warming up
the region
Yorkshire and Humber Climate Change Impact Scoping Study
“There is plenty of evidence that our climate is changing. We need drastic cuts in ‘greenhouse gas’ emissions but society must also be prepared to adapt to the change which is inevitable.”

Sir John Harman, Chairman of Environment Agency

“As much as we’d like to stop or even reverse the impact of climate change, and will continue to address its causes, the reality of the situation is that it is upon us and that we will have to learn how to adapt to it. It is essential therefore that we understand how climate change affects our region, for good and for bad, and at different times for quite some considerable time to come. This report goes a long way in helping us do that.”

Cllr A Barker, Yorkshire & Humber Assembly

“Yorkshire Forward recognises climate change is a major business issue for the Yorkshire and Humber region, with increased risks, but also new opportunities. Yorkshire Forward wants to ensure that the region grasps those opportunities. And, of course, if we act now, we can minimise the negative effects on business by adapting our businesses and our buildings.”

Pam Warhurst, Yorkshire Forward Board Member

“As the UK’s largest insurer, Norwich Union has already implemented a number of initiatives to address the issue of flooding. We want to reduce the number of preventable floods happening in the first place and are lobbying for improved flood defences and planning regulations.”

Clive Bolton, Director of Pricing for Norwich Union Insurance

‘Climate change will have a variety of impacts on our forests. Our trees and woodlands play a role in locking up carbon, are a source of renewable energy and a very sustainable construction material. But they are themselves also vulnerable to environmental damage. We are taking early action to assess our vulnerability and to identify priorities. Our forestry practices will have to be reviewed and revised as we gain in our understanding of the impacts and the consequences of climate change.’

Richard Britten, Forestry Commission’s Conservator for Yorkshire & the Humber

“The impacts of climate change could be devastating. With the Kyoto Protocol, the international community is making a first step to combat global warming.”

Margot Wallstrom, EU Commissioner for the Environment

“Over the past few years this region has learnt a lot about living with the effects of climate change. It is essential that we get a clearer picture of what the future impacts may be across the region if we are to prepare for these changes. We need to counter the adverse effects and, where possible, take full advantage of any beneficial effects.

It is good that the region is now working in partnership to look at those impacts and issues, but expressions of concern and studies will not be enough. Unless this work is followed up with definite action to ensure that we are fully prepared for and adapt to climate change then we will have failed the future generations left to solve the problems.”

Felicity Everiss, GOYH
THE YORKSHIRE & HUMBER REGION

Facts

The Yorkshire and Humber region is an area of nearly 15,000 km², stretching from the North Sea to within 50km of the Irish Sea. It is home to over 5 million people and includes the cities of Sheffield, Leeds, Bradford, Kingston-upon-Hull and York. The region is divided into four sub-regions; North Yorkshire, West Yorkshire, South Yorkshire and the Humber and includes two significant National Parks; the North Yorks Moors and Yorkshire Dales (Figure 1, see page 14).

Why it’s special

The Yorkshire and Humber region is characterised by its strong regional identity and its great diversity of landscapes, businesses and communities. Despite massive economic change over the last 20 to 30 years, the major urban centres still form part of the industrial heartland of the UK. Outside these areas the region is predominantly rural and of high environmental quality. Upland areas, such as the Pennines, provide a range of valued natural and semi-natural habitats and are of great natural beauty. Lowland valleys, such as the Vale of York, support highly productive agricultural activities. The region’s coastal areas include long stretches of designated Heritage Coast as well as the Humber Ports.

Vulnerability

The impacts of a changing climate will differ significantly across this geographically diverse region. Changing patterns of customer demand and disruption to transport services will affect urban centres while sea level rise and changing conditions for plant growth may transform the region’s valued coastal, agricultural and upland landscapes. Many of the region’s more marginal habitats, like the upland heaths and hay meadows, are particularly vulnerable and warming conditions could change them forever.

Opportunity

Both the public sector and businesses need to respond now to realise the potential opportunities, as well as address the risks of climate change. Important regional industries such as the agri-food business can maximise the opportunities of changes by incorporating climate scenarios into their strategies now rather than waiting for others to seize the opportunities and gain competitive advantage. Local authorities need to integrate climate change into sustainable development, land use planning and reinforce positive initiatives already underway to manage the natural environment and create a better quality of life for people living in the Yorkshire and Humber region.

“Climate change is another major challenge facing the region. The consequences seem to be beginning to manifest themselves through more frequent extreme weather events, sea level rise and increasing average temperatures. The region needs to plan for these consequences.”

Regional Sustainable Development Framework, 2001: p19
THE CHANGING CLIMATE

The historical climate

There is increasing evidence that the climate is changing. Globally, temperatures have risen by 0.6°C over the last 100 years. The Intergovernmental Panel on Climate Change (IPCC) has recently stated that most of the warming over the last 50 years is related to increased concentrations of greenhouse gases due to human activities.

The present climate

In Yorkshire and Humber sea levels and mean annual temperatures are already rising. Mean sea levels in the Humber Estuary and along the Yorkshire coast have risen at rates of between 1.5 and 3.6 mm per year over the last 80 years. Long term records of temperature in Sheffield show that the 1990s was the warmest decade since the late 19th century. There is also some evidence that winters in the 1990s were wetter than ever before. For example there was a threefold increase in the number of "wet" winter days at Whitby on the Yorkshire coast.

Climate futures

These trends seem set to continue and accelerate during this century as average temperatures increase all the year round and winters become wetter. By the 2050s, the average length of the growing season for farmers in the Vale of York will increase by around one month. By the 2080s, snowfall in coastal towns like Hull will be a thing of the past – it is unlikely for any significant snow events to occur in lowland and coastal areas. Despite the uncertainties in future greenhouse gas emissions and climate scenarios the balance of evidence suggests that the season to season and year to year variation of the region’s climate will also increase. Unusual climate events, such as droughts and floods, could become the norm within our lifetime.

Making the links

Changes in climate are due to both natural variations and human influences due to increasing emissions of greenhouse gases such as carbon dioxide (CO₂) and methane (CH₄). Today the concentration of CO₂ in the atmosphere is 30% higher than before the onset of the industrial revolution. The increase in CO₂ and other greenhouse gases has reduced the amount of energy lost to space, warming the Earth’s surface. The links between greenhouse gas emissions and rising temperatures are complex. The UK Hadley Centre for Climate Prediction and Research has developed a range of powerful computer models to describe these links and estimate future changes in climate for different levels of greenhouse gas emissions.

Responding to change

Our response to climate change should involve mitigation against the causes of climate change and adaptation to the impacts and opportunities arising from climate change.

Mitigation

Many initiatives have been established in an attempt to slow the rise in atmospheric greenhouse gas concentrations. Global scale agreements, such as The Kyoto Protocol will, if enforced, bind countries to modest national emissions reduction targets. Nationally the UK government aims to reduce UK CO₂ emissions by a more challenging 20% below 1990 figures by 2010. The Yorkshire and Humber region have pledged reductions equal to or greater than the UK target. Locally, campaigns have encouraged us all “to do our bit” by reducing energy consumption.


Adaptation

Despite these efforts, we are already committed to further climate change due to lags in the climate system. Furthermore, without greater cuts in emissions, the rise in greenhouse gas concentrations and global temperatures will continue. Consequently, planning and implementing adaptation strategies, such as changes in the design of buildings or substitution of present agricultural varieties for those more suitable to changed climatic conditions, is critical. Action is required now on both mitigation and adaptation to avoid the worst consequences of, and take full advantage of the opportunities arising from, climate change.

Future scenarios

It is unclear whether individual countries will meet short term and long term targets to cut greenhouse gas emissions. While it is certain that some warming is inevitable due to the legacy of past CO\textsubscript{2} emissions, future rates of global warming can’t be predicted. In order to provide a framework for dealing with this uncertainty the UK Climate Impacts Programme (UKCIP) has recently provided a new set of future climate scenarios\textsuperscript{1} that describe the rates of warming in response to different levels of emissions, namely Low Emissions, Medium-Low Emissions, Medium-High Emissions and High Emissions. These scenarios update and improve upon an earlier set of UKCIP scenarios released in 1998.

Climate scenarios for Yorkshire and Humber

The new climate scenarios suggest that the region will be between 1 and 2.5°C warmer by the 2050s and between 1.5 to 4°C warmer by the 2080s. This warming will occur throughout the year with the greatest rises in the summer months of up to 4.5 degrees in the Humber Estuary by the 2080s under the High Emissions scenario.

This warming will be accompanied by wetter winters and drier summers. In a major departure from the findings of the 1998 scenarios, the 2002 scenarios suggest that summers will be drier throughout the region and, along with drier springs and autumns, will lead to a reduction in average annual rainfall of up to 10%. Data from Low and High Emissions scenario are summarised in Tables 1 and 2. Maps of changes in winter rainfall and annual temperature are shown in Figures 2 and 3 (see pages 15 and 16). These data illustrate the wide range of possible climate futures for the region.

Table 1 Increases in temperature (°C) in Yorkshire and Humber, relative to 1961-1990

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual</th>
<th>Winter (DJF)</th>
<th>Summer (JJA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020s</td>
<td>L 0.5 to 1.0</td>
<td>5 to 1.0</td>
<td>0.5 to 1.1</td>
</tr>
<tr>
<td></td>
<td>H 0.5 to 1.0</td>
<td>0.5 to 1.0</td>
<td>1.0 to 1.3</td>
</tr>
<tr>
<td>2050s</td>
<td>L 1.0 to 1.4</td>
<td>1.0 to 1.4</td>
<td>1.5 to 1.8</td>
</tr>
<tr>
<td></td>
<td>H 2.1 to 2.3</td>
<td>1.6 to 1.8</td>
<td>2.5 to 2.9</td>
</tr>
<tr>
<td>2080s</td>
<td>L 1.6 to 2.0</td>
<td>1.4 to 1.6</td>
<td>2.3 to 2.6</td>
</tr>
<tr>
<td></td>
<td>H 3.5 to 3.9</td>
<td>2.7 to 3.0</td>
<td>4.0 to 4.6</td>
</tr>
</tbody>
</table>

Note: L – Low Emissions scenario; H – High Emissions scenario. These data are for the following periods: 2020s – 2011 to 2040, 2050s – 2041 to 2070, 2080s – 2071 to 2100 AD

Table 2 Increases in rainfall (%) in Yorkshire and Humber, relative to 1961-1990

<table>
<thead>
<tr>
<th>Period</th>
<th>Annual</th>
<th>Winter (DJF)</th>
<th>Summer (JJA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020s</td>
<td>L 0 to –5</td>
<td>0 to 5</td>
<td>–10 to –15</td>
</tr>
<tr>
<td></td>
<td>H 0 to –5</td>
<td>2 to 6</td>
<td>–12 to –15</td>
</tr>
<tr>
<td>2050s</td>
<td>L 0 to –5</td>
<td>8 to 12</td>
<td>–13 to –17</td>
</tr>
<tr>
<td></td>
<td>H 0 to –5</td>
<td>15 to 20</td>
<td>–27 to –32</td>
</tr>
<tr>
<td>2080s</td>
<td>L 0 to –5</td>
<td>13 to 17</td>
<td>–23 to –26</td>
</tr>
<tr>
<td></td>
<td>H –5 to –10</td>
<td>25 to 32</td>
<td>–47 to –52</td>
</tr>
</tbody>
</table>

The climate will change significantly by the 2050s and dramatically by the 2080s. The major changes by the 2080s include:

- Increases in sea level of between 6 and 82 cm, with the greatest rates of rise in the Humber Estuary under the High Emissions scenario. The scenarios for the Humber are centred on an average rate of 6mm per year that is currently used for planning purposes.
- An increase in high rainfall intensities during the winter across the region, causing urban flooding problems in Bradford and other cities.
- A fourfold decrease in “frost” nights, approximately five-fold increase in “warm” summer nights and two to threefold increase in warm summer days across the region.
- Increases in solar radiation and reductions in cloud cover of between 10 and 20% along the Yorkshire coast.
- A reduction in the number of days with fog across the region, including major transport routes, like the M62 and M1.
- More depressions across the UK may lead to stronger winds in winter across the region.
- Large reductions in soil moisture in summer across the region affecting farms, parks and gardens on sandy soils, for example on parts of the Vale of York, as well as increasing the risk of subidence of property on clay soils in the Vale of Lincolnshire and Mowbray.
- Increases in the number of very hot days throughout the region with the greatest impact in large cities like Leeds away from the coast.
- An increase in the length of the growing season by between 45 and 100 days along the Yorkshire and Lincolnshire coasts.
- A small increase in the frequency of extreme wind speeds under the Medium High and High Emissions scenarios.

While changing average conditions will affect many human activities and natural processes, the main impacts of climate change are likely to be related to changing extreme events. The most notable changes for the 2080s Medium High Emissions scenario include:

- A fourfold increase in the frequency of “wet” winters with 60% more rainfall than average (1961-1990)
- A fourfold increase in the frequency of a “dry” summer with 50% less rainfall than average (1961-1990)
- A hot “1995” type summer nearly every year rather than once in hundred years based on the 1961 to 1990 climate

Climate surprises

There has been some speculation that a weakening of the Gulf Stream could actually lead to a cooling of the UK climate in future. However, the recent UKCIP report concludes that this is unlikely to result in a cooling over the next 100 years. During this century the warming effects of greenhouse gases will far outweigh any changes to the Gulf Stream.
There are potential “wins” for the coastal zone, such as the development of new forms of tourism and recreation to take advantage of the warmer climatic conditions. The main business opportunities relate to increasing the tourism potential of the coastal areas and providing services to mitigate against climate extremes for example:

- Development of new forms of low impact tourism along the Yorkshire coast
- Development of new flood proofing and flood protection products
- Specialist services to reduce the risks of supply chain or utility disruption due to flooding and specialist insurance products and schemes to insure property in the tidal floodplain

Progress

Government agencies are already making some progress to adapt to climate change. New flood defences in the region have taken future rises in sea level into account. Our understanding of inter-relationships between the flood defence and coastal conservation is improving, and a more integrated approach is now taken to flood defence. Shoreline Management Plans and Integrated Coastal Zone Management programmes mean that the coastal flood defence sector have responded more to the threats of climate change than other sectors. The Environment Agency has recognised the potential losses of key inter-tidal habitats and is in the process of identifying suitable coastal sites for the managed realignment of embankments to create approximately 1000 hectares of inter-tidal habitat around the Humber on what was agricultural land.

Moving forward

There are still big challenges related to development, tidal floodplains and eroding shorelines. Current guidance suggests that all land within the coastal floodplain is at high risk but this is prime development land for new industry that may be required for the region’s development. More detailed zoning of the relative risks is required so that flood and erosion risks can be considered in detail alongside other planning considerations. Some Maritime District Councils, such as East Ridings, have started this process as part of their Integrated Coastal Zone Management Plan but more work is required at a regional level.

RISING SEA LEVELS

Introduction

The coastal zone is an important regeneration area for Yorkshire and the Humber. It includes Humber ports, the smaller towns of Scarborough, Bridlington, Cleethorpes and Whitley and the proposed Humber Trade Zone. The coast is particularly vulnerable to a changing climate in terms of rising sea levels, changing patterns of tidal flooding and coastal erosion and the warming of sea waters.

Potential Impacts

Rising sea levels are one of the most certain aspects of a changing climate. With the exception of the low lying fens around the Wash in Norfolk, the region has the largest area at risk from tidal flooding in the country. It also has the greatest value of assets at risk from flooding due to the lower standard of protection in the Humber compared to the Thames Estuary. However there are a wide range of potential impacts directly and indirectly on the coast due to changing patterns of river flow and quality, recreation and tourism activity and perceptions of flood risks associated with locating businesses in areas of possible tidal flooding.

The main impacts of climate change on the coastal zone will be:

- Rising sea levels leading to:
  - “Coastal squeeze.” Inter-tidal habitats that are important for birds and other species could be lost to the sea as they are trapped between rising sea waters and hard coastal defences.
  - Increased risk of tidal flooding including the overtopping, bypassing and breaching of coastal defences due to sea level rise and possibly changes in storminess. Tidal gates and pumping stations will have to be operated more frequently with possible knock-on effects for estuarine and river ecology.
  - A larger area of land within the 1 in 200 year tidal indicative floodplain map. This area is defined as “high” flood risk in Planning Policy Guidance note 25 (PPG25)
  - An increase in drainage problems because drains into the Humber estuary will be “tide-locked” more frequently due to higher sea levels. There will be a greater need for pumping of drainage water from low lying land into the estuary with the knock-on effect of increased energy use.
  - Disruption to coastal transport corridors due to increased frequency of flooding, particularly alongside the Humber Estuary.
  - Increased rates of coastal erosion and land sliding leading to losses in agricultural land and property.
  - Growing concern regarding tidal flood risks potentially leading to “insurance blight” for businesses and households and a reduction in inward investment into these priority areas due to the high risk of flooding.

- Changing sea temperatures that will affect the type and quantity of fish stocks. The area has already seen a reduction in cod stocks and an increase in red mullet due partly to warming waters.

- A possible increase in the likelihood of algal growth in coastal waters.
**INCREASING FLOOD RISKS**

**Introduction**

Inland areas are threatened by changing patterns of flood risk, as well as the coastal zone. Large areas of the region are affected by river flooding, groundwater flooding and urban drainage problems. This includes major urban areas such as Leeds and Doncaster, large parts of South Yorkshire’s “regeneration areas”, high quality agricultural land in the Vale of York and major transport links such as the A1.

The Autumn 2000 floods provided a powerful “wake up call” highlighting the linkages between climate, land use and flooding. Rivers in Yorkshire and Humber were among the worst hit in the country with major flooding in Barlby, Selby, York, Ripon, Goole and elsewhere. The flooding followed an unprecedented period of rainfall during which the normal October and November rainfall fell within two weeks between 26th October and 4th November, causing widespread river flooding and drainage problems.

Although the Autumn 2000 floods can’t be linked directly to climate change they illustrate the potential impacts. The climate scenarios suggest wetter winters and indicate an increased risk of flooding. This may be accompanied by changes in the level of risk in spring, summer and autumn and the overall impacts of the UKCIP02 scenarios is subject of an ongoing Department of Environment, Farming and Rural Affairs (DEFRA) study.

**Potential Impacts**

Patterns of flooding will change over the next 50 years. Increased rainfall in winter is likely to lead to larger and longer duration winter floods. Rather than individual floods lasting a few days, there may be a “flood season” with high river flows for weeks or months derived from higher groundwater and runoff inputs. The region’s flood defences were not designed for extreme, prolonged floods and further work is required to determine how best to react to those changing conditions.

The impacts of increased winter flooding will not only affect people and businesses located in the floodplain. The Autumn 2000 floods proved the floods affects business supply and demand chains, transport routes and water, gas and electricity utilities. The costs of emergency services, repairs to flood defences, disruption to manufacturing production and insurance pay outs affect everyone – we all have an impact on climate and we all, eventually, pay the bill for global warming.

Urban drainage infrastructure in cities such as Leeds, Bradford and Sheffield and towns such as Huddersfield, was built largely in the 19th century and may not cope with 21st century winter rainfall conditions. Even drainage and sewerage systems built over the last 30 years have been designed using historical data for the period up to the 1970s and, unlike coastal flood defences, no specific allowances have been made for climate change. Over the next 50 years, major investment may be required to both “retro-fit” underground storage systems to store urban flood water and move towards more sustainable drainage systems to prevent more frequent discharges of Combined Sewer Overflows into our rivers.

The main impacts on changing flood risks will be:

- Increased river flows and flood risks during winter months in the region’s lowland vales and estuaries (Map 1, see pages 14)
- An increase in the area of land covered by the 1 in 100 year fluvial indicative floodplain map
- The emergence of a winter flood season that may require different forms of flood defences in some areas and different strategies to return floodplain agricultural land to washlands or water meadows in others
- Changes in the pattern of flooding in other seasons

4 DEFRA/Environment Agency joint R&D programme into Coastal and Flood Defence.

**Progress**

The potential links between climate change and flood risks are subject to ongoing joint research programmes at DEFRA and the Environment Agency. In parallel with the Shoreline Management Planning process, Catchment Flood Management Plans will provide a more integrated assessment of flood risks and linkages with other planning issues.

**Moving forward**

Some increases in funding have followed the Autumn 2000 flooding. However, fundamental changes to the planning process and clear indications of the relative importance of different statutory guidelines, for example guidelines on flood risks versus those on brownfield development and housing density, are required to address some of the challenges of future regeneration and increased flood risks.
BALANCING WATER SUPPLY AND DEMAND

Introduction

The region has a diverse mixture of water supply sources including small upland reservoirs, abstractions from rivers like the Dose and Derwent and from groundwater sources. The changing balance of rainfall and evaporation over the next 50 years will impact on these sources in different ways, increasing resources in parts of the region reliant on groundwater and reducing them elsewhere. The quality of water as well the quantity will change, improving in situations where greater river flow dilutes pollution and deteriorating in some specific locations due to changes in soil and water chemistry. Over the same period, the demand for water will change due to social and economic changes as well as the increased demand in warmer, drier summers. Changing how people use water and investing in new water sources or distribution systems takes time and we need to plan now to balance future supplies and demands. Appropriate adaptation now will ensure that there is enough water for new households and businesses, recreational use, fisheries and important wetland habitats in the 2020s and beyond.

The 1995 drought had a large impact on the region, with local water sources “running dry” in West Yorkshire. Investment in water distribution systems over the last 7 years has made these communities less vulnerable to drought. However greater reductions in demand and further investment in appropriate management systems and possibly infrastructure will be required over the next 25 years to balance supply and demand across the region.

Potential Impacts

Wetter winters, drier summers and warmer temperatures will impact on the quantity and quality of water in our rivers and groundwater systems. The main impacts on water resources include:

- Greater average winter recharge to groundwater sources that is likely to increase the amount of water available and relieve the pressure on aquifers that are currently over-used.
- Higher river flows in the winter and much lower flows in the summer. This will provide positive benefits for water reservoirs but negative impacts on businesses that rely on abstracting from rivers in the summer months.
- A fine balance will need to be met between maintaining reservoir levels and pumping from rivers. Water companies need to optimise water management practices to minimise the impact on the environment of pumping water from rivers like the Derwent in summer, while reducing pumping costs and consequently their greenhouse gas emissions.
- Local seasonal and annual droughts may become more frequent. We need to use water more carefully during the summer months and water companies need to ensure that water can be distributed effectively throughout the region.
- Higher demands for water in the summer months from both households and some businesses.
- Agricultural needs for water will increase due to higher irrigation demand, particularly for potatoes, and increased demand nationally for seasonal salad products.
- In urban areas “hard won” water quality improvements may be lost if increased winter rainfall intensity leads to a greater frequency of urban sewer overflows into our rivers. Drainage systems in urban areas such as Bradford, Leeds and Sheffield need further investment to help improve water quality.
- In upland areas, including important drinking water reservoirs, water quality may deteriorate due to the release of organic soil materials that discolor water.

The 1995 drought had a large impact on the region, with local water sources “running dry” in West Yorkshire. Investment in water distribution systems over the last 7 years has made these communities less vulnerable to drought. However greater reductions in demand and further investment in appropriate management systems and possibly infrastructure will be required over the next 25 years to balance supply and demand across the region.
Figure 1 Map of the Yorkshire and Humber Region

Map 1 River and tidal floodplains in the Yorkshire and Humber Region showing areas at risk in the absence of flood defences.

Note: The area in green is the 1 in 200 year (0.5% probability) undefended tidal floodplain and the area in blue is the 1 in 100 year (1% probability) fluvial floodplain.

Figure 2 Changes in winter rainfall for England and Wales

© Crown Copyright 2002. The UKCIP02 climate scenario data have been made available by the Department for Environment, Food and Rural Affairs (DEFRA). DEFRA accepts no responsibility for any inaccuracies or omissions in the data nor for any loss or damage directly or indirectly caused to any person or body by reason of, or arising out of any use of, this data.
Figure 3 Changes in mean annual temperature for the Yorkshire and Humber Region

- In other areas water quality may improve due to increased river flows diluting pollution
- Changing water quantity, quality and warming of rivers will affect fisheries. Some exotic species like Common Carp and indigenous species, like eels may benefit while other valued species, like brown trout, could be badly affected.

There are also a range of opportunities for businesses related to the development of products that improve water efficiency for agriculture, industrial processes and public buildings

**Progress**

Both the water industry and government agencies have been concerned about the potential impacts of climate change for some time. Since the publication of the UKCIP98 climate scenarios, the water industry has invested heavily in research into the potential impacts on water supplies, demands, water quality and sewerage design. The Environment Agency have published a Water Resources Strategy for the Future that considers possible changes in populations, water use and climate change. Water companies are required to produce 25 year water resource plans taking climate change into account.

**Moving forward**

Although an increase in winter rainfall will have some benefits for water supply and water quality other changes will mean that there are negative impacts on individual businesses and communities. Businesses that will be affected need to invest in water efficiency and ensuring alternative water supplies. More work is required on finding suitable small scale water supplies, grey water recycling, understanding potential water quality changes, managing fisheries and drought contingency planning.
Agriculture and Food Case Study

The food and drink sector is of major importance to the economy of the Yorkshire and Humber region, with extremely strong links between local agriculture, fisheries and subsequent processing into finished food and drink.

Initial perceptions from within the industry about the potential impacts of climate change ranged from ‘there are opportunities for increased yields and profitability’ to ‘there will be minimum impact, the industry will cope as it always does’, through to concerns over the ‘severe damage to specific sectors’.

Potential Impacts

The main impacts of climate change that will affect the region’s agricultural landscape include:

- Global climate impacts on agriculture will affect food processing, one of the most important industries within the region.
- Some food manufacturers have located outside the region due to direct flood damages.
- The water demand of irrigated crops will increase in the summer months. Farmers reliant on abstraction from rivers will need to consider alternative water sources or develop small scale on-farm reservoirs.
- There may be a greater demand for salad crops from local urban centres and external markets in the UK and Europe.
- Increased yields, employment and possibly profit in the forestry industry. There are opportunities for win-win situations to mitigate against and adapt to climate change in this sector.
- Shallow rooted broad-leaved trees such as beech will suffer from drought stress and decline in numbers.
- Afforestation and changing rural land use have important roles to play in adaptation strategies in other sectors, such as flood defence, water supply and recreation and tourism. If agricultural land is taken out of production in the right locations, changing land use could provide multiple benefits for conservation, recreation and the reduction of flood risks.

Progress

Yields of potatoes and sugar beet have suffered in drought years but overall, farmers and the agricultural food business have developed strategies for coping with variations in climate. The Forestry Commission, DEFRA and the Country Land and Business Association have started to respond to the potential impacts of climate change and can provide farmers and rural businesses with advice on building climate change into decision making.

Moving forward

There are real opportunities in the food and forestry businesses to benefit from a changing climate. However European policy and changing world markets will still be the main driver of agricultural change. It’s important that any changes to national and international policy consider climate change and ensure that competitive advantages that will come with changing agricultural conditions and the demands for food can be gained by UK producers.

Evolving Agricultural Landscapes

Introduction

Agriculture is a major economic sector in the region, with rural land use covering 80% of Yorkshire and Humber and one fifth of the population living in rural areas. Major crops, such as cereals, sugar beet and potatoes and potential new crops will be affected by climate change in different ways, with the greatest impacts on irrigated crops on sandy soils that are less efficient at holding water in drought conditions.

Forestry is less important in terms of land cover and production but in future, the sector should benefit from a changing climate with increasing yields due to higher temperatures, rising CO2 levels and changing rainfall patterns.

Potential Impacts

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• Some food manufacturers have located outside the region due to direct flood damages.
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• There may be a greater demand for salad crops from local urban centres and external markets in the UK and Europe.
• Increased yields, employment and possibly profit in the forestry industry. There are opportunities for win-win situations to mitigate against and adapt to climate change in this sector.
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CHANGING HABITATS

Introduction

Yorkshire and Humber’s diverse natural environment is a key component of the region’s future development. The two National Parks, Areas of Outstanding Natural Beauty and Heritage Coast support a strong tourist industry and provide protection for important habitats and landscapes.

The region hosts over a quarter of the priority species identified in the UK Biodiversity Action Plan including the world’s only natural populations of some plants, for example Lady’s Slipper Orchid (Cypripedium calceolus) and Yorkshire Feather Moss (Thamnobryum cataractarum) whilst also providing the only breeding site for the corncrake in England.

Potential Impacts

Climate change will affect the region’s habitats in different ways. The habitats most at risk are upland heathlands, like the North Yorks Moors, mudflats at risk from coastal squeeze and wetland and peat bog habitats that are dependent on water regimes that will change significantly over the next 50 years. Individual species may be most vulnerable to small changes in the spring rather than the “headline” larger changes in the winter and summer months.

The main impacts of climate change on the natural environment include:

- Recreation pressures may increase with impacts on sensitive habitats
- Warming and drying will impact differently on individual plant and animal species. Some animal species, like badgers, are expected to initially do well under climate change.
- The overall impacts on biodiversity are uncertain but there may be an overall increase in biodiversity with major decreases only in coastal areas or where habitats are already marginal.

Progress

Biodiversity audits and action plans, research and climate impacts studies undertaken by English Nature and others have provided a better understanding of the region’s natural environment and the potential impacts of climate change.

Moving forward

Further work is required to develop flexible management plans for important habitats. Rather than preserve species and habitats that will migrate and change, these plans need to provide positive conservation benefits such as increased biodiversity, water habitats of good ecological quality and land management practices that enhance wildlife and benefit rural communities.
NEW OPPORTUNITIES FOR INDUSTRIAL CHANGE

Introduction

Industrial and commercial companies are beginning to realise the importance of future climate change in terms of opportunities and risks on their operations. In the past, climate was seen as an inevitable external influence and climate change was an issue that was only relevant to larger companies in the energy field and to environmental organisations. Now, larger companies are gradually becoming aware of the impacts of climate change on demands for products, raw materials and supply chains, the workforce, property and on financial investment. The challenge now is to engage and help the region’s small to medium sized companies to both protect themselves and benefit where possible from climate change impacts. This will be better achieved when environmental factors, including climate change, are brought closer to the priorities of the business, with investment and return, employment, best practice and regulatory compliance.

Potential Impacts

Impacts and opportunities are different for individual sectors and businesses. Extreme weather, including the 1995 drought and the Autumn 2000 floods, have affected most businesses either directly, (e.g. due to flooded premises), or indirectly, due to impacts on electricity or water supplies and transport networks.

The main impacts and opportunities on industry and commerce include:

<table>
<thead>
<tr>
<th>Issue</th>
<th>Impact</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business location</td>
<td>Changing flood risks, damage to property</td>
<td>Specialist services e.g. emergency response, insurance services</td>
</tr>
<tr>
<td>Industrial design</td>
<td>Processes sensitive to temperature, water quality or other environmental change will need to accommodate change</td>
<td>Real time control systems, for example to operate power station discharges</td>
</tr>
<tr>
<td>Building standards</td>
<td>Standards are based on cooler conditions with lower flood risks than the future climate. Insufficient climate control, flood proofing and drainage design</td>
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</tr>
<tr>
<td>Product Demands</td>
<td>Reduction in customer demand for some products</td>
<td>Increased consumption of drinks, salad crops, lifestyle products, environmental technology products</td>
</tr>
<tr>
<td>Workforce</td>
<td>Transport problems, comfort in the workplace</td>
<td>Increased attractiveness of some locations, developing good corporate image on environmental issues</td>
</tr>
<tr>
<td>Raw materials and utility supplies</td>
<td>Suppliers become unreliable, water or energy supply becomes less secure due to flooding and drought</td>
<td>Supply chain, energy and water management services</td>
</tr>
<tr>
<td>Finance, investment priorities and insurance</td>
<td>Higher insurance, insurance blight in floodplains and reluctance of inward investors due to climate risks</td>
<td>Invest in technologies that support adaptation strategies, e.g. water efficient processes. Specialist financial services</td>
</tr>
</tbody>
</table>

*Advisory Committee on Business and Environment http://www.defra.gov.uk/environment/acbe/pubs/acbcpolicy.htm

Progress

Some of the region’s largest companies have made responded to climate change issues. For example, energy saving schemes in industrial and commercial premises are designed and implemented in most large new developments. Some sections of the building industry have responded with both innovative and “compliance” design features in a wide range of buildings.

Moving forward

Small and medium sized enterprises need to become more involved in climate change adaptation. The region as a whole needs to identify and promote any competitive advantages offered by warming conditions, for example in leisure and tourist activities. In particular, small environmental technology and specialist service companies may be able to establish regional and national niches to provide services that help adapt to climate change and mitigate against global warming. This is already seen in energy-related technology enterprises in the region.

Profiting from the green economy

Waste minimisation, water efficiency and the reduction in energy use provide economic benefits as well as reducing greenhouse gas emissions and supporting climate change adaptation strategies. There are major opportunities for growth in the environmental technology sector to develop products and services that can make industry more eco-efficient.
CHALLENGING ROLE FOR THE SERVICE SECTOR

Introduction

Service providers including local authorities, the health sector, heritage, tourism and recreation and the insurance sectors are at the forefront of a changing climate. Local authorities and their professional partners provide a range of services and are in a unique position to provide integrated responses to climate change including the sustainable development of brownfield land, the encouragement of water and energy efficiency, waste minimisation and recycling in all development and the sustainable use of transport.

The vulnerability of the tourism sector to external events was recently highlighted by the Foot and Mouth epidemic with a reduction of visitor numbers by up to 40%. However, a number of positive initiatives focused on the region’s museums and theme parks, have shown how the industry can recover from set-backs. These actions make tourism well placed to respond positively to the potential impacts of climate change.

Potential Impacts

The main impacts of climate change on the service sector include:

- Heritage sites, like York Minster and Bolton Abbey are extremely fragile and could be damaged by extreme weather conditions, including drought, flooding and water-logging. In future the condition of historic buildings, parks and archaeological sites will need to be closely monitored to ensure adequate protection.

- Opportunities for tourism and recreation sectors including the re-branding and marketing of coastal tourism and increased use of country parks, such the Rother Valley and Pugneys Country Park in Wakefield.

- There will be a reduction in the number of cases of hypothermia, pneumonia and other health problems relating to cold weather conditions. Other health problems may increase, for example respiratory conditions due to damp in wetter winters and increased atmospheric pollution in warmer summers.

- Local authorities, health authorities and emergency services will need to adapt to changing patterns of flooding, fire risk, transport, health, social activity and lifestyles.

- The possibility of the end of flood cover within household and contents insurance products for properties located in the floodplain. The growth of specialist insurance services.

- Potential growth in specialist services, such as environmental technology, centred on the region’s university campuses and science parks in Leeds, Sheffield and elsewhere.

- Leisure activities, which are well-developed in the region, are often very dependent on the weather. Drier, warmer summers will provide more days to play cricket. In future improved drainage and more all-weather sports pitches will be required to play other sports throughout the year.

Progress

Certain elements of the service sector are taking action to combat climate change. For example, local authorities and regional government have made firm commitments to adapting to climate change as well as reducing greenhouse gas emissions by at least 20% by 2010. The insurance industry has acted at a national level but the market for specialist insurance to deal with “insurance blight” in areas flooded regularly has been slow to develop.

Moving forward

Local authorities have a prime function in ensuring integration. Many have had to take on a major role where flooding has occurred. This has focused local authorities on the long-term planning horizon, which will need to be maintained together with an adaptable and flexible approach to the unexpected. Such an approach will need more cross-regional working as well as raising the awareness, and gaining the support of the public for future action. In all of this realistic attitudes to local development and planning permissions will require nurturing.
CONCLUSIONS

The climate of Yorkshire and the Humber is changing. The region is committed to achieving targets of reducing greenhouse gas emissions by at least 20% by 2010. Some climate change is inevitable due to past greenhouse gas emissions but a coordinated effort must begin now to protect the region against future climate extremes and make the most from new opportunities influenced by a warming climate.

Major risks

The key impacts of climate change are related to increased temperatures all year round, wetter winters and drier summers. The major risks are that climate sensitive industries and government agencies fail to respond to the early warnings and continue to plan, design, build and operate as before. For example, industrial development should avoid the areas most at risk to flooding. In some places there can be a gradual “roll-back” of development from the coast, whereas in others, higher levels of protection may be required.

By acting now the risks can be managed and the regional costs of global warming can be reduced and the benefits realised.

Major opportunities

While the climate change “headlines” may be about flooding in winter and drought in summer, there are many opportunities presented by a warmer climate. An adaptive and innovative agriculture and food cluster could benefit from change as long as climate change is considered in long term planning. There could be a growth in specialist services and environmental technology companies building on the success of the region’s universities and science parks. Careful husbandry of the region’s land and water resources is required so that the region can maintain its high quality natural landscapes, continue to improve water quality and avoid the water scarcity that will affect other regions, particularly the South East.

Moving Forward

There are a number of themes that need to be addressed to promote climate change adaptation in Yorkshire and the Humber.

Building consensus

While some organisations perceive climate change as important, others still believe that it is of minor importance to their operations. Larger industries are responding, but there is a major role for business support and advice agencies to encourage smaller businesses to consider energy efficiency, water efficiency, climate risks and climate opportunities.

Managing the extremes

Over the last 20 years, Yorkshire and the Humber has been affected by extreme droughts and floods. The Environment Agency, water companies, local authorities and the emergency services were all involved in responding to the 1995 drought and the Autumn 2000 floods. Lessons learned from these events must be translated into more positive management strategies now to mitigate against more frequent floods and droughts in future.

Risk based decision making

Planning for extremes requires risk based decision making. Decision makers need to be informed about risks and advised on how to take account of changing conditions. Professional regional bodies and trade organisations have an important role to play in developing simple guidelines on how to take account of future risks.

Spatial planning

Planners are in a unique position to support climate change adaptation. Flood risks, the potential for new crops, changing health and transport patterns can all be mapped to develop scenarios of the future with and without planning inputs. Improved mapping of the potential impacts is needed to incorporate climate change in regional plans.

Integration with sustainable development

Climate variation, floods, heat-waves and droughts are not new and neither are many of the actions required to adapt to a changing climate. Climate change adaptation reinforces actions for sustainable development. Some of the region’s sustainable development targets, such as those relating to water quality, could be adversely affected by climate change over the next 50 years. Therefore, climate change makes sustainable development activities more urgent than ever before.
### Summary Table

<table>
<thead>
<tr>
<th>Sector</th>
<th>Likely Impacts</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coastal</strong></td>
<td>▲ Possible increase in tourism – Change in fish species</td>
<td>✅ Shoreline Management Plans and CitAmps</td>
</tr>
<tr>
<td></td>
<td>▼ Loss of land due to increased erosion rates and flooding</td>
<td>✅ Retention of Indicative Floodplain including through Strategic Flood Risk Assessments</td>
</tr>
<tr>
<td></td>
<td>▼ Larger area within the Indicative Floodplain causing regeneration and insurance problems</td>
<td>✅ Closer integration with planning system</td>
</tr>
<tr>
<td></td>
<td>▼ Loss of internationally important inter-tidal habitat</td>
<td></td>
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<tr>
<td></td>
<td>▼ Increased tidal flooding</td>
<td></td>
</tr>
<tr>
<td><strong>Drainage, rivers &amp; floodplains</strong></td>
<td>▼ More winter flooding</td>
<td>✅ Research into climate change and flood risk</td>
</tr>
<tr>
<td></td>
<td>▼ Larger area within the Indicative Floodplain</td>
<td>✅ Improvements to flood defence including the creation of more washlands and water meadows</td>
</tr>
<tr>
<td></td>
<td>▼ Urban drainage problems</td>
<td>✅ Closer integration with planning system</td>
</tr>
<tr>
<td><strong>Water resources</strong></td>
<td>▲ Greater winter rainfall will recharge aquifers and benefit reservoirs – Water quality will vary depending on flow</td>
<td>✅ Research by water industry and government agencies into potential impacts on supply, demand, water quality and sewerage design</td>
</tr>
<tr>
<td></td>
<td>▼ Lower summer flows will reduce water for abstraction</td>
<td>✅ Businesses and households need to increase water efficiency</td>
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<tr>
<td></td>
<td>▲ Greater demand for water in summer</td>
<td>✅ Ensure security of supplies and minimise pollution</td>
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<tr>
<td></td>
<td></td>
<td>✅ Need to find more small scale water supplies and adapt grey water recycling</td>
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<tr>
<td></td>
<td></td>
<td>✅ Drought contingency planning</td>
</tr>
<tr>
<td><strong>Agriculture &amp; forestry</strong></td>
<td>▲ Increased forest yields</td>
<td>✅ Work underway to provide advice to farmers and rural businesses</td>
</tr>
<tr>
<td></td>
<td>– Climate changes beyond the region will affect the food business</td>
<td>✅ Opportunities presented by climate change need to be realised in policy making</td>
</tr>
<tr>
<td></td>
<td>▼ Flooding of land or premises</td>
<td>✅ Identification of alternative summer water resources</td>
</tr>
<tr>
<td></td>
<td>▲ Increased need for irrigation</td>
<td></td>
</tr>
<tr>
<td><strong>Habitats &amp; biodiversity</strong></td>
<td>▲ Potential overall increase in biodiversity – Species migration</td>
<td>✅ Studies underway identifying likely impacts</td>
</tr>
<tr>
<td></td>
<td>▼ Increased pressure on National Parks and sensitive habitats</td>
<td>✅ Need for flexible management plans for species and habitats that focus on positive conservation benefits rather than preservation</td>
</tr>
<tr>
<td></td>
<td>▲ Increased fire risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▼ Loss of montane heathland and peat bogs</td>
<td></td>
</tr>
<tr>
<td><strong>Industry &amp; commerce</strong></td>
<td>▲ Potential new products – Transport affected by sea level rise, more flooding and heat stress but will benefit from less fog and cold weather problems</td>
<td>✅ Changes in building standards built into continual improvements</td>
</tr>
<tr>
<td></td>
<td>▼ Processes sensitive to environment e.g. temperature, need to adapt</td>
<td>✅ Need to identify any competitive advantages that may emerge for the region</td>
</tr>
<tr>
<td></td>
<td>▲ Change in type and location of raw materials</td>
<td>✅ Need to increase resource efficiency</td>
</tr>
<tr>
<td></td>
<td>▲ Loss or damage to infrastructure</td>
<td>✅ Small and medium sized companies need to address adaptation</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td>▲ Tourism and leisure industry likely to benefit from warmer weather</td>
<td>✅ Need to identify and promote the opportunities for tourism and recreation</td>
</tr>
<tr>
<td></td>
<td>▲ New insurance products</td>
<td>✅ Need to realise the potential for growth in resource management and insurance services</td>
</tr>
<tr>
<td></td>
<td>▲ Increased need for resource management services – Reduction in cold weather illnesses but increase in others e.g. respiratory conditions</td>
<td>✅ Need to monitor the condition of heritage and archaeological sites</td>
</tr>
<tr>
<td></td>
<td>▼ Heritage and archaeological sites vulnerable to drought, flooding and waterlogging</td>
<td>✅ Local authorities, health authorities and emergency services need to plan adaptation to changes in flooding, fire risk, transport, health, social activity and lifestyle</td>
</tr>
</tbody>
</table>

**Summary Table Key:**

- Negative Impact: Major ▲, Moderate ▼, Minor ▲, Neutral Impact: –
- Positive Impact: Major ▼, Moderate ▲, Minor ▼, Neutral Impact: –
- Response: Action Underway ✓, Action Needed ▲!
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