

CLIMATE CHANGE IN NOTTINGHAMSHIRE

IMPACTS AND OPTIONS FOR MITIGATION AND ADAPTATION

FINAL REPORT

A REPORT COMMISSIONED BY THE NOTTINGHAMSHIRE AGENDA 21 FORUM

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OCTOBER 2004**

CLIMATE CHANGE IN NOTTINGHAMSHIRE IMPACTS AND OPTIONS FOR MITIGATION AND ADAPTATION

EXECUTIVE SUMMARY

The climate is changing and the scientific consensus is that emissions of greenhouse gases (GHGs) are to blame. These include carbon dioxide, methane and some industrial gases. They are generated by man's activities: the main contribution is from carbon dioxide from the burning of fossil fuels. This report looks at the impacts of climate change and the emissions of GHGs in Nottinghamshire, how the county could adapt to such change and how it could reduce such emissions.

The future climate is uncertain and will depend on future emissions of greenhouse gases. Some change is predicted to be inevitable. This will be evident in higher temperatures all year round, wetter winters and drier summers and more frequent extreme events such as floods and droughts. Significant effort is required to reduce emissions; carbon dioxide reductions of about 60% are needed to stabilise the situation. Otherwise the potential climate changes are predicted to be severe by the end of the 21st century. The UK economy could probably adapt to this but some parts of the world will become uninhabitable and the economies of some developing nations will become unsustainable.

The local impacts will be seen in damage to the natural and historic environment, property and the economy, mainly from increased temperatures, lower summer rainfall and increased winter rainfall and related effects. This will affect farming, forestry and gardens as much as the natural wildlife, archaeological sites and historic buildings. Health impacts will be variable – some potentially beneficial. Disruption to transport and business by extreme heat or floods will increase in frequency. Lifestyle patterns will change. Some of these changes will mean that there are risks to individuals or corporate bodies but, by recognising these risks and adapting in an appropriate timescale, the impacts can be minimised and new opportunities recognised and exploited.

Nottinghamshire can make its contribution to reducing GHG emissions by a number of simple measures. Improving energy efficiency in homes and business by better insulation, more energy-efficient equipment and changing transport patterns will be a good start. These measures will have other social and economic benefits, particularly for the poorer sections of the community. Developing renewable energy sources such as wind, solar power and bio fuel will enable users to continue to gain the benefits from the use of energy without contributing to climate change. New markets are potentially available from the development of the supply chains for energy reduction, energy efficiency and renewable energy and there are opportunities to improve security of supplies.

Adapting to the changing climate will mean helping wildlife, agriculture, etc. to respond. New species will replace those lost to a changing environment. This could also mean, for example, new crops and changes to land management in gardens and public parks. Changes to the infrastructure and in building design and construction will be required to minimise the risks from the changing climate and to help protect modern and historic properties and the people who live or work in them. The report highlights other adaptation mechanisms that could be required. Many offer further opportunities for improvements in lifestyles or for business.

Time is of the essence. The end of the century seems a long way away. However, climate change is evident now. Changing energy use and adapting to climate change require time: time to educate and persuade, time to change behaviour, time to change investment decisions. Some changes can be made in a short timescale but investments over long periods and projects on a large scale (either geographically or in terms of numbers of properties or people) will take many years to plan and implement. Early responses can mean that the benefits are achieved sooner and the risks deferred or minimised.

This report, on behalf of Nottinghamshire Agenda 21 Forum, is aimed at starting more concerted action to tackle and adapt to climate change. Getting the interest and commitment of the key stakeholders then needs to translate into the involvement of the whole community asking themselves what they can do both to reduce GHG emissions and reduce the risks to themselves and their neighbours and colleagues.

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Acknowledgements

This report was prepared with financial support came from Nottinghamshire County Council. Philip Keynes, Emilie Lallemand and Andrew Clinkscale from Nottinghamshire County Council provided information and Figure 8. Bogus Zaba, Beverley Brown and Rob Wilby of the Environment Agency provided Figures 5 and 7 and reference material. The Nottinghamshire Agenda 21 Forum provided support and comment on the first draft and many others helped improve the Consultation Draft. All errors and omissions are mine.

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INTRODUCTION

The climate is always changing but it has undergone a significant warming since the 1970s with several records broken in the last decade. The most likely cause is the emission of greenhouse gases from human activity. Much has been published to support this view and the risks from climate change have been described by the Prime Minister as the most serious environmental problem facing the world.

The UK has been among the leaders in researching the phenomenon and arguing for international action. It has backed this concern by funding research into future climate scenarios, renewable energy, and adaptation. This report aims to bring together information from a wide range of sources in support of an initiative to develop a framework for action in Nottinghamshire.

"In my view, climate change is the most severe problem we are facing today, more serious even than the threat of terrorism" - Sir David King, UK Government Chief Scientist

1 THE CHANGING CLIMATE

The UK Climate Impacts Programme (UKCIP) published new climate scenarios in 2002¹. These were used to prepare an update to a study for the East Midlands in April 2004², building on earlier work published in 2000³. This study for Nottinghamshire is based on these scenarios. Nottinghamshire is within the East Midlands Region and the main conclusions for the region are extrapolated to the county in the boxes below. See Appendix 1 for a brief description of the background to the greenhouse effect, the use of scenarios and the terminology used.

THE FUTURE CLIMATE OF THE EAST MIDLANDS

The headline conclusions for the potential future climate scenarios in the region are:

Temperature

- For all emission scenarios, in the 2020s, average annual temperature and seasonal temperatures increase by about 0.5 to 1.0°C, except all summer averages and autumn averages for Medium-High and High scenarios which increase by nearer 1.5°C
- The spread widens in future years. By the 2080s, the annual average increase is 2.5 to 3.0°C for Low emissions to 3.5 to 4.5°C for High. Winter increases in averages are from 1.5 to 2.0° (Low) to 2.5 to 3.5°C (High) and summer from 2.0 to 3.0°C (Low) to more than 4.5°C (High).

Precipitation

- Annual rainfall averages show little change over the whole range of emission scenarios and timescales
- Winter rainfall shows increases across all scenarios with time, with the biggest increase of +30% toward the end of the century for High emissions
- Summer rainfall shows similar decreases, with time. The biggest decrease being over 50% for High emissions towards the end of the century.

There are less data about the other climate variables but the following summary conclusions can be made:

Soil Moisture Content: Changes in temperature and precipitation as well as wind speed, evaporation and radiation would be expected to affect soil moisture content. The percentage change is relatively small for annual and winter and spring seasons – less than 10% increases and decreases. The most severe impact is in the summer and autumn with decreases of about 30% and 50% respectively by the 2080s.

Variability: The main change is an increase in the variability between years, particularly of summer temperatures and winter precipitation.

Cloud cover: Small increase in winter but, by 2080s, a decrease of up to 15% in summer.

Relative humidity: Modest changes leading to up to 12% decrease in summer in 2080.

Daily wind speed: The worst case is up to about 10% increase in the winter.

Snowfall: 60 to 90% decrease by the 2080s.

Depressions: A small increase in the number overall with up to 40% increase in “deep depressions” in winter.

It should be noted that there is more uncertainty associated with these changes than with temperature and precipitation.

2.1 Extreme events

Structural damage and economic disruption as well as the effects on humans and biological systems are probably more affected by extreme events than the average trend. UKCIP02¹ gives more information on these although it is not as extensive as that for average results.

2.1.1 Precipitation

There are various ways of looking at this but all give a similar message. By the end of the 21st century there could be a doubling of the frequency of extreme winter rainfall events. Although the actual number of days remains small at two or three per annum, these are a common cause of flooding.

An alternative way of looking at the results is the return period (the long-term average time between events). For eastern England the range is 10 to 20% increase in the winter precipitation associated with a 2 year return period (15 to 25% decrease in summer). Extrapolation to longer return periods (flood and drought risk usually refer to return periods of 20 to 100 years) is difficult with only a short historical data record. For

example, UKCIP02¹ states that “amount of daily rainfall that at present could be expected to occur on average once in every 20 winters in south east England, increases by between 15 and 30% (depending on scenario)”.

Overall, the probabilities of extreme rainfall events increase in winter and decrease in summer.

2.1.2 Temperature

As with precipitation, there is a number of ways of looking at this. “Extremely warm days” (defined in terms of 90th percentile) could increase by up to 30 days in the summer. Over a full year this is 60 days (compared with the reference period 1961 to 1990). Similarly, the frequency with which any particular temperature is exceeded will increase. Currently, there is only about a 1% chance that the summer temperature on any day will exceed 30°C in Central England. By 2080 this probability could be 20%.

Temperatures could exceed 40°C once a decade by the 2080s. Conversely, the number of frosty day will decrease in winter.

2.2 Other effects

2.2.1 Growing season

The higher temperatures lead to an increase in the length of the growing season by between 40 and 100 days, depending on scenario. (Defined as temperature above 5.5°C for five consecutive days until below 5.5°C for five consecutive days).

2.2.2 Heating and cooling requirements

By comparing periods when the temperature is below 15.5° and above 22°C, and by how many degrees, UKCIP02 has made an estimate of the changes in the number of degree days. This can be used for estimating heating or cooling requirements. Depending on scenario, the percentage relative change for heating degree days is a reduction of between 20 and 45%. The absolute number of cooling degree days varies between 40 to 200 – depending on scenario and location.

2.3 Evidence for climate change

The recent report for the East Midlands² summarised the national picture:

“UKCIP02 reported that 1998 is still the warmest year in a 142 year record but 2001 became the second warmest and 2003 the fifth warmest on average. 2003 was noteworthy because of a heat wave across Europe during August which resulted in significant recorded deaths for the first time and structural damage and disruption to road and rail transport. Oxfordshire County Council reported that repairs to road surfaces due to the summer of 2003 would cost over £4M.

In terms of precipitation, 2000 was the wettest year in the 20th century and the third wettest since records began in 1766. There was 63% more rainfall in 2000 than in the relatively dry year 1996. There has been no discernable trend in annual average rainfall in recent years but the ratio of winter to summer averages has been increasing with an increased intensity of rainstorms. Lloyds has reported that, of the 10 worst recorded storms worldwide, 9 were in the last 10 years.

In the East Midlands and other parts of the UK there were serious floods in the winter of 2000 (and 2004 in the West Midlands). A dry summer in 2003 saw water resources under strain and predictions of a difficult summer in 2004 unless there was significant precipitation in the winter of 2003. February 2004 started with a record night time Central England Temperature of 11.2°C and a mean daytime temperature on the 4th of 12.5°C, beating the previous February record of 12.0°C from 1960. Earlier reported migration of birds such as swallows and, particularly, house martins reinforced the message. However, despite the upward trend in average temperatures, snow and ice in February reminded us that global warming does not mean that there will never be cold snaps. The new records and the variability are seen as indicative of the future climate.”

At a more local level, there is a weather station at Sutton Bonnington. Summary data for two overlapping thirty year periods are given which are consistent with climate change predictions – see Figure 1 below.

2.4 Summary

The evidence is that the climate is changing beyond that expected within natural variability and that the main cause is emissions of greenhouse gases (GHGs) from human activities. The major GHG is carbon dioxide that arises from the burning of fossil fuels but methane and other industrial gases (including propellants introduced to replace ozone depleting chemicals in aerosol cans) play a part. Unless action is taken to reduce these emissions, the climate will continue to change in a way that poses a severe threat to people and wildlife. The principle impacts will be warmer, drier summers and warmer, wetter winters with increased incidents of prolonged heavy rainfall. In extreme scenarios there could be more significant changes due to a breakdown in the coastal currents that gives the UK its temperate climate. This would lead to the UK climate becoming colder but it is thought that this is very unlikely, at least in the next 100 years.

Even if emissions of greenhouse gases were significantly reduced now the climate is already changing and is predicted to continue to change for at least 50 years due to the long “memory” within climate systems. Small changes can be significant in their impact. This means that, as well as reducing emissions as a contribution to a wider global action plan, the county needs to plan to adapt to the short to medium term changes and the associated risks to people, property and the economy now.

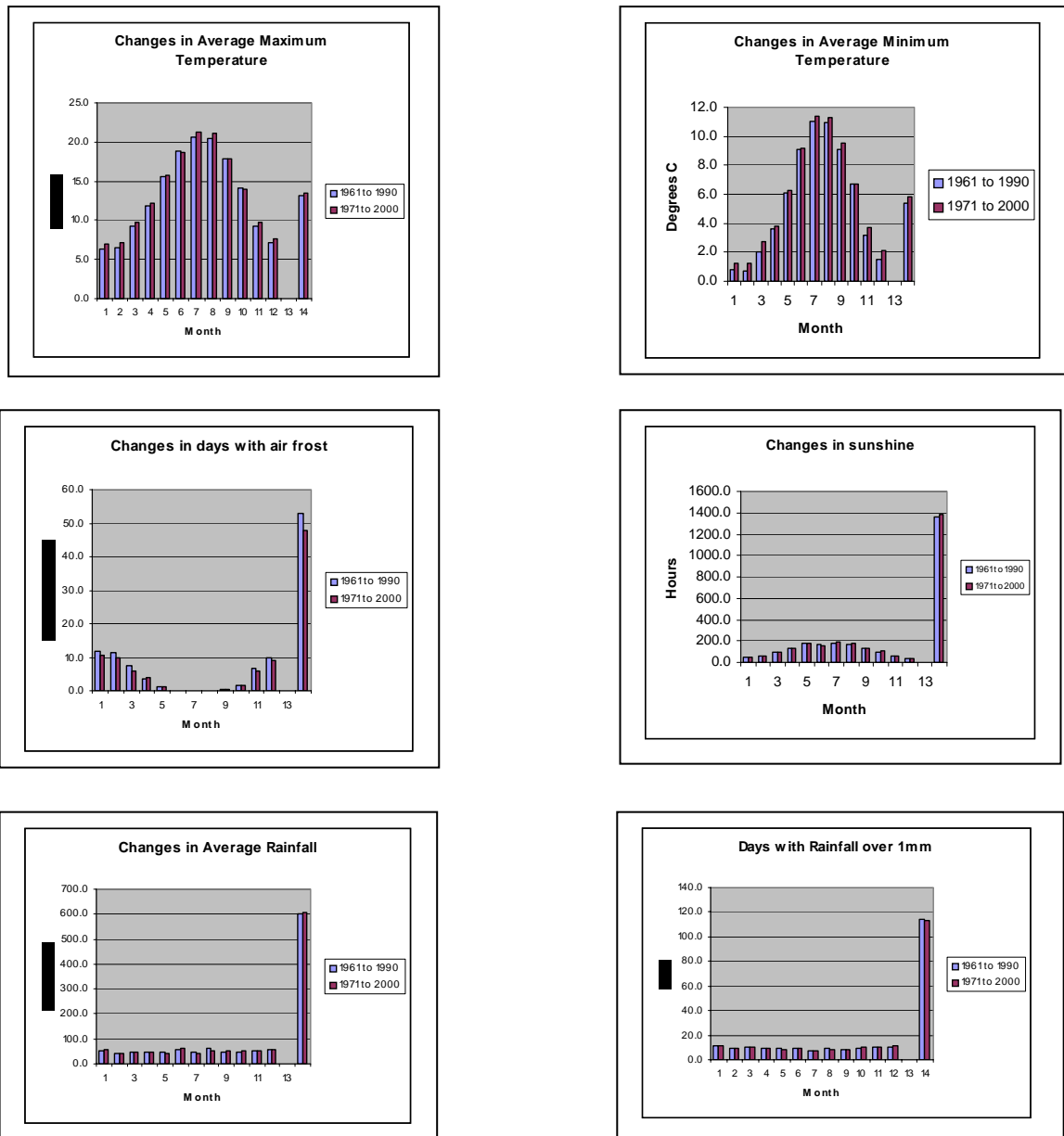


Figure 1: Changes in climate at Sutton Bonnington, Nottinghamshire

Data source: Met Office web site www.met-office.gov.uk

These charts compare 30 year records 1961 to 1990 (blue) with 1971 to 2000 (red).

Months labelled 1 to 12. Month 14 is the yearly average or total as appropriate.

Average monthly maximum and average monthly minimum temperatures have increased for most months and for the two yearly averages.

Numbers of days with air frost have decreased.

Hours of sunshine: no pattern.

Rainfall increased all months from September to January, decreased in May, July and August.

Number of days with rainfall over 1mm slightly reduced overall. Small reductions in May and September, small increases in October and December.

These results do not prove that the local climate is changing due to greenhouse gas emissions but local observations conform to the pattern predicted by future climate scenarios.

2 MITIGATION

Mitigation is the term used to describe actions to reduce greenhouse gas (GHG) emissions – in order to minimise or reverse their impact. The main GHG is carbon dioxide which has increased in the atmosphere as a result of burning fossil fuels such as coal, oil and natural gas. Mitigation has to tackle the burning of these fossil fuels by reducing the demand for energy and developing alternative sources that do not release carbon dioxide, or, possibly, by capturing the carbon dioxide and holding it in long term storage.

Some mitigation actions bring other benefits such as healthier lifestyles through walking and cycling, reduced air pollution and boosts to the local economy by supporting local food and renewable energy production.

Methane is another greenhouse gas that arises from leakage from coal mines and gas distribution systems, decaying matter and animals. Decomposing waste in landfill is one key source that can be reduced by waste minimisation and recycling. The other greenhouse gases (nitrous oxide and fluorinated gases) arise in much smaller quantities from industrial processes which are mainly being tackled through regulation of processes and industrial emissions.

Methane and the other greenhouse gases are more potent than carbon dioxide in terms of their ability to affect global climate changes. This report concentrates on carbon dioxide as being the most important and within the control of a wide range of organisations and the public. However, comments are made on some of the others where action could sensibly be taken at a local level.

3.1 National Framework

The government set out its initial programme in “Climate Change – The UK Programme”⁴ in November 2000. Some things have changed since then, for example new climate scenarios have been published¹. However, the programme set out the basis on which further work has progressed.

The programme covers mitigation and adaptation and commented on the initiation of IDeA’s (Improvement and Development Agency for local government) Councils for Climate Protection initiative and welcomed the launch of the Nottingham Declaration on climate change (Appendix 2) – both of which occurred in 2000. These were focussed mainly on mitigation. Adaptation is largely promoted through the UK Climate Impact Programme of regional and sectoral studies described in section 4.

3.1.1 The Energy White Paper

Subsequent government publications have been mainly on energy use and mitigation, culminating in the publication of the Energy White Paper⁵ in 2003. This set out proposals for aiming to reduce energy from fossil fuels by 60% by 2050 with substantial progress by 2020. This target is required if global temperature increases are to be halted. It makes the point that, in order to achieve this, action needs to start now. The diagrams below, from the White Paper, highlight the extent of the challenge and where the major changes need to be made.

Nationally, about 90% of total energy is derived from fossil fuels. The figure drops to 75% for electricity generation as nuclear and renewable sources play a bigger role than for the other main consumptive uses – principally heating and transport.

The largest use of energy is for transport at over one third, closely followed by the domestic sector. Industry accounts for about 20% of final energy consumption.

In setting the challenges in the White Paper, the government recognised some of the risks and included targets that ensured reliability of supply, continuing economic growth and that homes were adequately and affordably heated.

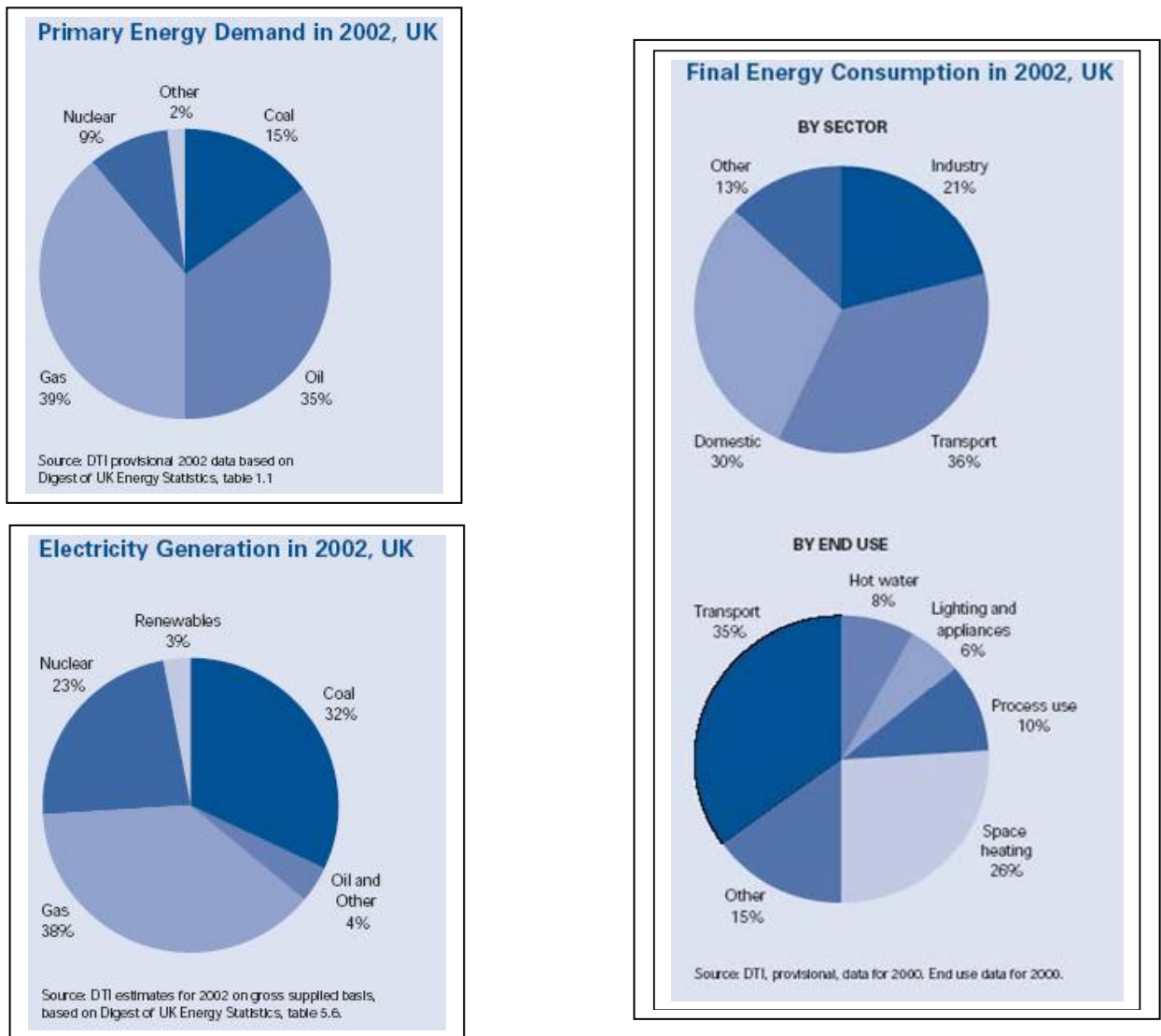


Figure 2: National statistics for energy use (from reference 5)

Various mechanisms are in place in support of these plans. These include the climate change levy and other taxes – for example on vehicles and fuel, support for renewable energy and regulatory measures through Integrated Pollution Prevention and Control. These are aimed at creating a secure and diverse market for energy with increasing

proportions being produced by smaller local schemes. The Energy Saving Trust has produced a Briefing Note for local authorities: Climate Change: What Your Council Can Do⁶ which describes the main initiatives across all the main energy uses. Advice and financial support is available to individuals and businesses from a wide range of sources including the Energy Savings Trust⁷, Action Energy⁸, and The Carbon Trust⁹.

The national trend in energy use is illustrated in the following graph¹⁰:

Total primary energy consumption, 1970 to 2001

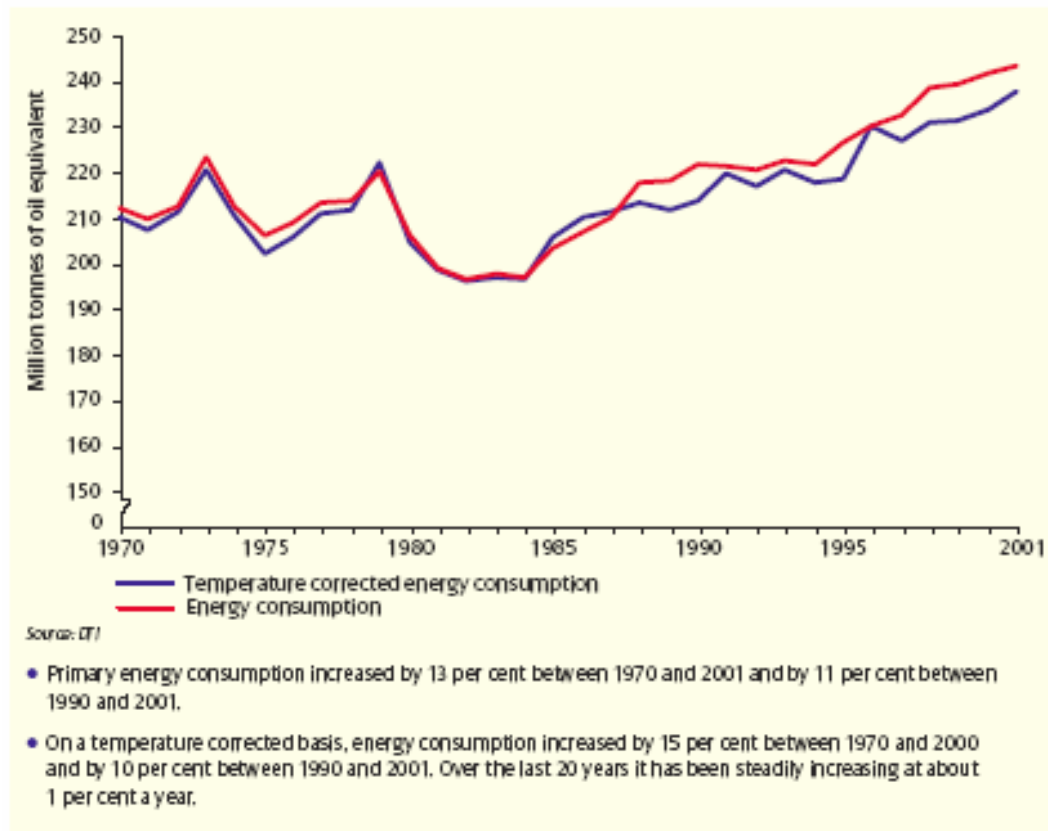


Figure 3: Long term national energy consumption (from reference 10)

More recently, the summary for 2003 national statistics included the statements¹¹:

- Total energy production was 4½ per cent lower than in 2002.
- Total primary energy consumption for energy uses rose by 2 per cent in 2003, but this is equivalent to a 1½ per cent rise when adjusted to take account of weather differences between 2002 and 2003.
- Final energy consumption rose by ½ per cent, with rises in each of the industrial, service, and domestic sectors of 2 per cent, 1 per cent, and ½ per cent respectively; there was a decrease in final energy consumption in the transport sector of 2 per cent.

Despite the reduction in energy for transport in 2003, the long term trend has been upward¹⁰

- Industry has had a modest increase in energy consumption
- Most of the increase has come from domestic use

- This is mainly due to an increase in the use of road transport for freight and car usage.

The changing pattern of energy use is reflected in carbon dioxide emissions:

Carbon dioxide emissions, by end user: 1970-2001

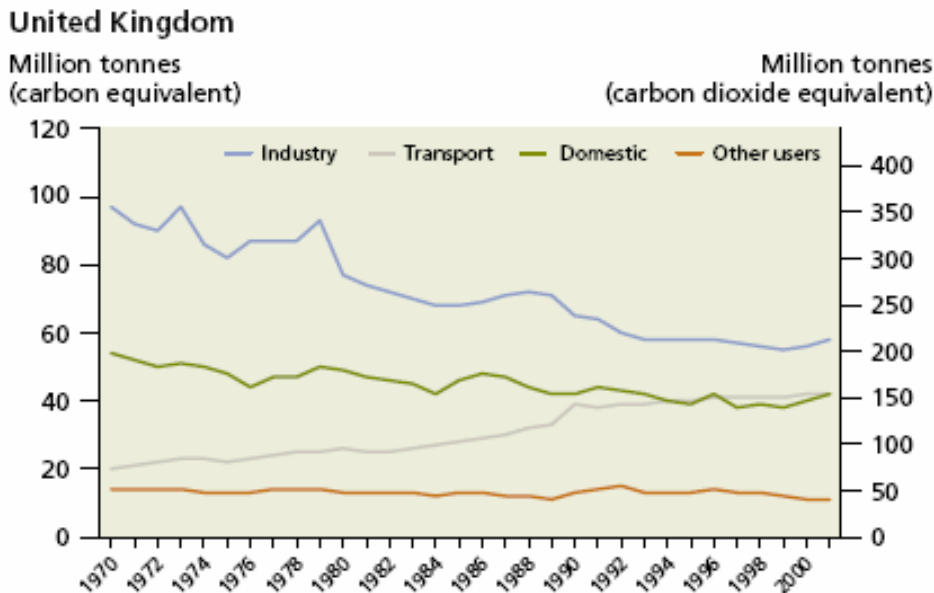


Figure 4: National carbon dioxide emissions (from reference 12)

It is difficult to collect statistics about local energy consumption and hence GHG emissions. It is reasonable to assume that the local use of energy in the industrial, domestic and transport sectors broadly reflects the national trends.

3.2 Energy use and carbon dioxide emissions in Nottinghamshire

The East Midlands is a major producer of electricity and a net exporter from the power stations along the River Trent. The problems from energy use are well recognised locally: energy is included as an important topic in the earlier East Midlands studies and the region and county already have initiatives underway. Reducing emissions of carbon dioxide (globally) will reduce the potential impacts of climate change, hence reducing risks and potential costs. National targets are ambitious and the longer the delay in making a start, the harder it will be to meet them.

It is a criticism in earlier reports that energy use statistics have been collected nationally and in a way that does not enable disaggregation to a more local basis. The DTI are moving towards providing these data but they are still not available yet.

Local data on a district council basis have enabled estimates of atmospheric emissions for 2000 (www.naei.org.uk) including carbon dioxide – see Figure 5. These are based on 1km squares. Data for 2002 have recently been released and more information is in Appendix 3.

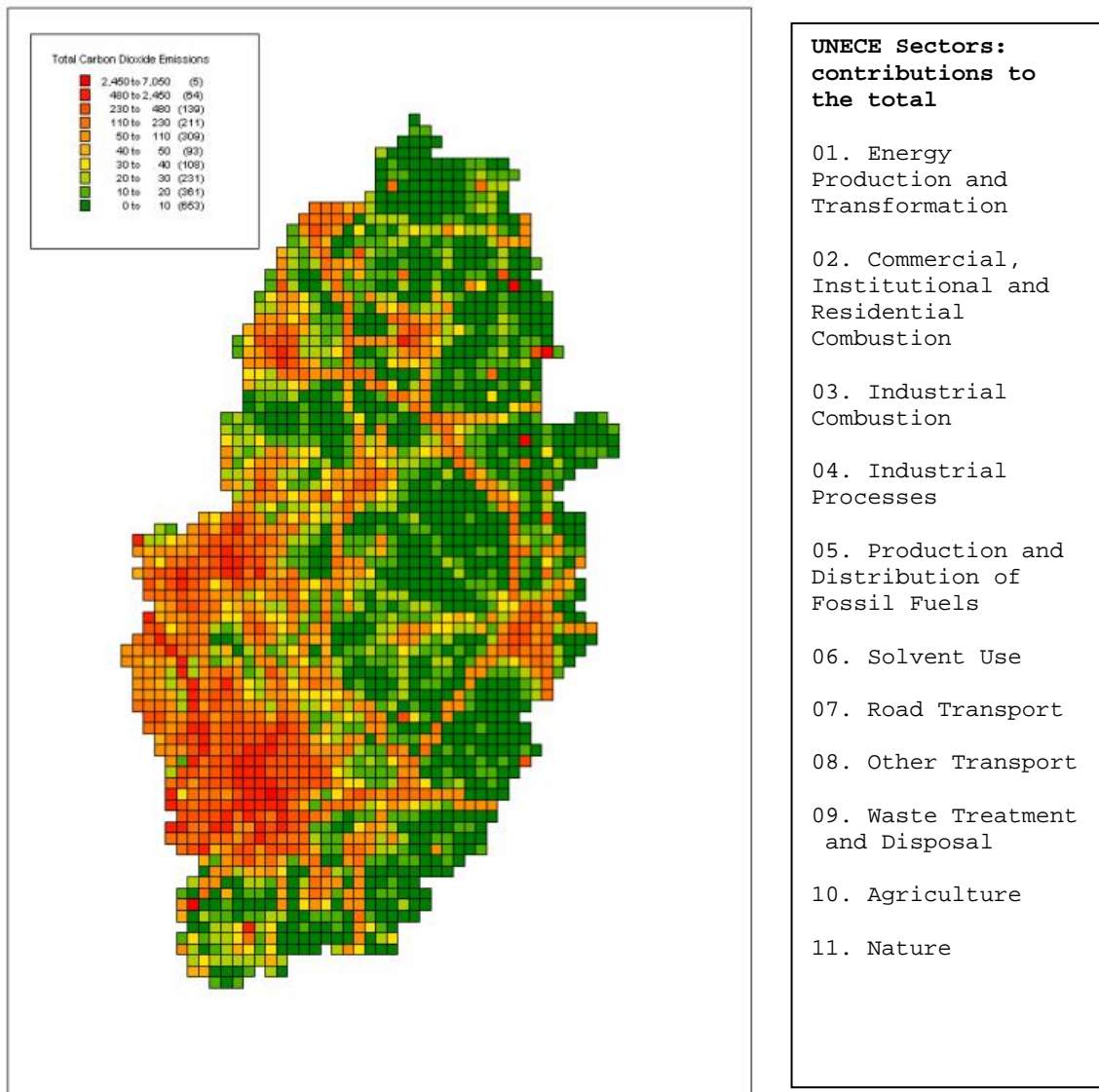


Figure 5: Emissions of carbon dioxide in Nottinghamshire for 2000

Data have been collected on a District Council basis for the sectors listed in the adjacent box. The main emissions are from urban areas and major trunk roads. From www.naei.org.uk.

The Environment Agency regulates the larger industries and the permitting process includes energy efficiency and emissions to all media including greenhouse gas emissions. Figure 6 shows all the regulated processes in Nottinghamshire that emit GHGs. The major sources are the power stations which, burning fossil fuel, is not surprising. As long as they continue they will remain the largest. Pentex Oil and Gas Ltd account for half the other eight sources.

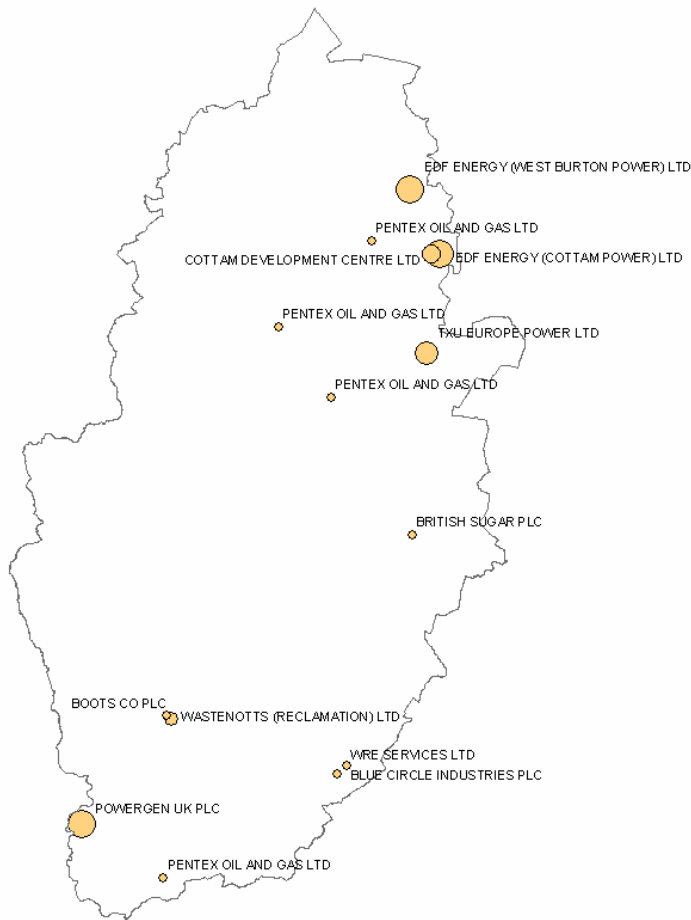


Figure 6: Major industrial sources of greenhouse gases in Nottinghamshire
 (© Crown Copyright. All rights reserved. Environment Agency, 100026380, 2004.)

3.3 Mitigation measures in the East Midlands at a regional level

The East Midlands has a long history of concern and action on energy efficiency and use. The East Midlands Regional Assembly has recently launched their Energy Challenge¹³. The four themes are:

- Reduce our use of energy
- Use energy more efficiently
- Move to energy from renewable sources
- Use remaining fossil fuels cleanly

This is supported by a draft strategy¹⁴ which recognises that:

- Energy production and the supporting industries form an important part of the Region's economic base and there are significant opportunities in new low carbon technologies that the Region could exploit.
- Energy generation and production are a major source of greenhouse gases as well as other pollutants and have an impact on the natural and built environment.
- The health and wellbeing of our communities and businesses are enhanced if they are able to access affordable heat and power through energy savings.
- The appropriate location of energy generation projects and attendant infrastructure must be addressed in spatial policy.

There are 17 policy statements which are geared towards reducing demand for energy services that damage the environment.

It should be noted that not all renewable energy developments are locally welcome. Visually obtrusive wind turbines and emissions from waste incinerators have particularly met with opposition so that any proposals for such developments would need to be carefully planned and explained.

Mitigation also depends on reducing emissions of methane and other GHGs. Some of these are regulated by the Environment Agency but emissions of methane can be significantly reduced by better waste management which involves the whole community.

3.4 Mitigation measures in Nottinghamshire

It would seem sensible that Nottinghamshire puts its effort into achieving the regional strategies and policies. There is a comprehensive energy strategy with emphasis on local action. Local actions to date (which are often part of a larger project with a broader sustainability basis) include:

- Several local authorities are improving the energy efficiency of their own property and purchasing green electricity
- 5 Nottinghamshire local authorities (Nottinghamshire County Council, Nottingham City, Mansfield, Broxtowe, Newark and Sherwood) have signed up to the Nottingham Declaration on climate change (out of a potential of 9)
- 3 local authorities were involved in the Councils for Climate Protection project
- The universities are active in energy research
- Newark and Sherwood District Council identified as a Beacon Local Authority for tackling fuel poverty

- Newark and Sherwood District Council has conducted its own emissions survey, plans to cut its own emissions by 20% by 2010 and is investigating a 60% cut for 2010
- Nottinghamshire County Council has installed several wood burning boilers in schools
- Sherwood Energy Village, Hockerton Housing Project, Millennium Green Scheme at Collingham are some examples of practical projects which have incorporated best design and operational practices
- Boots plc awarded Energy Manager of the Year 2002
- Nottingham City Council is updating its Climate Protection and Sustainable Energy position statement
- An energy service company, Renewable Nottinghamshire Utilities (ReNU) Ltd, has been formed with the County Council as a shareholder.

Nottinghamshire County Council produced a Climate Change Strategy Framework in April 2002¹⁵ which recommended actions for the County Council to take in the areas of its own activities in transport, procurement, waste and energy. The County Council has subsequently entered partnership with the Carbon Trust in July 2004 which has secured £1M of funding dedicated to “invest and save” energy measures.

Nottingham City has reported that home energy use has reduced by 12.2% since 1996 (Evening Post 26th May 2004). Over the previous 12 months, 5.5% of gas boilers had been replaced with energy efficient boilers, double glazing increased by 9%, loft insulation by 3.9% and cavity wall insulation by 6.8%. Since 1996 fuel bills were estimated to have reduced by £4m.

Travel in the wider community in Nottinghamshire is tackled through Local Transport Plans. These do not just focus on travel methods; issues such as safety are also important. The county’s efforts are recognised through a number of awards. The Progress Report for Greater Nottingham for 2002/03 recorded that the total volume of traffic was down by 1.5% compared with 2000/01, helped by increased bus usage of 6.8%. Since then the new tram system has started operation in 2004 and various other initiatives are underway¹⁶.

A similar Plan for North Nottinghamshire records traffic growth of 2% in the Mansfield area and 6% in the rural areas for 2003 compared with 2002 but this is 1% less than the 1999 base. A variety of measures, including promoting alternative means of transport, increasing the frequency on the Robin Hood Line, etc is in hand.

These actions can help to reduce carbon dioxide emissions from transport use but there is a long way to go to make significant reductions. The extent to which the cars currently being used or sold are becoming more fuel efficient over the years is not known although the recent growth in the sales of sports utility vehicles (SUVs) will not help. A new generation of alternative fuelled and hybrid vehicles is only just beginning to become available and will be relatively expensive for some time. Some progress could be made through promoting vehicles (including those for public transport) that use bio fuels, electric drives (single and combined) and private cars which have the highest fuel efficiency.

3.5 Construction and maintenance of buildings

Much work has been done on design and construction methods for new buildings (see also comments in section 4.1.3), particularly looking at energy efficiency, sustainable techniques and related matters. A good example of this is the use of lime mortar rather than cement – lime mortar requires less energy for its production and it also absorbs CO₂. Sourcing materials locally and using earth and timber techniques also reduce total energy use. Examples exist in Nottinghamshire of demonstration and completed developments that incorporate many good features. Many of these feature in the Nottinghamshire Sustainable Developer Guide produced in July 2004⁵¹. Some examples from the wider East Midlands are quoted in the update report for the East Midlands².

Consideration of the wider issues around older buildings is also important: the embodied energy in materials of construction can be a significant factor. The trade off between refurbishing existing buildings rather than building new and the reuse and recycling of building materials can have an impact. For all buildings, maintenance is critical to maintaining energy efficiency – see, for example, www.maintainourheritage.co.uk.

3.6 Waste management

Nottinghamshire produced about 3,078 million tonnes of waste in 1998-1999 from all sources; recycled and reused 1,354M tonnes, land-filled 1,494M tonnes and produced energy from 149,000 tonnes¹⁷. The balance went to a variety of other outlets or cannot be accounted for. Waste to land-fill decays to produce methane, a powerful GHG. Much waste consumes energy in its production and energy is used in transporting and disposing of most of it. There are other issues to do with resource efficiency, lack of land-fill sites, amenity, cost of disposal, etc. which support arguments in favour of minimising waste production and increasing the amount that is recycled, composted or converted to energy. The emission of greenhouse gases just reinforces these arguments.

Nottinghamshire is in the process of putting new arrangements in place that will tackle these problems and increase the amount of waste that is reused or recycled. These will not be fully operational until 2006 but educating those that produce waste that it contributes to the GHG problem as well as all the other reasons to minimise the amount produced could start the reduction before 2006.

3.7 Summary

The sources and trends of GHGs in Nottinghamshire are probably similar to the national picture. Although carbon dioxide is less potent than the other GHGs, the quantity emitted is so large that it merits priority for action through measures to reduce consumption and provide renewable sources. Heating, lighting and industrial processes are all important but transport is the use probably requiring most attention.

At the same time, regulation of other industrial emissions and, in particular, the management of waste also have parts to play in mitigating climate change.

4 ADAPTATION

Some climate change is inevitable however successful the efforts to reduce the emissions of carbon dioxide and other GHGs. The inertia in the climate system means that the outcome to the 2050s is fixed (see Appendix 1). Beyond that the scenarios diverge depending on GHG concentrations. So some adaptation to a changing climate will be required.

DETR commissioned ERM consultants to produce a Technical Report to government¹⁸ in 2000 on Potential Adaptation Strategies for Climate Change. This was the part of a developing programme that highlighted the main risks and how to respond. The risks were seen as being to water resources, flooding, damage to buildings and infrastructure and to nature conservation and biodiversity. It recommended using the planning system to help in the adaptation process and the adoption of a “no regrets” approach to action. Government priorities were suggested to be driven by urgency (need for action over 5 years and 10-20 years), economic importance to the UK, scope for strategic response (i.e. up to government) and public perception. This approach could be useful in reflecting on how local actions should be prioritised.

The response and most subsequent work have been conducted mainly under the UK Climate Impacts Programme (UKCIP), although the Environment Agency also has a three year programme of research into impacts and adaptation that started in January 2004. UKCIP is a DEFRA funded organisation that supports and co-ordinates impact and adaptation studies and publishes the results on their web site www.ukcip.org.uk.

4.1 Sectoral studies

Many studies have been conducted into the risks to a particular sector and suitable adaptation responses. This section summarises some of the key studies which could be relevant to Nottinghamshire.

4.1.1 Water resources

The Environment Agency is responsible for regulating water resources, carried out by resource planning and licensing of abstractions. The supply of water to homes and businesses is mainly by Severn-Trent Water Ltd, although some consumers have their own borehole or surface water abstraction. As far as Nottinghamshire is concerned, the main sources of water are the River Trent, the tributaries of the Trent and groundwater from sandstone and limestone aquifers.

The Trent was too polluted for many years to be suitable for abstraction for water supply. However, since quality improved in the latter part of the 20th century, there is increasing demand from water supply companies. There are also abstractions for agriculture and other uses such as cooling water for power generation. In parts of the county the availability of water is already limited. Groundwater is already at the limit of abstraction (or in some cases over licensed) and restrictions are frequently imposed on surface water abstractions in the spring and summer due to low flows. This is just at the time when farmers are most likely to require water. (Although agriculture accounts for about 4% of total use, it is concentrated into a few months).

Climate change could increase the demand for water with higher temperatures and reduced soil moisture contents. The Environment Agency produced a Water Resources Strategy in 2001^{19, 20} which adopted a scenario approach to planning for the next 25 years. Socioeconomic and climate scenarios were used. The need for environmental protection and a move towards sustainability required some reductions in abstractions. The increasing demand for water meant that new sources would be required and that water efficiency in home and business would be essential. Farmers would have to look to efficiency but also consider storage and alternative crops.

Further studies in Climate Change and the Demand for Water²¹ suggest that the increase in demand by domestic and industrial consumers will only be a few percent, but that the increase in demand from agriculture could be up to 20%.

Water quality is affected by river flow – the dilution available for effluents is used in deriving the limits applied to consents for discharges. Tighter limits will need to be applied to maintain the same river quality if flows reduce in the summer months. This could increase the complexity and cost of effluent treatment at sewage and industrial works and the energy consumption. The dilution available for unregulated discharges will also be less although these should be of a limited nature. However, there is the potential to reduce dissolved oxygen concentrations at a faster rate due to higher temperatures.

The impact of climate change on water supply is being investigated by UK Water Industry Research Ltd which has produced a series of research reports on specialist topics.

4.1.2 Flooding

The increased risk of flooding has come to the fore with the public following recent flood events and the difficulty that some householders are experiencing in obtaining insurance cover. The Office of Science and Technology commissioned the Foresight Programme to look at the changing risk and the final report was published in April 2004²².

This study considered the impact of a range of factors, including climate change. The four Foresight socio-economic scenarios were used and all indicated an increased risk of flooding. This ranged from an increase from the current national cost of £1.4 billion by between £1 billion and £27 billion by 2080, depending on scenario. Most of the increases were expected to have occurred by 2050. Flooding from rivers, coast and urban drainage were included. Flooding from surcharging of drains could increase by up to four-fold. Climate change was not the only causal factor. Other factors included urbanisation and land management.

The Association of British Insurers is also expressing its concern. They claim that a 25 to 39% increase in winter rainfall could lead to a 20% increase in peak river flows, doubling the risk of flooding or halving the effectiveness of existing defences. DEFRA recommend a 20% margin for peak flows to allow for climate change. This has recently been shown to be adequate for a sample of catchments²³.

The Environment Agency is the principle flood regulatory and operating body in England and Wales for fluvial flooding. Its short term strategy is to improve the flood risk maps and take them forward to 2050, including the effects of climate change. It is also enhancing its current operations to deal with the present risk. It will shortly publish a strategy for the protection of flooding from the River Trent.

Parts of the county already suffer from flooding, the most recent severe event being in the autumn of 2000. In this event 123 properties and 77 caravans were reported flooded in the Trent catchment. The estimated return period varied between 60 and 90 years depending on location. Nottingham city and many parts avoided flooding as they are protected to a design return period of 100 years. However, defences at Attenborough and Farndon, with a design period of 50 years were over-topped. This accounted for nearly half the flooded properties. The remainder were in undefended areas.

The Environment Agency produces flood risk maps showing the indicative flood plain (areas at risk with a 1% and 0.1% probability of flooding or a return period of 100 and 1000years, if not defended), copied in Figure 7. Detailed maps are available on the web site www.environment-agency.gov.uk.

Planning guidance recommends that development should adopt a risk-based approach, avoiding inappropriate development in high flood risk areas. The Joint Structure Plan reinforces that view. Climate change will increase the risk of flooding. This will be observed in two ways: those already at a 1% risk could find that risk increasing – implying more frequent flooding; and those currently at less than 1% risk, who have probably never flooded, will be similarly affected – implying an increasing risk of first time flooding.

There is no comparable map showing flood risk from other sources such as surface run-off and surcharged sewers and drains. Flooding from surface water sewers in urban areas is mainly the responsibility of Severn Trent Water Limited. The Company is putting plans to upgrade sewers at risk in its bid to OFWAT for funding in the future.

4.1.3 Built Environment

The (new) Construction Research and Innovation Strategy Panel (CRISP, now nCRISP) has recognised the challenge for energy use and efficiency and for adapting to climate change that faces the construction industry. It has its own task group looking at the aspects of climate change that will affect the built environment, nationally and regionally and finding out what relevant work has been undertaken and what relevant experience exists. It has supported the development of a programme by UKCIP and the Engineering and Physical Sciences Research Council (EPSRC) which has recently got under way²⁴. This will invest £2M in the next few years in research into urban drainage, urban environments and planning, energy and telecoms, buildings, transport and built heritage.

The main problems likely to be faced are:

- Flooding from rivers or inadequate drainage systems on buildings or underground
- Town and city centres are likely to suffer from the urban heat island effect – the concentration of heat due to buildings and paved areas resulting mainly in an increase in night time temperatures. Planning of the layout and facilities for

shade, etc. and details of the building design can help to minimise these effects. This is most likely to be of concern to larger centres such as Nottingham.

**Nottinghamshire County 1% and 0.1% flood risk outline
(excluding any existing or planned defences)**

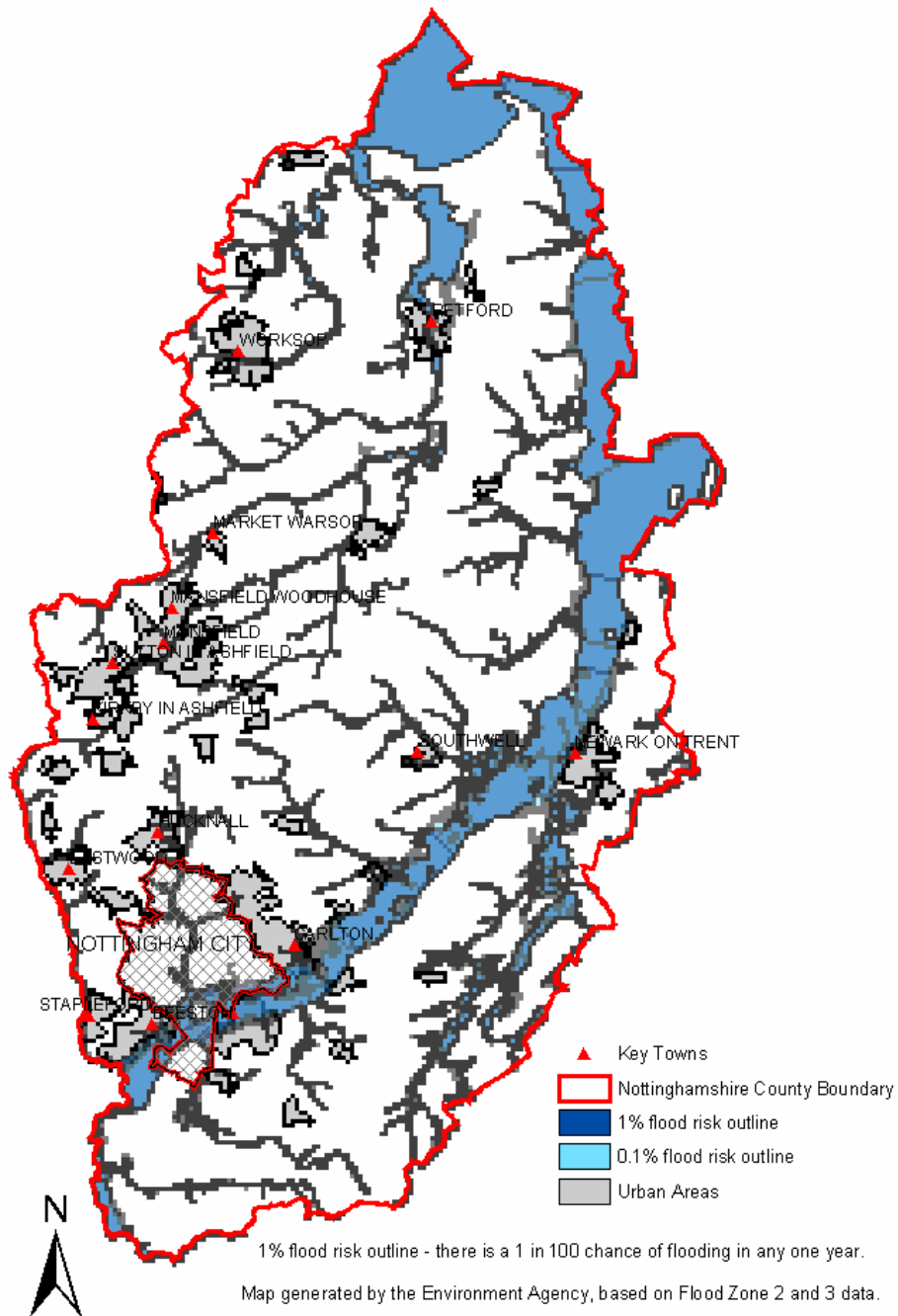


Figure 7: Indicative flood plain for Nottinghamshire

- Subsidence on clay soils as they dry out
- Structural damage from storms, rain penetration and heat
- Increased demand for air conditioning
- Disruption to construction due to weather in some seasons, counterbalanced by better weather in others
- Damage to infrastructure, such as roads and rail, from flooding or extremes of heat.

4.1.4 The natural environment

There have been several reports on these wide-ranging but related topics. Five recent key ones are summarised below.

(i) Nature Conservation - MONARCH

The Summary Report for Phase 1 of Climate Change and Nature Conservation in Britain and Ireland (MONARCH- Modelling Natural Resource Responses to Climate Change) was published in 2001²⁵. It identified the potential implications for terrestrial, freshwater, marine and coastal environments and highlighted potential “winners and losers” on a national scale. Not all the habitats are present in Nottinghamshire and nothing was highlighted that related to the county.

The related report Climate Change and UK Nature Conservation²⁶ identified the need for Biodiversity Action Plans and Habitat and Species Action Plans to take account of climate change and for changes in UK and European policies. It contained a lot more detail, including a wide range of impact analysis on a wide variety of habitat types and species. None was identified in Nottinghamshire, possibly reflecting the poor biodiversity in the East Midlands generally although some of the examples used are probably relevant.

Monarch is continuing into a second phase which will develop the earlier methodology on to a local scale. Nowhere in the East Midlands is included so far. However, a forthcoming review of the impact of climate change on biodiversity is expected to be conducted on a local scale and should pick up the main issues for the county.

(ii) Agriculture

DEFRA (and the predecessor, MAFF) has conducted a lot of research into the impact of climate change. A summary of recent projects is in Climate Change Impacts & Adaptations Research Programme (CC03) - Project Summaries Report 1987 – 2002²⁷. There is far too much content to do justice to in this summary.

The Institute of Grassland and Environmental research has conducted some of the work for DEFRA and held workshops with farmers and other interested parties²⁸. The messages coming from these are:

- Current short term pressures on agriculture mean that long term issues are unlikely to result in decisions today
- Agriculture contributes to GHG emissions but can also help to mitigate by sequestration and producing energy crops
- The opportunities from longer growing season, new crops and carbon trading could more than compensate for any downside
- Need for simple information and advice

- Concerns about soil conservation, flooding, water supplies and storm events

A report within the same reference shows how increasing carbon dioxide concentrations could compensate for decreased water availability to result in little change to the yields of winter wheat and sugar beet in the East Midlands, except on shallow soils. The general message suggests that, overall, low priority could be given to adaptation for agriculture except where the availability of water is potentially a limiting factor.

Little is available specifically looking at the impact of climate change in Nottinghamshire. In broad terms, the nature of the terrain is sandy to the west of the county and in the extreme east, with clay in a band from the north east through the centre and again in the south east (Figure 8). Much of the arable land is over the sandy soils and will require more irrigation water in summer for traditional crops such as potatoes and sugar beet. It is these areas which are already short of water – see section 4.4.1. On the other hand, clay soils are likely to suffer water logging in winter making access and growing difficult.

(iii) Woodland and forestry

The Woodland Trust has produced its own report²⁹ that concluded that *“our native woods of oak, beech, ash and Caledonian pine from Cornwall to Scotland are at risk from changes in our seasons, increased temperatures, droughts and water shortages, extreme weather events and exotic pests and diseases. Woods, as we know them today, may have changed irreversibly by the end of the 21st century and some of the plants, animals, birds and insects which live in woodland may be in danger of becoming extinct.”* The Trust runs the UK phenology network (UKPN) (the recording of natural life cycles over time, including more than trees) in conjunction with the Centre for Ecology and Hydrology as a means of tracking changes. It has some records dating back to the 1700s. These records show unequivocal evidence that species events are now considerably earlier than even 30 years ago –as much as 2-3 weeks, and that autumn is now about 1 week later on average than 30 years ago. Analysis of these data with temperature data shows statistically significant correlations between the changed timing of events and climate.

The threat is not just to trees; UKPN has recently shown that relative phenological change between species is not constant across all taxa. Plants and bird life can get out of synchronisation with the way tree development is changing which, in turn, threatens their life cycles. New pests and diseases (such as the Asian Longhorn beetle) are a threat. Increased storm damage is also seen as a potential problem if it starts to exceed the current natural beneficial cycle.

Some mobile species of wildlife can adapt and redistribute to sites where conditions are better. However, for trees and many of the species associated with ancient woods, which are typically quite immobile, the rate of migration may not be sufficient to keep up with the rate of climate change. Moreover, with the fragmented nature of the relatively low wooded areas in Nottinghamshire and the intense agricultural or urban land surrounding them, further migration could be impeded. The sandy soil in parts of the county increases the risk of water stress and in dry conditions there is an enhanced fire risk. Sherwood Forest is the only National Nature Reserve in the county and one of its top tourist attractions and so it needs special consideration. The Woodland Trust advocates a landscape approach through buffering and extending woodland, increasing

the core area which will help wildlife adapt to climate change. This approach is similar to that of the Environment Agency which, for example, promotes the use of river corridors to link habitats.

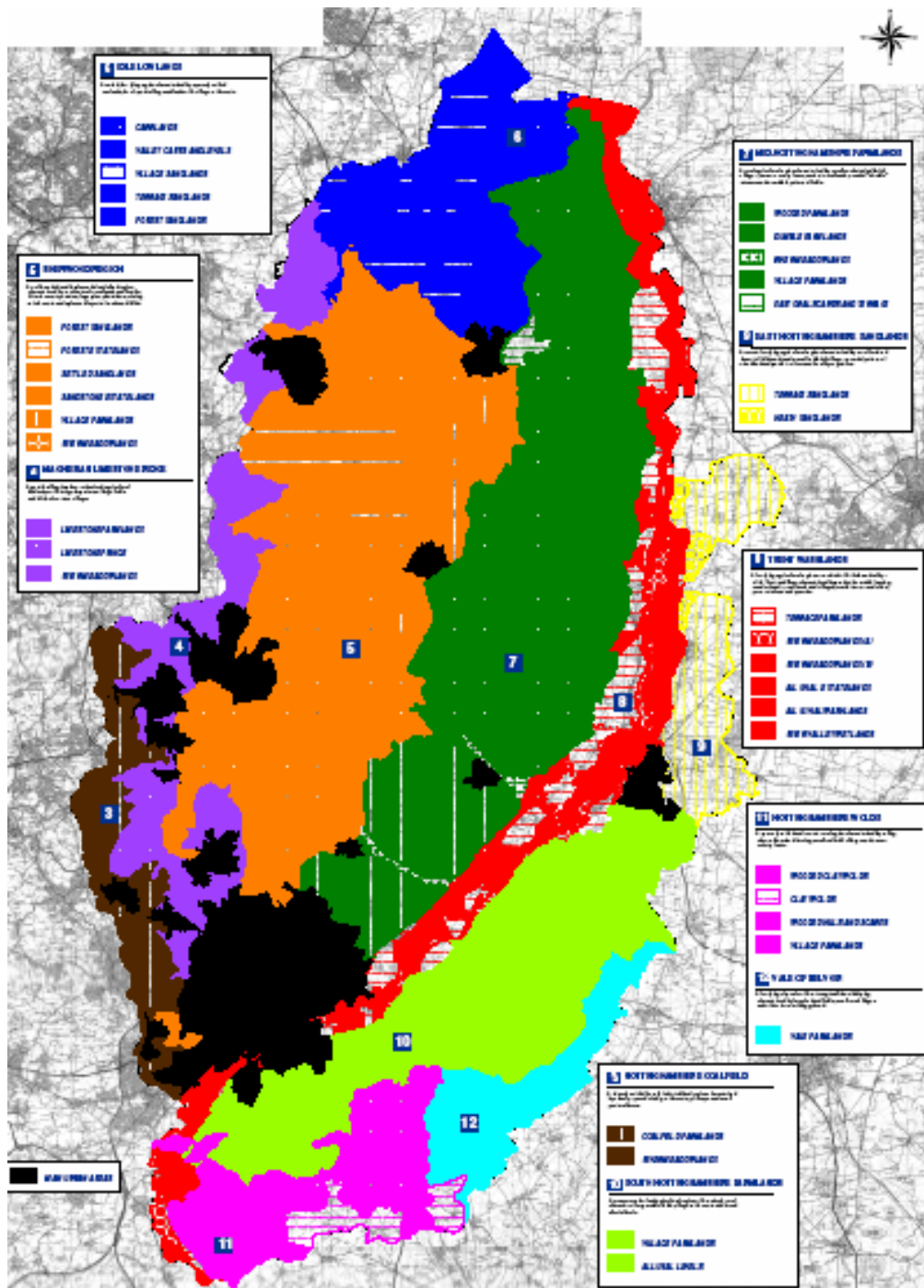


Figure 8: Landscape in Nottinghamshire

From the Nottinghamshire Landscape Guidelines, Landscape Types Plan. Sandy soils are predominantly found in the solid orange area (6) and the hatched yellow area (9). Clay is found in the green area (7 and 10) and mauve and blue (11 and 12). Based on the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office. © Crown Copyright reserved. Licence No. 071404

The Forestry Commission is also interested in the impact of climate change and, with the Woodland Trust, is supporting phase 2 of MONARCH.

(iv) REGIS

The Regional Climate Change Impact and Response Study (REGIS) has adopted an integrated approach to quantify the cross-sectoral interactions affecting landscape in East Anglia and North West England³⁰. Climate and socioeconomic models were used to study the potential impact on the coast, agriculture, water and biodiversity.

The results show how different socio-economic models (Enterprise and Global Sustainability – see Appendix 1) lead to different outcomes in respect of such issues as flood risk, how agriculture develops, the availability of water resources and the impacts on biodiversity.

The lessons that seem to be transferable to Nottinghamshire are:

- Agriculture is more likely to be influenced by socio-economic trends than climate change
- Flood risk in parts of the county could be an issue
- Water resources and quality could be at risk
- Biodiversity of lowland species is at less risk than montane species unless particularly sensitive to drought

The conclusion for the integrated impact was: *“the actual response of species and habitats to climate change is likely to be strongly influenced by future socio-economic decisions, for example on flood defence policy, water abstraction and the allocation of water to the environment, changes from grassland to arable cropping, and conversion to organic agriculture”*. This conclusion is of importance to Nottinghamshire in that it would be easy to focus on one aspect of changes to the local environment and ignore other factors which could have a greater impact.

(v) Gardens

The publication “Gardening in the Global Greenhouse” by the Royal Horticultural Society and the National Trust³¹ was aimed at public and private gardens. However, much of the information contained would also apply to other public areas such as parks and amenity areas. Plants and trees are vulnerable to storm damage as well as changes in temperature and drought, water-logging and soil erosion. Many gardeners see growing plants in difficult circumstances as a challenge but most of the owners of public land at risk would probably prefer to adapt.

The main conclusions from this study were:

- Higher carbon dioxide concentrations and temperatures will encourage growth but aspects of the life cycle such as bud burst, flowering and fruiting of many plants respond differently.
- Temperature changes will allow some sensitive plants (e.g. grapes) to grow in more northerly climates but some plants (e.g. onions) may produce lower yields.
- Higher temperatures will increase soil activity hastening the reduction in organic matter and releasing nutrients. Soil fertility may also be reduced by heavier rainfall and enhanced growth rates removing nutrients.

- Organic content in lighter soils will help to alleviate drought whereas incorporation of grit in clay soils will help alleviate water-logging.
- Trees will also be more vulnerable to storm damage (there is already evidence of this happening) as well as the factors affecting all plants.
- Insect pests could become more of a nuisance with longer periods to grow and breed and reduced loss in winters. Predators will be similarly affected perhaps counter-balancing the risk. Some new pests could be expected to migrate northwards, including from continental Europe. Termites, Asian gypsy moth and horse chestnut leaf miner are alien species already recorded in southern Britain.
- Viruses and other diseases caused by fungi will be affected in similar ways and the report highlights risks to sycamore, oak, yew, box and holly trees.
- Weed growth will be encouraged, bracken could spread further uphill and the spread of alien plant species will also be promoted. These will cause problems for bodies responsible for the maintenance of larger open areas.

Choices to fight change or adapt will be influenced by cost and time considerations as well as practicality. Public bodies will be less likely to want to irrigate, cut grass more frequently or indulge in expensive maintenance programmes. Whereas changing plants with a short life is less of a problem, decisions about larger grassed areas and trees are longer term and need to be considered now. The creation of green spaces can reduce urban heat islands by providing shade and reducing the concentration of heat-absorbing surfaces. The use of trees to provide shade in public parks and housing for comfort and health reasons (see below) is another factor requiring a longer term view.

Water features will be adversely affected by warmer temperatures and more intense light with increased algal blooms, potential problems with toxic algae and fish stress. Structures and furniture will be subject to storm and climatic damage.

In summary, the overall picture for the natural environment which could influence how Nottinghamshire plans to adapt is:

- Changes to plant and animal species distribution
- Loss of habitat such as grassland and shallow rooted trees
- Extended growing and breeding seasons
- Risks from new pests and diseases and extended risks from current alien species such as Japanese Knotweed and Himalayan Balsam
- Challenges in respect of water availability and soil fertility
- Increased damage from drought and storms and, for example, silt in streams
- Opportunities for new crops and other plants and new techniques for irrigation
- A requirement for longer term planning for adaptation in some cases.

4.1.5 Historic environment

The historic environment sector has been fairly slow to respond to the issues relating to climate change as at present no sector study exists. It is mentioned in all of the regional studies, although the East Midlands study² is the weakest just giving numbers of sites and stating that historic buildings may be at risk. Relevant bodies such as English Heritage and the National Trust are alert to the risks to buildings, landscapes and other

aspects of the heritage and are looking at the actions needed to introduce mitigation measures and adapt. The risks are shared with those for the built environment, natural environment and from flooding already highlighted. General mitigation measures will help to reduce the risks to historic sites over time. However, direct mitigation actions (for example, insulating historic buildings) may be more constrained by the need to preserve the assets. Climate induced risks to buildings, trees, gardens etc. are also of more concern as they are preserved for their heritage value and so flooding or subsidence or radical changes to structures or landscape in order to adapt would damage that value.

Nottinghamshire has an opportunity to take a lead in identifying and responding to the threats from climate change to the historic environment.

4.1.6 Health

The department of Health published a report in 2001 on the Health Effects of Climate Change in the UK³². This was a detailed analysis which was based on the Medium-High UKCIP98 scenario for 2050. The summary conclusions were:

- Cold-related winter deaths are likely to decrease substantially, by perhaps 20,000 per annum;
- Heat-related summer deaths are likely to increase, by around 2800 cases per annum;
- Cases of food poisoning are likely to increase significantly, by perhaps 10,000 cases per annum;
- Insect-borne diseases may present local problems, but the increase in their overall impact is likely to be small;
- Water-borne diseases may increase, but the overall impact is likely to be small;
- The risk from disasters caused by severe winter gales and coastal flooding is likely to increase;
- In general, the effects of air pollutants on health are likely to decline but the effects of ozone during the summer are likely to increase: several thousand extra deaths and a similar number of hospital admissions may occur each year;
- Cases of skin cancer are likely to increase by up to 5,000 cases per year and cataracts by 2000 cases per year;
- Measures taken to reduce the rate of climate change by reducing greenhouse gas emissions could produce secondary beneficial effects on health.

Some of the messages should form part of public education and awareness campaigns. Nottinghamshire could consider this in relation to food hygiene, heat risks, skin cancers and cataracts.

4.1.7 Transport

The Department for Transport (DfT) has considered the impact of climate change on transport³³. The main risks identified were:

- Some coastal stretches may be at risk of inundation by the sea during periods of particularly high winds when this is coupled with the highest tides. This will be

of particular concern for coastal railways, e.g. in Wales and parts of South West England.

- More extreme heat during summer could lead to heat exhaustion for vulnerable passengers on the London Underground particularly when subject to delays;
- Sudden structural failures are extremely uncommon, but, if no action were taken, the risk of such failures could increase due to soil saturation and the scouring action of rain/high rivers.
- Difficult driving conditions due to snow and ice would decrease but the number of days when driving was difficult due to rain, leaves and storms would increase.
- Even though the number of days of frost and snow will decrease, it will be important to retain experience in dealing with sub-zero temperatures.

Some of these risks are relevant to Nottinghamshire. The DfT plans research and action to address the concerns and to protect its investment in transport infrastructure.

4.1.8 Local authority services

Many of the issues around the built environment and some of the others referred to above feature in “Climate change and local communities - How prepared are you?” – a publication from UKCIP, IDeA and the LGA³⁴. This is aimed at local authorities and sets out a series of examples of possible adaptation responses for a range of services. It raises the issues with local authorities through a series of questions:

- Do you expect your buildings and infrastructure to still be in place in 50 years’ time?
- Are you planning new buildings and infrastructure that will still be in place in 50 years’ time?
- Do any of your streets and buildings get uncomfortably hot during summer weather?
- Does your council area contain rivers, canals or coastline?
- Do you have problems with river flooding and drainage overflows?
- Do you have natural ecosystems, parks and gardens to look after?
- Do you manage emergency services?
- Are your roads at risk from flooding, landslips, snowfall, or wind debris?
- Does your community face competition for water supply or water quality problems?

The supposition is that if you can answer “yes” to any of these questions, there is a risk that climate change will make current problems worse, or create new problems. The probability is that most local authorities will answer “yes” to all of these. The report is supported by a developing web site at www.ukcip.org.uk and is used as the basis for developing the actions later.

4.1.9 Insurance

The Association of British Insurers (ABI) has reflected increasing concern in the industry about the potential liabilities from climate change³⁵. Their main concern is that household claims have increased by 2-4% per year due to weather damage, principally storm and flood damage. National claims have doubled to over £6 billion in the period

1998 to 2003 compared with the previous five years and with the prospect of a further tripling by 2050. There are also concerns about other aspects of insurance as well as the new opportunities to insure new technologies.

The ABI is in dialogue with government about the reduction of flood risk to maintain insurance cover for property.

4.1.10 Climate adaptation: risk, uncertainty and decision-making

UKCIP, DEFRA and the Environment Agency have produced guidance on a risk-based approach to decision-making³⁶. This aims to help decide on strategies based on an assessment of the risks from climate change in association with any other risks that may be relevant. It follows a structured approach which leads to option appraisal under conditions of uncertainty leading to “no regrets” or “low regrets” decisions which reduce the risk of making choices which could, with hindsight, prove to have been insensitive to climate change.

The guide looks complicated but it appraises a range of techniques, of which only one or two are likely to be relevant to any particular application. Simple training can get most potential users up to speed and the case study provides insight into the process. It could have a useful role in developing a strategy for Nottinghamshire.

4.2 Regional studies

The UK Climate Impact Programme (UKCIP) has also been overseeing the production of a range of regional studies. All regions of the UK have now produced an impact study and they are all accessible through the UKCIP web site. This section picks out the conclusions which are relevant to Nottinghamshire.

4.2.1 East Midlands

Anything published specifically for the East Midlands is most likely to be relevant to Nottinghamshire. The East Midlands Sustainable Development Round Table (emsdOt) commissioned a report into The Potential Impact of Climate Change in the East Midlands which reported in July 2000³. This was updated at the request of the East Midlands Regional Assembly in April 2004². The update took account of the most recent climate scenarios and national and regional publications. Section 1 of this report summarises the main climate scenarios for Nottinghamshire. The East Midlands reports also commented on emissions of greenhouse gases (including the lack of regional data) and what the region could do to mitigate climate change. This is covered in section 3.

The emsdOt report used stakeholder responses to help identify the most vulnerable areas for the region. These were:

- [Water resources and quality](#)
- [Flooding – urban and lowland](#)
- [Agriculture](#)
- [Coastal region](#)
- [Biodiversity](#)

- Manufacturing, Services and Retail
- Construction and building
- Tourism and recreation
- Transport

Apart from coastal issues, these would all be relevant to Nottinghamshire. However, it does not follow that a Nottinghamshire stakeholder review would produce exactly the same result. These headings do form a good basis for further discussion and they are included in section 5.

4.2.2 Nottinghamshire

Little appears to be happening locally to adapt to climate change. Nottinghamshire County Council and Nottingham City Council are preparing a new Joint Structure Plan. This is based on the concept of sustainable development. It promotes a sequential approach to development whereby previously developed land in urban areas is the first priority for new development, followed by other urban areas, then sites adjoining urban areas and, finally, sites outside urban areas as a last option. All should have good access public transport. This aims to meet the Joint Structure Plan's objectives to encourage energy efficient patterns of development and to reduce the need to travel. The Joint Structure Plan also contains a policy regarding flood protection and flood risk reduction.

The County Council is responsible for Emergency Planning and potential extreme climate events such as flooding or high temperatures could increase the need for co-ordination and action by the council and all the other emergency and public services that could get involved. All potentially affected bodies (public services and commercial) also need to consider business continuity under extreme adverse conditions.

4.2.3 Other regions and devolved administrations

Eleven reports have been produced by the English regions, Wales and Scotland^{37 to 46}. They have been produced over about five years and each has built on the previous ones. The emphasis in each is different, reflecting the different topographies, locations, economies and pressures. However, some common threads run through them all. Each region has grouped overlapping issues in different ways and used different terminology at times. This means that direct comparisons are not simple. Table 1 attempts to produce a summary of the main areas of concern. It also shows the status of the potential impacts by colour coding. The final two columns distil out what are seen as risks and/or opportunities for Nottinghamshire for development in section 5.

References to issues within other regional reports													
	Regions and devolved administrations										Risks for Nottinghamshire	Opportunities for Nottinghamshire	
	East Midlands	London	South East	Eastern England	Yorkshire and Humberside	North East	North West	West Midlands	South West	Wales			Scotland
Adaptation issues													
Water resources and quality													
Flooding - urban and lowland													
Agriculture													
Coastal region													
Biodiversity													
Manufacturing, Services and retail													
Construction and building													
Tourism and Recreation													
Transport													
Air quality													
Financial sector													
Forestry													
Fisheries													
Health													
Heritage													
Energy													
Emergency planning													
Waste disposal													

Table 1: Summary of issues from regional adaptation reports

Notes: Terminology has been simplified as all reports are not comparable.

Red implies a generally negative impact, green a positive impact and orange either uncertain or mixed impact.

West Midlands identified 5 “hot topics”: Water management, Land use and the built environment, Agriculture, Transport and Energy within a longer list shown here.

5 RISKS AND OPPORTUNITIES FOR NOTTINGHAMSHIRE FROM A CHANGING CLIMATE

In summarising the main conclusions from the above to draw out the dominant issues for Nottinghamshire, four factors need to be borne in mind:

- There are opportunities in both mitigation and adaptation to improve the environment, to improve the lives of people and to take advantage of new business opportunities.
- Any mitigation measures adopted will not impact directly on the climate of the county but the county needs to make its contribution to the global picture. Climate change is driven by global carbon dioxide and other GHG concentrations and Nottinghamshire on its own would not make a measurable impact even if it completely stopped all emissions. However there would be other local benefits.
- The risks from climate change are shared with many other localities; Nottinghamshire is not unique. However, taking action shows solidarity and concern for those likely to more adversely affected.
- The news tends to paint a gloomy picture yet for many in Nottinghamshire the initial climate changes, implying a moderately warmer climate in the short term, could be welcome.

None of the above should be seen as an excuse to do nothing. This section highlights the main risks and opportunities and suggests potential actions. These are addressed to all the major organisations in Nottinghamshire: what they could do themselves, how they could engage the wider community and lead by example.

5.1 Mitigation measures

Reducing greenhouse gas emissions is going to have to involve everyone. All individuals and organisations are responsible for their production through the actions they take and the goods and services that they buy. As stated above, Nottinghamshire on its own cannot make sufficient difference, but there is demonstrable commitment to energy efficiency and the use of renewables that can be developed.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Difficult to promote mitigation action as not immediate response • Perception that action increases costs • May require initial capital costs • Obstacles to some renewable schemes • Difficult to get people out of their cars • Difficulties with heritage and other protected buildings in improving energy efficiency 	<ul style="list-style-type: none"> • To alleviate fuel poverty • To improve housing stock • New businesses to provide new fuels and equipment and service facilities • Possibilities for carbon sequestration • Improved public transport could improve air quality • Cycling and walking have health benefits • New business opportunities in energy related businesses

Possible Actions

- Embrace the East Midlands energy strategy, taking a strong lead and striving to deliver all the outcomes on renewable energy, reduced energy use, energy efficiency and transport
- Promote energy saving advice resources such as Carbon Trust, Action Energy and Energy Saving Trust
- Understand better the local use of energy and monitor changes in use and GHG emissions, developing the data already collected locally
- Develop and promote the benefits of Forum for the Future's vision⁴⁷ of a low carbon economy for Nottinghamshire and their "ten steps"
- Local authorities and other public bodies make a positive commitment to be beacons of good practice, demonstrating leadership in all their decision making processes and in their own properties
- County Council to deliver energy targets and set target date for carbon neutrality
- Rapid progress to reduce the amount of waste produced and going to landfill – with special emphasis on such issues as packaging
- Ensure that best outcomes are achieved for the Home Energy Conservation Act 1995, the Climate Change Levy and other government initiatives
- Adopt new technologies such as video conferencing and remote working
- Don't ignore the other GHGs such as propellants and other solvents – look to reduce or eliminate their use
- Use local authority influence to draw other institutions into the process through purchasing, education, etc. and to lobby Government for regulation, support and leadership
- Explain, educate and engage the wider community to promote energy efficiency and reduce GHG emissions
- Explore new businesses for biofuels and recycling waste wood (such as non-recyclable pallets) for wood burning.

5.2 Adaptation measures

5.2.1 Water resources

Water supply to most houses and businesses is by Severn Trent Water Limited. The Company has its own plans to monitor the impact of climate change and to manage demand and the development of new sources of supply. The local authorities and other large users can play their part in reducing usage in buildings, vehicle washing and irrigation.

Some water is abstracted directly by users and those most at risk are farmers in some parts of the county. In particular there is already no new water available in the north of the county, south of Doncaster, around Hatfield and Retford. This means that new abstraction licences are unlikely to be granted to meet increasing drought conditions.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Reducing availability at a time of increasing demand • Water quality deterioration • Biodiversity impacts in water ecosystems 	<ul style="list-style-type: none"> • New crops • Develop water storage on farms • Savings on energy and cost of water and effluent treatment

Possible actions

- Promote water efficiency in local authority property and operations
- Promote water efficiency as part of public engagement and education
- Use of drought resistant plants in public spaces
- Support farmers and horticulturalists by education in adaptation and irrigation techniques such as trickle irrigation and the use of wetting agents
- Possible partnerships with garden centres to educate and adopt new ideas for drought resistant gardening.

5.2.2 Flooding

Nottinghamshire is already at risk of flooding and the situation could get worse. Responsibilities lie mainly with the Environment Agency and Severn Trent Water but local authorities have an influential role in avoiding future risks through the planning process and development control. Property owners also need to be aware of the risks and how to adapt and respond.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Increased flooding of property from rivers and sewers • Increased disruption to transport and other services • Difficulties in obtaining insurance 	<ul style="list-style-type: none"> • Preserve and develop new flood wash lands for the benefit of the natural and historic environment • Ensure that surface water drains are upgraded as property is refurbished • Land management to reduce run off to water courses • Flood protection devices for sale

Possible actions

- Oppose development in flood risk areas
- Ensure emergency planning is kept in step with the changing risk
- Promote the use of flood storage areas in wash land
- Promote sustainable drainage systems (SuDS) for built developments and roads, etc.

5.2.3 Built Environment

Owners and operators of buildings and other structures need to take account of the risks to structures, the opportunities for improvement as they arise and the potential savings

from energy efficiency, etc. The risk of subsidence in clay soils in the central part of the County may increase.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Flooding, heat damage, storm damage, subsidence to buildings and structures • Urban heat island⁴⁸ • Demand for air conditioning and consequential energy demand • Adaptive changes may impact on historic buildings 	<ul style="list-style-type: none"> • Take advantage of maintenance programmes to improve • Design and planting for shade • Solar and wind power incorporated into buildings and structures

Possible actions

- Survey and review potential sites at risk –lead by local authorities
- Develop an action plan based on the opportunities and benefits
- Educate the public to follow suit
- Choice of materials for new and refurbished property
- Ensure flood risk is minimised by location and design
- New and refurbished buildings to include best practice for energy efficiency.

5.2.4 Nature conservation and biodiversity

Many organisations have an interest in this topic, ranging from the Nottinghamshire Wildlife Trust and other conservation bodies, through public bodies such as the Environment Agency, English Nature and local authorities, to the interested amateur and owners or operators of parks and public open spaces.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Loss of traditional species and habitats • Soil erosion • Wetlands particularly under threat • New pests, diseases and alien species • Increased maintenance costs • Increased demand for water • Stress to trees and fire risk 	<ul style="list-style-type: none"> • New species and, with help, new habitats • Longer growing and breeding seasons • Opportunity to try new plant species that are temperature and drought tolerant • Migrant birds overwinter

Possible actions

- Local biodiversity impact study is already planned
- Look for opportunities to link isolated sensitive sites on a landscape scale
- Plan for adaptation of parks and open spaces.

5.2.5 Agriculture

Agriculture is important to the county and higher temperatures and changing rainfall patterns will affect crops and animal husbandry. However, other factors will have an impact on farming and much adaptation can be taken over a short timescale.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Insufficient water for irrigation • Some traditional crops unsustainable • Animal stress • Damage to soils (erosion, nutrient status, etc.) • Alternative crops could affect wildlife or bring new pests and diseases 	<ul style="list-style-type: none"> • Try new crops • Renewable energy sources • Longer growing season • Agriculture can respond in a short timescale in many cases

Possible actions

- Discuss with farmers and horticulturalists the potential changes
- Discuss with training and educational centres how climate change is included in the curriculum
- Develop water storage for farms and explore innovative irrigation techniques such as trickle irrigation and the use of wetting agents.

5.2.6 Historic environment

Threats to the historic environment resulting from climate change have yet to be formally identified in any published study and heritage organisations have been slow to identify such impacts. There are few opportunities and benefits currently identified.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Loss of sites through increased riverine erosion • Wetland archaeology particularly under threat • Storm damage • Increased maintenance costs • Impact of installation of air conditioning and ventilation equipment • Loss of veteran trees and historic planting schemes 	<ul style="list-style-type: none"> • Reduction in floodplain development • Restoration of floodplain will benefit wetland sites and historic character • Potential increase in visitors (although increased impact from them)

Possible actions

- Carry out a study of the potential impacts of climate change on historic environments in Nottinghamshire
- Promote the value of better maintenance of historic properties to reduce climate change impacts

- Look for opportunities to achieve mutual benefit to the natural and historic environment in flood alleviation schemes.

5.2.7 Health

The main issues are for the health authorities but there are some things that people can do to protect themselves.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Food poisoning • Skin cancer • Cataracts • Heat stroke • Infection from contaminated flood water • Injury from storm damage • Possible new diseases from insect vectors or bacteria and viruses 	<ul style="list-style-type: none"> • Outdoor lifestyle • Overall reduced death rate due to climate factors • Building design for cooling • Planning for shade

Possible actions

- Education of public about risks and avoiding them
- Provide shade in parks and amenity areas.

5.2.8 Tourism and Recreation

A warmer climate and longer season (coupled with increasingly unpleasant conditions in southern Europe) could increase demand for tourism in the UK. Nottinghamshire should be able to take advantage of the increased demand for short breaks as well as part of the longer holiday break.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Increased pressure on water resources and nature • Need to have plenty to offer and market it – all other regions have similar plans • Damage to “honey pot” sites through over use • Increased costs to site operators 	<ul style="list-style-type: none"> • Local residents more likely to spend more recreational time in Nottinghamshire • Opportunities for local attractions and open spaces • Links with adjacent areas • Opportunities in leisure related businesses

Possible actions

- Market destinations through emda Tourism Strategy and tourist offices
- Create bridleways, cycle ways and footpaths.

5.2.9 Manufacturing services and retail

The opportunities identified above can be translated into new or growing businesses but there are some risks to businesses.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Reduced productivity • Increased energy use for cooling • Local businesses slow to react to supply chain risks (raw materials, transport, etc.) • Some businesses will struggle to survive unless they adapt to changing demand (e.g. carpet sales) • SMEs lack resources to identify risks and respond 	<ul style="list-style-type: none"> • Energy efficiency, renewable energy and energy trading save money and need new businesses • Tourism and recreation – accommodation, clothing, cycle hire etc • Refrigeration and air conditioning • Water efficiency services • Local production and services reducing energy use

Possible actions

- Engage Chamber of Commerce and other business organisations
- Potential role for local authorities and emda to support local businesses
- Adopt energy and water initiatives as examples to others.

5.2.10 Local authority services

The county and district councils probably answers “yes” to all of the questions aimed at local authorities in section 4.1.8. They are potentially affected in respect of assets that they own and operate and through their relationships with the wider community. The adaptation guide for local authorities³⁴ suggests that priority should be given to building adaptation into planning and developing major infrastructure such as buildings and roads.

RISKS AND THREATS	OPPORTUNITIES AND BENEFITS
<ul style="list-style-type: none"> • Damage to authority property • Failure to galvanise the local population • Increased risks to others in community • Missed opportunities 	<ul style="list-style-type: none"> • “No regrets” approach improves local community regardless of actual climate change • Head start reduces impact and creates opportunities for local authorities and others

Possible actions

- Dialogue with elected members
- Training for staff to take climate change into account in their normal roles
- Engage the wider community as described above, promoting behavioural changes
- All local authorities work together to develop GHG inventory and define targets and actions.

6 CONCLUSIONS AND RECOMMENDATIONS

There is little doubt that the climate is changing and will continue to change. These changes will depend in the longer term on how successful the global community is in reducing emissions of greenhouse gases, particularly carbon dioxide. In any event, there are expected to be environmental, social and economic impacts from climate change which will affect Nottinghamshire both directly and indirectly.

There is potentially a lot that needs to be done to address mitigation and adaptation to climate change. This report sets out the initial issues for Nottinghamshire. It incorporates comments from the Nottinghamshire Agenda 21 Forum and a wider consultation. Whatever action is taken should fit in with or complement the plans being developed through the East Midlands Regional Assembly.

The county needs to play its part in reducing emissions through better use of energy and reducing reliance on fossil fuels. This will require technological and behavioural changes but will bring other potential benefits and opportunities. Adaptation measures will also be required. Some are not required immediately but others are of higher priority where they will have long term consequences.

DEFRA has produced guidance for local authorities⁴⁹ and local authority chief executives⁵⁰ which are consistent with this report. This guidance assumes that action is going to be taken. In taking this report forward, it will help to engage others and gain commitment if all local authorities are able to say that they have already considered their own positions, have been taking some action in the past and are now planning new actions on several fronts.

It is recommended that organisations in Nottinghamshire, possibly led by the County Council:

- Consider the issues that affect them directly through their property and other assets and incorporate climate change into their plans and policies
- Push for rapid progress on reducing use of fossil fuels throughout different economic sectors and throughout the county
- Organise a wider consultation to reflect on the issues raised in this report and to recommend priorities for action in the broader community
- Produce an action plan to reflect the agreed priorities
- Work to incorporate climate change into mainstream thinking and planning
- Work to ensure that all sectors are fully considered in any future plans
- Engage with the other local authorities in the county to share ideas and opportunities.

In following this through, it is important not to lose sight of the other factors (economic and social) which will also have an impact on many of the issues raised. They could be overlooked in the process. The means to overcome this is to ensure that climate change is embedded in business in the same way that other factors are. Nevertheless, it is recommended that there is some dedicated resource for promoting mitigation and adaptation and acting as a source of information and advice.

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APPENDIX 1: BACKGROUND TO CLIMATE CHANGE

The climate changes all the time. It is the result of the complex interaction between atmosphere, oceans and the biosphere but is increasingly being influenced by man. The earth has experienced periods of warming and ice ages over the last few millennia. We are in a warming period at the moment that is unusual in its timing and rate of warming and much research has identified the “greenhouse effect” as the most likely cause.

This effect has been known since the 19th century as the reason the earth is as warm as it is. It is due to carbon dioxide in the atmosphere that traps heat arriving from the sun and reduces the amount that radiates back off into space. The earth would be colder without the effect. The earth’s average temperature has increased by about 0.6°C in the last 100 years. This does not sound much but the difference in the average temperature between the last ice age and the present is only about 5°C. So a small shift can be significant.

Other gases also cause the greenhouse effect – known as greenhouse gases (GHGs). Methane occurs naturally but is also produced as a result of man’s activities. Some other industrial gases also cause it. The change coincides with the industrialisation of the economy and the increase in the burning of fossil fuels. Carbon dioxide is by far the most important contributor and the main source for the increase is fossil fuel combustion.

Work in the UK and elsewhere has been studying the effect and trying to predict what the future temperature will be. The concentrations of carbon dioxide will continue to rise unless something is done to reduce the reliance on fossil fuels. Predicting the future is difficult as no-one knows what the future consumption of fuels and how successful efforts to reduce emissions will be, and any changes induced by man are within a significant natural variability.

Use of scenarios

The approach adopted is to use *scenarios* which consider alternative futures and see what that tells us. There is a framework of scenarios well established under the Foresight Programme of the Office of Science and Technology for a range of scientific, social and economic studies. These make assumptions about the nature of future society and use four scenarios: World Markets, National Enterprise, Local Stewardship and Global Sustainability. These describe four possible futures – all considered equally likely; in reality the actual future will be a combination of these. Their use, however, puts boundaries on what we could expect. The names indicate how they differ but more detail can be found at www.foresight.gov.uk.

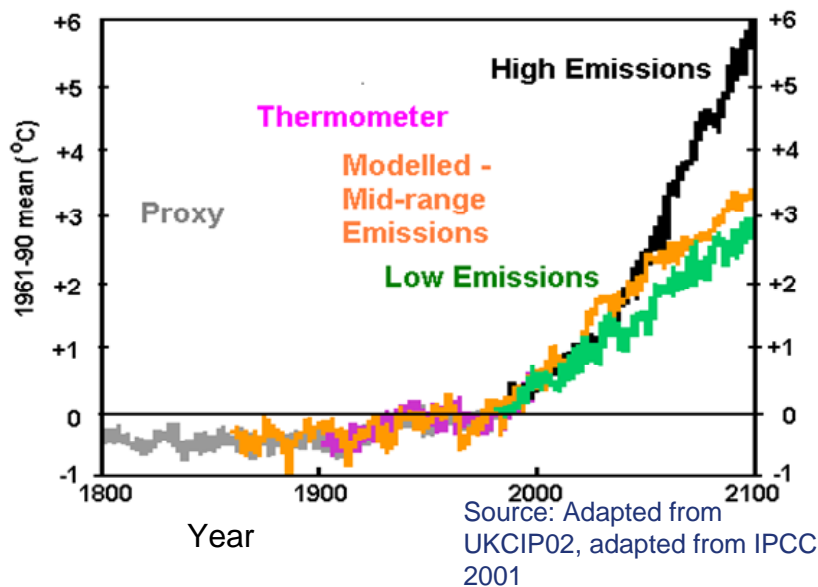
Climate scenarios

These scenarios are the starting point for climate studies. The different economic and social models imply differing futures for the use of energy, production of waste, etc. In turn, these imply differing emissions of GHGs. Higher GHG concentrations in the atmosphere lead to higher global mean temperatures which, in turn, affect other aspects

of the climate. The results reported in Section 2 are from the latest UK scenarios published in 2002. They are based on four sets of emissions labelled: Low, Medium-low, Medium-high and High. Full details can be found at reference 1. Reference 2 gives details for the East Midlands.

The following diagram indicates the range of potential temperature increases towards the end of the 21st century. The range from 3° to 6 °C depends on the actual emissions of GHGs. Note that the temperature up to 2050 is more or less independent of the scenario. This implies that it depends on current GHG concentrations and any reduction in emissions in the next couple of decades will have little impact until towards the end of the century. So, however successful we are in reducing emissions, it seems likely that a temperature rise of 1 or 2°C is inevitable. The challenge is to avoid a rise of 6°C in a hundred years' time.

Northern Hemisphere Temperatures



APPENDIX 2: Text of The Nottingham Declaration

.....Council recognises that climate change is likely to be one of the key drivers of change within our community this century.

We acknowledge that

- Evidence continues to mount that climate change is occurring.
- Climate change will have far reaching effects on the UK's economy, society and environment.

We welcome the

- Social, economic and environmental benefits which will come from combating climate change.
- Recognition by many sectors, especially government and business, of the need for change.
- Emissions targets agreed by central government and the programme for delivering change as set out in the *Climate Change – UK Programme*.
- Opportunity for local government to lead the response at a local level and thereby play a major role in helping to deliver the national programme.
- Opportunity for us to encourage and help local residents and local businesses – to reduce their energy costs, to reduce congestion, to improve the local environment and to deal with fuel poverty in our communities.
- Additional powers to address the social, economic and environmental well-being of our communities contained within the Local Government Act 2000, which will assist in this process.

We commit our Council to

- Work with central government to contribute, at a local level, to the delivery of the UK climate change programme.
- Prepare a plan with our local communities, by December 2002, to address the causes and effects of climate change and to secure maximum benefit for our communities.
- Publicly declare, within the plan, the commitment to achieve a significant reduction in greenhouse gas emissions from our own authority's operations especially energy sourcing and use, travel and transport, waste production and disposal and the purchasing of goods and services.
- Encourage all sectors in the local community to take the opportunity to reduce their own greenhouse gas emissions and to make public their commitment to action.
- Work with key providers, including health authorities, business and development organisation, to assess the potential effects of climate change on our communities, and to identify ways in which we can adapt.
- Provide opportunities for the development of renewable energy generation within the area.
- Monitor the progress of our plan against the actions needed and publish the results.

APPENDIX 3: CARBON DIOXIDE EMISSIONS IN NOTTINGHAMSHIRE

Section 3.2 refers to data collected by the National Atmospheric Emissions Directory (www.naei.org.uk), supported by DEFRA. These are collected on a district council basis in 1km squares based on the national grid. They are not from direct measurements; instead, national factors are applied to other data such as domestic property numbers or transport statistics to give estimates of carbon dioxide and other emissions to atmosphere. This means that the results are disaggregated from national emissions according to local population etc. and so do not reflect local initiatives that could have made a difference.

The data used here are for carbon dioxide expressed as carbon. Figure 5 showed the results for 2000 plotted on a map of Nottinghamshire. The data have recently been updated for 2002. The sectors reported are:

- a01. Energy Production and Transformation
- a02. Commercial, Institutional and Residential Combustion
- a03. Industrial Combustion
- a04. Industrial Processes
- a05. Production and Distribution of Fossil Fuels
- a06. Solvent Use
- a07. Road Transport
- a08. Other Transport
- a09. Waste Treatment and Disposal
- a10. Agriculture
- a11. Nature

In the following analyses the following codes are also used:

- at - area total (i.e. for that district council area excluding major point sources)
- pt - point sources (i.e. major emissions such as power stations)
- t - total (i.e. at + pt)

The Table below shows detailed summaries for each district council area in Nottinghamshire for the headings above. These are plotted in two pie charts. The first shows the discharge of total carbon dioxide (t) and the second excludes the point sources (i.e. equates to at).

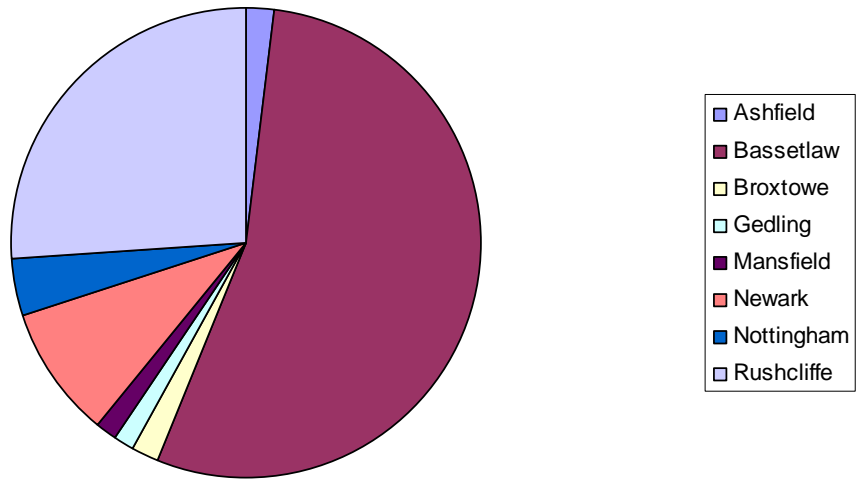
The charts show the contribution made by each district area which mainly reflects population density. However, it does bring out the contribution made by point sources.

In identifying areas for action, the greatest impact will be made in those areas with the highest emissions.

	a01	a02	a03	a04	a05	a07	a08	a09	a10	a11	at	pt	t
Ashfield	2718.006	60054.9	20274.03	0	0	60352.96	462.5223	204.402	128.708	4744.25	144084.4	0	144084.4
Bassetlaw	3309.212	67258.3	25040.21	0.00039	0	87882.61	7537.612	100.3	1313.364	4824.239	191177.1	3773420	3964049
Broxtowe	9.16	52567.1	16843.95	0.00116	0	73822.05	2610.93	2.838	76.089	5029.29	145816.5	0	145816.5
Gedling	673.3	56572.65	11931.2	0	0	23118.82	707.6775	8.763	174.111	4740.337	92989.9	0	92989.9
Mansfield	2613.292	60253.6	12864.16	0.05734	0	23091.63	3521.558	53.525	83.598	4180.93	102377.1	0	102377.1
Newark	26.8	2050.02	328.3	0	0	7102.767	317.0412	0	178.14	201.82	9823.4	668000	677769.2
Nottingham	1587.507	148257	34757.69	0.0031	0	67503.78	925.655	821.7955	41.9522	11078.9	253858	29400	283188
Rushcliffe	78.5	25172.89	5263.6	0	0	20242.25	1837.857	0.985	208.279	1745.825	52603.5	1850000	1901554

Carbon Dioxide emissions as tonnes carbon for 2002

Total carbon dioxide emissions by District Council in Nottinghamshire 2002 - includes point sources



Area carbon dioxide emissions by District Council in Nottinghamshire 2002 - excludes point sources

