



the potential **impacts** of CLIMATE in the **East Midlands** CHANGE



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SUMMARY REPORT

JULY 2000

emsdOt

East Midlands Sustainable Development Round Table

This study was commissioned by the East Midlands Sustainable Development Round Table (emsdOt).

It is a consultation document intended to stimulate discussion and help with the formulation of policy within the East Midlands.

The work was undertaken by Entec UK Limited, overseen by a Task Group. The work was supported by the Sponsors listed on the back cover. The Round Table is grateful to the Sponsors for making the study possible. The results and opinions contained in this report can not be ascribed to any member of the Round Table or the Sponsors.

This document is a summary of the study. A fuller technical report and further information about the study can be obtained from: Dr. Brian Waters, Regional Water Manager, Environment Agency, 550 Streetsbrook Road, Solihull, B91 1QT. Tel: 0121 711 5802.

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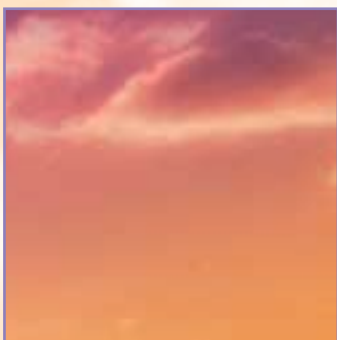
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SUMMARY REPORT

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Entec UK Limited





FOREWORD

Most observers now accept that the climate is changing and will continue to change in the future. It is also generally accepted that emissions of gases to the atmosphere are a key factor in causing climate change. These are the so-called greenhouse gases - the most important of which is carbon dioxide released by the burning of fossil fuels. There is still uncertainty about the extent and timing of these changes, not least due to a variety of assumptions about the way that greenhouse gas concentrations may reduce in the future through collective or individual nations' policies and actions.

Even if attempts to reduce greenhouse gases were successful, significant climate changes are still predicted. We live in an economy and environment that should be able to adapt but not without cost and local pain. By contrast, many regions of the world are threatened by flooding, drought or storm that will threaten their very existence. The challenge for the wealthier nations of the world is twofold:-

a) to adopt a positive approach to the reduction in greenhouse gas emissions. Such an approach could actually improve the efficiency of existing businesses or generate new business opportunities.

b) to adapt to the inevitable local climate changes, taking advantage of those that are beneficial and developing plans to respond to changes which would otherwise threaten our economy and lifestyle.

This report is seen as the start of a process that should involve a wide section of local interests - not just business and industry

This summary report is the result of a study commissioned by the East Midlands Sustainable Development Round Table (emsdOt) into the Impacts of Climate Change in the East Midlands. A more detailed technical report is available for those interested in the detailed results. The brief was not to conduct original research but to summarise what had already been done that was of regional significance and to assess the views of local stakeholders with a potential interest in the subject. In some respects the East Midlands is on "the front line" as a net exporter of energy derived from fossil fuel. It also has businesses that could be threatened by tighter controls on emissions, fiscal measures such as the climate change levy, or simply by the impact of changes in the climate.

This study is one of a series conducted under the general guidance of the UK Climate Impacts Programme (UKCIP). Other regional and cross-sectoral studies are under way, some of which have already reported. emsdOt is keen to ensure that the work continues by raising awareness and ensuring that the East Midlands positions itself to minimise the risks and maximise the opportunities of climate change. This report is seen as the start of a process that should involve a wide section of local interests - not just business and industry. Agriculture and the environment are particularly affected and all local people will experience the effects of climate change to some extent. Planning authorities have a role in helping to ensure that our strategic and local plans take account of the issues and include flexibility to cope with the uncertainties that remain. Above all, local leaders from all sectors need to be seen to take the subject seriously and involve themselves in planning for the future.

We at emsdOt hope that this report will encourage more people in the East Midlands to take an interest in the potential effects of climate change on our own and future generations' lifestyles. We need to consider how we might respond individually and together in the region so that we can shape our future to minimise the risks and maximise the opportunities which, inevitably, climate change will bring.

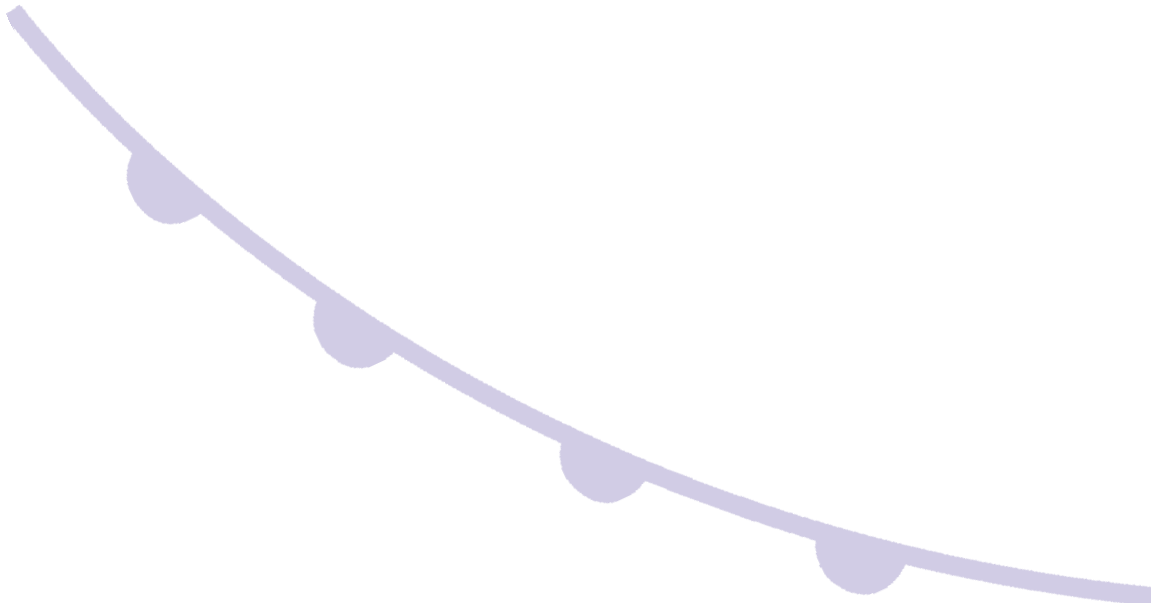
Responses to the publication of this report and a conference in July will contribute to the development of recommendations for policy and action by emsdOt in September 2000.

Professor David Chiddick
Chair of emsdOt

The study was commissioned by the East Midlands Sustainable Development Round Table. It was carried out by a team consisting of Jim Kersey, Entec (environmental consultants); Dr Rob Wilby, University of Derby (UD); Dr Paul Fleming, DeMontfort University (DMU) and Dr Simon Shackley, University of Manchester Institute of Science and Technology (UMIST). They were assisted by a number of contributors including Dorian Speakman and Sarah Mander (UMIST), Peter Webber, Helen Chadwick and Dr Patrick Devine-Wright (DMU) and John Shacklock (UD).

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8 **BRIEF SUMMARY**

This summary report is the first step in understanding what climate change could mean to the Region and what we can do to minimise further climate change. It is accompanied by a technical report for the specialist reader that describes in more detail the climate change models that were used, the impacts of climate change in the Region, the stakeholder discussions, the background to the Region and its greenhouse gas emissions.

The climate of the East Midlands has changed over the last century and is expected to change in the 21st century.

In the last century temperatures across the Region increased by over 0.5°C. The pattern of rainfall has changed - by 1999 there was more rain in the winter and less in the summer. Sea levels have risen on the East Coast by between 1 and 2 mm a year and there were more storms in the 1990s than the rest of the 20th century.

Predictions of the climate in the 21st century show that there is the possibility of a further increase in the Region's temperature of up to 3°C by the end of the century and further changes in rainfall patterns. Sea level rise could be in the range 22-83cm on the East Coast by the middle of the century.

The climate of the East Midlands has changed over the last century and is expected to change in the 21st century



ABOVE
1998 FLOODS IN
NORTHAMPTON



These climate changes could have the following adverse effects:

- Less water available for domestic, industrial and agricultural purposes. This will mean that we will have to use water more efficiently and/or collect more winter water for use in the summer;
- More flooding on the coast and around rivers. This could cause more damage to land and properties and restrict where we can put new houses and commercial development. We could see more floods like the ones experienced in Northampton at Easter 1998;
- Changes in the types of crops grown in the Region;



* Courtesy Nick Jacoby

- Higher temperatures could lead to deterioration in the working conditions for employees. We may have to modify our workplaces and homes to be more comfortable during hot periods. However, wider spread use of air conditioning could lead to higher energy use with increases in associated emissions;
- More summers like the hot summer of 1995 with its high temperatures, water shortages, droughts and associated stresses upon wetland habitats and agriculture;
- Damage to buildings through subsidence, as soils dry out due to higher temperatures and lack of water;
- Changes in the sorts of plant and animal species found in the Region. The Region's biodiversity is already under tremendous pressure; and
- An increase in the number of tourists in the Region. Increased temperatures could have the effect of attracting more people to visit the Region. This could lead to more erosion of the Region's top tourist attractions such as the Peak District National Park, as well as causing greater congestion due to transport.

Depending on how we choose to deal with climate change, there could be opportunities for the Region:

- One of the sources of the main gas that causes climate change, carbon dioxide, is energy production. In April 2001 the Government will introduce an energy tax (the climate change levy) on businesses in order to reduce emissions. By using energy more efficiently and generating energy from renewable sources, such as wind and biofuels, businesses could reduce their energy costs and improve their commercial performance at the same time. This could give businesses in the Region a competitive edge as well as reducing emissions. The Government is also introducing £150 million worth of support for the uptake of clean and renewable energy technologies as part of the climate change levy. The Region's businesses could benefit from this too;
- The Region may be able to produce more energy from renewable sources. It could grow crops that could be used for energy production and produce no net greenhouse gas emissions;
- Agricultural and horticultural produce that is new to the Region could be grown and sold;
- Manufacturing and selling new technologies and equipment to reduce emissions and energy use and in other ways respond to climate change;

ABOVE LEFT
LADYBOWER
RESERVOIR IN 1995*
OPPOSITE
EXISTING COASTLINE



the potential **impacts** of
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- Plants and animals could benefit from a different approach to managing the Region's environment such as increasing the amount of wetlands or managed realignment of the coastline. This could benefit certain birds and plants that are rare in the Region. Higher temperatures could encourage tree growth but the effect of an expansion of woodlands on water resources would have to be considered. The Region has one of the lowest amounts of forests and woodlands in the UK;
- Higher temperatures could lead to more visitors to the Region and increased income from tourism;
- Lifestyles and health may benefit from a move to a more outdoors culture throughout the year, providing that the potential adverse health impacts from increased exposure to sunlight and air pollution are limited;
- Reducing fuel poverty by allowing people on lower incomes to have affordable warmth through improving the energy efficiency of dwellings.

Overall, we will have to live with some level of climate change and plan accordingly. In order to do this we will have to take climate change into account when planning our water resources, flood defences, industry, agriculture, housing and other developments and biodiversity.

However, the priority for action is to avoid causing even more harmful changes in our climate. Climate change is caused by certain types of gases, called greenhouse gases, that we release into the atmosphere. The most important greenhouse gas, carbon dioxide, is produced when we burn fossil fuels - in our cars, our homes and in industry and in the production of energy such as in our power stations. We need to reduce these releases drastically if we are to limit further damaging climate change. The consequences of these releases are felt around the world, because they contribute to climate change globally, not just in the East Midlands.

The people of the Region are concerned about climate change. They feel that it is the third most important issue facing the Region. There is support for action to be taken to deal with the consequences of climate change and avoid future change. There is also a recognition that climate change is just one of the many changes that are facing the Region. Other social, economic and environmental changes will have to be considered along with climate change in planning for the future of the Region.

The Region has a reputation for carrying out innovations to reduce greenhouse gas emissions, most notably in the areas of energy efficiency and renewable energy. However more work needs to be done and the Region should set itself tough targets for reducing emissions of gases that cause climate change. The Region should also be monitoring climate change variables such as temperature and rainfall and the impacts on climate change of the Region's economic, social and environmental processes.

The following sections give more details about climate change in the East Midlands.

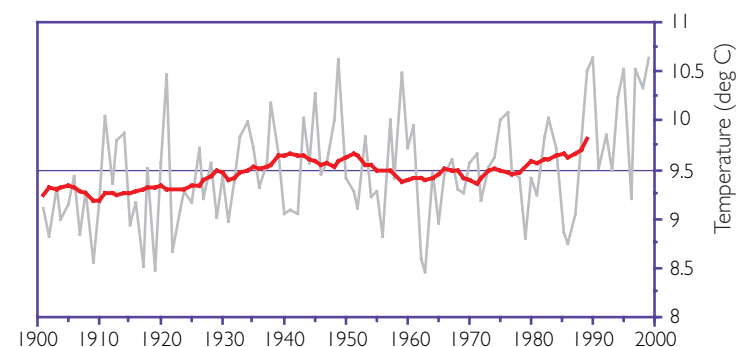


FIGURE 1

Annual mean temperatures for the Central England Temperature (CET) series 1901-1999. The smooth curve shows the 20 year moving averages and the horizontal line shows the 1961-1990 average.

Overall, we will have to live with some level of climate change and plan accordingly

HAS THE CLIMATE CHANGED OVER THE LAST CENTURY?

The following conclusions can be drawn from analyses of historic climate data for the Region:

- Annual mean temperatures over Central England showed a warming trend of +0.6°C between 1901 and 1998. Five of the ten warmest years of the 20th Century occurred in the 1990s. These were 1990, 1995, 1997, 1998 and 1999 (see Figure 1);
- The rate of warming was greatest for the four months August-November with little or no warming trend in any other month except March;
- Annual rainfall totals across Central and Eastern England have increased slightly (+3%) since the 1930s;
- December rainfall totals increased by 38% and July totals fell by 31% over the same period;
- There has been an increase in summer dry spell lengths and a reduction in the intensity of the heaviest summer storms since the 1960s;
- There has been no long-term trend in the frequency of severe gales since 1881, but the 1990s experienced more gales than average;
- Summer flows in the Rivers Dove and Manifold have declined since the 1950s and 1960s. This trend has been partly offset by slight increases in winter flow;

and

- Sea level rises on the East Coast range from 1 to 2mm/year (see Figure 2). These sea level rises include falling land levels due to post-glacial coastal subsidence.



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ABOVE
WETLANDS MAY
BE UNDER THREAT

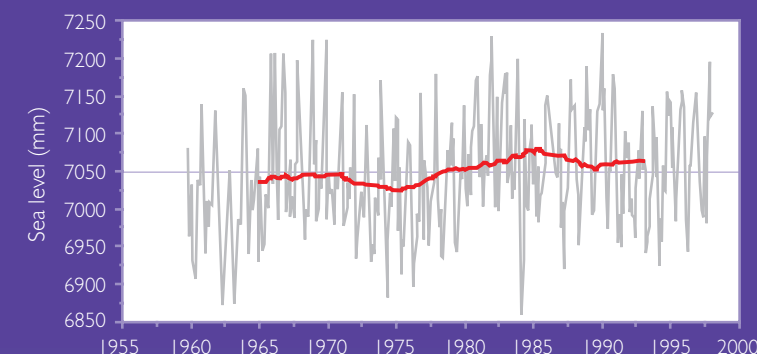


FIGURE 2

Monthly mean sea level at Immingham 1960-1997. The smooth line shows the 10 year moving averages, the horizontal line shows the 1961-1990 average sea level. Between 1960-1995 the average sea level rose by 11.1 mm a decade.

WHY IS CLIMATE CHANGE HAPPENING?

Our activities are affecting the climate. During our daily lives, at work and at home, our activities are causing vast amounts of gases to pour into the atmosphere that cause climate change. These gases - called greenhouse gases (because they affect the amount of energy trapped by the atmosphere and hence the temperature and climate of the earth) are mostly the result of burning fossil fuels (coal, gas, oil and petrol) for energy production and transport. There is a wide range of greenhouse gases and the six included in the Kyoto climate change agreement are given in the table box with examples of their main sources:

The Region produced the CO₂ equivalent of nearly 60 million tonnes of these gases in 1997, representing approximately 8.7% of UK emissions.

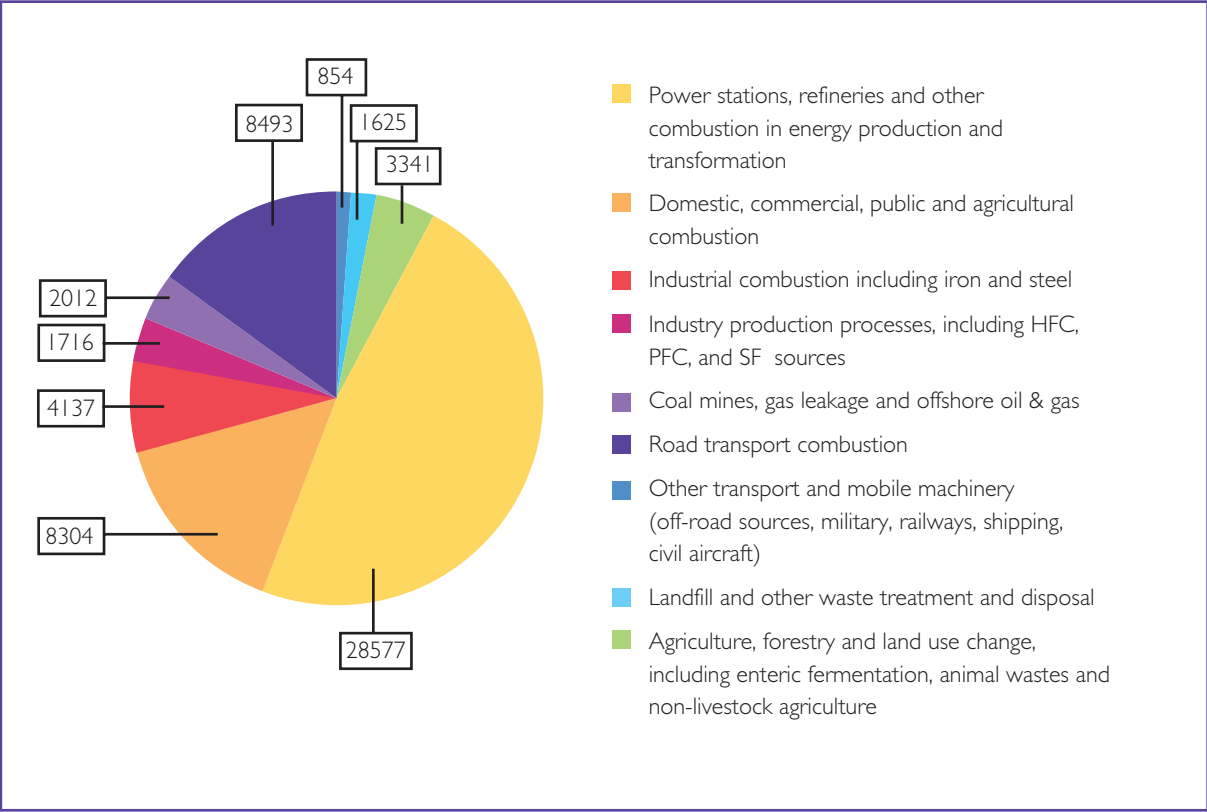
Figure 3 is a pie chart illustrating the Region's emissions expressed as CO₂ equivalent. It shows that over 80% of the Region's greenhouse gas emissions are related to the use of energy (48% from power station emissions, 14% from road transport, 14% from domestic and business fuel use and 7% from industrial fuel use).

GREENHOUSE GAS	MAIN SOURCES
Carbon dioxide (CO ₂)	Combustion of fossil fuels in power stations, road transport, domestic, commercial, agricultural and industrial sectors
Methane (CH ₄)	Coal mines, landfill sites, agricultural livestock and leakage from the gas distribution network
Nitrous oxide (N ₂ O)	Agricultural soils, power stations and nylon and nitric acid production
Hydrofluorocarbons (HFCs)	Refrigeration, aerosols and halocarbon production (fire fighting chemical)
Perfluorocarbons (PFCs)	Electronics industry and aluminium production
Sulphur hexafluoride (SF ₆)	Electrical insulation and magnesium manufacture

The remaining emissions are from non-livestock agricultural sources (4%), coalmines and gas transmission and distribution (3%) landfill sites (2%) and livestock (2%).

Comprehensive and detailed figures for greenhouse gas emissions do not exist for the Region. The estimates given here have therefore been derived from national figures. In order to set targets and measure progress on greenhouse gas reductions it is essential that comprehensive figures for greenhouse gas emissions are established and maintained for the Region.

FIGURE 3
East Midlands Greenhouse Gas Emissions by Source (1997) (kt CO₂ equivalent)



In 1990, the UK produced 784 million tonnes* (CO₂ equivalent) of the six main greenhouse gases. The UK Government has set a number of targets for reducing greenhouse gases. These include reducing the amount of carbon dioxide we emit into the atmosphere by 20% below 1990 emissions by 2010 and reducing the six main greenhouse gases included in the Kyoto agreement by 12.5% below 1990 levels by 2008-2012. However, these targets are only a starting point and much more needs to be done to reduce emissions. Some organisations are asking for reductions of 60% and beyond in order to avoid large-scale climate change.

At the national level emissions from industrial sectors are declining. Domestic emissions are relatively stable but predicted to rise due to increases in the number of houses. The largest increase is in emissions from transport, especially from air transport, and these are predicted to rise further.

* Climate Change, Draft Programme. DETR, March 2000.

The Region produced the CO₂ equivalent of nearly 60 million tonnes of these gases in 1997

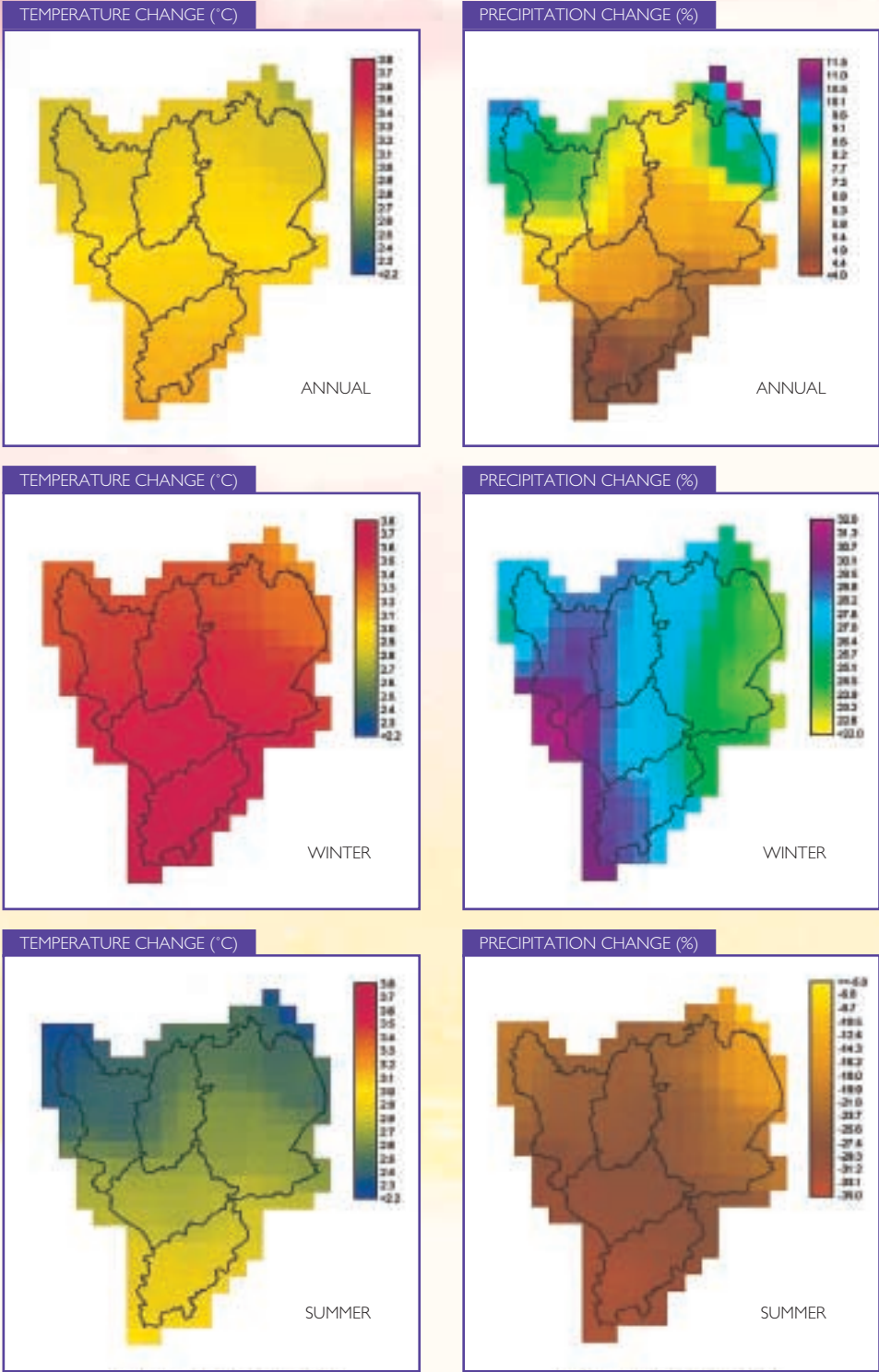
WHAT COULD THE CLIMATE OF THE EAST MIDLANDS BE IN THE 21ST CENTURY?

Possible future climate changes for the Region were estimated based on the UKCIP climate scenarios and regional climate model results. *The conclusions from these models include:*

- Annual mean temperatures show a warming of +0.6 to 1.4°C by the 2020s, +0.9 to 2.3°C by the 2050s and +1.1 to 3.2°C by the 2080s. The warming is slightly greater in summer than winter until the 2050s. Thereafter the opposite applies;
 - The annual number of days with temperatures greater than 25°C in Derbyshire increases from about 2 to 7 by the 2050s, and from about 8 to 19 in Nottinghamshire;
 - The annual number of freezing winter nights decreases across the region by about 50% by the 2050s;
 - Annual mean temperature increases are greater in the south of the Region than in the north by 2080-2100 (see Figure 4);
 - Annual precipitation increases by 1 to 2% by the 2050s and by 1 to 6% by the 2080s. The winter precipitation increases by 6 to 13% and summer precipitation reduces by 4 to 18% by the 2050s;
 - The increase in annual precipitation ranges from +4% in south Leicestershire to +9% on the Lincolnshire coast by 2080-2100 (see Figure 4). Winter precipitation increases are greatest in the west of the region. Summer precipitation reductions are greatest in the south;
 - There is no discernible trend in the frequency of severe winter and summer gales;
 - Annual evaporation rates increase by between 5 and 16% by the 2050s and between 9 and 18% by the 2080s. The increase in evaporation rates is greatest in autumn, reaching up to 37% by the 2080s;
- and
- Sea level rise of 22 to 83cm for the East Anglian coast by the 2050s.
- For an in depth discussion of these general results, as well as the methods used to estimate climate change at the regional level, refer to the Technical Report.

FIGURE 4

Change in mean annual, winter and summer climate over Central/Eastern England by 2080-2100 relative to 1961-90 adapted from the Medium-high UKCIP98 scenario: (left panel); precipitation (right panel).



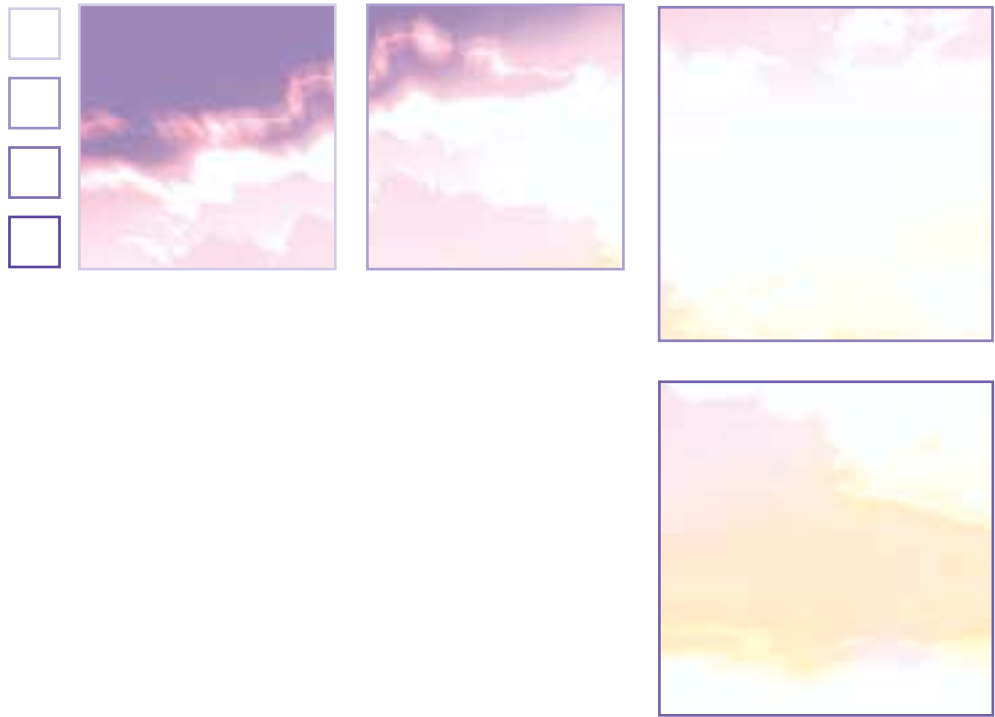
WHAT ARE THE POSSIBLE CONSEQUENCES
OF THE CHANGING CLIMATE FOR THE REGION?

The East Midlands Region covers approximately 12% of England's land area. Its population of 4.2 million is about 7% of the UK total. It includes the counties of Leicestershire, Nottinghamshire, Lincolnshire, Derbyshire, Northamptonshire and Rutland. The Region has considerable economic, social, landscape and geographical variety. It extends from the upland moorland landscape of the Peak District, through the central farmlands of Northamptonshire and Nottinghamshire, river valleys such as the Trent, to the low flat landscape of the Lincolnshire Fens running down to the North Sea coast.

The following areas are those that may be most vulnerable to the effects of climate change:

- Water Resources and Quality;
- Flooding - Urban and Lowland;
- Agriculture;
- Coastal Region;
- Biodiversity;
- Manufacturing, Services and Retail;
- Construction and Building;
- Tourism and Recreation; and
- Transport.

The following sections explain what the consequences of climate change could be in these areas. The tables at the end of the section summarise the potential climate change impacts for the Region and the possible responses.



WATER RESOURCES AND QUALITY

Surface water abstraction from rivers and reservoirs provides a large proportion of the Region's public water supply. Aquifers (natural underground water stores) are also important in Lincolnshire, Nottinghamshire and the Trent catchment. Water is supplied to the major urban regions from the Derwent Valley (Ladybower Reservoir to Leicester and Derby), from Rutland Water and from other reservoirs. The Rivers Derwent and Dove are both major sources of drinking water.

Many aquifers in the East Midlands are now considered to be fully committed to existing water abstractions and most of the surface catchments are fully licensed in the summer. The Environment Agency and Severn Trent Water have already negotiated a reduction in water abstraction from the Sherwood sandstone aquifer, with further future reductions under discussion. Due to increasing temperatures, and hence increasing evaporation, and changing rainfall patterns, climate change could affect the Region's water resources. Availability of surface water in reservoirs and rivers for abstraction would be reduced in the summer according to some of the climate change models. Severn Trent Water estimate a reduction in the yields of the River Trent and Derwent valley reservoir system under a wide range of plausible climate change conditions in the 2020s and 2050s, for example. The Sherwood aquifer might even benefit from increased winter rainfall under climate change but it is too early to say for certain. Low river flow levels have an adverse impact on water quality, as also do turbulent river flows after heavy rainfall, both of which may require enhanced water

treatment. There is already evidence of rising river temperatures in the East Midlands that may be contributing towards a decline in fish populations.

Reductions in the flows in rivers could also lead to a deterioration in water quality as there could be less water to dilute the licensed discharges.

Water demand at the household level can be reduced through awareness raising and campaigns to promote water metering and low-water demand gardens, though more knowledge is required of behavioural change in patterns of

water consumption. More winter rain storage is one response, especially for agricultural uses. Designing houses with rainwater collection systems for use in gardening and toilets has the potential to reduce flood risk as well as the demand for treated water. Water companies are also considering other options such as more intra-regional water transfer schemes (eg from excess groundwater in Birmingham to the East Midlands

via the River Trent), better water treatment for recycling and, in the longer-term, inter-regional water transfers.

Low river flows
have an adverse impact
on water quality

**FLOODING -
URBAN AND LOWLAND**

Flood risk is high for the floodplains of major rivers in the Region such as the Trent, Derwent, Soar, Witham and Nene. A large area of the East Midlands (15% of the total) is vulnerable to 1:100 year floods (assuming no flood defences are in place). Nearly 1500km² of Lincolnshire are protected from tidal flooding and without the flood defences to protect it, would be regularly flooded. Much of this is valuable high-grade agricultural land. 99% of grade 1 agricultural land in the East Midlands is below the 5m contour line.

River flooding has been a persistent local problem in the East Midlands, most recently in April 1998, when 5cm of rain fell in 24 hours onto water-saturated land in Northampton. The flooding that followed caused two deaths, and had a substantial impact on the health and welfare of 10,000 residents, upon local businesses such as Church's Shoes, and cost several hundred million pounds in disruption and insurance claims. The April 1998 floods also affected the Soar and Wreake Catchments. Pedigree Petfoods located near Melton Mowbray was flooded, and narrowly avoided having to shut down production. Coastal flooding has been a persistent problem along the North Sea coast, with storms in 1953, 1976 and 1978 being particularly remembered (the latter destroying much of the pier at Skegness).

Climate change could lead to increased risk of flooding in low-lying urban and coastal areas across significant areas of the East Midlands for a number of reasons including:

- It is more difficult to disperse the surface water that accumulates during intense rainfall; and
- Sea level rise will make even moderate coastal sea surges from storms more damaging.

There could be a number of responses to these impacts including:

- Changes in insurance provision for flood damage;
- The need to increase the capacity of waste water treatment plants and sewers as they could receive more water, particularly during intense rainfall events when the risk of sewer overflows is greater;
- The need to upgrade flood defences and flood water storage systems;
- The need to restrict new development in flood plains; and
- The need to ensure that new developments are designed in such a way that water run-off is not increased and preferably decreased through storage and control of incoming water. This is as proposed in the Environment Agency's strategic review of flooding and development in and around Northampton.

AGRICULTURE

Agriculture is a significant feature of the Region, accounting for 80% of land-use by area and nearly 2% of employment (rising to 7% in Lincolnshire). Apart from those directly employed in agriculture, there is significant employment and economic value-added in related industries such as food processing and agricultural engineering.

Climate change could have the following effects:

- Increased likelihood of summer droughts and soil water deficits will lead to increased demand for irrigation, in particular for horticultural produce such as salad crops and potatoes, and for sugar beet, putting more pressure on water resources in the Region and/or affecting yields;
- Heat stress on livestock;
- Soil erosion from flash flooding (especially in the Peak District);
- New crop pests such as the Colorado Beetle and European Corn Borer;
- Increased potential for planting of crops for energy production;
- New crops would become viable, such as grain maize, sunflowers and Navy beans;
- Other crops could be less viable such as vining peas (reduced harvesting time due to higher temperatures);
- Opportunities for new crops or for change between arable and livestock will be limited by the need for infrastructure investment in equipment and associated processing plant;
- Sea (salt) water contamination of farmland; and
- New crops would change the exposure of soils to erosion and have implications for biodiversity.

COASTLINE

Lincolnshire has a long North Sea coastline stretching from the Wash (Britain's largest estuary) to the mouth of the Humber. It includes important wildlife habitats, towns (including resorts such as Skegness and Mablethorpe) and ports with agricultural land adjacent.

Climate change could have the following effects on the Region's coastline:

- Higher sea levels, storm surges and wave heights could lead to increased sea wall and cliff erosion;
- Loss of coastal habitats for wildlife;
- Damage to property and agricultural land along the coast; and
- Increased tourism opportunities.

The Lincolnshire Wash is the site of some of the first managed realignment initiatives in the UK, i.e. in which the current primary sea wall is being abandoned and a sea wall further back is adopted as the primary defence. Where more development is prevalent, as along the coastline between Skegness and Mablethorpe, the policy is to hold the present line of sea defences. The response is an extensive coastal protection initiative called the LincShore Project at an expense of approximately £70 million, involving raising sea-wall heights and beach replenishment. Coastal defence programmes already include an allowance for the effects of rising sea levels, though not necessarily for the impacts of a change in storm surge events.

BIODIVERSITY

There are species and habitats of international importance in the Region such as the Peak District National Park, the Lincolnshire Coast and Wolds and The Wash (which is home to 180,000 wading birds, ducks and geese).

However in the rest of the Region biodiversity has declined perhaps faster than almost anywhere else in Britain.

Climate change could have the following effects on the Region's biodiversity:

- As the temperature increases there could be a loss of those species that are at the southerly edge of their distribution such as Jacob's Ladder in the Peak District;
- Potential loss of the most south easterly raised peat bogs in the UK, located in the Peak District;

- There could be a spread of the species at the northern edge of their distribution such as the stemless thistle in the Peak and incoming southern species such as the Little Egret;
- Loss of coastal habitats for wildlife due to continued erosion, including loss of mudflats on the East Coast that are important for wading birds;
- Loss of wet and lowland heath species such as sundew and butterburs in Lincolnshire, with evidence already compiled of the declining fortunes of wetland habitats in the East Midlands;
- Reduction in summer rainfall could have a major effect on grassland;
- An increase in storminess could affect bird populations in the River Ouse/Wash area; and
- Winter flooding would probably be beneficial to birds, though increased summer flooding is generally harmful.

Potential loss of most south easterly raised peat bogs in the UK, located in the Peak District

MANUFACTURING, SERVICES AND RETAIL

The Region has a diverse industrial and commercial base. Sectors include: mining, fuel processing, metals, minerals (mainly building materials), mechanical engineering, transport equipment (cars, aerospace, trains) and textiles, footwear and clothing. Food processing is also a significant sector in the Region.

Climate change could have the following effects on manufacturing and retail:

- Limitation on the use of water for chemical and food and drinks processing (one brewery abstracting water from the Sherwood aquifer has had to rely upon more tap water in recent drought years, which is a more expensive option). Reduction in the efficiency of river water in cooling chemical plant (mentioned by a chemicals company in Derby), perhaps requiring installation of cooling equipment and increasing energy bills;
- Deterioration in working conditions due to higher temperatures (this was experienced during the hot summers of the 1990s in a number of factories and offices in the Region). Some companies have already responded by readjusting work patterns, encouraging some of the workforce to start earlier or late. If large air conditioning bills are to be avoided, such continental-type work patterns may become increasingly necessary;
- Higher temperatures could make food preparation, handling and storage more difficult. Costs of refrigerating foods in retail outlets will increase;
- Distribution centres in low-lying areas could be at increased risk from flooding;
- The insurance industry is likely to move towards a more risk-based approach to insurance underwriting if flood and other weather-related losses continue to increase. This could have repercussions on property values and insurance premiums in higher risk areas, with the possibility of flood risk cover being removed all together for new developments.

CONSTRUCTION AND BUILDING

Apart from contemporary commercial, industrial and residential buildings, the Region also has a significant collection of older buildings with cultural and heritage value. It is also estimated that the East Midlands will need approximately 363,000 new houses by 2021.

Climate change could have the following effects on older and contemporary buildings and construction:

- Increased demand for air conditioning due to higher temperatures;
- Increased number of available construction days: in summer due to fewer rain days and in winter due to fewer frosts;
- Increased drought and flood related problems such as soil shrinkage and subsidence.

Higher temperatures could make food preparation, handling and storage more difficult. Costs of refrigerating foods in retail outlets will increase



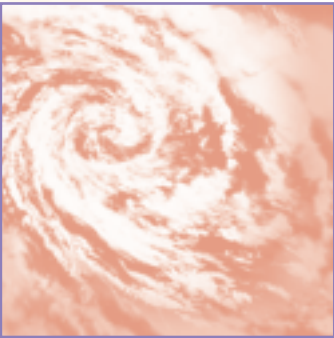
TOURISM AND RECREATION

Tourism is a major feature of some parts of the Region such as the Peak District and the Lincolnshire Coast. Most tourism in the Region is short breaks and day trips from surrounding conurbations and is dependent on the Region's many sites of historic and cultural interest such as Belvoir Castle, Lincoln Cathedral, Sherwood Forest and Chatsworth House and historic battlefields such as Bosworth and Naseby. Tourism is also a major employer in these areas.

Climate change could have the following effects on tourism and leisure:

- Accentuation of the social trend towards an all year round tourism market which has major impacts on the economic viability of tourism and tourism related investment in resorts such as Skegness;
- Increased number of tourists due to warmer weather could lead to negative impacts on biodiversity such as the disturbance of birds' breeding season and increased erosion of already stressed areas such as Kinder Scout;
- Increased tourism could also lead to increased transport demand, congestion and pollution; and
- Angling could be affected by disturbance to the breeding season of fish.

An appropriate response to the impacts of climate change on tourism is to translate more day visits into staying visits. This would reduce the impact of tourism upon the environment at the same time as generating a greater return for the local economy. A further possible response is to direct additional tourism pressure towards those areas which are currently less visited, such as areas of Nottinghamshire (eg Sherwood Forest), Lincolnshire and the Leicestershire uplands. Finally, climate change could become an important part of public communication and information delivered by tourism bodies and providers.



TRANSPORT

The Region contains a number of important national and international transport links such as the M1, A1 and A14. East Midlands Airport provides international links. The Region also has a number of small ports - Boston, Fosdyke, Sutton Bridge (all on the Wash) and Gainsborough (on the navigable Trent).

Climate change could have the following effects on transport in the Region:

- Risk of buckling on rail tracks due to increased temperature;
- Asphalt road surface melting more frequently;
- Flooding of roads and railways;
- Increased risk of flooding and surge damage in ports and associated loading areas;
- Warmer winters could result in less cold weather disruption.

As can be seen for the above, climate change could have a number of significant impacts on important sectors and areas in the Region. However, these impacts will not just affect individual sectors but may have knock on effects in other areas. For instance, changes in agriculture due to climate change will in turn affect biodiversity and increased flooding risk will affect the location of building developments. Climate change should also be considered along with other socio-economic and environmental changes affecting the Region.

The following tables summarise the potential impacts of climate change in the Region and possible responses. They present the impact, the response and the timescale (short - up to 5 years, medium or long term - 20 years or more) for the response.

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Changes to Water Supply: Possible reduction in yields of surface water (e.g. for River Trent and Derwent Valley systems), though some aquifer recharge could benefit (e.g. Sherwood aquifer).				Demand-side management e.g. water meters, water conservation and efficiency campaigns.
Reduction in water abstraction				Supply-side management: e.g. leakage reduction, increased pump storage of winter water, farm reservoirs, more water recycling, more regional water transfer schemes (e.g. West to East Midlands via River Trent). Long term supply options: e.g. north west UK to south east UK water transfers; new reservoirs
Changes to Water Quality: e.g. through low river flow rates hence less dilution, turbulence from intense rainfall				Enhanced water treatment More management of rivers to maintain and control flows

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Lowland flooding risk				Increase the height of levees (e.g. Northampton)
				Restrict/control over development
				Stronger policy framework on appropriate development in flood plains from central government
				Adjust planning restriction to only allow development that does not have runoff rates greater than greenfield sites (e.g. strategic review of development in Northampton)
				Use sustainable urban drainage techniques such as settling ponds to intercept flood water (e.g. Central Rivers Project) and replacing bends in rivers to slow down water (e.g. Erewash)
Socio-economic impact of flood (insurance claims procedures, costs, psychological impact)				Designated floodplain area (e.g. Trent Floodplain Initiative)
				Social and community involvement in response (e.g. 'Flood Alert' in Northampton)
Increased pumping costs for land drainage				Pro-active response from Insurance industry
				Potential redesign/retro-fitting of pumping installations for internal drainage to increase capacity
Urban & Industrial Waste Water Management Foul water Flooding				Reed bed settling ponds for purification
				Upgrade the capacity of flood water storage systems
				Increase pumping capacity
				Increase capacity for waste water treatment

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Summer droughts leading to increased irrigation demand from new crops				Install small scale water reservoirs on farmland
				More efficient use of water (mechanical and biotechnological) Re-negotiation of water abstraction licences Water charging/tradable permit schemes to promote efficient use of prescribed (reduced) source
				Change the perceptions of supermarkets demanding "thirsty" varieties of crop and associated irrigation regimes
Difficulty in predicting suitability for planting in Autumn				More flexible approach to planting (French approach)
Clay soils difficult to work in wetter conditions				Addition of organic material into soil
Heat stress upon livestock				Increase tree cover to provide shade
Flooding				Move towards farmers as "custodian" of floodplain lands or of 'carbon sinks' in the uplands with appropriate compensation
Soils erosion from flash flooding Slope failure from excessive rainfall				Diversification, set aside, reduce grazing pressures
				Advice on adaptation of agricultural practice (contour ploughing)
				Increase woodland and hedgerow area of farmland, which should also increase the amenity value of landscape
				Improve plant breeding technology
New crops e.g. Colorado Beetle, European Corn Borer				Sustainable integrated pesticides strategy
Suitability of conditions for crops to move Northwards				Investment in flexible processing plants for peas, salad crops, etc. such as those that can be easily installed/moved over a period of years
Knock-on effect on the supply chain				Increase potential for supplying demand locally/regionally/nationally
Potential opportunities for increased food processing and packaging industries				Potential need for new types of agricultural machinery for irrigation, planting and harvesting, etc.
Increased potential for biomass crops				Potential benefit for biomass energy crops

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Increased sea level, surges, wave heights Increased sea wall and cliff erosion				Increase sea wall height (e.g. Skegness)
				Managed realignment (e.g. The Wash)
				Soft design of sea defences - sand dunes used for defence and beach replenishment (e.g. LincShore Project)
Loss of coastal habitats for wildlife				New habitat creation through realignment of sea defences (e.g. Lincolnshire Fens)
Loss of agricultural land				Managed retreat
Damage to buildings and socio-economic losses				Adaptation of buildings to coastal inundation
				Potential relocation of existing buildings
Tourism opportunities				Market opportunities as season extends throughout the year (e.g. Skegness, Mablethorpe, etc.)
				Need for new infrastructure (sewage, water), and better public transport (e.g. Ingoldmells caravan site, nr. Skegness)

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Loss of species at edge of southerly distribution (e.g. Jacobs Ladder in the Peak District)				Habitat corridors (though not always possible for species restricted to specific isolated soils)
Increasing species at edge of northern distribution				Management regimes to decrease grazing pressure
Incoming southern species (e.g. Little Egret)				Reduce drainage, reduce water extraction, perhaps even artificial recharge of aquifers (though expensive)
Loss of wet and lowland heath species (e.g. sundew, butterburs in Lincs.)				Maintain (and increase?) sacrificial flooding areas (floodplains)
Impact on uplands uncertain: impacts of increased rainfall and increased temperatures unclear on vegetation and on peat formation or deterioration. Complex interplay of other factors (e.g. winds, visitor pressure, fires)				Adapt to dynamics instead of preservation per se (e.g. National Trust). Increase in habitat management investment, 'land banking' (e.g. Gibraltar Point)
				Decrease erosion through management of fires (including public education) (e.g. National Trust, Peak District National Park Authority)
				Afforestation with native species to improve habitat
Grassland: decreased summer rainfall causes major effects on grasslands, especially on sandy and silty soils				What kind of land management regime can help plants adapt to climate change?
Earlier growth of vegetation sensitive to late frosts (relatively common in the Region. Bracken very sensitive to late frosts)				Deliberate microclimate modification by planting trees, hedgerows, artificial lakes, etc.
Knock-on effect on insects and hence birds				
Longer breeding season for certain species				

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Limitation on water usage for chemical and food and drinks processing; less efficient cooling from river water				Water efficiency schemes (e.g. Boots), water recycling
Industrial waste water management systems				Tradable water licences
				As in section on flooding
Working and manufacturing conditions more difficult under high temperatures in industry				Installation of air conditioning systems (but will increase energy consumption)
				Building design - solar design to make optimum use of solar energy
				Retrofitting "natural" ventilation systems
Food preservation				Adaptation of working patterns - e.g. earlier and/or late in the day (e.g. Church's Shoes)
				Better storage facilities, e.g. more refrigeration but this will increase costs
				Transfer of suppliers to reduce transport times and costs
Global supply chains				Potential need to adjust sourcing
Distribution and production centres at risk from flooding in low lying flat land				Adaptation of flood defences (e.g. Pedigree). Storage capacity to intercept incoming and outgoing water to reduce flood risk.
Increased insurance claims				Strengthening of buildings (esp. roofs), adaptation to flood risk
Open shopping areas, more open air retail and social activity				Planning process to factor-in climate change; open outdoor spaces seen as integral to built environment

CONSTRUCTION AND BUILDING

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Air conditioning demand increased				Insulation to limit temperature extremes (e.g. Gusto Construction)
				Installation of natural ventilation systems (e.g. Queens Building, De Montfort University, Inland Revenue Building, Nottingham)
				Urban greening to ameliorate urban microclimatic extremes
				Temperature sensitive housing design Photovoltaic cells as integral to building design
Drought/flooding problems				Increase in size of rain collection tanks (e.g. Gusto Construction)
				Permeable pavements (being tested)

TOURISM AND RECREATION

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Increased tourism and hence impacts on biodiversity (disturbance of birds' breeding season)				Restrict timing of visits to nature reserves during critical periods (e.g. Gibraltar Point)
Increased tourism leading to increased transport demand, congestion and pollution extended through year				Sustainable transport initiatives (road closing, charging, cheap frequent, reliable public transport) (e.g. Peak District)
Wetter West and drier East though wetter winters?				All weather facilities (e.g. Skegness)
Angling affected by disturbance to breeding season of fish				Adjustment of angling season
Market Opportunities but increased tourist pressure on current most popular destinations				Spread of tourism throughout Region (Derwent Valley, Sherwood Forest, Leicestershire Uplands)

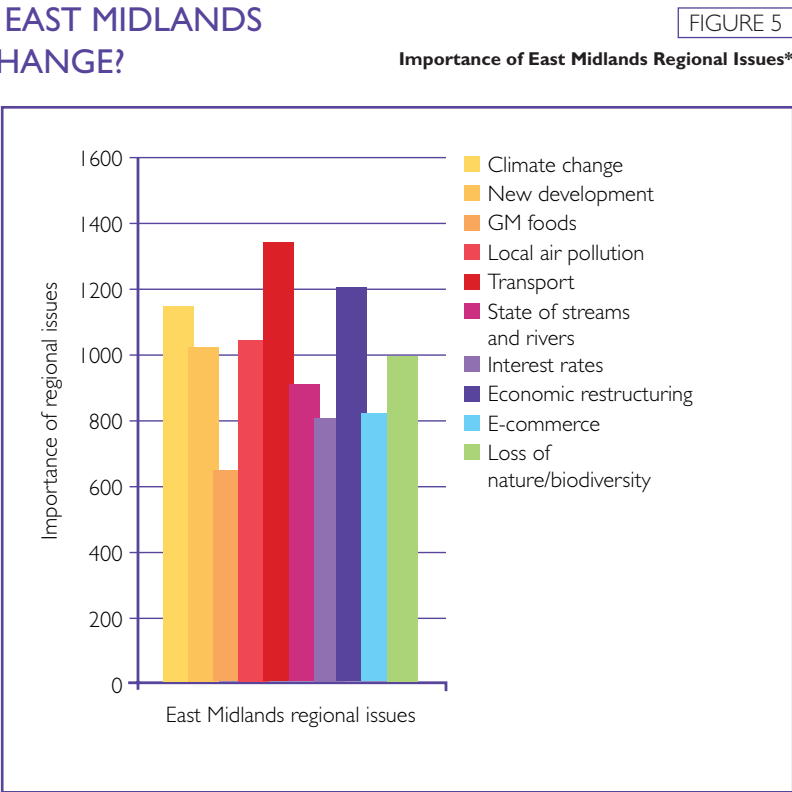
TRANSPORT

IMPACT	Time scale for Response			Adaptation Strategy (example in brackets)
	S	M	L	
Overheating of diesel engines				Adaptation of cooling systems
Risk of buckling of railway track				Speed limits - reconfigure track specification for higher temperatures
Road surface asphalt melting				Alter asphalt composition
Warmer winters - less cold weather disruption but risk of complacency with less frequent snow and ice				Less road grit required - less salt pollution Change in winter strategy by road maintenance departments and Railtrack.
Aircraft engine efficiency decreases in hot weather				Reduce payloads (e.g. East Midlands Airport, Rolls Royce)
Canals affected by drought				Sharing of lock use by barges, restrictions on summer use
Flooding of roads and railways				Improve design and maintenance of infrastructure in risk areas
Landslips in uplands from excessive precipitation and overgrazing of pastures				Land management, strengthening of cuttings and embankments

WHAT DO PEOPLE IN THE EAST MIDLANDS
THINK ABOUT CLIMATE CHANGE?

A detailed postal questionnaire, to assess perceptions of climate change in the East Midlands, was sent to 1 000 stakeholders in the East Midlands, including industry and commerce, local government, agencies, public health officials and NGOs. These stakeholders were ones that had already expressed an interest in environmental issues. 190 responses have been received.

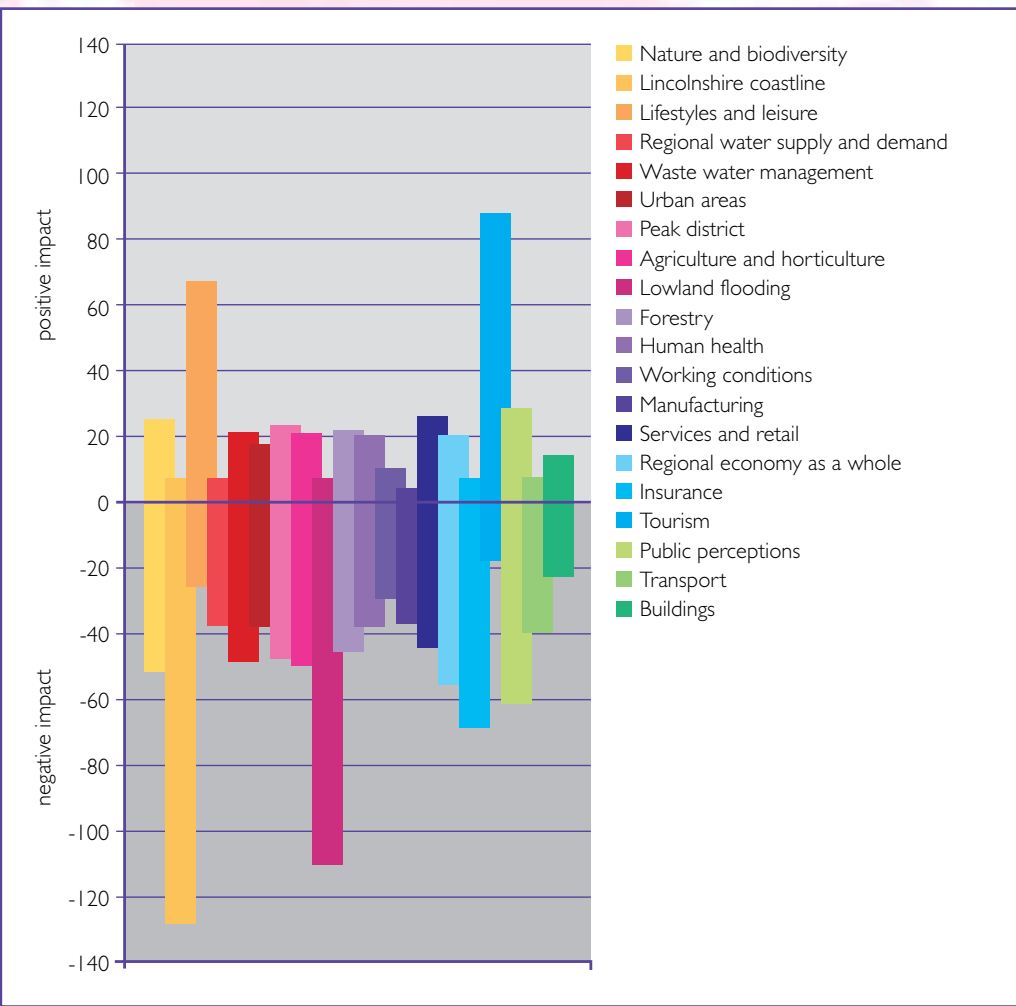
One of the most striking findings is that the respondents consider climate change to be the **third most important issue out of ten** current issues for public debate and concern in the East Midlands (Figure 5). The most important issue for the region is, by a significant margin, transport, followed by economic restructuring. Climate change comes third, followed by local air pollution, with little to chose between new development (such as building) and loss of nature, in fifth and sixth place. For this group of stakeholders, e-commerce, interest rates and GMOs were of less importance for the East Midlands.



The respondents consider climate change to be the third most important issue out of ten

*Respondents were asked to rank the issues on a scale from 1 to 10, with 1 being the least important issue and 10 the most important. To determine importance, we have aggregated the rankings for each impact.

The respondents were also asked to assess the impacts of a "high" scenario of climate change by 2050 upon 20 different sectors ranging from flooding to lifestyles. The overall assessment of the seriousness of the scenario for each sector is shown in Figure 6.



** The more negative the score, the more negative the impacts were considered to be.

The overwhelming perception is that climate change will have negative rather than positive impacts. Only **tourism** and **lifestyles and leisure** come out as overall positive, and then by a smaller extent than the big two negatives: **Lincolnshire coastline** and **lowland flooding**. Tourism is perceived as the most positive impact, whilst impacts upon **lifestyles and leisure** are regarded as being about as positive as impacts on **insurance** are negative. For all twenty climate impact domain areas, however, some respondents did identify positive impacts. These results are broadly consistent with the

discussions in five stakeholder workshops that were conducted, where some potential benefits were identified for not only tourism, but also agriculture and horticulture, services and retail and human health.

The other main sectors where it was felt that impacts would be negative were: **regional water supply and demand, agriculture and horticulture, regional economy, public perceptions and biodiversity**.

In summary, respondents appeared to be informed about climate change and felt reasonably confident about

answering the questions. Their perceptions of the impacts of climate change were largely negative, especially with respect to coastal and lowland flooding and insurance, though across the board respondents did identify some positive impacts. Only tourism, lifestyles and leisure were regarded as experiencing a net benefit from climate change. The predominantly negative perceptions of climate change impacts may have been influenced by an implicit "business as usual" assumption in how we might respond to the impacts.

32 WHAT SHOULD WE BE DOING ABOUT CLIMATE CHANGE?

The region has considerable experience in implementing initiatives that reduce greenhouse gas emissions. However there is much more to do. There are a number of strategic processes in the Region e.g. the Integrated Regional Strategy, that could be used to address climate change issues such as reducing emissions and adapting to the consequences of climate change, where these are unavoidable. The region should also set up systems to measure climate change and set tough targets for reducing greenhouse gas emissions. There is considerable support in the Region for tough targets. The following sections discuss these areas in more detail.

REGIONAL INITIATIVES TO REDUCE GREENHOUSE GAS EMISSIONS

The Region has already taken action to reduce greenhouse gas emissions from energy use. Indeed the Region could be considered to be the leading region in terms of the implementation of energy efficiency and renewable energy measures. For instance, there is a commitment in the draft Regional Planning Guidance to work towards a target capacity of 400MW of renewable energy by 2005. However, further investment is needed to help stabilise greenhouse gas emissions.

The following is a list of some of the initiatives in the Region that will reduce greenhouse gas emissions:

- The Region's Universities are active in research to reduce the threat of climate change, with groups at De Montfort University, Loughborough University, Nottingham University and Nottingham Trent University researching and teaching energy efficiency and renewable energy;
- There are two European Energy Agencies (Leicester and Newark and Sherwood) and Local Energy Advice Centres in the Region that are helping households and businesses reduce their greenhouse gas emissions;
- Establishment of the Midlands Renewable Energy Technology Transfer initiative to promote renewable energy technology. Broughton Pumping Station provides renewable energy by using woodchip sourced from local sustainable woodland.
- Many homes in the Region have been built to standards far in excess of Building Regulation standards such as Leicester City Council's "Boot Houses", Hockerton Housing Project, and Millenium Green at Collingham. Further developments are underway on a larger scale such as the Sherwood Energy Village in Ollerton and Ashton Green in Leicester.

Local Authorities in the Region have a long record of energy efficiency investment in municipal buildings, schools and housing.

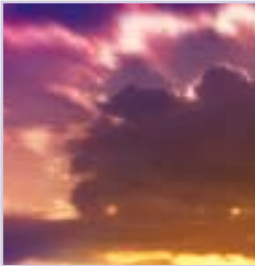
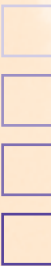
STRATEGIC PROCESSES FOR ADDRESSING CLIMATE CHANGE ISSUES

There are a number of strategic processes in the East Midlands that should be considering the potential impacts of climate change. Probably the most important of these processes is the Integrated Regional Strategy (IRS) being coordinated by the Regional Assembly.

The IRS has four principle purposes:

- Provide a framework for sustainable development;
- Strengthen regional partnership working;
- Integration of regional policies and strategies;
- Maximise influence for the region with national Government, the European Union and other bodies.

The achievement of all these aims will be necessary if climate change is to be fully integrated into the strategies for the Region. This study can help to inform the development of the IRS.



INDICATORS OF CLIMATE CHANGE

Monitoring of climate change should be conducted in order to assess whether human-induced climate change is happening in the Region, its impact and the quantity of greenhouse emissions.

Indicators of climate change can cover:

- Long term, continuous measurements of climate variables such as rainfall and temperatures. These measurement will identify whether climate change is happening;
- Assessment of climate change impacts such as changes in agricultural practice, distribution of flora and fauna, river flows, storms and sea level changes. These assessments help in planning adaptations to climate change;
- Emissions of greenhouse gases. This information will help in setting targets for reducing greenhouse gas reductions.



CLIMATE VARIABLES

Long records of temperature and rainfall exist in the Region and should be monitored and analysed to identify changes in climate variables.

CLIMATE CHANGE IMPACTS

Some climate change impacts are measured by statutory agencies such as the Environment Agency, whilst data on others are collected more informally such as that on species distribution and behaviour. Water companies collect data on the availability of water resources, which is an indirect measure of changes in climate. Other organisations such as MAFF collect data on agricultural practices.

EMISSIONS OF GREENHOUSE GASES

At present little data exists on emissions of greenhouse gases in the Region. This is a major barrier to formulating appropriate, sectorally based, emission reduction targets. The document "Sustainable Development Indicators - monitoring change in the East Midlands" also observed that energy use expressed as CO₂ should be a key indicator. The indicator should cover emissions of all greenhouse gases.

The Department of the Environment, Transport and the Regions (DETR) has produced a set of indicators for sustainable development in its publication "Quality of life counts". The indicators are split into two categories - headline indicators (to present a high level overview of progress and that can be used for communicating the main messages) and detailed indicators (that can be used for more detailed analyses).

The headline indicator that has been proposed for climate change is emissions of greenhouse gases. The reason for using this indicator is to assess progress on reducing our emissions of greenhouses now and to plan for greater reductions in the longer term.

Carbon dioxide emissions fell in the first half of the 1990s due mainly to a switch from coal to gas and nuclear power for electricity generation. Emissions are expected to rise again after 2005. However, larger reductions will be needed in the future to address the risk of climate change. The Royal Commission on Environmental Pollution is recommending a reduction of 60%.

34 **CLIMATE CHANGE TARGETS**

There are two types of targets that could be used in the Region for climate change - quantitative and qualitative.

Examples of quantitative climate change targets are:

- The Government's commitment to reducing CO₂ emissions to 20% below 1990 levels by 2010;
- Under the Kyoto Protocol, the Government is also committed to reducing the six major greenhouse gases by 12.5% compared to 1990 levels over the period 2008-2012;
- There are also quantitative targets that could be used to help reduce greenhouse gas emissions such as the Government's target to generate 5% of the UK's electricity from renewable energy by 2003 and 10% by 2010.

A target could be set for the amount of electricity sales in the Region that are from renewable sources as it is now possible for large and small consumers to purchase electricity from renewable energy sources.

An example of a qualitative target is the number of businesses and organisations implementing greenhouse gas reduction programmes. In June 1999, DETR produced guidelines for company reporting on greenhouse gas emissions. Organisations could use these guidelines to assess their emissions and then produce a reduction plan.

Most of the above indicators and targets could be used in the Region. However, there are some information gaps, most notably on greenhouse gas emissions. Further work should be undertaken to assess the feasibility of collecting the data and implementing both indicators and targets. It may be possible for instance for the Region to have higher targets for renewable energy generation and emissions reductions. There is support for this in the Region as discussed in the following section.

A target could be set for the amount of electricity sales in the Region that are from renewable sources

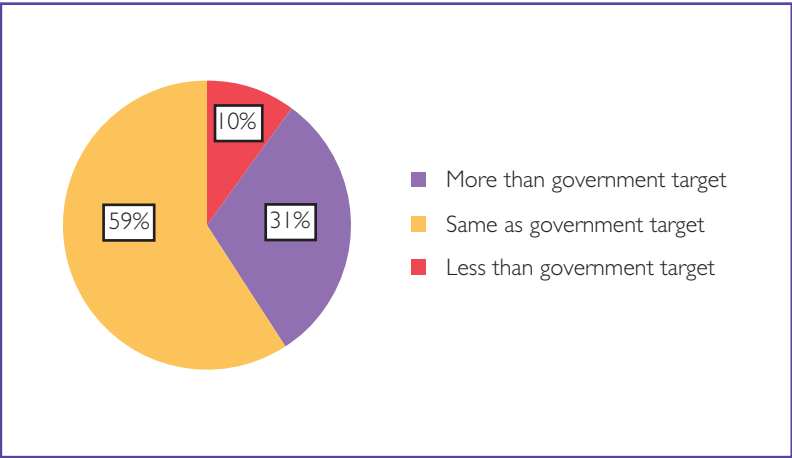


FIGURE 7
Support for reduction targets

SUPPORT FOR CLIMATE CHANGE TARGETS

When we asked stakeholders how a reduction of 20% in CO₂ emissions by 2010 (relative to 1990) could be achieved, we found that nearly a third wanted to see more support for energy efficiency measures and about a quarter saw renewable energy as the way forward. Other options mentioned by respondents were: woodland carbon sinks, improved public transport and liquid petroleum gas (LPG) powered vehicles and lifestyle changes.

Nearly two thirds of the sample considered that the East Midlands should adopt the same target for emission reductions as the Government (see Figure 7). However, nearly a third wanted to see a higher target, and a smaller percentage a lower target.

Finally, we asked the respondents what emission reductions might, in their view, be required by 2050. The average answer was a 45% reduction relative to 1990 levels. This is an encouraging result since it suggests that our sample is well informed about the need for emission reductions to continue into this century beyond the Kyoto requirement of 12.5% or the domestic target of 20%.

Whilst reducing greenhouse gas emissions should be the primary focus of policy there will also need to be consideration of the measures needed to adapt to some level of climate change such as in the areas of flood defences, water resources and agriculture. These adaptive measures are presented in the tables in this summary report.

36 ARE THERE ANY OPPORTUNITIES FOR THE REGION?

There could be a number of market opportunities for the Region arising from climate change including:

- Growth in regional tourism, recreation and associated retail and services. However this will have to be managed in order to avoid further pressures on existing destinations that are already well visited and to highlight the attraction of other existing and emerging tourist destinations in the Region such as the coast, woodlands and forest and cultural and historical sites;
- Growth in markets for high value-added locally grown produce;
- Growth in markets for renewable energy technologies. With its proximity to large population centres (South Yorkshire, Greater Manchester, West Midlands and the South East), providing a potential market, the East Midlands could be in a good position to export energy generated from renewable sources in the Region - the key opportunities could be on- and off-shore wind, biomass (woodland, energy crops) and photovoltaics;
- Growth in markets for new technologies and services that reduce greenhouse gas emissions, in particular with the onset of the Climate Change Levy and exploratory emissions trading schemes. There are numerous opportunities for the engineering and construction industries to increase efficiency of energy use in industrial and commercial processes and buildings of all sorts;
- Growth in markets for new technologies and services that help to address the consequences of climate change, eg coastal and riverine protection, provision of new agricultural supplies, equipment and advice, better water management and sustainable urban drainage systems, etc;
- Growth in markets for appropriate clothing, footwear and personal hygiene products.

Cost effective initiatives to reduce emissions should also help to improve the performance of the Region's businesses.

There is also a range of wider societal benefits arising from responding to climate change

There is also a range of wider societal benefits arising from responding to climate change.

- Tree planting can help to provide shade in cities, recreational spaces, reduce flood risk, promote biodiversity and can potentially store carbon;
- Design of buildings in response to climate change will generally improve the comfort level of those buildings to existing extreme temperatures, as well as potentially reducing energy bills;
 - Promotion of energy conservation and efficiency in the home can help to tackle the problem of fuel poverty;
 - Developing a biodiversity policy which is more in tune with the concept of dynamic, evolving systems will help to increase the resilience of biodiversity to inevitable change more generally;
 - Protecting flood plains will promote biodiversity and enhance the amenity value of land surrounding rivers;
- Managed realignment can also enhance biodiversity through development of new salt and fresh-water marshes.

CONCLUSIONS

This summary report demonstrates the following:

- The climate of the Region has changed during the 20th century;
- The climate of the Region is expected to continue to change in the 21st century due, at least in part, to greenhouse gas emissions from human activities;
- This climate change could have a number of important impacts in the Region such as reduced water resources, increased risk of flooding, changes in agricultural practices, changes in plant and animal species, adverse impacts on infrastructure, increased opportunities for tourism and more outdoor lifestyles;
- The Region will have to adapt to some level of climate change. This will include planning appropriate flood defences, using water resources more efficiently, restricting development in vulnerable areas and adapting living and working conditions;
- Not all the impacts will be negative and there could be considerable opportunities for the Region to develop products and services that help organisations and people to adapt to climate change and also reduce their emissions. Depending on how the Region plans to respond to climate change there could be benefits in some areas including biodiversity, agriculture, renewable energy and commercial and industrial performance improvements;
- A sample of East Midlands residents revealed that there is a good level of knowledge and concern about climate change. The respondents were those that had already expressed an interest in environmental issues. The respondents also supported the setting of tough targets for reductions in the Region's greenhouse gas emissions;
- Climate change will also have to be considered alongside other changes affecting the Region from social, economic and environmental trends; and
- The Region should monitor for climate change and set itself tough targets for reducing its greenhouse gas emissions.

The Region will have to adapt to some level of climate change



the potential **impacts** of
CLIMATE in the **East Midlands**
CHANGE



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