government to review whether the current approach to encouraging voluntary land use change through incentives and advice is sufficient in the face of climate change.

Recreation and navigation

Our responsibilities

We are the statutory navigation authority for:

- the Great Ouse river system, alongside the Nene, Stour, Ancholme, Glen, Welland and the Black Sluice;
- the non-tidal Thames;
- the non-tidal Medway, part of the Royal Military Canal in Kent and Rye Harbour;
- the River Wye (below Hay-on-Wye) and the Dee Estuary.

We maintain and improve navigation on these waters and licence boats using them. We also promote recreation on these waters and the land that we own by providing improved facilities for users.

In Wales, we support the Strategic Plan for Water Related Recreation.

The risks we face

We expect climate change to make it more difficult to maintain waterways. Low flows can make it difficult for boats to pass through locks and high flows could increase bank-side erosion, damage infrastructure or be unsafe for river users. Higher temperatures are likely to increase plant growth and algal blooms.

We expect climate change to alter the recreational use of the land and water we manage. In the short term, we may see more people using them during warm weather, particularly if domestic tourism increases. In the longer term, extremely high or low river flows could limit safe and pleasant recreation. Low river flows during summer droughts could affect wildlife and reduce opportunities for angling.

The action we are taking

We will work with other navigation authorities to keep waterways open through dredging and managing weed growth. Drought conditions present problems for us and we will need to manage minimum flows and levels to protect wildlife while keeping waterways open for boats as far as possible. Should risk of drought conditions increase we will develop practices to seek to maintain a minimum flow and manage lock movements.

We will review the recreational facilities we provide on the land and waters we manage to make sure they can be used safely.

The pressure on waterways from climate change could lead to conflict and competition between users. We will help to resolve problems where they arise.

We will improve our evidence base by:

- evaluating emerging evidence on high river flows, increasing evaporation rates, vegetation growth, spread of invasive non-native species and algal blooms;
- using climate projections of river flows to understand how low flows could affect the usability and maintenance of the navigable waters for which we are responsible;
- reviewing data on strong stream flows and 30-day duration mean flows to find trends that could affect maintenance, asset management and the advice we give on strong streams to warn river users.

Sustainable Places

Our responsibilities

We work with local authorities and local partnerships to progress key environmental issues, to ensure that new development does not affect environmental objectives and to increase the resilience of existing developments. This includes work with planning authorities to ensure that local plans take account of environmental constraints and future climate change risks.

The risks we face

Our responsibilities towards sustainable places are not sensitive to climate change but we have an opportunity to help others adapt and consider climate change in their work.

The action we are taking

We will work with partners to promote adaptation, including:

- local authorities as part of our partnership approach to address environmental risks such as flooding and water stress;
- emerging Local Enterprise Partnerships in England to provide information and evidence on environmental constraints and future climate risks;
- policy makers, developers and other partners to provide evidence on sustainable building standards addressing climate change risks;

- planning authorities to ensure that spatial strategies (local, sub-national and the Wales Spatial Plan) account for climate risks;
- the Infrastructure Planning Commission (and successor body) to highlight climate change to infrastructure developers;
- governments in England and Wales to help advise planners and developers on using the UKCP09 climate projections.

Environmental assessments offer an opportunity to promote adaptation. We will:

- use our role as a statutory consultee to recognise climate change in Strategic Environmental Assessments and Environmental Impact Assessments;
- update our guidance on Strategic Environmental Assessments to include climate change;
- advise government so that climate change is included in Environmental Impact Assessment guidance.

Business continuity and managing our facilities

Our responsibilities

Like any organisation, we need to make sure that we have the facilities and systems in place to support our activities. As a Category 1 responder under the Civil Contingencies Act we also have a legal requirement to be able to deliver certain critical services at all times, such as flood warnings. To do this we need:

- suitable buildings, depots, vehicles and equipment;
- to mitigate the impact of unforeseen events so that we can maintain our operational response and meet the requirements of the Civil Contingencies Act;
- to safeguard our staff, systems and property from disruption through contingency planning and alternative ways of working.

The risks we face

We expect more extreme weather events as the climate changes and these could disrupt our own operations and those of our suppliers. Increased frequency and severity of extreme weather could mean that our incident management and response capabilities need to be more robust. If one of our key sites is affected by a business continuity emergency, we have contingency arrangements in place to deliver our critical services from another site.

The action we are taking

We are managing the impact that weather and climate have, or could have, on our operations. Our plans include:

- analysing the vulnerability of our facilities and buildings (for example, to flood risk) to determine which could be most affected by climate change;
- managing potential disruption to services (for example our utilities supplies) by understanding our vulnerabilities and putting systems in place to manage climate change incidents (e.g. emergency generators for critical systems);

- considering climate change in our long-term incident management planning and in our contingency planning, notably for flood risk;
- considering a wider range of possible climate impacts on our activities and in planning to provide suitable facilities for our staff;
- building greater resilience into our third party supply chain by considering climate risks in our procurement processes;
- making sure that our suppliers manage their own resilience to climate change and confirm that they will prioritise maintaining their service to us.

Reducing carbon emissions

Our responsibilities

We aim to play our full part in helping England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts, including running the EU Emissions Trading System and the CRC Energy Efficiency Scheme.

We also plan to reduce our own carbon emissions by 33 per cent by 2015 from 2006-07 levels.

The risks we face

Our objective to help England and Wales meet greenhouse gas targets is not sensitive to climate change but we can promote adaptation in the design of low carbon technologies.

There is negligible climate risk to our target to reduce our own carbon emissions by 2015. In the longer term, the risks could be greater, for example the impact of extreme weather events on the need to pump water for flood risk and drought management.

The action we are taking

We will ensure that our mitigation activities consider the sustainability of low carbon technologies, and incorporate the need for climate change adaptation in their design and delivery (e.g. hydropower, biomass, anaerobic digestion, and ground source heat pumps).

5 Our adaptation programme

The risk assessment and action plans that underpin this report give us confidence that we are taking the right actions to manage the climate risks we face now and in the future. They show that:

- Climate change affects much of what we do.
- Our priority risks relate to flooding and coastal erosion, water resources and quality, wildlife and habitats. We are already making good progress on the actions we need to take to manage these risks.
- We need to manage specific risks in other areas of our business and adapt how we work to achieve the outcomes we want – we have plans in place to do this.
- Partnership working is essential for adaptation and we are working closely with the UK Government, the Welsh Assembly Government, local government, local communities, business and the third sector.
- Many of our climate risks interact and need to be managed in an integrated way – we are well placed to do this effectively.
- We will continue to develop our evidence base to improve our understanding of risks and advise others. We will update our risk assessment and adaptation plans as our evidence improves or our remit changes.

We are already implementing the actions set out in this report. The four-way characterisation of our climate risks gives us a way of comparing the implications of climate change for everything we do and we can use this information to take decisions on our immediate, and longer-term, priorities. We will implement a formal adaptation programme based on the analysis presented here. It will:

- be sponsored by one of our Directors;
- ensure that we prioritise our actions to address climate risks in the priority areas listed above; that we take appropriate action to mitigate other specific risks and that we monitor changes to all our risks over time;
- continue to contribute to the UK Government's Adapting to Climate Change Programme, hosted by Defra, and to the development of the Welsh Assembly Government's Adaptation Framework;
- monitor implementation of our plans and report on our progress;
- identify and share good practice approaches to managing climate risks;
- ensure that our staff have the knowledge, skills and tools they need to address climate change and make this available to our partners as well;
- ensure that our research and analysis is coordinated both internally and with our partners;
- review and update our assessment as our understanding improves or our objectives change.

We believe our adaptation programme puts us in a good position to help the Government deliver its own National Adaptation Programme, due in 2012.

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