The East Midlands in 2006 – Evidence Base for the East Midlands Regional Economic Strategy 2006-2020: The East Midlands Environment

A report prepared by *emda*

2006

This document forms part of the *emda* Knowledge Bank

Six

The East Midlands environment

The East Midlands environment

1. Introduction

This chapter presents a perspective on some of the relationships that exist between economic development and the environment. Whilst the focus is on the East Midlands, the complexity of these relationships is such that they may exist at the global, national, regional or local level and policy responses are available at global, national, regional and local level – such as local authority regulation of waste management. The relationships are rarely spatially and temporally specific: they form an ongoing dynamic and tend to flow in and out of equilibrium depending on the forces that affect them. This chapter seeks to interpret these relationships, focusing on the way the environment is both affected by and affects economic growth and society. Data will be examined relating to climate change and greenhouse gases, air quality, pollution incidents, waste, water, geology and mineral resources, biodiversity, landscape and heritage. These are all inter-related.

The East Midlands covers an area of over 15,607 km^2 and is the fourth largest region within England. More than half the region's land is arable or horticultural, with over three quarters of this classified as the best and most versatile agricultural land. However, parts of the East Midlands have a significantly degraded environment, needing careful rehabilitation and management to bring them up to the national standard in terms of biodiversity and landscape. The region's already scarce natural assets are under growing stress, particularly from intensive agriculture.

So like any other region, the East Midlands has its own specific environmental characteristics, unique qualities and problems. When viewed alongside the economic growth needed to create wealth and tackle poverty and other social challenges, they ultimately affect our quality of life. It is from this basis that the exploration of economy and environment is made. A substantial part of the information on the East Midlands environment has been drawn from the Strategic Environmental Assessment (SEA) Baseline Report prepared by Halcrow, in which more detailed data can be found.[1] A number of other partners have also made contributions to this section of *The East Midlands in 2006*, for which we are grateful.[2]

> There are some fine physical features in the East Midlands, but parts of the region's environment are significantly degraded

[1] Halcrow, *SEA Baseline Collection for East Midlands Regional Economic Strategy Sustainability Appraisal and Strategic Environmental Assessment*, August 2005.

[2] These are the Environment Agency, English Nature, the Countryside Agency, the Rural Development Service, the East Midlands Regional Assembly, the British Geological Survey and the National Stone Centre.

2. Economic growth and environmental impact

Economic growth both affects and is affected by the state of the environment. Firstly, the environment acts as a source of inputs (raw materials and fuels such as coal and oil) for economic activity. Secondly, the reverse occurs whereby the environment acts as a sink, absorbing some of the outputs of economic activity (waste, air emissions, etc). Thirdly, the environment poses hazards of its own, and can constrain economic growth in some areas (for example on floodplains). The environment also provides services, such as recreation, that contribute to individuals' quality of life.

In supporting the East Midlands' aspirations for increased economic growth and wellbeing, sustainable development will be a key element underpinning activity in support of the RES vision.[3] Information presented in the UK Sustainable Development Strategy *Securing the Future*[4] confirms the following characteristics of consumption and production patterns and their links to the environment:

- By 2050, global energy demand could double as populations rise and developing countries expand their economies[5];
- Since 1950, global water use has more than tripled, and within 25 years half of the world's population could have difficulty finding enough fresh water for drinking and irrigation[6];
- The cost of wasted natural resources to UK manufacturing industry is equivalent to around 7% of profit[7], and energy efficiency improvements by business and individuals could save £12 billion annually across the UK economy[8];
- Production, distribution and consumption of food in the UK are responsible for around 22% of its total greenhouse gas emissions. Other significant sources are heating, lighting and domestic appliances, private transport and air travel[9];
- More than 80% of all product-related environmental impacts are determined by product design.[10] As an example, new fridge freezers sold in the UK today consume on average 50% less energy than those sold just 8 years ago.[11]

3. Climate change

3.1 Evidence base for climate change[12]

It is now without doubt that average global atmospheric and sea surface temperatures are rising. Since the beginning of the industrial revolution, global average temperatures have risen by 0.7˚C.[13] Ten of the warmest summers recorded since the reliable instrument record began in 1860 have occurred in the last decade, with 2005 being the second warmest year on record. The Arctic is warming at twice the rate of the global average, with sea ice reaching the minimum summer extent ever observed in September 2005.[14] Recent geophysical surveys have confirmed that the Arctic sea ice is also thinning.[15] Overall, land-based ice caps on the world's mountain ranges are wasting away, with an average reduction in thickness of 8m over the last 30 years. Average global sea level has risen by 0.1m over the last 100 years, much of it caused by thermal expansion, but if significant land based ice continues to melt sea level rise will accelerate due to displacement by meltwater. Rising sea temperatures have a direct influence on the energy dissipated through tropical storms and hurricanes. In the last 50 years energy dissipated through such weather systems has increased by 50%. The 2005 North Atlantic hurricane season has been devastating and broken over 20 records.[16]

> Average annual temperatures in central England have risen by almost 1°C over the last 100 years

[3] Regional Economic Strategy for the East Midlands: A Flourishing Region, East Midlands Development Agency, July 2006.
[4] HM Government, *The UK Sustainable Development Strategy: Securing the Future*, TSO, March 2005.
[5] World Energy Organisation at **www.worldenergy.org/wec-geis/edc/scenario.asp**
[6] United Nations Environment Programme, 2003, Key Facts, at **www.unep.org/wed/2003/keyfacts.htm**
[7] Cambridge Econometrics and AEA Technology for the Environment Agency, *The Benefits of Greener Business*.
[8] *The Energy Review performance and innovation unit report,* at **www.strategy.gov.uk/downloads/su/energy/TheEnergyReview.pdf**
[9] e2 Consulting, Bourne 2002 and Office for National Statistics, *Achieving the UK's climate change commitments: the efficiency of the food cycle,* 2004.
[10] German Federal Environment Agency (ed), *How to do ecodesign: A guide for environmentally friendly and economically sound design,* 2000.
[11] Market Transformation Programme at **www.mtprog.com**
[12] Background information relating to this section can be found in: *Climate Change: Menace or Myth,* 2005, New Scientist.com news service; Houghton, J., *Global Warming: the complete briefing,* 2005, Cambridge University Press, 3rd Edition.
[13] Defra, Defra Science Notes 2: *How is Defra Tackling Climate Change?*, 2005.
[14] Rothrick, D. A., Yu, Y. & Maykut, G. A.,1999, *Thinning of the Arctic sea ice cover,* University of Washington, Seattle.
[15] NASA, 2005. Arctic sea ice continues to decline, Arctic temperatures continue to rise in 2005.
[16] NOAA magazine 2005. Noteworthy records of the 2005 Atlantic Hurricane Season **http://www.noaanews.noaa.gov/stories2005/s2540b.htm**

Latest statistics on climate change for the UK[17] show that:

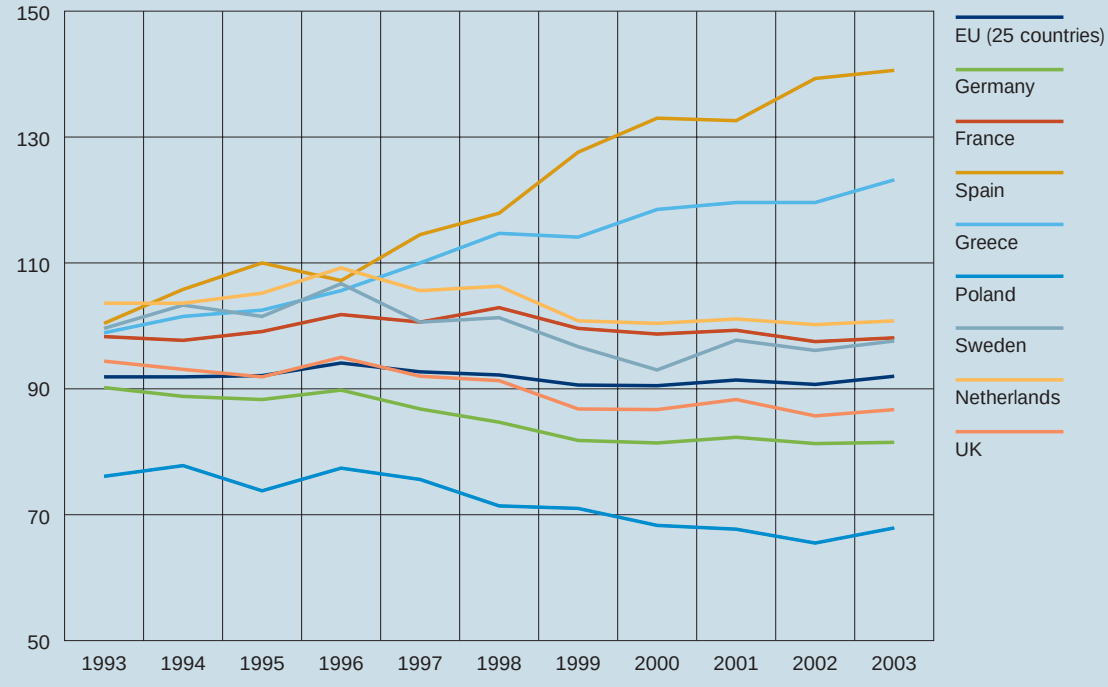
- Average annual temperatures in central England have risen by almost 1°C over the last 100 years;
- The highest temperature recorded in the UK is 38.5°C, which was recorded on 10 August 2003 at Brogdale near Faversham (Kent);
- The three warmest years on record have all occurred since 1998 and 19 of the warmest 20 since 1980.

The economic impacts of climate change have been felt around the globe, demonstrating that in a global economy, local extreme weather and climate change have implications for us all. For instance, in 2005 energy prices in the East Midlands rose as a result of refinery and oil production interruption by hurricanes in the Gulf of Mexico.

To combat climate change, the UN Framework Convention on Climate Change (United Nations, 1992) agreed that each participating developed country would reduce their greenhouse gas emissions to 1990 levels by 2000. The Kyoto Protocol to the United Nations Framework Convention on Climate Change (Intergovernmental Panel on Climate Change, 1997) made these reductions legally binding and reduced emissions targets further. Emissions of a basket of six greenhouse gases covered by the Protocol (carbon dioxide, methane, nitrous oxide, HFC, PFC and SF6) can be expressed as the total Global Warming Potential (GWP) which is the carbon dioxide equivalent mass.

CHART 1

Index of total greenhouse gas emissions from a selection of EU countries, and the EU as a whole (base year=100)



Source: European Environment Agency, Topic Centre on Air and Climate Change (2005)[18]

[17] Defra, *Defra Science Notes 2: How is Defra Tackling Climate Change?,* 2005.

[18] Emissions of the six greenhouse gases covered by the Protocol are weighted by their global warming potentials (GWPs) and aggregated to give total emissions in CO_2 equivalents. The emissions are presented as indices, with the base year = 100. In general, the base year is 1990 for the non-fluorinated gases (CO_2, CH_4 and N_2O) and 1995 for the fluorinated gases (HFC, PFC and SF6). Data exclude emissions and removals due to land use change and forestry.

As Chart 1 demonstrates, emissions of greenhouse gases from the EU as a whole have tended to remain relatively stable since 1993, while a number of Western European countries, including the UK, have achieved a reduction in emissions. Of the sample of countries presented in the chart, it can be seen that:

- The countries with the lowest emissions of greenhouse gases in 2003 were Poland and Germany. Poland was typical of eastern European countries in exhibiting relatively low and falling emissions, even though it might be expected that the legacy of heavy industry in these countries would result in high emissions of greenhouse gases;

- Emissions of greenhouse gases were highest in Spain and Greece, which were also the only two countries in the sample to exhibit an increase in emissions over the 10 years to 2003. In fact all southern European countries experienced a similar increase in emissions.

3.2 Impacts of climate change

Climate change scenarios for the UK, published by Defra in April 2002, predict:

- Annual temperatures averaged across the UK may rise by between 2 and 3.5 degrees centigrade by the 2080s, depending on the future scale of global emissions of greenhouse gases. Warming will generally be greatest in parts of the South East, where temperatures may rise by up to 5°C in summer by the 2080s. High summer temperatures will become more frequent and cold winters will become increasingly rare;

- Winters will become wetter and summers may become drier across all of the UK. The largest relative changes will be in the south and east where summer precipitation may decline by up to 50% by the 2080s. Heavy winter precipitation will become more frequent, but the amount of snow may decline by up to 90% in lowland areas by the 2080s;

- Sea-levels are expected to continue to rise around the UK, in line with global changes but with local variations due to land movement. In South East England sea-levels could rise by between 26 and 86cm by the 2080s. This means that, at some east coast locations, extreme sea-levels that currently have a 2% chance of occurring in any given year could occur between 10 and 20 times more frequently by the 2080s. No contribution from the melting of Greenland or Antarctic ice is assumed on this timescale.

3.3 Adaptation to climate change

More attention is now being given to adaptation but technically the subject is in its infancy. It is clear that climate change is happening and some degree of adaptation will be necessary regardless of curbs on emissions, as the climate and ocean systems will take many decades to respond. The Government and devolved administrations are taking a lead in preparing to adapt to climate change. Strategic decisions that are made now have long lifetimes: to reduce risks, minimise damage and take advantage of potential benefits, adaptation must be factored in at an early stage. The more excessive regional temperature increases and precipitation changes may only be felt in a few decades time, but many investment and infrastructure decisions are designed to last this long. Adaptation to cope with more frequent weather extremes and to plan for the longer-term changes needs to begin now.

Higher summer temperatures and a greater likelihood of flooding and storminess during the winter months would have an impact on almost all aspects of life in the UK, including business, transport, tourism, health, insurance, water supply, agriculture and wildlife.

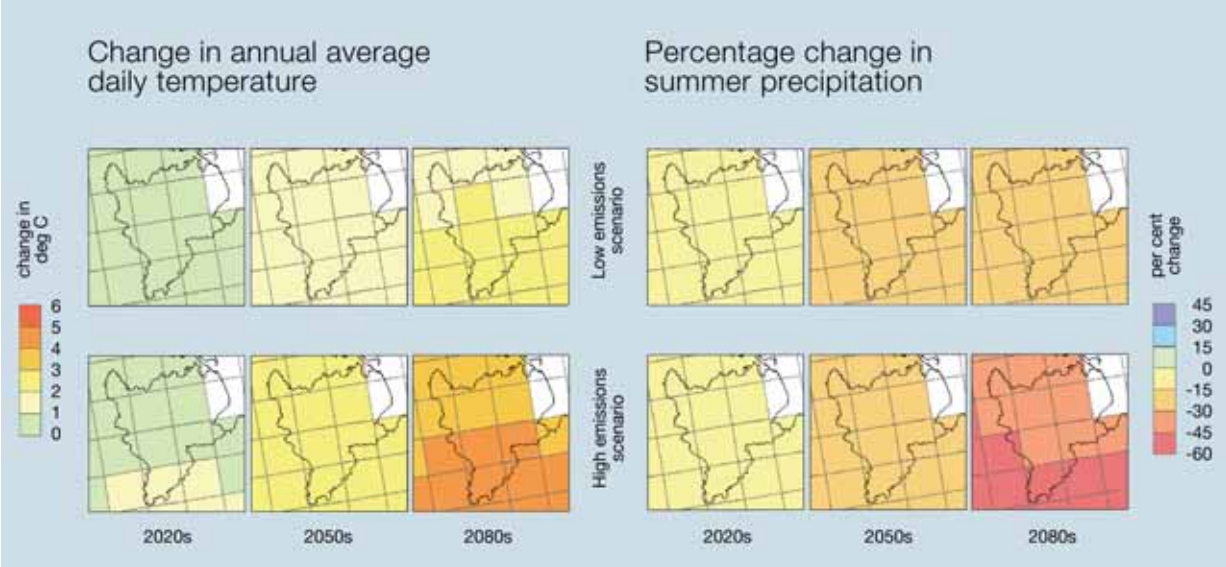
3.4 Climate change in the East Midlands

During the last century temperatures across the region increased by over 0.5ºC and it is anticipated that this will continue. Chart 2 illustrates the predicted climate changes for the East Midlands. They are expected to be amongst the most substantial in England, with daily average temperatures possibly increasing by up to 5°C by the 2080s and the mean annual temperature by 4.5°C. Summer rainfall could decrease by up to 60% in the southern part of the region and winter rainfall could increase by up to 30%.[19]

[19] East Midlands Regional Assembly, *East Midlands Regional Environment Strategy,* 2003.

CHART 2

Temperature and precipitation change in the East Midlands



Source: UKCIP02 Climate Change Scenarios (funded by Defra, produced by Tyndall and Hadley Centres for UKCIP).

The potential global and national impacts of climate change were discussed above. The social, economic and environmental effects brought about by climate change in the East Midlands could include:

- Greater damage to buildings through subsidence, and consequent economic impact due to an increase in insurance claims;
- More flooding on the Lincolnshire coast and around rivers. Much of the East Midlands is low lying and vulnerable to flooding, while coastal areas will also be exposed to increased coastal erosion and landslip risk due to rising sea level, more intense storm activity and increased incidence of wet/dry extremes. For example, a sea level rise of up to 80cm could lead to erosion on the east coast with the likely loss of coastal habitats;
- Higher temperatures, leading to deterioration in working conditions and potential disruption to transport;
- Less water available for domestic, industrial and agricultural purposes;
- A mixture of effects on crop production – some beneficial (such as reduced frost damage and accelerated growth encouraged by warmer temperatures), others detrimental (such as spread of crop diseases, pests and increased water stress reducing crop yields). Periods of dry or very wet weather coupled with poor germination could lead to significant soil erosion due to wind, especially in spring;
- Changes in the sorts of plant and animal species found in the region: species that are temperature or water sensitive are likely to suffer stress and this could lead to local extinctions, while species preferring warmer conditions could become more prevalent.

4. Greenhouse gas emissions

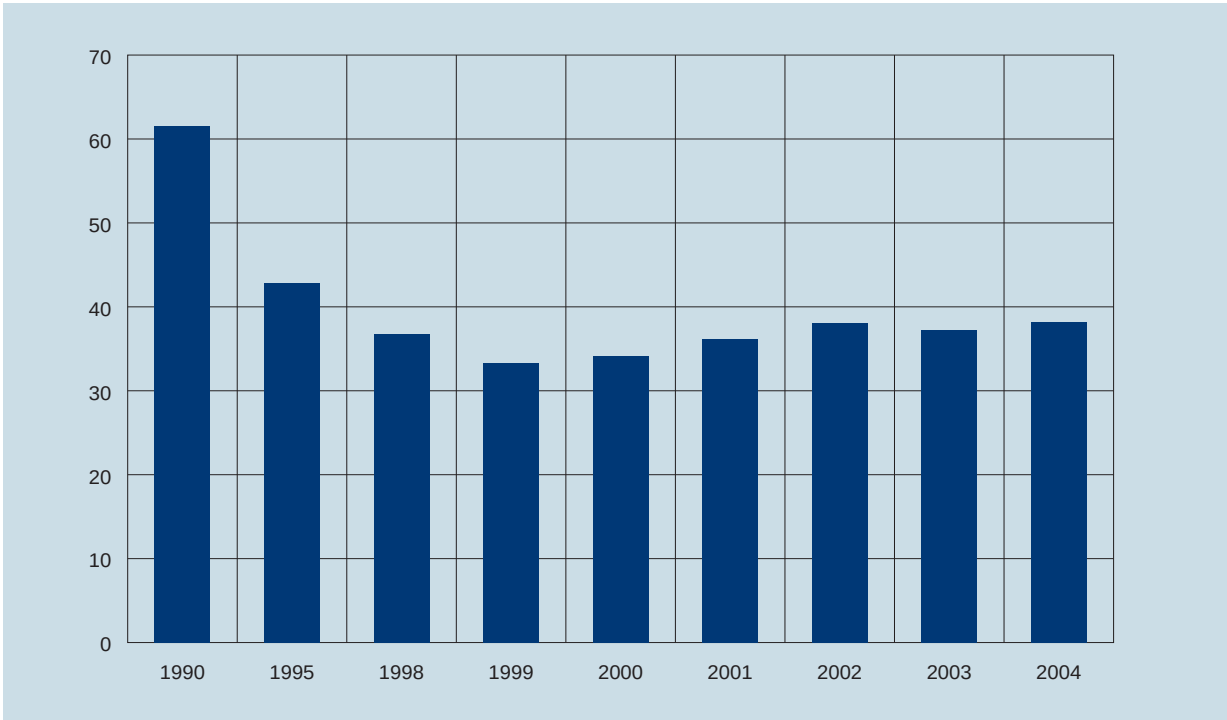
Carbon dioxide is the main greenhouse gas emitted in the East Midlands, with smaller contributions from methane and nitrous oxide. Chart 3 shows the trend in total GWP emissions for the East Midlands:

- In 1990 GWP emissions totalled over 60 billion Kg CO_2 equivalents. During the 1990s this fell to around 33 billion Kg CO_2 equivalents;
- Between 1999 and 2004 there was an upward overall trend. Emissions were rising towards 40 billion Kg CO_2 equivalents.

The fall in emissions between 1990 and 1999 is thought to be linked to the introduction of more efficient electricity generation plant together with some substitution of fuel burnt in power stations. The difficulty of achieving further reductions in a climate of continuing demand for electrical power can be seen in the trend since 1998.

CHART 3

Greenhouse gas emissions expressed as GWP 1990-2004 (billion Kg CO_2 equivalent)



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

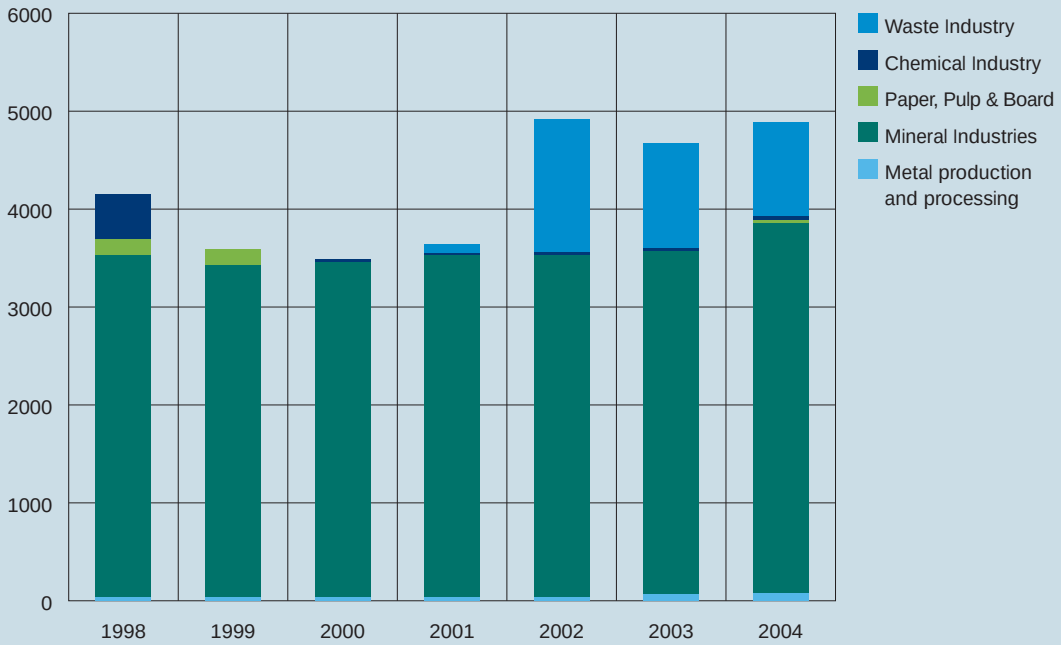
Chart 4 shows these emissions with a breakdown by broad sector between 1998 and 2004 (a longer time series is unavailable for this data). It should be noted that the chart does not display data on emissions from the Fuel and Power Production and Associated Processes sector, because the figures are too large. There are two key points to note:

- The fluctuation in emissions between 1998 and 2004 is largely driven by fluctuations in emissions from Fuel and Power Production and Associated Processes;
- The chart shows an increase in emissions from the Waste industry since 2001. This is largely a function of additional reporting requirements imposed on the industry from 2002 onwards.

The most significant source of greenhouse gas emissions (as much as 80%) is from the Fuel and Power Production and Associated Processes sector, mainly from the Trent Valley power stations.[20] Indeed the East Midlands has some of the largest point sources of CO_2 emissions in the UK, such as Ratcliffe Power Station, south of Nottingham, which generates at least 13 kilotonnes of CO_2 per year (Map 1). However, it should be noted that this production serves demand from consumers and industrial users from the East Midlands and beyond. As well as point sources, there are a number of 'mobile' sources of CO_2 emissions, mainly from transport routes such as the M1 running through the region.

CHART 4

Greenhouse gas emissions expressed as GWP 1998-2004 (million Kg CO_2 equivalent), by broad sector



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence base, 2005

[20] Emissions from power stations result from both the burning of fossil fuels and from flue gas desulphurisation (FGD) equipment, which reduces sulphur emissions, but increases CO^2 emissions.

Greenhouse gas emissions from the minerals industry (mainly from downstream mineral processing), the second largest source in the region, have remained steady in this period. The main downstream mineral processes with greenhouse gas emission implications are:

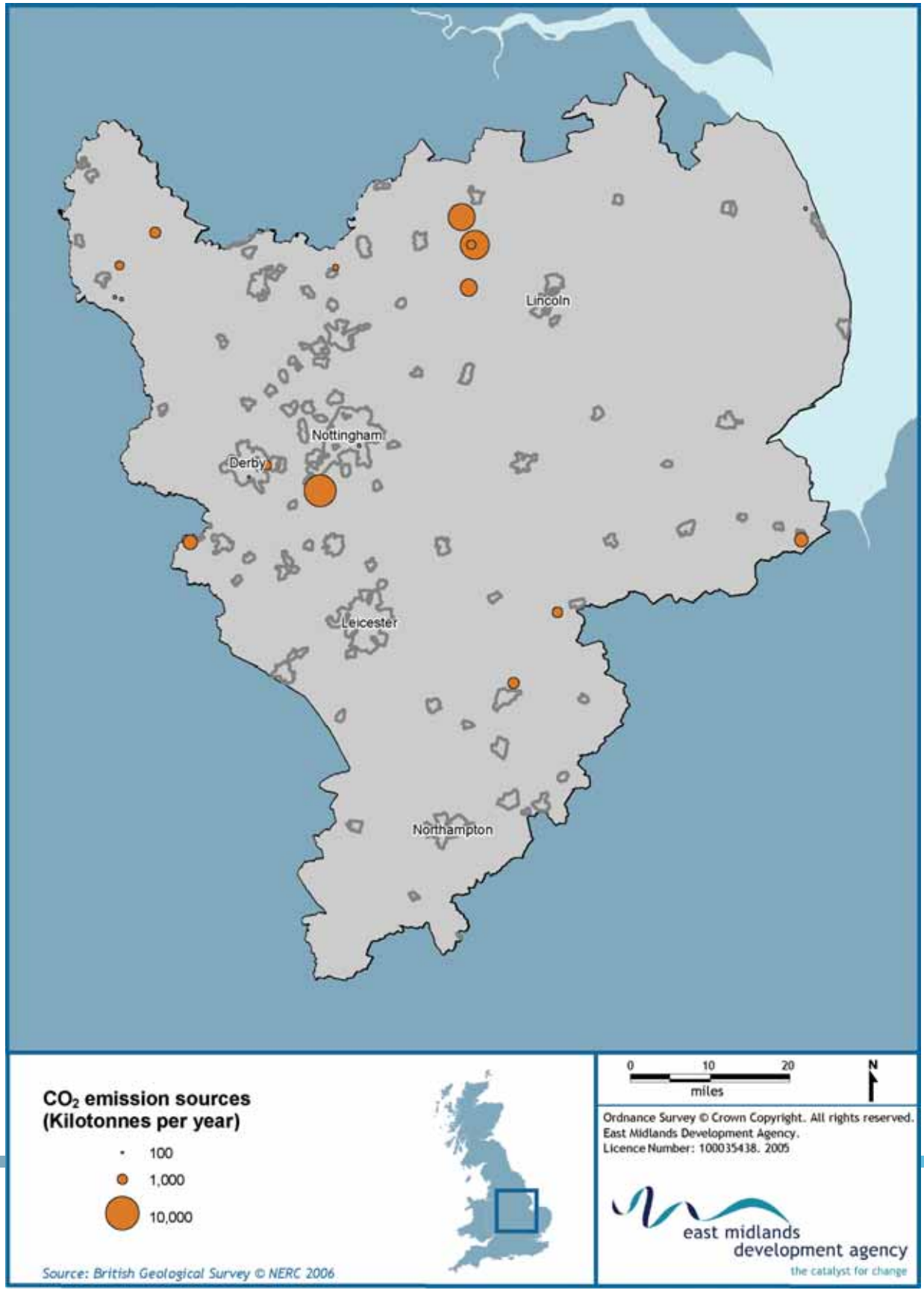
- **Aggregate processing:** This accounts for the bulk of mineral production in the region, and has significant energy requirements, although gaseous emissions are largely of steam;
- **Lime production:** Where limestone is heated to produce lime, carbon dioxide is emitted into the atmosphere. The East Midlands is by far the largest producer of lime. Total UK tonnage of limestone, dolomite and chalk for conversion to lime was 2.9 million tonnes in 2004 (producing c. 1.3 million tonnes of CO_2). A substantial proportion of lime production (at least two thirds) was carried out in the East Midlands at three Derbyshire sites;[21]
- **Cement production:** In 2003, almost 3 million tonnes of limestone were used for cement making in the East Midlands, producing a similar amount of carbon dioxide to the lime industry.

The second largest source of greenhouse gas emissions in the East Midlands is the minerals industry

[21] United Kingdom Minerals Yearbook 2004, Keyworth, British Geological Survey. Available for download from **http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html**

MAP 1

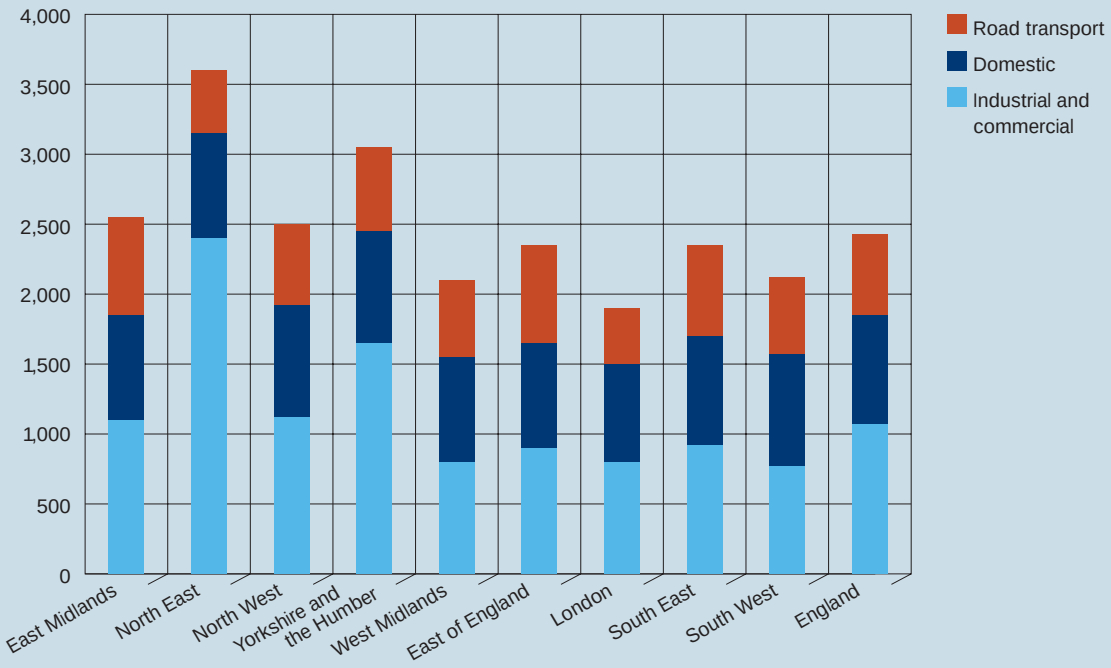
Major point sources of carbon dioxide emissions in the East Midlands, based on 2002 data supplied by the EA.[22]



[22] Emissions vary annually depending on the load factor at which power stations are operating and the type of fuels used.

CHART 5

Carbon dioxide emissions per head by end user, 2003 (kilograms carbon equivalent per resident)



Source: Defra experimental statistics of carbon dioxide emissions at local and regional level, 2003

Chart 5 indicates total carbon dioxide emissions per head from each English region (as well as for England as a whole) broken down by source.[23] The chart confirms the importance of industrial and commercial sources of carbon dioxide emissions in the East Midlands, but, through comparison with other English regions, some interesting points can be drawn out:

- Carbon dioxide emissions per head in the East Midlands exceed the English average, at 2,550 kilograms of carbon equivalent per capita compared to 2,470 in England as a whole. Emissions per head from the East Midlands are the third highest of any English region;
- There is a broad North-South split, with higher carbon dioxide emissions per head in northern and midlands regions, particularly in the North East and Yorkshire & the Humber, and lower emissions in southern regions;
- These differences are due largely to the higher emissions from industrial and commercial processes in the north and midlands. This is likely to reflect the continued importance of manufacturing industry to the economic base of the north. In the south, higher population growth rates mean that road transport and domestic sources make up a greater proportion of total carbon dioxide emissions per head.

[23] These figures exclude emissions from domestic aviation and shipping and the offshore oil and gas industry, which cannot readily be attributed to regions.

As would be expected, the density of carbon emissions within the UK is highest in urban centres and along major transport routes.

Projections for CO_2 emissions in the UK in 2020 range between 144.6 million tonnes of carbon and 147.3 million tonnes.[24] The UK government target is for emissions to be reduced by at least 60% by 2050. With the rise in transport use, particularly vehicles and aircraft, and the growth of emerging economies in Asia and South America, it seems likely that large industrial emission sources will have to be reduced by more than 60% to compensate, if the target is to be reached. Carbon dioxide emissions in the UK were projected to have fallen by as much as 21% by 2010, although the government has now conceded that it is unlikely to meet this target, and is aiming for a 15-18% cut in emissions from 1990 levels (though CO_2 emissions have in fact increased over the past three years). It is not clear how much the East Midlands will have contributed to any reduction.[25]

> Carbon dixoide emissions per head in the East Midlands are the third highest of any English region

5. Air quality and pollution incidents

In developed and rapidly industrialising countries, the major component of air pollution has historically been high levels of smoke and sulphur dioxide arising from the combustion of sulphur-containing fossil fuels such as coal for domestic and industrial purposes. The major threat to air quality is now posed by traffic emissions. Petrol and diesel-engine motor vehicles emit a wide variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NOx), volatile organic compounds (VOCs) and particulates (PM10s), which have an increasing impact on urban air quality. In addition, photochemical reactions resulting from the action of sunlight on nitrogen dioxide (NO_2) and VOCs from vehicles leads to the formation of ozone, a secondary long-range pollutant, which affects areas often far from the original emission site. Acid rain[26] is another long-range pollutant influenced by vehicle NOx emissions.

In all except worst-case situations, industrial and domestic pollutant sources, together with their impact on air quality, tend to be steady-state or improving over time. However, despite improvements in engine technology and fuel additives, worldwide traffic pollution problems are worsening (due to increased volume and density).

Air quality in the East Midlands is generally better than the national average, although less good along the main road routes. This is mainly due to transport and industry producing nitrogen oxides (NOx), particulate matter (PM10) and sulphur dioxide (SO_2). Emissions from industry have improved over recent years but there are fears that emissions from transport will increase in line with traffic volumes.[27] The level of road traffic within the East Midlands has increased by 1.2 billion vehicle km since 2001 and has grown more quickly than in any other English region during the last 10 years. In addition, residents of the East Midlands tend to make more and longer journeys by private transport (mainly car) than the average for England.[28]

[24] HMSO, *Climate Change: The UK Programme 2006,* March 2006.
[25] East Midlands Regional Assembly, *England's East Midlands Integrated Regional Strategy – Our Sustainable Development Framework,* 2005.
[26] Acid rain is a term used to describe all forms of acid precipitation (rain, snow, hail, etc.). Atmospheric pollutants, particularly oxides of sulphur and nitrogen, can cause precipitation to become more acidic when converted to suphuric and nitric acids – hence the term acid rain.
[27] Ibid 25.
[28] See Section 6 of *The East Midlands in 2006*, *Transport, Infrastructure and Development.*

5.1 Pollution inventory data on air quality strategy substances

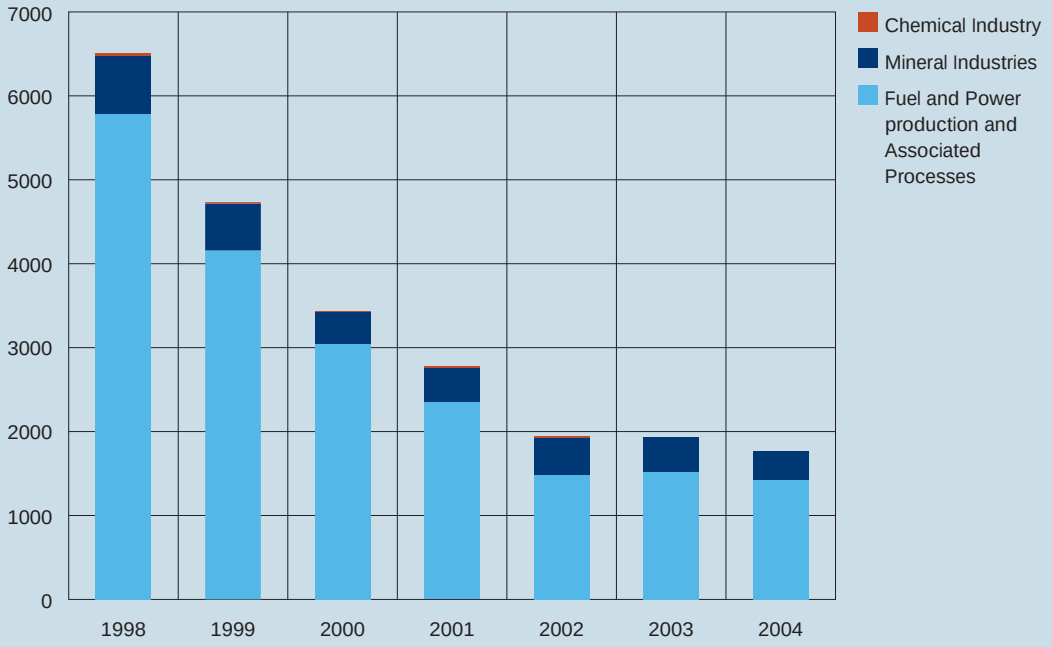
There are a number of substances whose concentrations are monitored as part of the Government's Air Quality Strategy (AQS Substances). Amongst these are benzene, carbon monoxide, lead, sulphur and nitrogen oxides, and particulate matter. Presented below are data on releases of a selection of these substances, which are released in significant quantities from regulated processes in the East Midlands.

Chart 6 shows emissions of PM10 particulates, which is particulate matter less than 10 micrometres in diameter. The key points to note are:

- Total emissions of PM10 have fallen from around 6,500 milligrams per cubic metre in 1998 to just under 2,000 milligrams per cubic metre in 2004;
- This fall has largely been driven by a fall in emissions from Fuel and Power Production and Associated Processes, but there has also been a fall in emissions from Mineral Industries;
- Total emissions of PM10s were relatively low in all regions in 1999, with London reporting the lowest level. Emissions in the East Midlands were the fourth highest of all English regions.

CHART 6

Releases of PM10 by Environment Agency regulated processes in the East Midlands, 1998-2004 (milligrams per cubic metre)



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

Chart 7 shows emissions of sulphur oxides in the East Midlands. It should be noted that the chart does not display data on emissions from the Fuel and Power Production and Associated Processes sector, because the figures are too large. Chart 7 does show us though that:

- Total emissions of sulphur oxides have fallen from around 350 million parts per billion (ppb) in 1998 to around 120 million ppb in 2004;
- Emissions from Fuel and Power Production and Associated Processes account for the vast majority of sulphur oxide emissions and falls in this sector have driven the overall fall;
- For comparison, in 1999 the East Midlands emitted by far the greatest amount of sulphur dioxide of any region – more than two and a half times the English average.

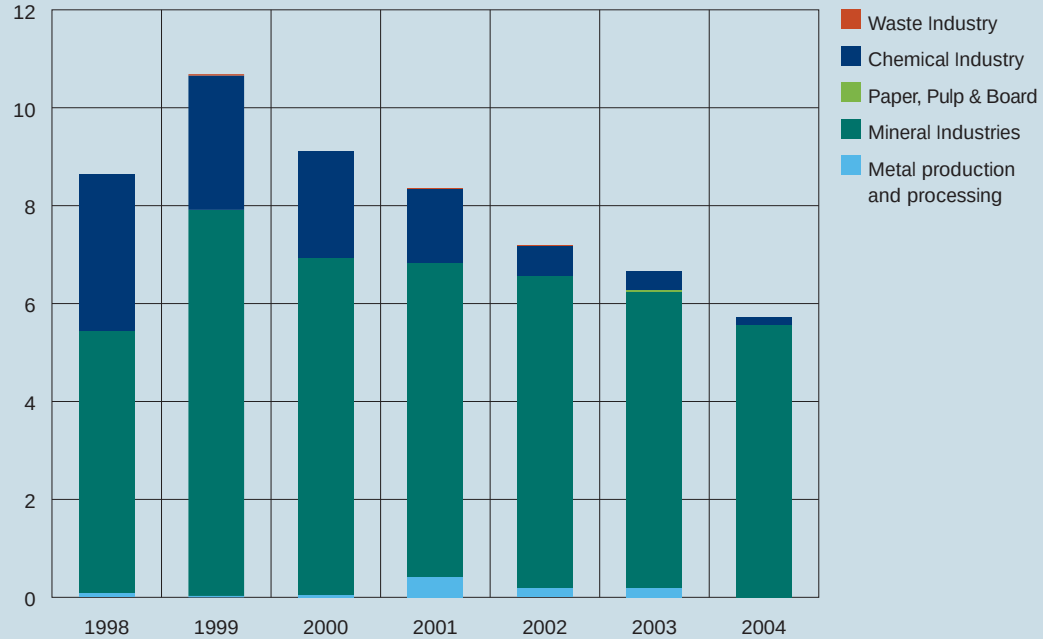
Charts 6 and 7 both show the strong positive impact of new technologies on environmental emissions. Both particulate releases and SOx emissions have been considerably reduced by the application of cleaner technologies and fuels in the power industry.

Finally, Chart 8 shows emissions of nitrogen oxides (again excluding emissions from Fuel and Power Production and Associated processes). As with greenhouse gas emissions shown in Chart 4, nitrogen oxide emissions are much more difficult to control with technological improvements:

- Since 1998, total emissions of nitrogen oxides have fluctuated around 80 million ppb;
- Emissions of nitrogen oxides were relatively high in the East Midlands compared to other regions in 1999, with only Yorkshire & the Humber and the South East emitting greater quantities.

CHART 7

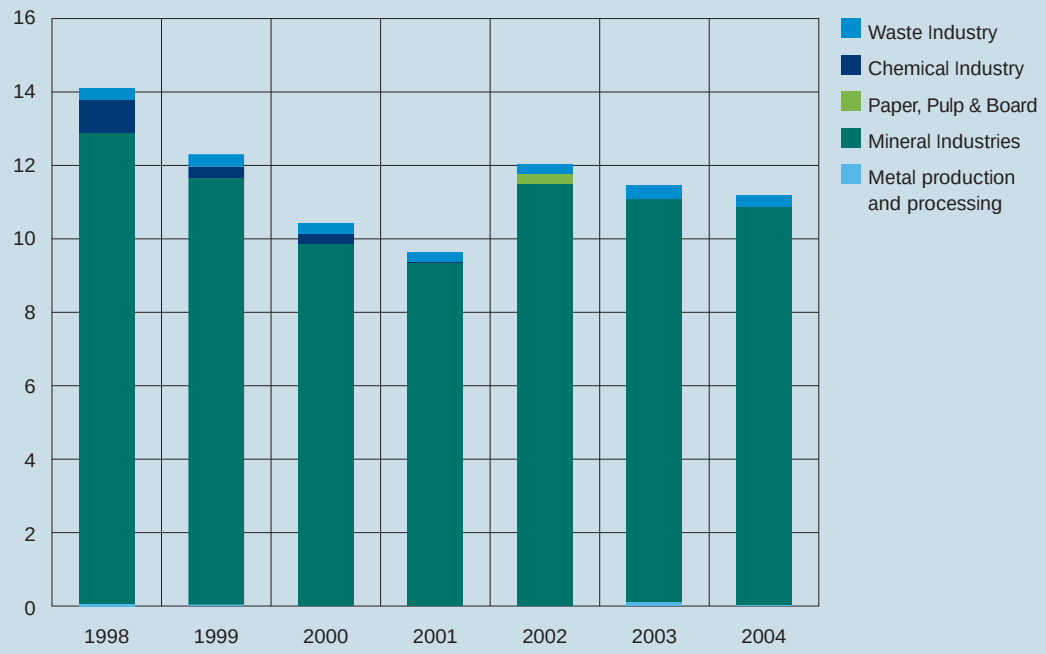
Releases of sulphur oxides by Environment Agency regulated processes in the East Midlands, 1998-2004 (million parts per billion), by broad sector



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

CHART 8

Releases of nitrogen oxides by Environment Agency regulated processes in the East Midlands, 1998-2004 (million parts per billion), by broad sector



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

The majority of emissions of Air Quality Strategy (AQS) substances in the East Midlands are accounted for by Fuel and Power Production and Associated Processes. However, the minerals industry is the second largest sector contributing to emissions of AQS substances (particularly nitrogen oxides) by regulated processes. The impact of the cement and lime producing industries is noted above. In addition, the firing of clay to produce bricks, pipes, tiles, etc generates flue gases.

5.2 Pollution incidents

Environment Agency data[29] concerning pollution incidents in the 'Major' and 'Significant' impact categories[30] shows that 99 incidents took place in 2003. Chart 9 shows the breakdown:

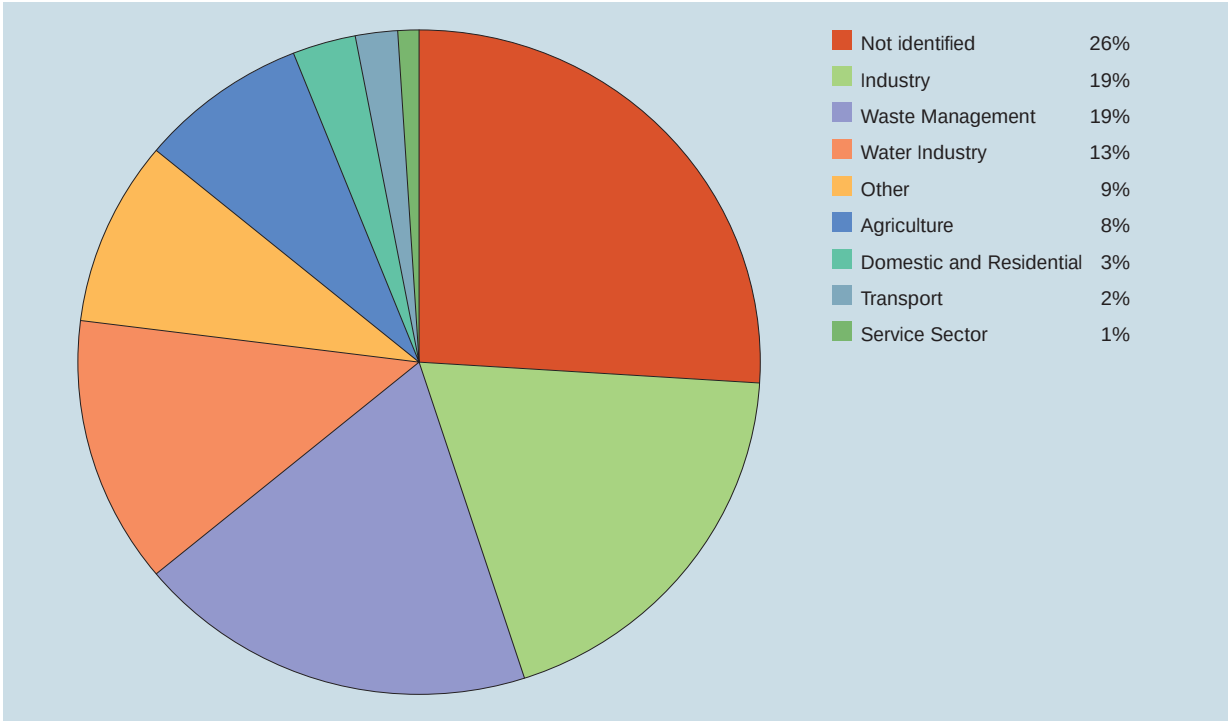
- The largest proportions where the source could be identified were from the waste management industry and general industry (including manufacturing, power generation & supply, construction & demolition), each accounting for 19% of the total;
- The water industry (sewage treatment) was the next most significant contributor, accounting for a further 13%;
- Just over one quarter of incidents were not identified by source.

[29] Environment Agency, *Environment Agency contribution to Regional Economic Strategy Review – Evidence Base,* 2005.

[30] A 'major' impact is one that causes major damage to the ecosystem and has a serious impact on humans. A 'significant' impact is less severe and would cause significant damage to the ecosystem and have an impact on humans.

CHART 9

Pollution incidents with major or significant impacts, 2003



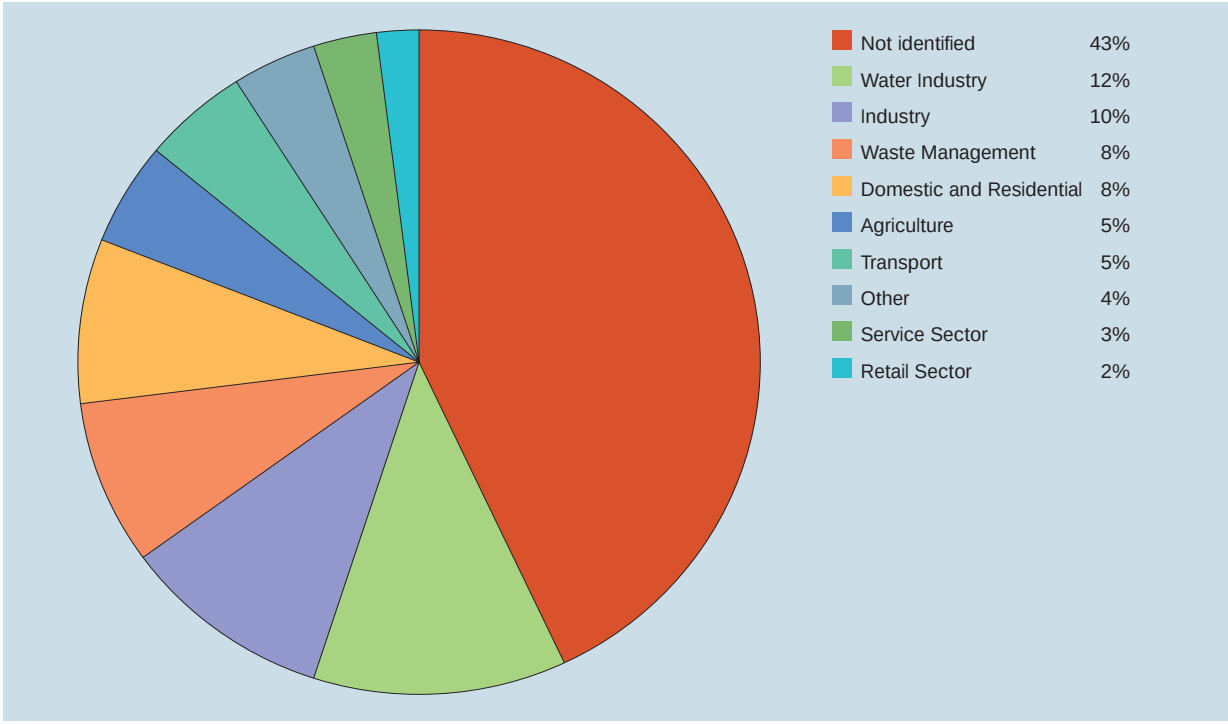
Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

If a similar analysis is carried out for all incidents with any environmental impact (including minor impact), we find 2,329 such incidents were recorded in 2003. Chart 10 shows how these were broken down:

- A larger proportion of these incidents are not easily identified as to source – 43% compared to 26% for major and significant incidents;
- Of those identified, the water industry is the highest contributor (12%) with general industry (10%) and waste management processes (8%) following.

CHART 10

Pollution incidents with any environmental impact, 2003



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

We can conclude that of the most environmentally damaging incidents where a source can be identified, the largest proportion (at least 60%) have an industrial source. Domestic, agricultural, transport and service sectors are minor by comparison. When incidents of minor impact are considered, industrial sources account for at least 40% of all incidents with an identifiable source.

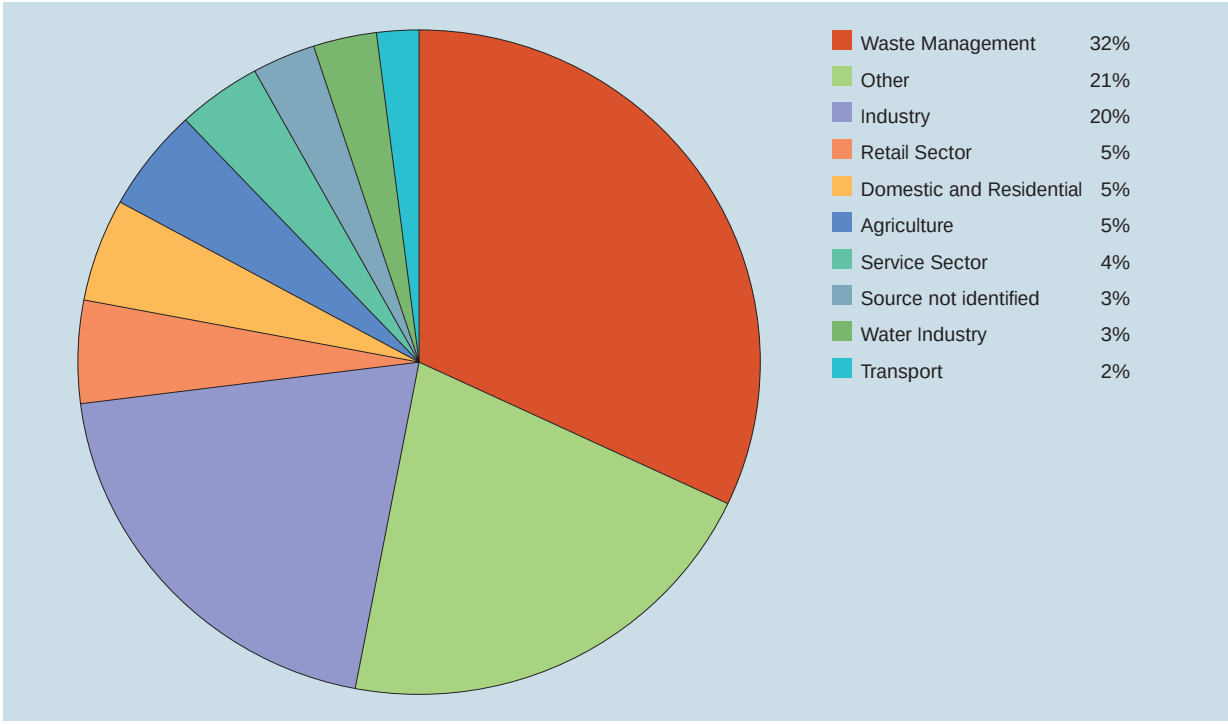
5.2.1 Air pollution incidents

Chart 11 shows that most air pollution incidents in the region arise from the waste management (32%) and industry sectors (20%), including manufacturing, power generation, and construction and demolition. In 2003 there were 433 confirmed pollution incidents affecting air in the East Midlands – a reduction of almost 20% since 2002. The main causes of these were fires (37%) and control system failures (22%)[31] and the main pollutants were smoke (49%) and landfill odour (22%).[32] The overall number of incidents from fires decreased between 2002 and 2003 but those from the burning of waste increased by 28%.

[31] East Midlands Regional Assembly, *East Midlands Integrated Regional Strategy – Our sustainable development framework,* January 2005.
[32] Environment Agency, *Environment Agency Contribution to Regional Economic Strategy Review – Evidence Base,* 2005.

CHART 11

Pollution incidents with impact to air, 2003



Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

6. Energy

6.1 Introduction

International Energy Authority (IEA) projections[33] show global energy demand increasing by 50% by 2030, with 90% of that energy being derived from fossil fuels. In recent years energy has been relatively cheap, plentiful and reliable, but this is less likely to be the case in the future. Energy use will also become increasingly carbon constrained. This will bring significant challenges and opportunities to the region, which is well placed to develop and deploy new energy infrastructure and technology. The UK government forecast is that by 2025, 80% of electricity will be gas-generated (75% of which will be imported) and 40% of generating capacity will be wound up.[34]

6.2 Energy production

In the East Midlands, the majority of energy is generated from fossil fuels[35], traditionally based on the production of coal in Derbyshire, Leicestershire and Nottinghamshire. Coal has been a vital source of the region's wealth and industrial development over the past 250 years. This abundant energy source, coupled with local demand and the nearby River Trent for cooling, led to the development of numerous major (~2000MW) power stations in the Trent valley. Three of these, Ratcliffe on Soar, Cottam and West Burton, are in the East Midlands. Ratcliffe (with Drax in Yorkshire) is one of the two largest generating stations in the UK, and has been retro-fitted with flue-gas desulphurisation (FGD) equipment and other clean technologies to reduce sulphur emissions by 97%. (Note the fall in emissions of sulphur oxides since 1998 in Chart 7). The region's coal-fired power stations account for approximately 10-15% of the UK's total generating capacity.

[33] IEA 2004. World Energy Outlook 2004: FactSheet: Energy & Development. http://www.iea.org/textbase/papers/2005/weoenergydevel_fact.pdf

[34] DTI, *Our Energy Challenge: Securing clean, affordable energy for the long term*, Energy Review Consultation Document, January 2006.

[35] Fossil fuels are coal, oil and gas, and are so-called because they form over millions of years through the decay, burial and compaction of rotting vegetation on land (coal) and marine organisms on the sea floor (oil and gas).

There are two gas-fired power stations, at Spalding and Sutton Bridge, both of which utilise North Sea gas. Staythorpe (formerly coal-fired) Power Station is being reconstructed as a gas-fired station and there are similar proposals for the recently closed Drakelow station.

There is approximately 50 Megawatts (MW) of renewable electricity capacity in the region,[36] which is less than 2% of total regional capacity. The East Midlands has seen a small increase in the generation of electricity from renewable resources in recent years but does not generate as much as other regions. At present most of the renewable energy produced in the East Midlands is generated from the combustion of landfill gas.

There are seven hydropower plants operating within the region, six of which are in Derbyshire. Total capacity of the hydropower plants is nearly 2.5 MW and they have an average annual energy output of 11.5 GWh. Three further schemes are under construction.[37]

In 2000, there was 292 MW of combined heat and power (CHP) electricity generation capacity in the East Midlands (6.8% of UK CHP capacity). CHP systems involve the simultaneous generation of heat and power to achieve high overall efficiencies and to utilise heat that would otherwise be wasted in other electricity generation systems. However, very little new CHP capacity has been installed in the East Midlands in recent years.

Finally, it should be noted that energy production is important for the East Midlands economy, with the region currently exporting electricity to other parts of England. The energy generation sector and its supply chains currently contribute approximately £3.4 billion of turnover to the region's economy.[38]

6.3 Energy resources

6.3.1 Coal

The region includes the Notts-Derby and Leicestershire Coalfields (Map 2). Three of the eight major deep mines still producing in the UK are located in the region (Thoresby, Welbeck and Harworth, as of March 2006). A small drift mine still operates in North Derbyshire. Albion Extension and Arkwright were the only opencast sites operational in the region in March 2005, out of a total of 41 sites operational in the UK at this time.[39] However, there are permitted sites due to be opened and a number at various stages in the planning process. The bulk of existing accessible economic reserves are associated with the deep mines. There are two sources of reserves and resource estimates for these collieries: the collieries themselves and the International Mining Consultants (IMC) estimates. Both are quoted in IMC 2002.[40] IMC's estimates of reserves and resources are shown in Table 1.

> Three of the eight major deep coal mines still producing in the UK are located in the East Midlands

[36] East Midlands Regional Assembly, *Towards a Regional Energy Strategy: A Sustainable Approach to Energy in the East Midlands,* 2003.
[37] East Midlands Regional Assembly, *East Midlands Regional Spatial Strategy Annual Monitoring Report,* 2005.
[38] Optimat Ltd, *East Midlands Power Generation Equipment Cluster Research,* September 2002.
[39] **http://www.dti.gov.uk/energy/statistics/source/coal/page18529.html**
[40] International Mining Consultants, 2002. *Review of the Remaining Reserves at Deep Mines for the Department of Trade and Industry* **http://www.dti.gov.uk/files/file15982.pdf**

TABLE 1

Estimates of coal reserves and resources in the East Midlands, 2002[41]

Colliery	Seam	Reserves (10^6 tonnes)	Resources (10^6 tonnes)
Harworth	Deep Soft	3.327	3.190
Thoresby	Deep Soft	0	7.272
	Parkgate	6.398	3.087
Welbeck	Deep Soft	2.695	2.721
	Parkgate	3.035	0
Total		**15.455**	**16.27**

Source: International Mining Consultants, 2002. 'Review of the remaining reserves at deep mines for the Department of Trade and Industry'.

Recent annual regional production from deep mines output has varied between 4 and 5 million tonnes, which is between a third and a quarter of national production. Opencast coal output tends to fluctuate considerably. In the five years before 2003, average annual regional production was above 1.3 million tonnes, approximately 10% of the UK total.[42] Regional production fell rapidly in 2004 and 2005. About 75% of the region's coal output is used in electricity generation.

Without new mine development it is likely that deep mine coal production will cease by 2030. Future deep mine prospect areas for which good exploration data exist include the Witham and Till Prospects on the Nottinghamshire/Lincolnshire border, and NE Leicestershire,[43] representing the bulk of future new deep mine prospects explored on the UK mainland. These would require major investment to access the resources, which are at depths of between 500 and 1000m. The total of reserves and resources estimated for the Witham prospect is 147 million tonnes.[44]

6.3.2 Clean coal extraction technologies

This is a portfolio of technologies that derive energy from coal without mining it:

Abandoned Mine Methane (AMM) – This is the extraction of methane released from coal as a result of it being disturbed from former mining. Abandoned mine methane can be an environmental and safety hazard. Removing methane from abandoned mine workings mitigates this potential hazard and generates electricity. AMM is currently being extracted from 4 sites in the region (Markham, Shirebrook & Bentinck, Mansfield Woodhouse and Whitwell) with a total installed capacity of 8MW. Future decommissioning of existing deep mines could provide significant new AMM opportunities, especially if an appropriate mine abandonment strategy is possible.

Coal Mine Methane (CMM) – This is the extraction of methane released from coal in active mines. It is widely practised and is currently generating 18.8 MW.

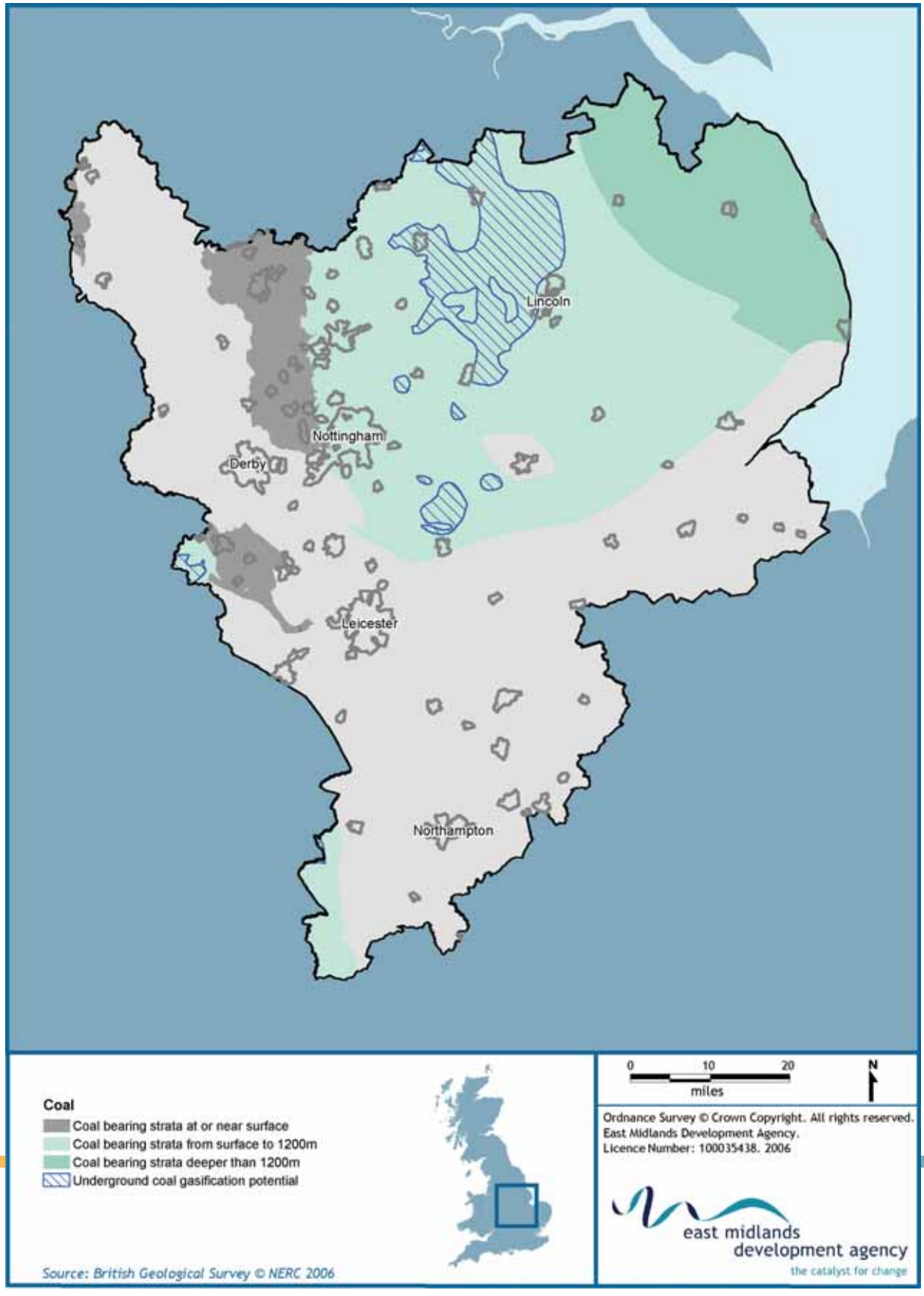
Coal Bed Methane (CBM) – This is the extraction of methane from unmined coal seams. Methane is released by fracturing the coal via boreholes. Currently there are no CBM activities in the region. The potential gas resource in the East Midlands is over 400 billion m^3.[45]

Underground Coal Gasification (UCG) – Coal can be gasified in situ by burning it in a controlled way underground via boreholes, thus avoiding the high cost of mining. The gas is brought to the surface and used in electricity generation. UCG is potentially the most effective way of extracting energy from coal, but the technology is in its infancy. The East Midlands has good prospects for the deployment of UCG.[46] The most attractive prospects are coals at depths between 600 and 1200m. These include coals in and around the Till, Witham and parts of the NE Leicestershire exploration prospects. The volume of potentially suitable coal in the region is in excess of 2 billion m^3.[47] UCG prospects are shown in map 2.

[41] A reserve is defined as the proportion of a resource that it is considered can be extracted under current economic conditions. A resource is defined as an area of mineral in which there is an economic interest, with seam properties and geological environment known to a specified degree. See IMC, 2002, *Review of the Remaining Reserves at Deep Mines,* Appendix 1.
[42] J A Hillier, L E Taylor, D E Highley, K Hitichen, T B Colman & G R Chapman, *United Kingdom Minerals Yearbook 2004,* British Geological Survey.
[43] The NE Leicestershire prospect was formerly worked from the Asfordby mine, which was forced to close in 1997 due to adverse geological conditions.
[44] International Mining Consultants, 1999. *Review of Prospects for Coal Production in England, Scotland and Wales*. Stationery Office for Department of Trade and Industry, London.
[45] Jones, N.S., Holloway, S., Creedy, D. P., Garner, K., Smith, N. J. P. & Duracan, S., 2004, *UK Coal Resources for new exploitation technologies*. Technical report CR/01/015N, British Geological Survey, Keyworth, Nottingham.
[46] Experiments on UCG were conducted at Newman's spinney, Barlborough, Derbyshire, in the 1950s – the whole site was subsequently uncovered as an opencast operation.
[47] Jones, N.S., Holloway, S., Creedy, D. P., Garner, K., Smith, N. J. P. & Duracan, S., 2004, *UK Coal Resources for new exploitation technologies*. Technical report CR/01/015N, British Geological Survey, Keyworth, Nottingham.

MAP 2

Coal resources in the East Midlands. Based on BGS digital data at the 1:100,000 scale.



6.3.4 Oil and gas

The East Midlands remains an important region for UK onshore oil production. Over 20 fields have been discovered, and over 40m barrels so far produced (about 11% of total historic UK onshore oil production – 65% excluding the giant Wytch Farm field in Dorset). Current economic reserves (2005) are about 15m barrels.[48]

Most fields are small with less than 1 million barrels. However, Welton is the second largest onshore field in the UK, with over 15 million barrels discovered, of which about 10% has been produced.[49] Exploration interest for oil and gas in the region fluctuates with the oil price, with high prices stimulating interest. It is likely that oil and gas prices will continue to rise over the coming decades.

The Saltfleetby Gas Field is Britain's largest onshore gas field.[50] Since production started in 1999 it has produced 54 billion cubic feet of gas and a million barrels of condensate (petroleum gas). The original recoverable gas reserves were approximately 90 billion cubic feet of which about 30% are yet to be produced. Original condensate reserves were 1.26 million barrels of which about 20% are yet to be produced.

The region has potential for unconventional gas exploration and production known as "tight gas". This particular exploration and production technique has shown significant growth in the USA, but has yet to be applied to the East Midlands.

> There are good prospects for the development of renewable energy resources in the East Midlands

6.3.5 Renewable energy resources

As Chart 12 shows, the proportion of total electricity generated from renewable energy sources in the UK is amongst the lowest in the EU, at less than 3% over the 10 years since 1993. By contrast, an average of 13% of all electricity generated in the 25 countries of the EU was produced from renewable sources in this period, while in Sweden and Latvia the average was as high as 50%. The UK target for 2010 is also relatively modest: the aim is for 10% of all electricity to be generated from renewable sources by this date. In the East Midlands in 2000, renewable energy sources accounted for only 1.6% of electricity consumption.[51]

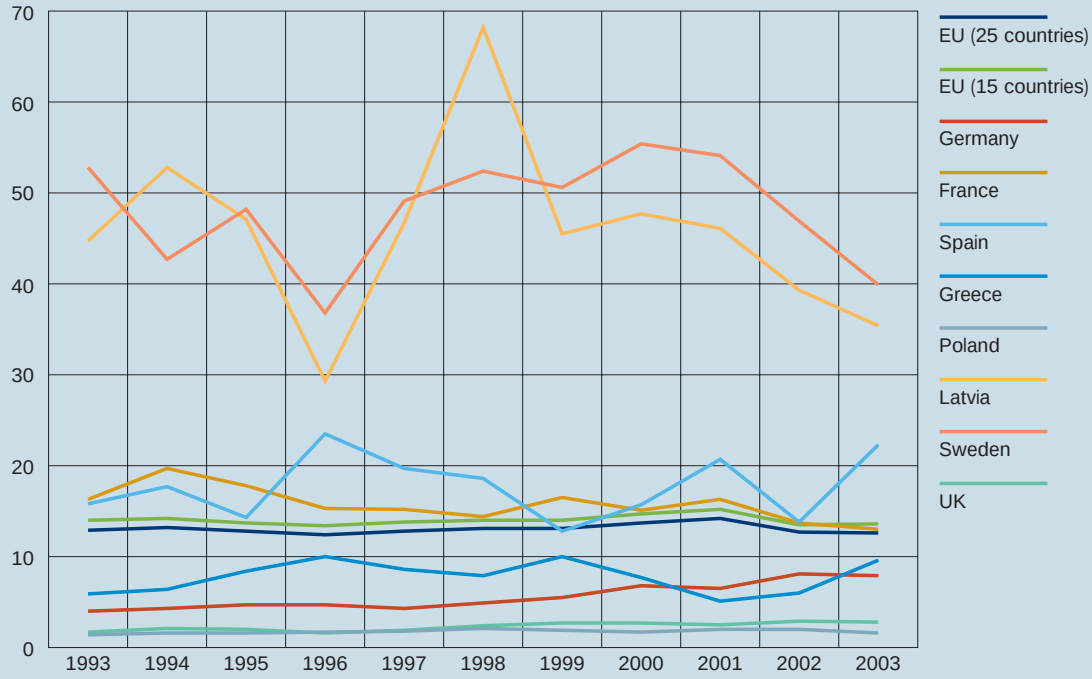
Renewable energy projects could bring many benefits to the region, not only for indigenous energy production, but also for reducing emissions of harmful greenhouse gases, with increased opportunities for the manufacturing, energy, agricultural, offshore supply and fisheries sectors. Potential renewable energy projects include:

- Wind farms in Lincolnshire, both on- and off-shore. 6GW of offshore capacity has been identified by the Department of Trade and Industry,[52] and six major offshore wind projects are under consideration in Lincolnshire. The potential on-shore wind resource (taking into account planning and development constraints) is 388MW – mostly in Derbyshire and Leicestershire;[53]
- Biofuel production, particularly in Lincolnshire's agricultural districts. There is good potential for co-firing crops such as willow coppice in existing coal burning power stations within the region;
- Ground source heat pumps would be well suited to the region's generally low-lying land and high water tables. The region's deeper aquifers, particularly beneath Lincolnshire, have a geothermal potential amongst the best in the UK;
- The above average sunshine in the region could be utilised for passive solar heating and photovoltaics;[54]
- Biogas is already generated in the region from sewage sludge and food processing waste. Electricity is being generated using methane captured from landfill waste, while waste incineration is being used for district heating systems (in Nottingham City centre for example). In 2000, landfill gas provided the bulk of the supply of renewable energy within the East Midlands.

[48] The level of reserves changes with the oil price: as prices rise, more oil is economically extractable and vice versa.
[49] DTI Oil & Gas production figures – **http://www.og.dti.gov.uk/information/bb_updates/chapters/reserves_index.htm**
[50] Hodge, T., 2003, *The Saltfleetby Field, Block L47/16, Licence PEDL 005, Onshore UK*. In Gluyas, J.G. & Hitchens, H.M. (Eds), *United Kingdom Oil and Gas Fields. Commemorative Millennium Volume*. Geological Society, London, Memoir 20, 911 – 919.
[51] East Midlands Regional Assembly, Land Use Consultants with IT Power Ltd., *Viewpoints on sustainable energy in the East Midlands: A Study of Current Energy Projects and Future Prospects*, March 2001.
[52] DTI, *Energy White Paper,* 2003.
[53] East Midlands Regional Assembly, Land Use Consultants with IT Power Ltd., *Viewpoints on sustainable energy in the East Midlands: A Study of Current Energy Projects and Future Prospects*, March 2001.
[54] Passive solar heating is a means of deriving energy directly from the sun, by careful planning of buildings and use of particular building materials to collect the sun's heat, thus reducing the need for heating inside the building. Photovoltaics is the use of solar panels on buildings to transform solar radiation directly into electricity.

CHART 12

Share of electricity generated from renewable energy sources in gross electricity generation, for a selection of EU countries (%)



Source: Eurostat sustainable development indicators (2006)

7. Waste

The latest figure for total waste arising in the East Midlands is 20.4 million tonnes, 10.8% of the total for England (2002/2003).[55] Gross Value Added for the East Midlands in 2003 was £61,681 million. This means that for every £1,000 of GVA generated in the East Midlands, one third of a tonne of waste is produced, while in England, less than one quarter of a tonne of waste is produced for every £1,000 of GVA generated. Therefore the East Midlands is significantly less resource efficient than the national average according to this measure. The contribution of different sectors to total waste in the East Midlands in 2002-3 was as follows:

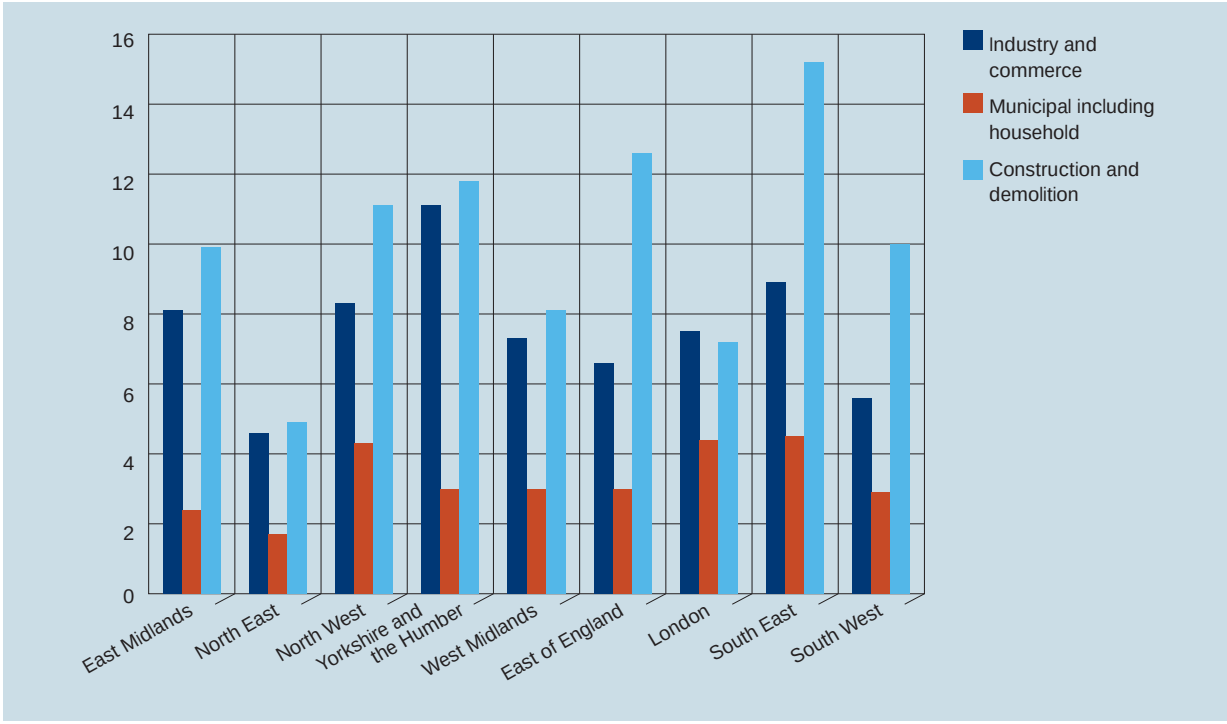
- 48% was produced by construction and demolition;
- 40% came from industry and commerce;
- 12% was municipal and household waste.[56]

Chart 13 shows how the East Midlands compares with other English regions in terms of the amount of waste generated from these three sources.

[55] Defra, Sustainable Development Indicators (2005).
[56] East Midlands Regional Assembly, *East Midlands Regional Waste Strategy Consultation Draft,* 2004.

CHART 13

Waste arisings by sector, 2002-3 (million tonnes)



Source: Defra Sustainable Development Indicators (December 2005), Environment Agency, Office of the Deputy Prime Minister (2005)

The following points can be drawn out:

- In the East Midlands, 20.4 million tonnes of waste were produced. The South East produced the largest amount of waste in total (28.6 million tonnes), while the smallest amount (11.1 million tonnes) was produced in the North East;
- Waste generated by industry and commerce was comparatively high in the East Midlands, although it did not constitute as large a proportion of total waste as in some other regions such as the North East, West Midlands and London;
- The East Midlands produced the smallest amount of municipal and household waste of any region except the North East. This reflects the fact that it has the second smallest population of the English regions;
- In all regions municipal waste was the smallest component of total waste;
- In all regions except London the largest amount of waste was produced by construction and demolition.

The cost of dealing with the total amount of waste produced by the region is estimated to be at least £400 million per year. Local authorities within the region are making steady progress to recover or recycle more of the municipal waste streams: in 2002/3, 17% of municipal waste was recovered, recycled or composted.[57] However, this is still significantly below Waste Strategy targets. Table 2 demonstrates that the proportion of all waste in the East Midlands which is recycled is comparable to the percentage for England as a whole.

[57] East Midlands Regional Assembly, *East Midlands Regional Waste Strategy,* January 2005.

TABLE 2

Proportion of all waste which is recycled, by region, 2002-3

Region	% of total waste recycled
North East	44
North West	37
Yorkshire & the Humber	44
East Midlands	43
West Midlands	48
East of England	43
London	53
South East	34
South West	44
England	43

Source: Defra Sustainable Development Indicators (December 2005), Environment Agency, Office of the Deputy Prime Minister

There are various ways of disposing of and treating waste. Data is available from the Environment Agency on landfill and treatment in the region. Categories of waste deposits reported to the Environment Agency are:

- Inert / Construction & Demolition;
- Special waste (including toxic and hazardous materials);
- Municipal waste;
- Commercial and Industrial waste (not including any special waste from these sources).

Table 3 shows the quantity of waste in each of these categories which is deposited in landfill.

TABLE 3

Deposit of waste to landfill in East Midlands and its sub-regions (tonnes) in 2002-3

Sub-region	Inert/C&D	Special	Municipal	Ind/Comm
Derbyshire	691,654	44,149	224,527	315,255
Leicestershire	935,609	15,894	206,527	252,289
Lincolnshire	336,448	1,882	360,676	192,212
Northamptonshire	954,662	22,496	133,991	637,659
Nottinghamshire	1,634,340	15,302	182,990	626,893
East Midlands Total	**4,552,713**	**99,723**	**1,108,712**	**2,024,308**

Source: Environment Agency contribution to Regional Economic Strategy Review – Evidence Base, 2005

The key points to note from Table 3 are:

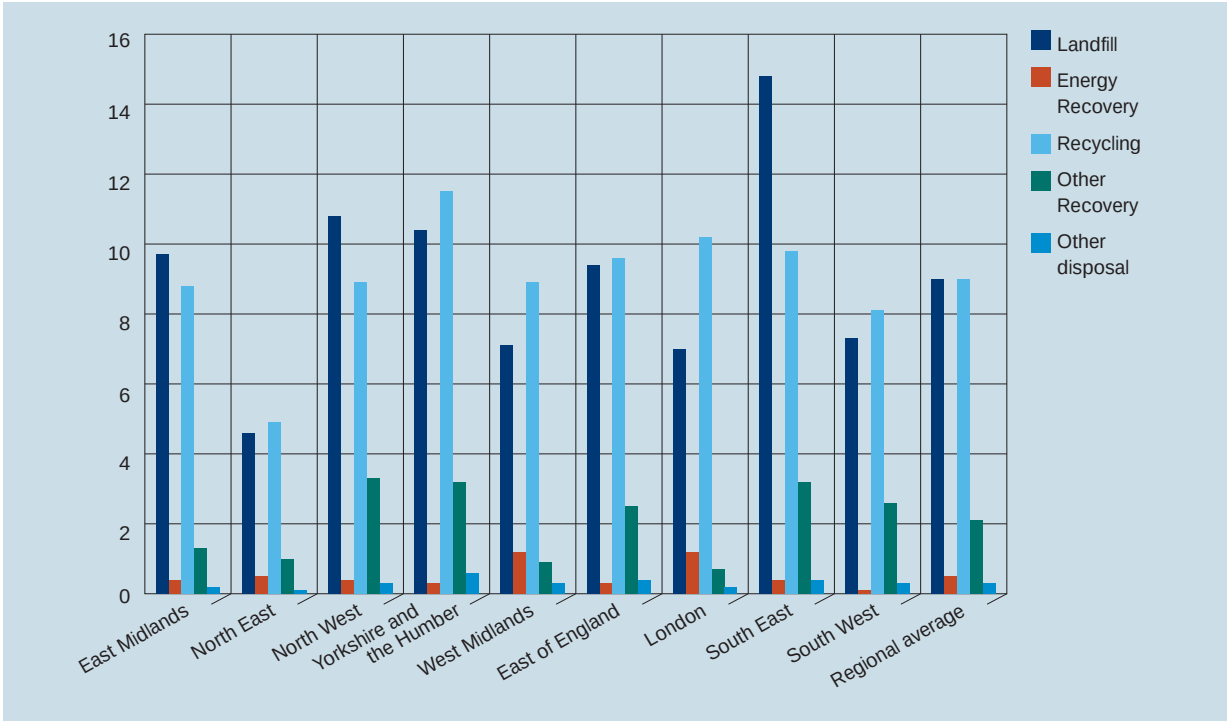
- Construction & Demolition (C&D) and other sources of inert waste (essentially non-biodegradable sources) accounted for almost 60% (around 4.5 million tonnes) of waste deposited in landfill in 2002/03. However, most of the usable C&D waste produced (approximately 40% of C&D waste arising – see section 7.1) is recycled as aggregate;
- A further 26% (just over 2 million tonnes) of landfill deposits were Industrial/Commercial waste and 14% (1.1 million tonnes) was Municipal waste;
- Only a small proportion (around 1.3%) of landfill deposits was of Special waste.

Data on treatment shows that around 1.25 million tonnes of waste were treated at facilities in the East Midlands in 2002-3. Almost 70% of this waste was treated by physical or chemical methods and the remainder by biological methods. Just over half of all treated waste was from Industrial/Commercial sources and a further 38% was Construction & Demolition/Inert waste. Significantly in the East Midlands, more special waste is subject to treatment (110,244 tonnes) than is deposited in landfill (99,723 tonnes). This is not the case nationally where more is deposited in landfill than treated.

Chart 14 offers a comparative perspective on the importance of different forms of waste disposal in different regions.

CHART 14

Waste arisings by disposal, 2002-3 (million tonnes)



Source: Defra Sustainable Development Indicators (December 2005), Environment Agency, Office of the Deputy Prime Minister

The main points to note from the chart are:

- The amount of waste deposited in landfill in the East Midlands is slightly higher than the average for all English regions, at 9.7 million tonnes, compared to the average of 9 million tonnes;
- The largest amount of waste sent to landfill was in the South East, while the North East disposed of the smallest amount of waste by this means. This is likely to reflect the fact that these two regions also produce the largest and smallest amount of waste in total (as noted above);
- More waste is subject to energy recovery in London and the West Midlands than in any other region;
- In all regions except the South East, more waste is recycled or recovered than is sent to landfill. However, in the East Midlands there is still a discrepancy between the capacity of waste management systems and the demands put upon them by the production of waste.

> The amount of waste deposited in landfill in the East Midlands is slightly higher than the average for all English regions

7.1 Recycled and secondary aggregates

Until the 1970s, the East Midlands, the best endowed of all English regions as far as natural aggregate resources are concerned, could also tap into a wide range of other materials, by-products or "waste" from other industries and demolition. Important usable by-products from industry were iron and steel slag, pulverised fuel ash (PFA), furnace bottom ash (FBA), colliery spoil (burnt or unburnt), and brick/ceramic waste. Demolition waste principally comprised airfield concrete, especially in the eastern/southern counties. With the notable exception of PFA and FBA, most of these materials are now no longer available, and certainly not in the quantities previously experienced. Even supplies of PFA and FBA have greatly reduced with the closure of a number of coal-fired power stations. However no comprehensive or consistent series of figures is available to quantify such trends. The following summarises the present position:

Construction and Demolition waste: ODPM commissioned national studies relating to 2001 and 2003.[58] Attempts were made to derive regional figures but users were cautioned against over-interpretation. The results are summarised in Table 4:

In the East Midlands over 40% of demolition and excavation waste is recycled as aggregate

TABLE 4

Waste arisings from construction and demolition in the East Midlands, 2001 and 2003

Demolition/Excavation Waste: East Midlands			
Year	**Total Arising (Million tonnes)**	**Used as aggregate (Million tonnes)**	**Confidence limits**
2001	10.59	4.09	±55%
2003	9.88	4.26	±14%

Source: Survey of arisings and use of construction and demolition waste in England and Wales in 2001, for ODPM 2002; Survey of arisings and use of construction and demolition waste in England and Wales in 2003, for ODPM 2004.

[58] Survey of arisings and use of construction and demolition waste in England and Wales in 2001 (Symonds Group) for ODPM 2002; Survey of arisings and use of construction and demolition waste in England and Wales in 2003 (Symonds Group) for ODPM 2004.

Over 40% of demolition/excavation waste is used as aggregate and the bulk of the remainder includes soil and material unsuitable for use as aggregates. This was employed in landfill, backfilling quarry voids, land reclamation, landscaping for leisure projects, etc. No records of the arisings within various parts of the region are held, but these are likely to be heavily concentrated in the three main cities and the former coalfield area.

PFA and FBA: Coal-fired stations produce significant volumes of pulverised fuel ash and furnace bottom ash. The latest estimates available (c. 2000/1) suggest that this figure is over one million tonnes annually.[59] These materials can be processed and used as aggregates (estimated at 33-50%), most of the remainder being employed in the systematic restoration of sand and gravel workings.

Road Planings: The East Midlands Aggregates Working Party is currently collecting information from Highways Authorities. In the past, levels recorded have been extremely modest, amounting to only a few tens of thousands of tonnes. However the practice and related facilities have increased since the last surveys (in the 1990s). In addition to the recycling of aggregate per se, the rising price of bitumen will also act as a spur. Many of the main routes in the region (notably the M1) are programmed for surface renewal, and recycling is now normally a condition of contract.

Airfield Concrete: The scope for further recycling of airfield concrete is the subject of a WRAP (Waste and Resources Action Programme) study, which was due to report in March 2006. This will cover the whole of England but may be significant for the southern and eastern parts of the region.

8. Water

Approximately 40% of the region is underlain by useable aquifers, which comprise bedrock aquifers as well as the River Trent gravels. Bedrock aquifers include the Sherwood Sandstone, Lower Magnesian Limestone, Carboniferous Limestone, Lincolnshire Limestone, Spilsby Sandstone and Chalk. Aquifers are recharged from rainfall and from streams flowing along their outcrops. The locations of major aquifers are shown in map 3. The Sherwood Sandstone, the various limestone formations, and the River Trent Gravels are the main aquifers. Together with the surface water from the River Trent and major tributaries,[60] they comprise the main water resources in the region.

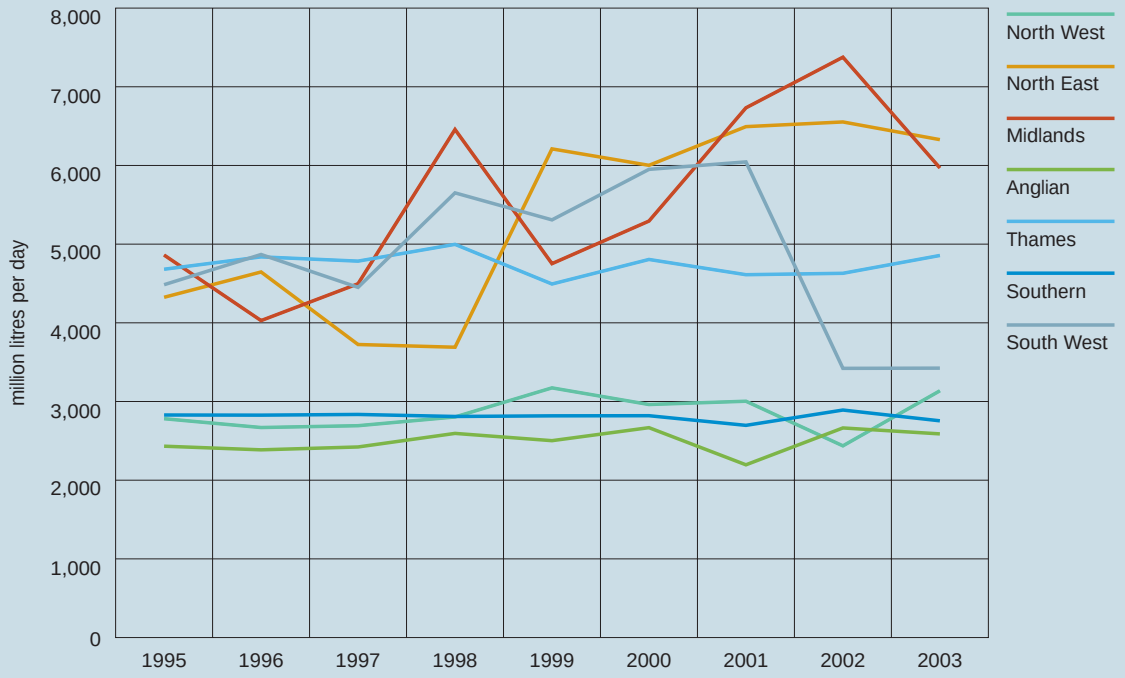
Chart 15 offers a comparison between the Environment Agency's regions in terms of the volume of water abstractions between 1995 and 2003. It is important to note that the East Midlands cannot be isolated from the data, as it is covered by the Midlands and Anglian regions. Nonetheless, useful comparisons can be drawn out:

- Water abstractions in the Midlands as a whole have been amongst the highest in England since 1995, peaking at 6,733 million litres per day in 2002;
- In most regions, water abstractions remained fairly steady or declined between 1995 and 2003, but abstractions in the North East, and to a lesser extent the Midlands, increased markedly in this period;
- In all years except 2002, the Anglian region recorded the lowest volume of abstractions.

[59] Source: East Midlands Aggregates Working Party.
[60] Most water is drawn from the rivers Derwent and Dove, not the Trent itself.

CHART 15

Estimated total abstractions from non-tidal surface waters and groundwaters, 1995 to 2003 (million litres/day)



Source: Defra Sustainable Development Indicators (December 2005), Environment Agency.

Currently over 1,150 million litres of water per day (Ml/d) are abstracted for public water supplies in the East Midlands, 350 Ml/d for industrial uses and 90 Ml/d for spray irrigation. Estimates suggest that the East Midlands population will grow by 400,000 by 2025 which could increase demand for abstraction by up to 40%. This will have a significant effect on river and wetland habitats as already some abstractions exceed the current sustainable limit.[61]

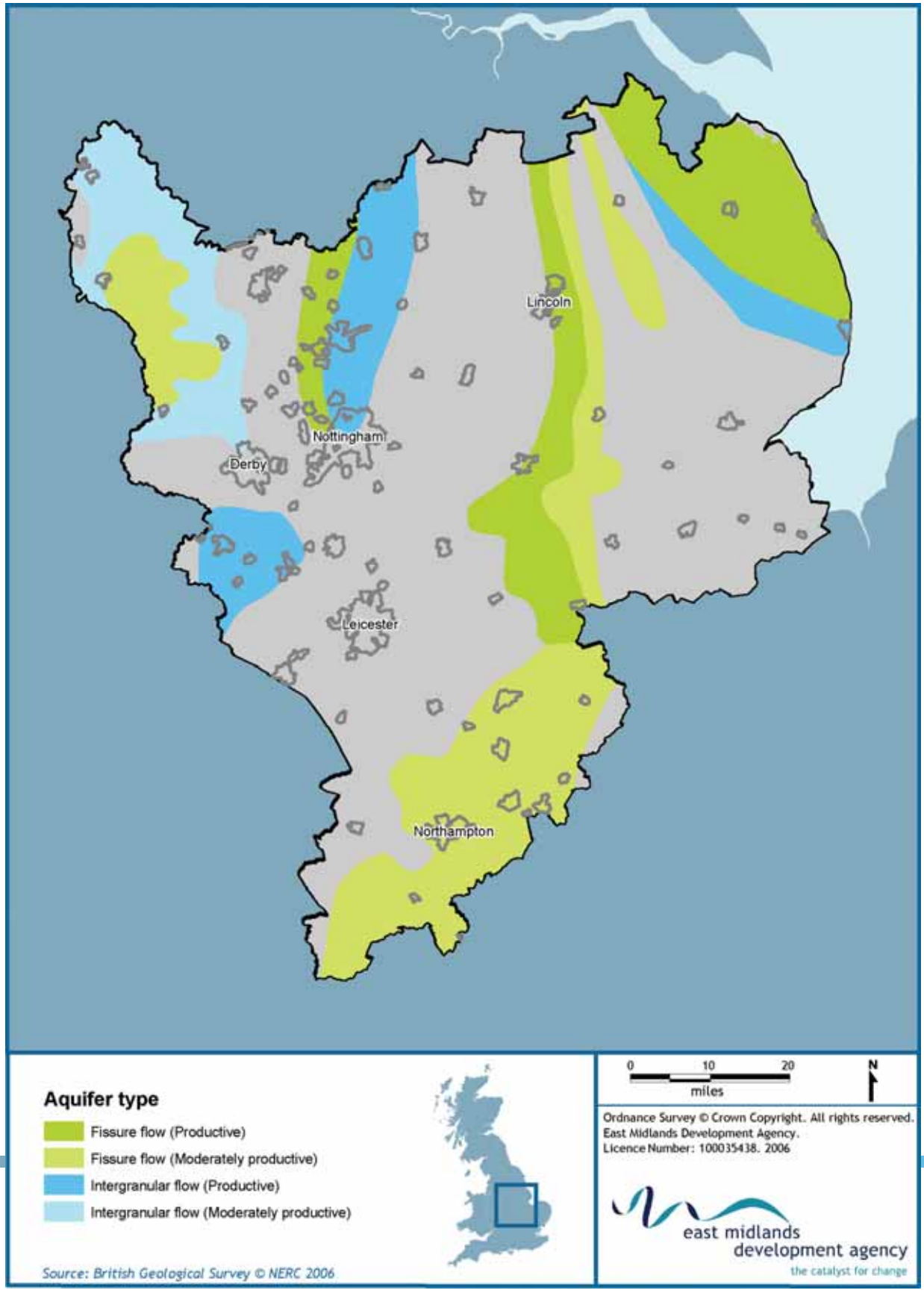
Parts of the East Midlands are amongst the driest in England, particularly Lincolnshire, which needs water to support the high quality agricultural land in that part of the region. Higher rainfall is experienced in the west of the region, due to the physical effect of the Pennine hills in encouraging rainfall.

In the East Midlands over 1,150 million litres of water per day are abstracted for public water supplies

[61] Environment Agency website **http://www.environment-agency.gov.uk**

MAP 3

Location of major aquifers in the East Midlands region, indicating aquifer type.



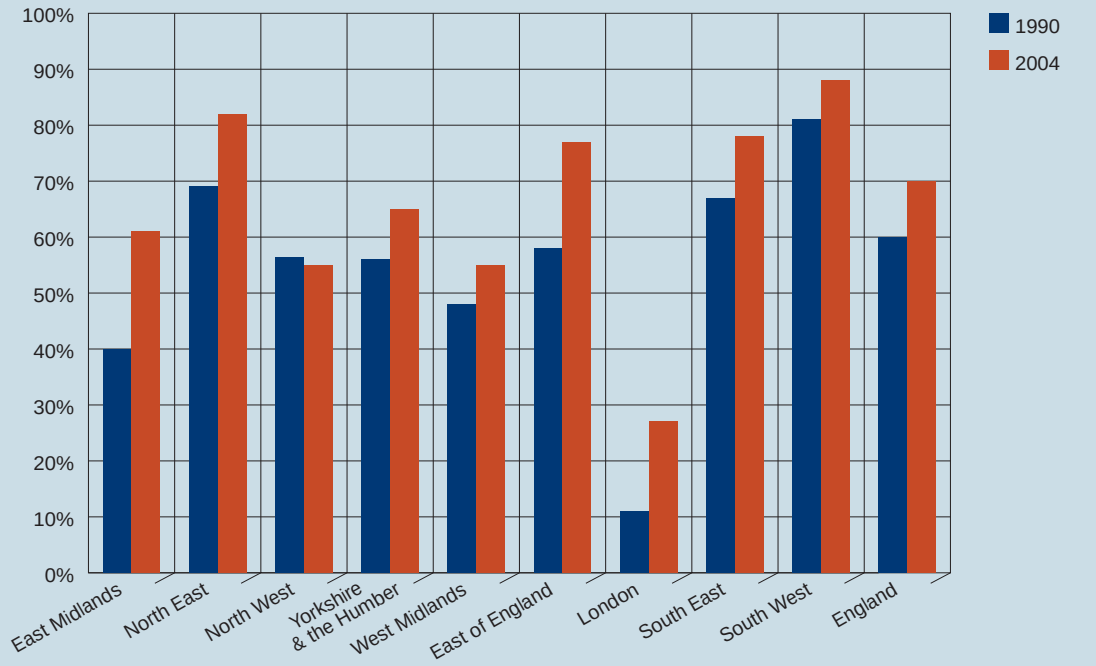
N.B.' Intergranular flow' is the term for groundwater flowing through pore spaces, while 'fissure flow' refers to groundwater being transmitted, more rapidly, through fractures and fissures.

8.1 Water quality

The quality of river water in the East Midlands was below the average for England in 2004, as Charts 16 and 17 demonstrate.

CHART 16

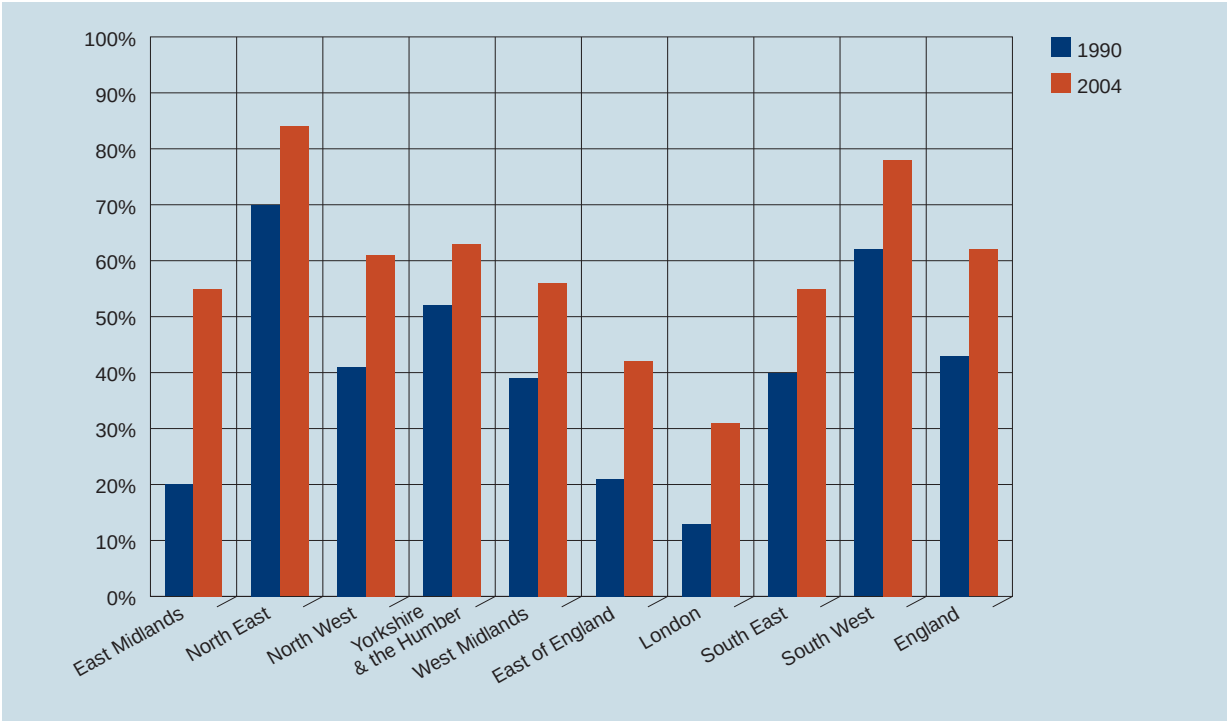
Percentage of rivers classified as of good biological quality, by region, 1990 and 2004



Source: Defra Sustainable Development Indicators (December 2005)

CHART 17

Percentage of rivers classified as of good chemical quality, by region, 1990 and 2004



Source: Defra Sustainable Development Indicators (December 2005)

The key points to note from the charts are:

- The percentage of rivers of good biological and chemical quality increased between 1990 and 2004 in all English regions;
- The improvement in quality was most marked in the East Midlands: the proportion of rivers of good biological quality increased by 20.7 percentage points between 1990 and 2004, while for rivers of good chemical quality the increase was 34.5 percentage points;
- The regions with the greatest proportion of good quality rivers (in both biological and chemical terms) were the South West and North East;
- Water quality was poorest in London, where just 27% of rivers were classified as of good biological quality in 2004, and 31% of good chemical quality. This is to be expected given the dense concentration of population and industrial and construction activity in the capital, all of which contribute to water pollution through sewage and waste disposal.

There were 2,329 confirmed pollution incidents in the East Midlands in 2003, a 10% reduction on the figure for 2002. 'Fly-tipping' and 'containment and control failure' were major sources of pollution incidents. The most common pollutants were 'oils and fuels' and 'sewage materials', each accounting for 17% of incidents.

8.2 Nitrate vulnerable zones

Nitrate Vulnerable Zones cover 55% of England and 3% of Wales and aim to prevent nitrates entering groundwater by limiting the amount of nitrogen fertiliser applied to farmland. Within the East Midlands 19,120 hectares of agricultural land are designated as Nitrate Vulnerable Zones – mostly in the northern and central parts of Nottinghamshire and Lincolnshire and in southern Northamptonshire. This, however, represents only a small proportion of the ground and surface waters in the region vulnerable to nitrate pollution from agriculture, with much larger EU Nitrate Directive Nitrate Vulnerable Zones designated.[62]

8.3 Flood risk

In the East Midlands flood risk is a major economic and social issue in low-lying areas developed on broad floodplains, such as the River Trent valley.[63] The region also contains some of the most extensive flood-prone coastal areas in the UK. Small tributary valleys are not free from risk, as they can be affected by unpredictable 'flash floods' of the type that devastated Louth (Lincolnshire) in 1920,[64] and more recently Northampton, in 1998. Floodplain inundation can be widespread across arable tracts that border river channels, but is particularly damaging in urbanized parts of the floodplain, where housing is dense and drain or sewer systems are unable to cope with significantly raised groundwater levels. Map 4 is an indicative flood risk map, which zones the likelihood of flooding on the basis of topography, hydrology and documentary evidence of historic events.

It is estimated that approximately 17% of the land area in the East Midlands is at risk of flooding, affecting over 350,000 people in 143,000 homes and significant numbers of businesses. Importantly, 20% of the region is low lying and protected by drainage and flood defences and over half of the best and most versatile agricultural land is situated less than five metres above sea level. Extrapolations over the next 50 or so years suggest that the social, economic and environmental consequences of climate change could be severe.[65] Global-scale climatic simulations conclude that sea-levels will rise, placing coastal regions at greater risk from marine inundation. The frequency of severe inland flood events, such as that of November 2000, will also increase significantly. To combat these likely outcomes a number of options are being considered, ranging from 'hard', engineered flood defence structures, to more 'sustainable' scenarios that may include the removal of defences and consequent reversion of natural floodable tracts to their former wetland environments.

> Flood risk is a major economic and social issue in low-lying areas

[62] Defra, *England Rural Development Programme (ERDP) Regional Chapters – East Midlands,* May 2005.

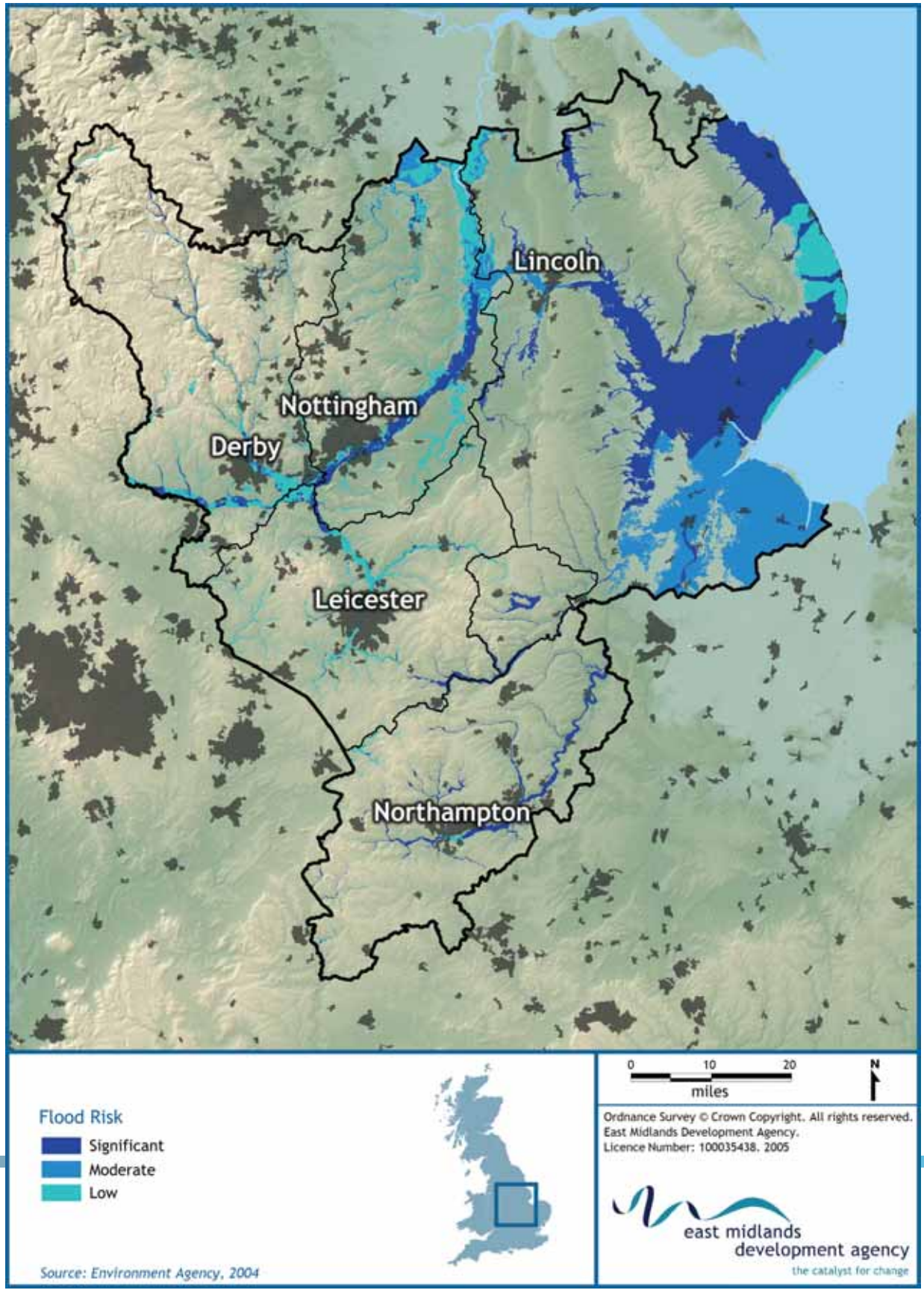
[63] Carney, J. N. and Napier, B., 2005, 'Geology-based methodologies for visualizing inland floodplains and understanding fluvial processes', *European Geologist,* No.20, 14-17. A flooplain is the flat land of a river valley close to the river banks. It is a fertile area of land, usually found in the lower course of a river and often used for agriculture.

[64] Robinson, D. N., 2000, *The Louth Flood – the story of the events of Saturday 29th May 1920.* Louth: Louth Naturalist's Antiquarian and Literary Society.

[65] Environment Agency website **http://www.environment-agency.gov.uk**

MAP 4

Flood risk in the East Midlands (non-managed)



9. Geology and mineral resources

9.1 Geology

The geology of the East Midlands region,[66] in terms of the geological periods and diversity of rock types represented, is arguably without parallel elsewhere in the south and midlands. Accordingly, geology has exerted an important influence over the region's industrial development and rural land use, and will continue to do so. Potentially adverse ground conditions ('geohazards'), caused by the physical properties of the substrate are geological factors that must be taken into consideration in planning and development.[67] Allied to these factors are changes to the subsurface brought about by human activities such as mining, quarrying and landfill.

Maps 5 and 6 show the distribution of the two principal geological formations – the solid substrate, or bedrock, and the overlying and generally much thinner superficial deposits. The mineral wealth of the East Midlands is largely due to the diversity of the bedrocks, which encompass 600 million years of geological time during which the region has seen volcanoes, deep rift valleys and mountain belts. The oldest rocks, around Charnwood Forest and Mountsorrel, possess excellent qualities for aggregate production and have an economic importance out of all proportion to their small outcrop area. Carboniferous strata are largely responsible for the region's mining heritage, in the Peak District and surrounding coalfields.[68]

Superficial deposits (commonly confused with 'soils') are younger, unconsolidated deposits which overlie the bedrock. The superficial deposits of the East Midlands consist of unconsolidated clays, silts and sands. Sand and gravel is of significant economic importance to the East Midlands (see section 9.2.2).

> In the East Midlands geology exerts an important influence on industrial development and rural land use

Compared to most parts of the world the East Midlands is geologically quiescent (for example, we do not have active volcanoes). Despite this, hazards posed by geology do exist and although they are generally subtle, their cost can be significant. Engineering (geotechnical) ground conditions are related to the underlying geology and have a profound influence on development. Key geotechnical issues (geohazards) in the region include:

- Clays with significant swelling and shrinking properties, which are particularly widespread in the bedrocks and superficial deposits of the region (Map 7); the estimated aerial extent of ground affected being comparable with that for the Eastern Region[69];
- Radon gas is an unseen natural hazard to health and the likelihood of it occurring can be assessed from digital geological maps showing distributions of the source rocks from which it is emitted (Map 8);
- Landslides can be a hazard in areas such as the Pennines, and in the lower-lying scarp-and-dip slope topography farther east. In both settings, factors such as steep slopes and the type of geological material combine to produce zones of potentially unstable ground, the surface area affected being comparable with that for the West Midlands and South West region.

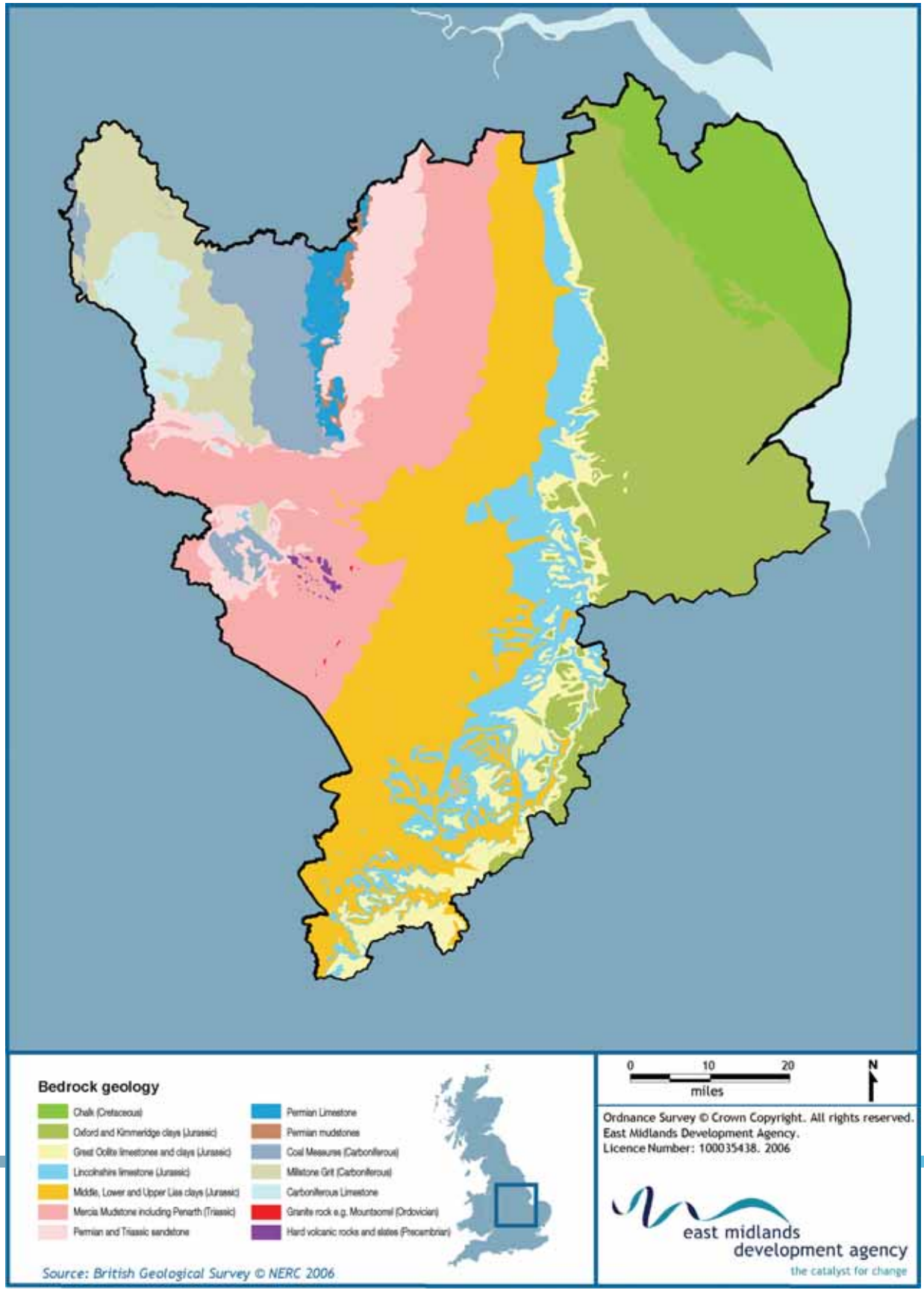
Other hazards, such as soluble rocks, compressible ground and running sand are present in this region. Human influence on the geology can also be responsible for the often unpredictable nature of ground conditions, as a result of: opencast coal or ironstone reinstatement, coal mining, made ground after sand/gravel working, and other mining activities, such as the legacy of lead mining in the Peak District.

Earthquake risk tends to be ignored in the East Midlands, and yet this region contains some of the largest fault systems to be found in England. Small to moderate earthquakes (magnitude ~4ML[70]) occur every several years and major events have also been documented, such as the earthquake of 1185 (estimated magnitude 5.5 ML) that destroyed Lincoln Cathedral. The largest measured shock was the Derby earthquake of 1957, with a magnitude of 5.3ML. It is the only earthquake in the UK to have caused significant damage to a major engineered structure (the dam wall of the Blackbrook Reservoir, near Shepshed).[71]

[66] Hains, B. A. and Horton, A., 1969, *British Regional Geology. Central England.* (3rd Edition). Keyworth: British Geological Survey.
[67] Charsley, T. J. et al., 1990, Nottingham: A geological background for planning and development. *British Geological Survey Technical Report,* WA/90/1.
[68] Aitkenhead, N. et al., 2002, The Pennines and adjacent areas. *British Regional Geology Series* (Keyworth: British Geological Survey).
[69] Land underlain by shrink-swell clay will swell when wet and shrink as it dries out. The problem is most widespread in southern and eastern England where young clay-rich rocks are at or near the surface. This can cause damage to both property and highways, and is exacerbated by extreme variations in weather conditions **http://www.nerc.ac.uk/publications/documents/pe-aut04/cracking-open.pdf** After the drought of 2003, insurers saw a sharp increase in natural land instability related calls. (**http://www.landmarkinfo.co.uk/corp/graphics/corp2/data_index_instability.pdf**
[70] ML (Richter local magnitude) is a measure of earthquake size. Several different scales exist, all of which are logarithmic because of the large range of earthquake energies (for example a magnitude 6 ML is 30 times larger, in terms of energy, than a magnitude 5 ML). The Richter local magnitude (ML) is used for 'local' earthquakes up to 600 km away, and is the magnitude scale used by BGS when locating UK earthquakes. See **http://www.earthquakes.bgs.ac.uk/earthquakes/education/faqs/faq15.html** for further information.
[71] Neilson, G. et al., 1984, *Macroseismic reports on historical British earthquakes V: Midlands*. British Geological Survey Global Seismology Report, 228b.

MAP 5

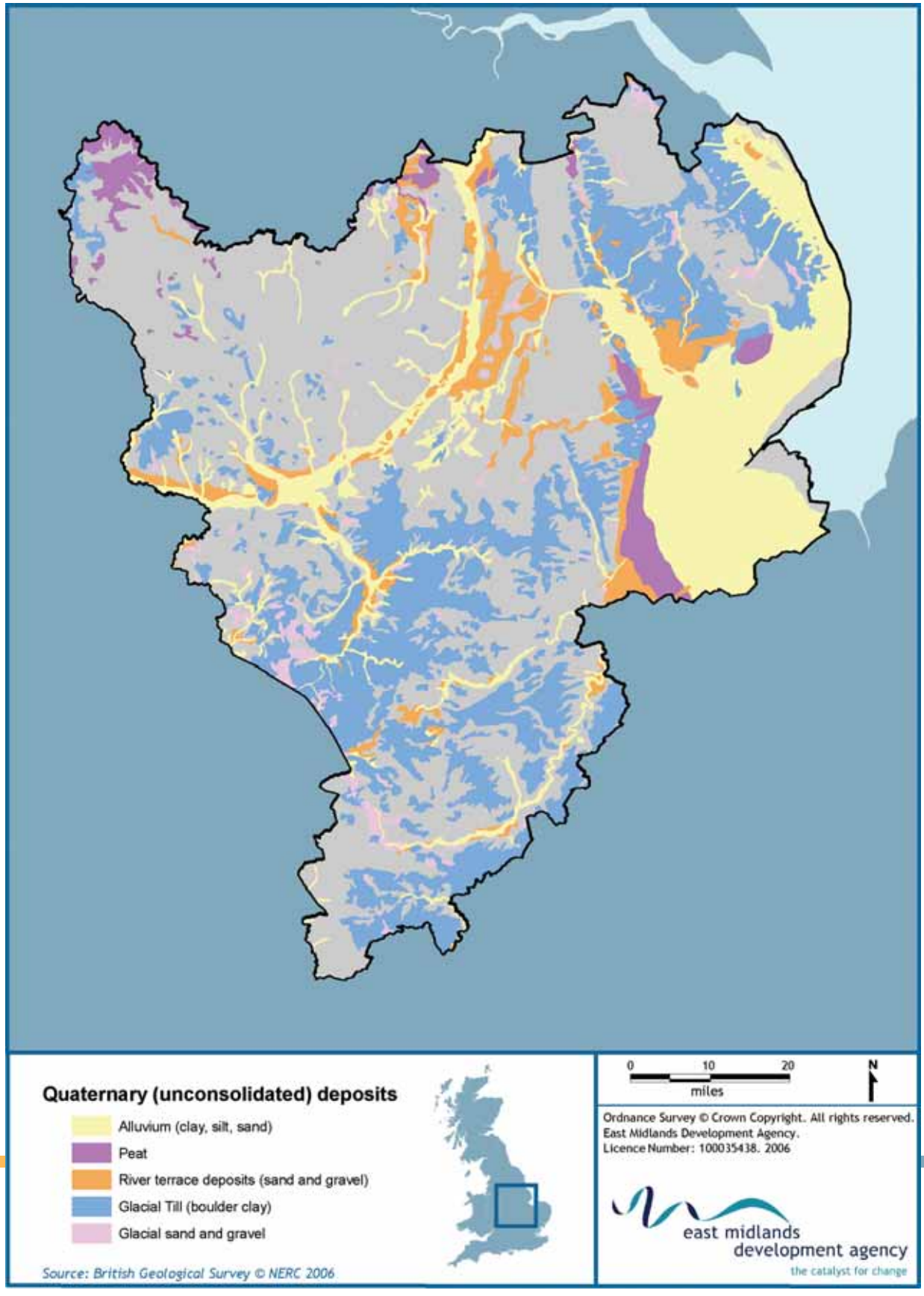
Bedrock geology of the East Midlands, based on British Geological Survey (BGS) digital geological map data at the 1:625,000 scale[72]



[72] More detailed digital geological mapping is available for the region, but this was the scale which displayed best for the map in this section.

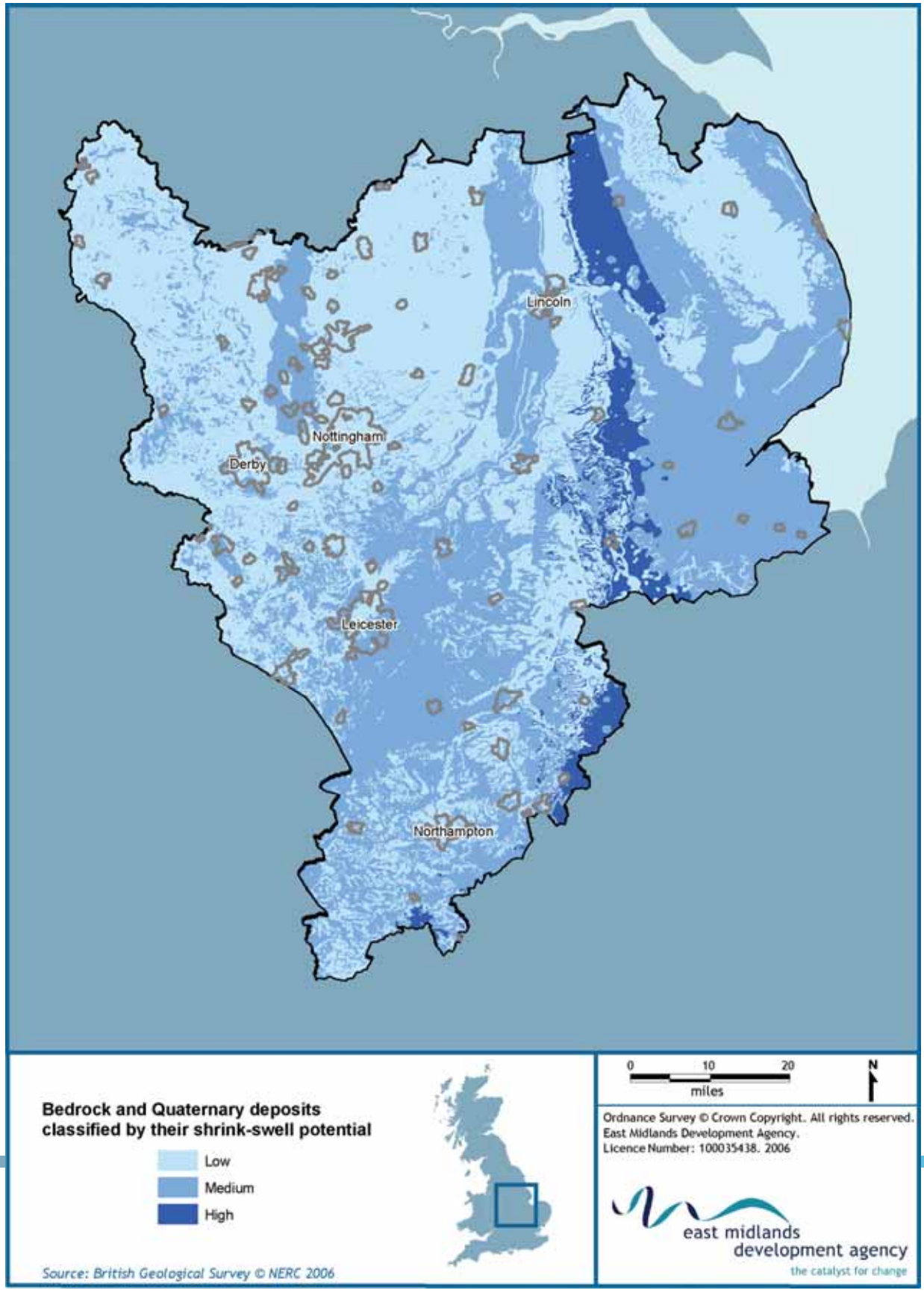
MAP 6

Quaternary (superficial) geology of the East Midlands, based on British Geological Survey digital geological map data at the 1:625,000 scale



MAP 7

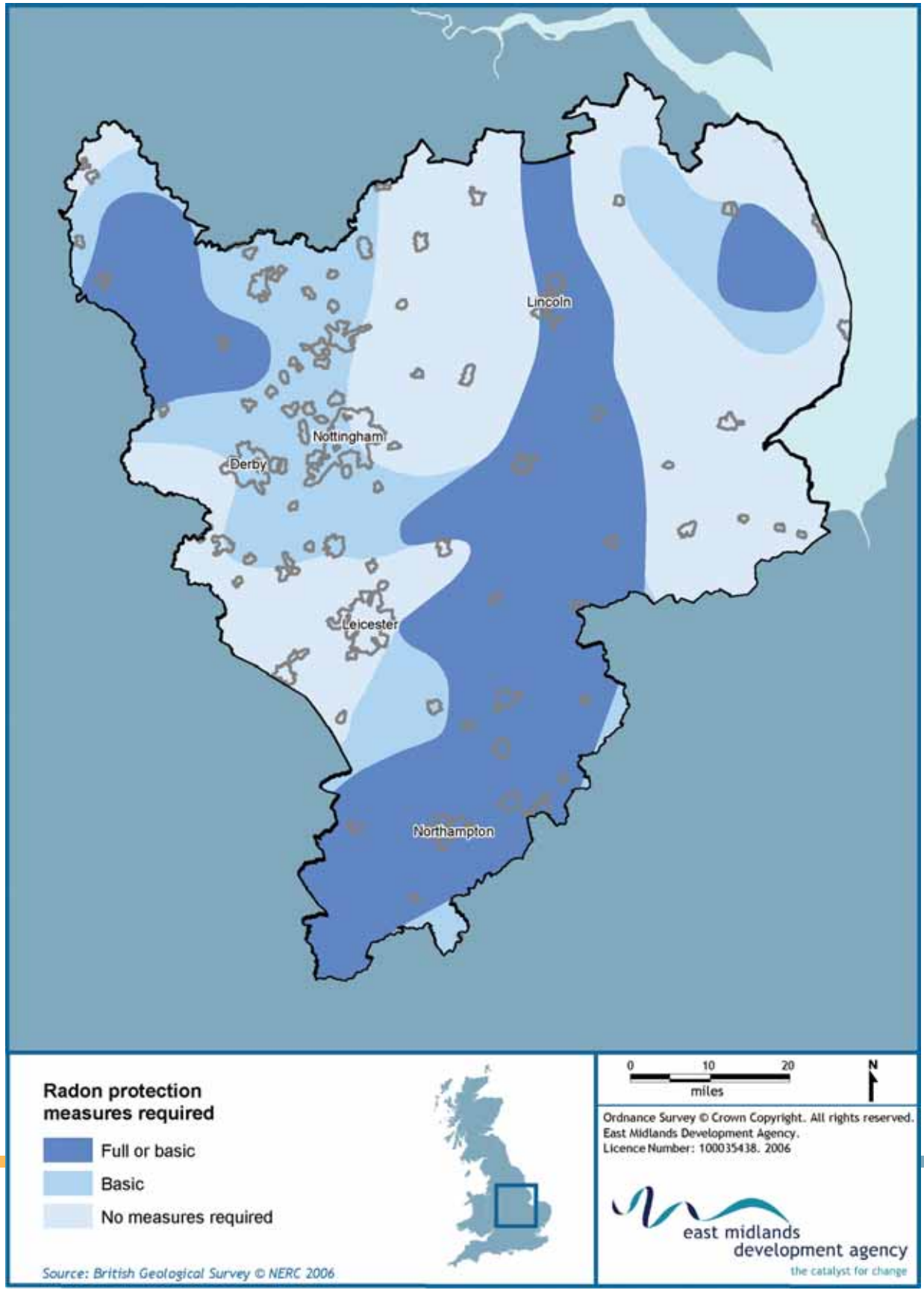
Shrink-swell clay potential for the East Midlands, based on British Geological Survey "Geosure" digital data at the 1:50,000 scale[73]



[73] http://www.bgs.ac.uk/products/geosure/home.html

MAP 8

Areas of the East Midlands requiring radon protective measures to be installed in new buildings and extensions, based on British Geological Survey digital data at the 1:250,000 scale



9.2 Mineral resources[74]

The East Midlands is an important producer of a wide range of minerals.[75] Mineral resources are shown in Map 9, with extraction sites shown in Map 10. Crushed rock aggregates, including limestone and igneous rock, satisfy local consumption and are exported in large amounts to other regions, especially the South East and North West. The region is Britain's major producer of gypsum and only producer of fluorspar. Manufactured goods from minerals, such as cement, lime, concrete blocks, plasterboard, ceramics, bricks and tiles, are an important part of the region's economy, as are smaller uses of minerals for fillers and extenders. Historically the major coal and iron ore resources, as well as smaller amounts of lead and other mineral ores, have underpinned the region's development as a major industrial area. Despite the demise of significant sections of the minerals industry, not only is the region still the UK's leading minerals producer, it also hosts the national head offices of leading companies in the producing and related servicing industries, and of professional and research bodies. It also hosts Britain's leading biennial trade fair for the industry. The East Midlands could thus rightly claim to be the "geocentre" of the UK.

> The East Midlands is the UK's leading minerals producer

9.2.1 Aggregates[76]

Aggregates include crushed rock, sand and gravel. The East Midlands region is the largest aggregate producer in the UK, having increased its production of crushed rock substantially since the mid-1980s (Charts 18 and 19). In 2004 18.6% of the total land-won material in Great Britain (sand, gravel, crushed rock) was produced in the East Midlands. The key resources are:

- The igneous and metamorphic rocks of Charnwood and south of Leicester in Leicestershire. Ninety-nine percent of the region's igneous rock reserves are located in Leicestershire. In 2004, the region was the largest producer of igneous rock in the UK (13.2 Mt – 30% of the total);

- The Carboniferous Limestone of Derbyshire and the Peak District (extending westward into a small part of Staffordshire). The majority of the region's limestone extraction occurs in Derbyshire. Eighty-one percent of the East Midlands' permitted limestone reserves are located there. The region was the largest producer of limestone, and the second largest producer of limestone aggregates in 2004 (15.1 Mt – about 22% of total UK production);

- The sands and gravels of the Trent and its tributary valleys (from near Burton upon Trent through Nottingham almost to Gainsborough). In 2004 the East Midlands was the third largest producer of sand and gravel (10.9 Mt – 12.5% of the UK total).

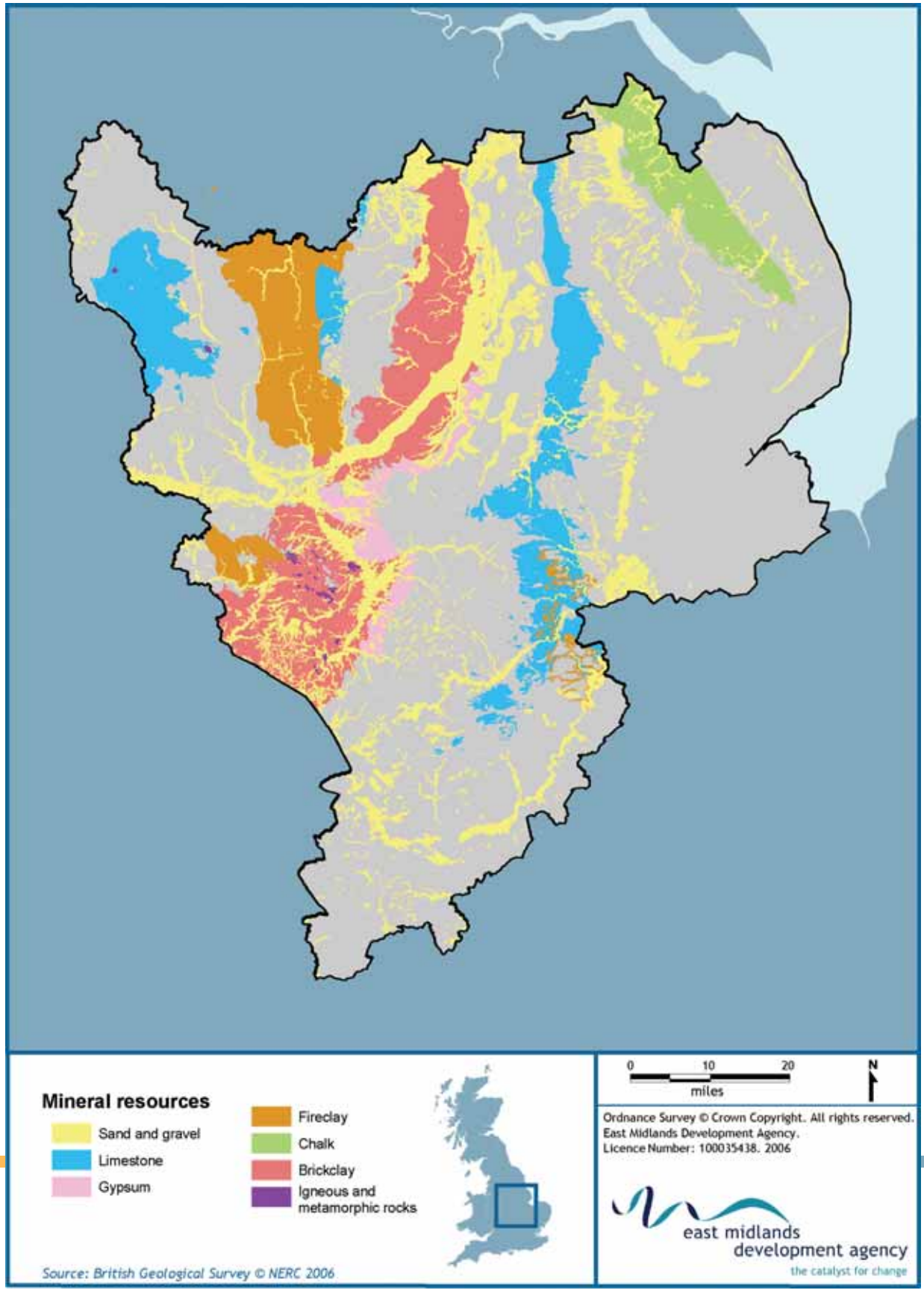
[74] The statistics in this section are drawn from the Collation of the Results of the 2001 Aggregates Minerals Survey (British Geological Survey report CR/03/53N), the 2004 Minerals Yearbook (Keyworth, British Geological Survey), both at **http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html** and the Annual Reports of the East Midlands Aggregates Working Party, at **http://www.odpm.gov.uk/index.asp?id=1144935**

[75] Minerals-related information for the East Midlands Region can be accessed online at **http://www.bgs.ac.uk/mineralsuk/digital_maps/background/home.html**

[76] BGS/ODPM Mineral Planning Factsheet 'Construction Aggregates', available for download at **http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html**

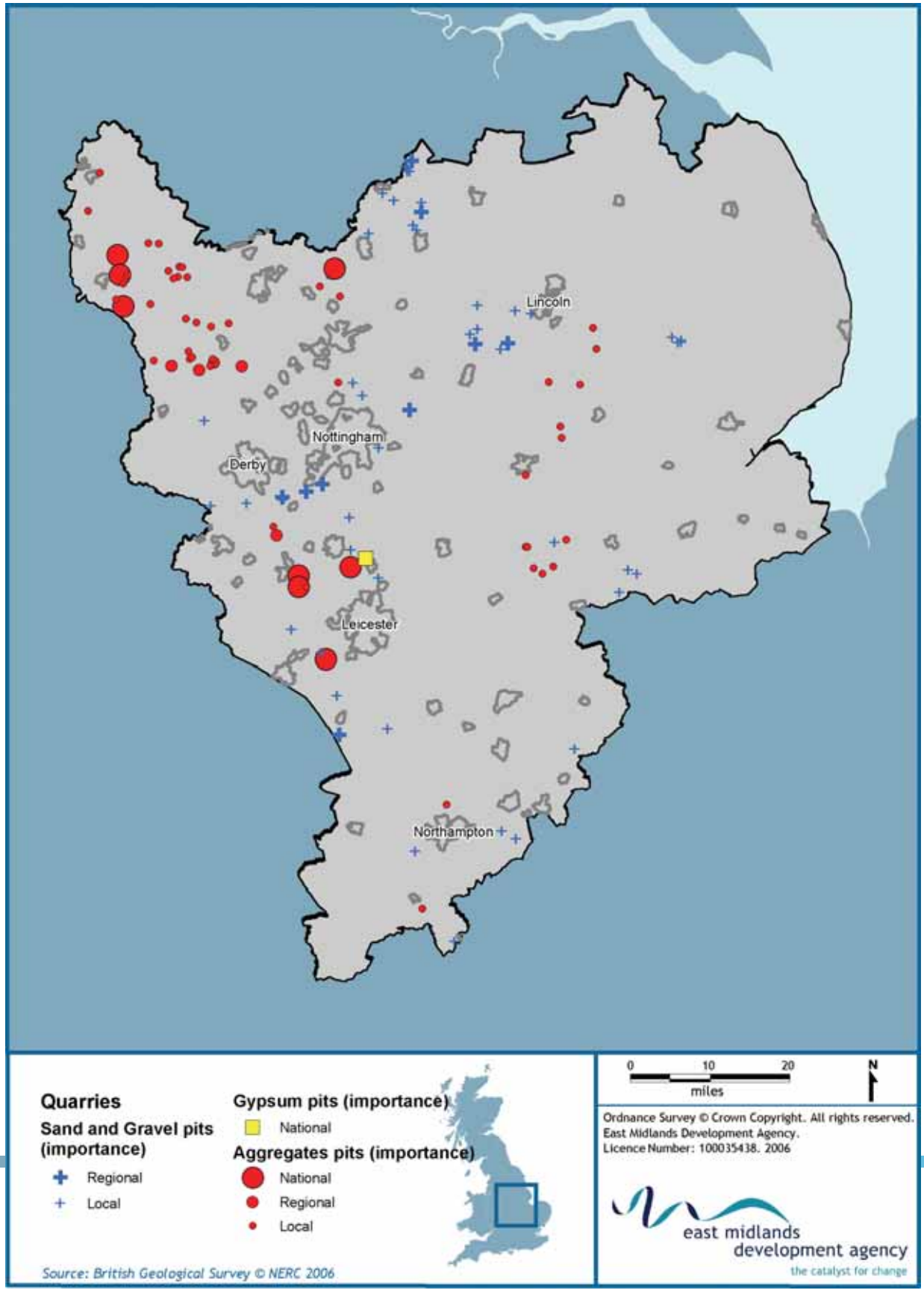
MAP 9

Mineral resources of the East Midlands, based on British Geological Survey digital mineral resource mapping at 1:50,000 scale



MAP 10

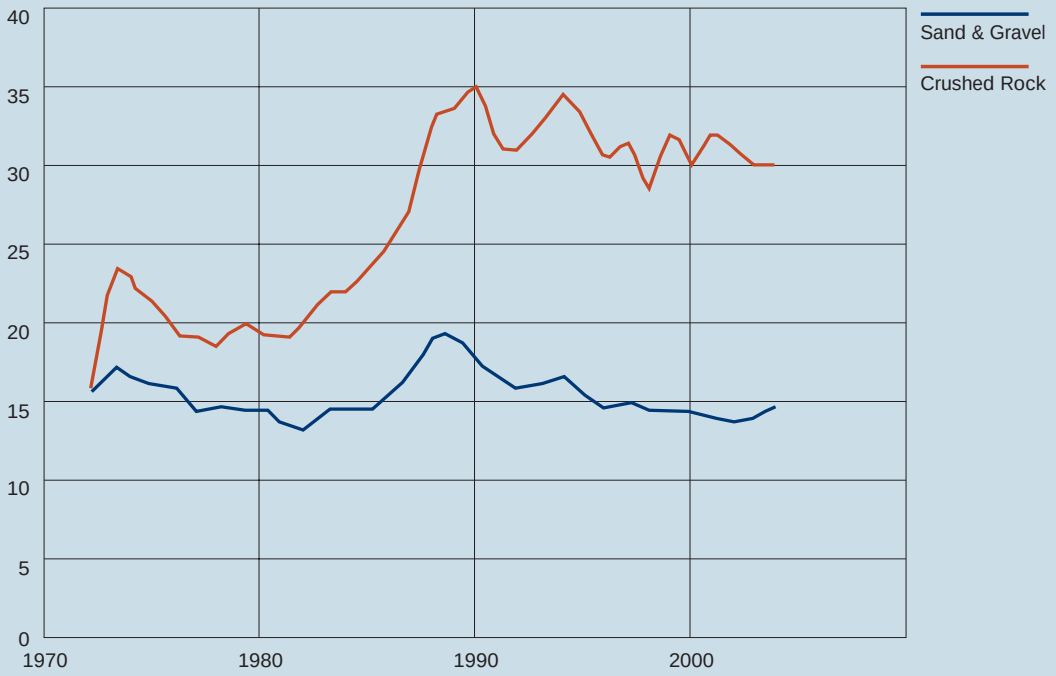
Mineral extraction sites in the East Midlands, created from BGS Britpits database[77]



[77] http://www.bgs.ac.uk/mineralsuk/data/britpits/home.html

CHART 18

East Midlands production of aggregates (sand and gravel and crushed rock), 1972-2004 (million tonnes)



Source: Annual Minerals Raised Inquiry, ONS, 2004

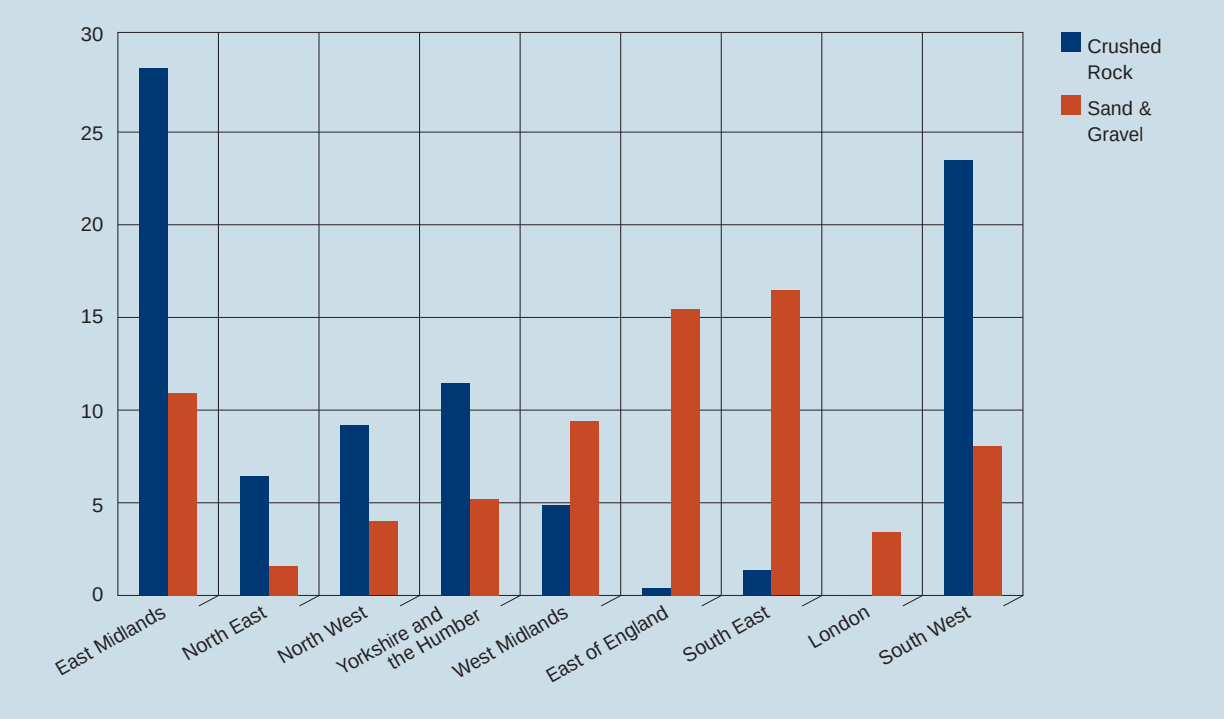
As Chart 19 shows, production of aggregate minerals in England is not uniformly distributed:

- Crushed rock aggregates output in the East Midlands amounts to 33% of English production. This reflects the availability of suitable hard rocks at or near the surface, coupled with the convenient geographical location of the region near the South East and London, which import a significant proportion of their aggregates from the East Midlands;
- Sand and gravel production is less dominant in the East Midlands, though still important, at 15% of the total output;
- The South East and East of England produce the largest amounts of sand and gravel (more than 15 million tonnes from each region per year), reflecting the demand for construction in these areas;
- The smallest amounts of crushed rock are produced in the East of England and South East, at 0.4 and 1.4 million tonnes respectively, while no crushed rock at all is produced in London. This reflects the absence of suitable hard rocks at or near the surface.

> The East Midlands produces the largest amount of crushed rock of any English region

CHART 19

Aggregate production by region in 2004 (million tonnes)



Source: British Geological Survey, 2005

Not only is the region the largest producer, it is the largest aggregates exporter (Map 11),[78] dispatching 21 Mt, or 51% of the output to other regions in 2001. By way of comparison, this is greater than the total production of aggregates in Wales and two and a half times the tonnage exported from the next largest producer, the South West. Substantial quantities of crushed rock are distributed to Yorkshire and the Humber (mainly limestone), the North West (mainly limestone) and the West Midlands (all types) – these three regions each taking 4.5-5 Mt – and to the South East, London and East of England (principally igneous rock plus some limestone – c.3.3 Mt) (see Map 11).

The limestone extraction industry is particularly concentrated in the Peak District, mainly around the fringes of the National Park. The four igneous rock quarries in Leicestershire are some of the largest in Europe (in terms of tonnage extracted) with annual outputs of over a million tonnes.

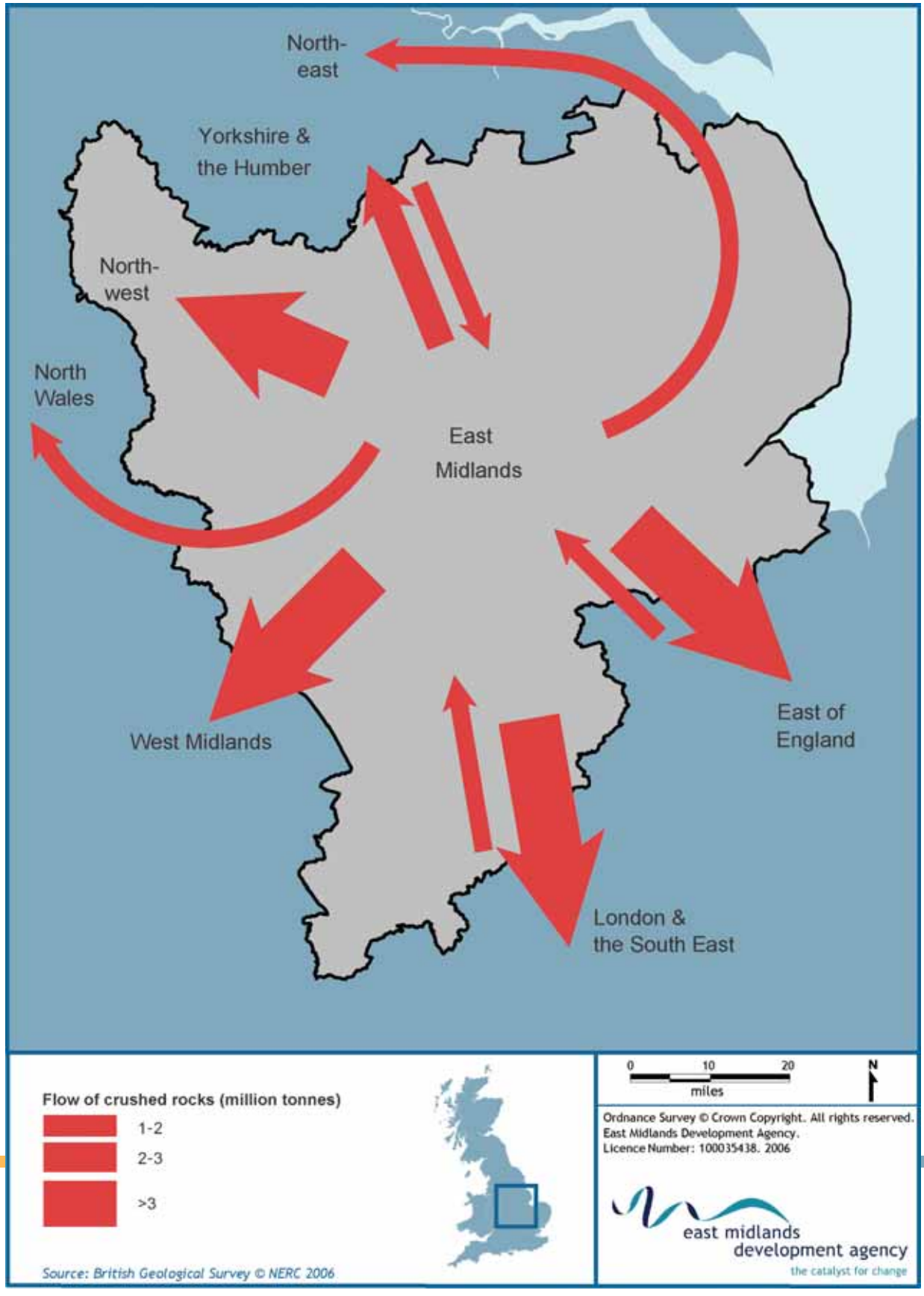
In addition to large-scale exports, the region has consistently "consumed" a much higher than average tonnage of aggregates, most likely because of the use of aggregates as a feed to the concrete products industry. The region has some of the largest plants in this sector and its central location in the UK enables it to send these value-added products over considerable distances, as far as the south coast and southern Scotland.

In 2001, the region's permitted reserves of aggregates (2.3 billion tonnes) accounted for about 40% of the total for England and Wales.

[78] For national versions of the figures shown on this map, see Collation of the Results of the 2001 Aggregates Minerals Survey, British Geological Survey report CR/03/53N, available for download at **http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html**

MAP 11

Inter-regional flow of crushed rocks



9.2.2 Other construction minerals

Total production of building stone in the UK is relatively modest but is of increasing significance as a contribution to conservation of the built environment.[79] For building stone purposes, in 2001 the East Midlands was second to Yorkshire and the Humber in its production of sandstone, and second also to the much predominant South West in its output of limestone.

The most important sandstones for building occur extensively in Derbyshire and the Peak District within the Millstone Grit Group and Coal Measures. The region's sandstone building stone contribution is significant in that it serves a UK market, being particularly favoured in Scotland (there are more sandstone quarries in the southern Pennines than in the whole of Scotland) and has also been used elsewhere for prestige projects such as Portcullis House (the new Parliamentary Building).

The most important limestones for building are the oolitic and shelly limestones of the Lincolnshire Limestone of Middle Jurassic age.[80]

The East Midlands is also an important brick-producing region with an output of 487 million bricks in 2003, accounting for about 18% of total brick production in England.[81] The Mercia Mudstone is the principal source of brick clay in the region. It has an extensive outcrop in the East Midlands, most notably in Leicestershire, where it is used for brickmaking at five sites, and also in Nottinghamshire where it is worked at two. Carboniferous mudstones are worked in Derbyshire for brickmaking at two sites.

The East Midlands has been the principal source of fireclay in the UK for many years.[82] Output has been mainly from the South Derbyshire Coalfield and parts of the coalfield in north-west Leicestershire where production is based on fireclays in the Pottery Clays Formation (Middle and Upper Coal Measures).

9.2.3 Industrial limestone and cement

The East Midlands is an important cement-producing region, accounting for approximately 25% of UK output. There are three large cement plants in the region, located at Hope, near Castleton in the Peak District National Park, at Tunstead near Buxton and at Ketton in Rutland. Capacity of the Tunstead plant has just been greatly expanded (at a cost of £110 million).

The East Midlands is also the principal source of high chemical purity (>97% $CaCO_3$) limestone for industrial applications in the UK. It is estimated that the East Midlands produced about 5.5 Mt or just under 60% of the UK requirements for high purity limestone/dolomite in 2003,[83] almost all of which was extracted in the Buxton and Wirksworth areas of Derbyshire.

Flue gas desulphurisation (FGD), the process introduced to reduce sulphur emissions from power stations, places an additional demand for high-purity limestone on the region. In 1994, the two largest power stations in the UK, Ratcliffe on Soar and Drax (Yorkshire) were retrofitted with FGD plant. The process involves reacting very pure limestone sourced from the Peak District with the emerging gases, producing gypsum, which can be used as an alternative to natural gypsum for some applications. The limestone requirement is of the order of 1 million tonnes per annum but will increase significantly when the FGD plant at West Burton and the planned plant at Cottam, within the region, together with two others in neighbouring regions, come on stream.

9.2.4 Other minerals

The East Midlands is the most important source of gypsum in Britain.[84] Production occurs in both Nottinghamshire and Leicestershire, the latter now being the most important source. The large Barrow Mine in Leicestershire has an output approaching 1 million tonnes per year. Production of natural gypsum has fallen as production of gypsum by FGD has risen. UK annual output of natural gypsum was approximately 1.7 million tonnes in 2003. Synthetic gypsum output is now estimated to be 1.2 million tonnes per annum.

Fluorspar production in the UK is now confined to the Southern Pennines, mainly in the Peak District National Park.[85] Fluorspar occurs mainly as vein infillings in faults that cut limestones of Carboniferous age. Production is mainly by open pit methods. The fluorspar ore is processed at the Cavendish Mill near Stoney Middleton to produce a high-purity acid-grade fluorspar (>97% CaF_2) product. Barytes, lead concentrates and limestone are by-products of the process. The Cavendish Mill is the only source of barytes in England.[86]

[79] BGS/ODPM Mineral Planning Factsheet 'Building and Roofing Stone', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

[80] Oolitic limestone is a carbonate rock made up mostly of ooliths, which are sand-sized carbonate particles that have concentric rings of calcium carbonate. These rings are formed around grains of sand or shell fragments that were rolled around on the shallow sea floor, gathering layer after layer of limestone. Shelly limestone consists of a large number of fossils held together mainly in a calcite cement.

[81] BGS/ODPM Mineral Planning Factsheet 'Brick Clay', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

[82] BGS/ODPM Mineral Planning Factsheet 'Fireclay', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

[83] Source: National Stone Centre. In detail, this represents about a quarter of the UK materials for agriculture, 90% for specialist fillers (e.g. used in plastics, paper, paints, sealants), 100% for glass making and a substantial proportion (probably over 80%) of limestone utilised in the production of chemicals.The latter includes over a million tonnes annually destined for plants in Cheshire, the main one being the only works in the UK producing soda ash (sodium carbonate), the main alkali feedstock for the chemical industry.

[84] BGS/ODPM Mineral Planning Factsheet 'Gypsum', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

[85] BGS/ODPM Mineral Planning Factsheet 'Fluorspar', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

[86] BGS/ODPM Mineral Planning Factsheet 'Construction Aggregates', available for download at http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html

10. Biodiversity, landscape, cultural heritage and agriculture

10.1 Biodiversity

Levels of biodiversity have decreased as a result of the intensification of agriculture and changes in land use. Biodiversity has declined faster in the East Midlands than in any other region in England. In particular:

- The region has the second lowest proportion of its land area designated as Sites of Special Scientific Interest (SSSIs)[87] in England. In March 2006 just under 40% of the total area of SSSIs in the region was classified as 'unfavourable declining', 'unfavourable – no change', 'part destroyed' or 'destroyed'. This represents an improvement since 2002, when just over half of SSSIs in the region fell into these categories. The figures are influenced by the condition of the relatively large SSSI in the Uplands of the Peak District and the Wash. The conditions of lowland SSSIs are significantly better and closer to the national average.[88] Overall the region has made progress during the last two years and is approaching the national average condition;

- Over the last century on average one plant species became extinct every year in each county within the region, and 70% of scarce plant species have become extinct since 1970 in Leicestershire, Northamptonshire and Nottinghamshire;

- There has been a significant decline in the number of farmland, woodland and wetland birds in the region since 2001,[89] though numbers have fluctuated quite markedly since the mid-1990s, as Chart 20 shows.[90]

The chart also demonstrates that:

- Bird populations have tended to decline from their 1994 levels in the South East and South West, but have increased significantly in northern regions;

- The widest fluctuations in bird populations have been seen in the East Midlands, although they have generally remained above their 1994 levels, except in 1997 and 1998.

> The East Midlands has the poorest biodiversity in the country, but is showing signs of improvement

[87] SSSIs are the country's very best wildlife and geological sites. There are over 4,000 in England, covering around 7% of the country's land area. SSSIs are important because they support plants and animals that find it more difficult to survive in the wider countryside. SSSIs need active management to maintain their conservation interest.

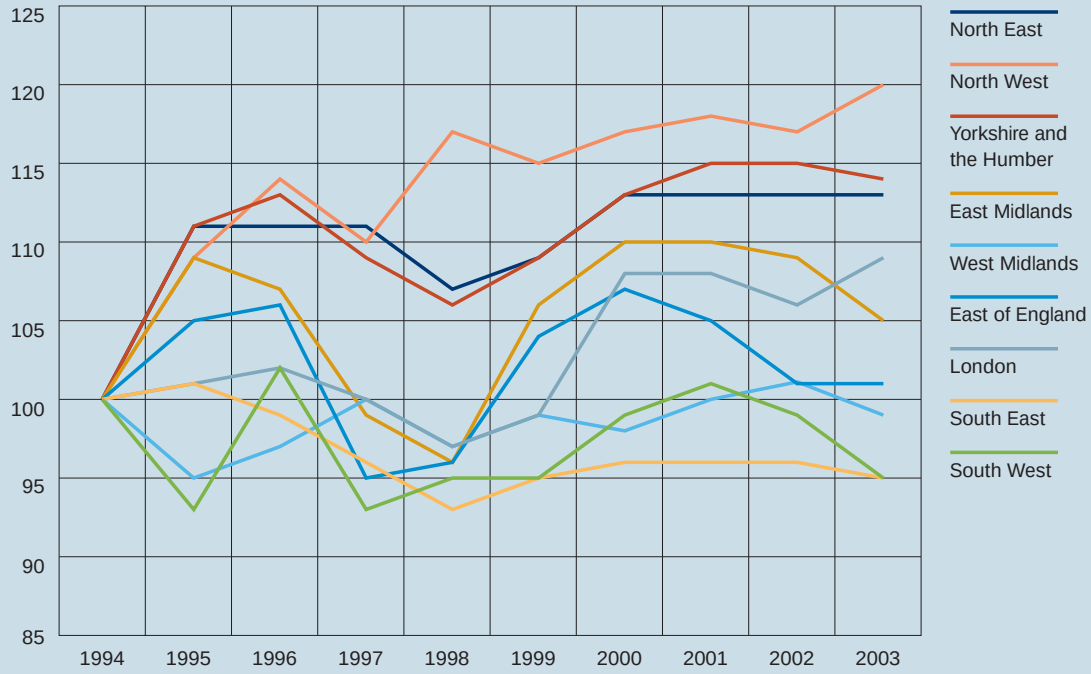
[88] English Nature, *The Condition of Sites of Special Scientific Interest in the East Midlands Region*, March 2006.

[89] Halcrow, *SEA Baseline Collection for East Midlands Regional Economic Strategy Sustainability Appraisal and Strategic Environmental Assessment,* August 2005.

[90] Data on biodiversity is relatively limited, so this chart simply represents one indicator of changes in biodiversity.

CHART 20

Population indices for all bird species, 1994-2003 (1994=100)



Source: Defra Sustainable Development Indicators (December 2005), RSPB, British Trust for Ornithology

There are continuing threats to biodiversity in the East Midlands from intensive farming practices and development pressures but also from climate change. Climate change is believed to have a direct effect on the following habitats which are important to different parts of the East Midlands:[91]

- Blanket bog;[92]
- Lowland wood pasture and parkland;
- Salt marsh;[93]
- Lowland hay meadows.

The region's geological assets offer a greater geodiversity than most other regions, and many geological and geomorphological sites have been designated as SSSIs. The range of interest also attracts geologically based tourism.

10.2 Landscape

The region contains the Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB) and the Peak District National Park. Progress is being made on the County Historic Landscape Characterisation, with Derbyshire, Northamptonshire and Nottinghamshire completed and Leicestershire underway.[94] However, the total area of nationally designated landscapes in the East Midlands is the lowest of all English regions (See Chart 21).

The chart also indicates that:

- By far the largest areas of land designated as AONBs are in the South West and South East;
- The regions with the largest areas of national parkland are Yorkshire & the Humber (incorporating the Dales National Park) and the North West (covering part of the Peak District).

[91] English Nature, *The Effects of Climate Change and Biodiversity Report*, 2005.

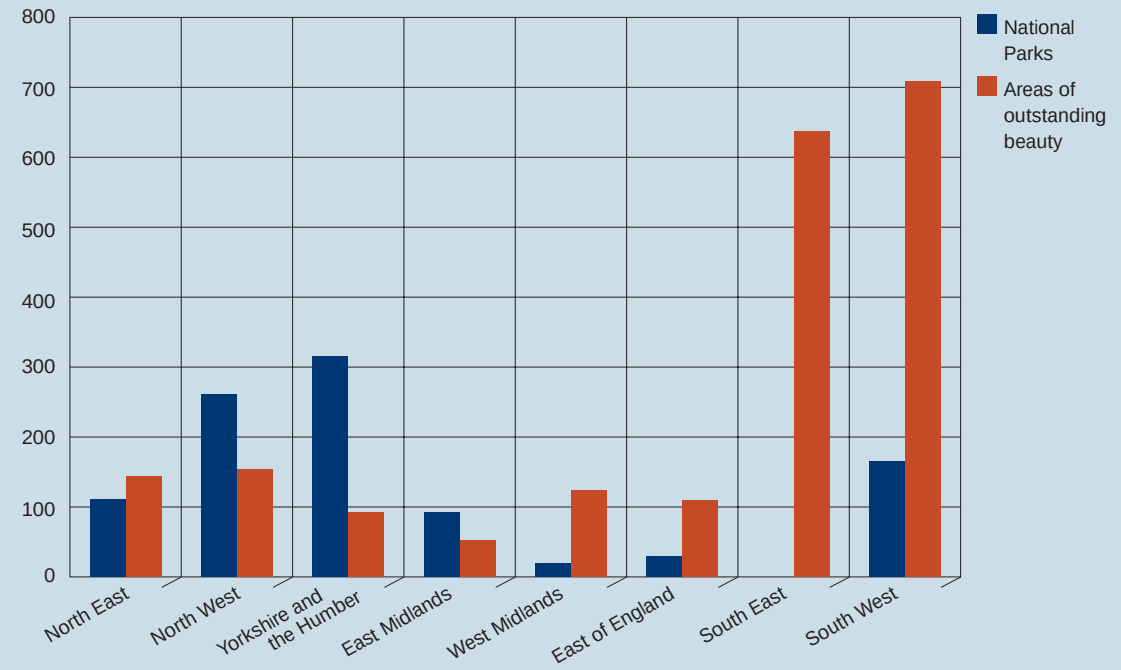
[92] Blanket bog is a peatland habitat confined to cool, wet, typically oceanic climates. It is one of the most extensive semi-natural habitats in the UK, ranging from Devon in the south to Shetland in the north.

[93] Salt marsh is a wetland with vegetation tolerant to seawater. Marshes develop in relatively sheltered locations: in estuaries, in saline lagoons, behind barrier islands, at the heads of sea lochs, and on beach plains. The marshes are formed by the deposition of mud around salt tolerant vegetation as the tides come in and out.

[94] The County Historic Landscape Characterisation is a national programme developed and funded by English Heritage. It involves a systematic examination and assessment of the modern landscape of each county, in order to infer the historic processes that have formed the landscape as it is seen today.

CHART 21

Area covered by national parks and areas of outstanding beauty, by region, estimated at March 2004 (thousand hectares)



Source: Defra Sustainable Development Indicators (December 2005)

Eight out of the 23 designated Countryside Character areas[95] in the East Midlands have seen marked changes that are inconsistent with underlying landscape character. Another 10 have seen some changes inconsistent with character. Only 5 of the 23 areas within the region are considered to have had the character of their landscape enhanced during the period 1990-1998.[96] Overall the East Midlands has experienced a decline in the quality of its landscape.

10.2.1 Light pollution

The use of artificial lighting along roads and within settlements has contributed to the 24% increase in the level of light pollution across the UK since 1993. The trend in the East Midlands has been worse, with light pollution having increased by some 30% between 1993 and 2000.[97] Only 2% of the East Midlands has truly dark night skies: of the region's six counties, only Lincolnshire has any areas of truly dark skies.

[95] The Countryside Agency has divided each English region into Countryside Character areas. The features that define the landscape of each area are recorded in individual descriptions which explain what makes one area different from another, and show how that character has arisen and how it is changing.

[96] Countryside Agency, *The State of the Countryside in the East Midlands Region in 2004,* February 2005.

[97] Campaign for the Protection of Rural England, *Night Blight in the East Midlands,* August 2003.

10.2.2 Tranquil areas

Tranquil areas are places which are considered sufficiently far away from the visual or noise intrusion of disturbing factors such as roads, railways and built development to be considered unspoilt by them. Areas of tranquility in the East Midlands have followed the national trend of increasing erosion and fragmentation. Lincolnshire remains the most tranquil county in the region, and Nottinghamshire has experienced the greatest decline in tranquillity between the 1960s and 1990s.[98]

10.2.3 Rights of way and open access land

The region has an extensive network of statutory rights of way, including National Trails, such as the Trans Pennine Trail, which provide a well-used recreational resource. The Sustrans National Cycle Network is being developed through the region.

Open Country access land in the East Midlands has been mapped in three areas. Area 2 (Lower North West), which includes the Peak District National Park, provides for significant areas of open access land. Access in this area has already legally commenced. In Area 8, (Nottinghamshire and Lincolnshire) and Area 7 (all other parts of the East Midlands) access land is minimal.

10.2.4 Tourism

In 2002, domestic tourists made around eleven million trips to the region and it hosted about 825,000 foreign visitors, the majority of whom were likely to have travelled by private car.[99] The Peak District, especially, experiences high visitor numbers, placing heavy pressure on infrastructure and the natural environment. There is currently a lack of available data on levels of access to the countryside (and, in particular, the urban fringe) for people living in urban areas of the region, although data from 2000 indicates that the extent of signposting and ease of use of public rights of way is significantly below the national average. However, the Countryside and Rights of Way Act 2000 is leading to improvements.

> The East Midlands contains many nationally important historic sites, but these are often under threat from high recreational use

10.3 Cultural heritage and archaeology

Evidence suggests that whilst the East Midlands has a rich and diverse historic environment, it is often under-valued and under threat. A number of sites in the East Midlands offer testimony to the important industrial heritage of the region, including the Derwent Valley Mills World Heritage Site and the relics of past mineral working such as the Derbyshire lead rakes. The network of waterways is also an integral part of the region's industrial past, linking historic buildings and structures with the natural environment. The diverse character of the region's built environment reflects the history of the development of its settlements. Many buildings use locally-distinctive materials and building styles. Throughout the 20th century, local distinctiveness was increasingly eroded by the use of standardised designs and materials.

Some of the region's historic sites are subjected to high recreational use and also form part of its cultural assets, generating benefits for the economy from visitors. These sites include the historic parks of Clumber, Rufford, Chatsworth and Althorp. There are also important archaeological remains such as Creswell Crags, remnants of former hunting forests (such as Sherwood and Rockingham) and field systems such as medieval ridge and furrow and enclosure landscapes. Historic buildings include castles like Tattershall and Fotheringay, country houses such as Chatsworth and Boughton House and many other buildings spread across the region.

There are more than 1000 Conservation Areas in the East Midlands, with outstanding examples including the Cathedral City of Lincoln, Stamford and Buxton.[100] The East Midlands also contains 138 registered parks and gardens and 5 registered battlefields, including Bosworth Fields.

There are over 1,493 Scheduled Monuments and 29,600 listed buildings in the region (representing 7.8% of the national total).[101] Of the Grade I and II* listed buildings, 4.8% are classified as being 'at risk' – above the national average of 3.7%.[102] Thirty-five percent of scheduled monuments are also at risk (13% at high risk and 22% at medium risk). This means that they require urgent action to prevent deterioration, loss or damage.[103]

[98] Environment Agency, Countryside Agency, East Midlands Regional Local Government Association and Government Office for the East Midlands, *Viewpoints on the East Midlands Environment,* May 1999.

[99] Countryside Agency, *Leisure Day Visit Survey for England, Wales and Scotland,* 2003 *emda*, October 2005.

[100] Local authorities have the power to designate as a conservation area any area of 'special architectural or historic interest', whose character or appearance is worth protecting or enhancing. This 'specialness' is judged against local and regional criteria, rather than national importance as is the case with listed buildings.

[101] Scheduled monuments are deliberately created structures, features and remains which are of national importance and are given legal protection by being placed on a list, or 'schedule' by the Secretary of State for Culture, Media and Sport.

[102] English Heritage, *Heritage Counts: The State of the East Midland's Historic Environment*, 2005. This includes maps showing the density of Scheduled Monuments, Listed Buildings, Battlefields, and Parks and Gardens.

[103] English Heritage, *Scheduled Monuments at Risk: East Midlands Region,* February 2006.

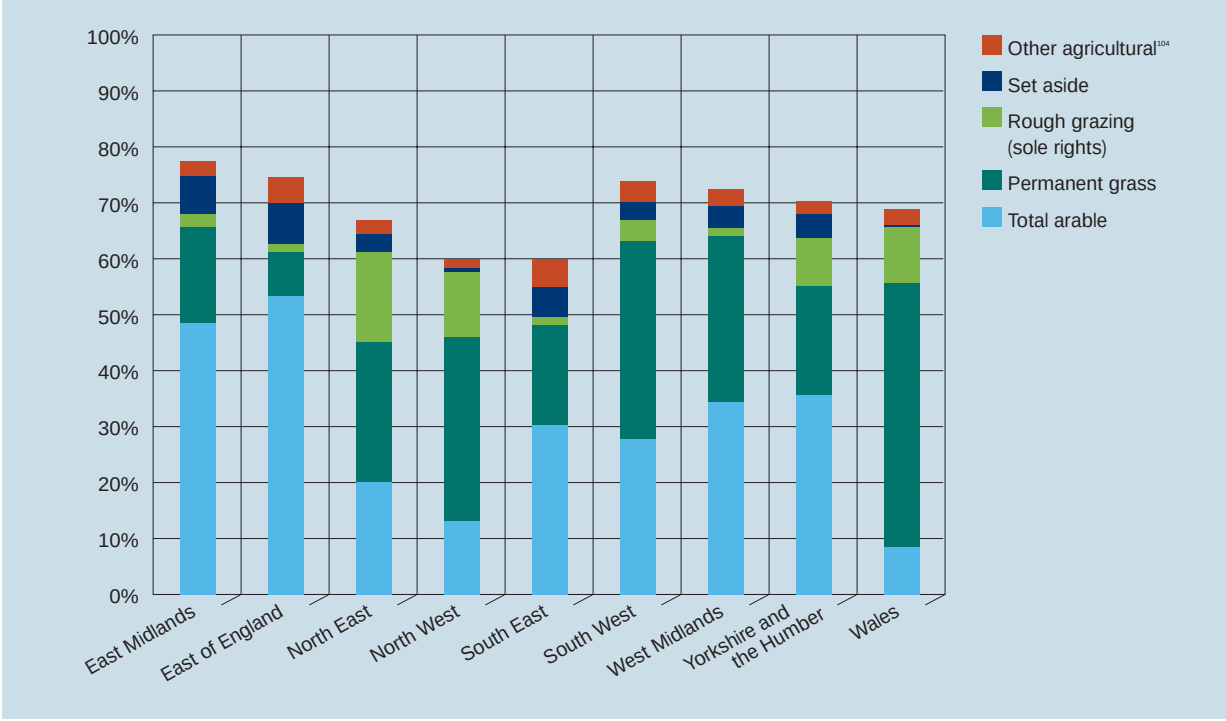
10.4 Agriculture and soil resource

The East Midlands is a very productive area for agriculture, containing a significant percentage of the total national resource of the best and most versatile agricultural land. The proportion of agricultural land in the East Midlands of the most versatile grades (Grades 1, 2 and 3a) is 47% compared to 39% across all of England. The region also has a significant percentage (34%) of the total national resource of Grade 1 land. This enables a wide range of crops to be grown, adding robustness to the local economy and helping to support a wide range of complementary and ancillary rural businesses and services. Over 1.2 million hectares of land are in agricultural use, employing over 40,000 people across some 20,000 farms in the region. As a result, arable farmland dominates the landscape, reflecting the national trend towards arable farming being more dominant in the east and permanent grassland dominating in the west. This is confirmed by Chart 22:

- The East Midlands has the second largest proportion of arable land of any English region (behind the East of England), representing almost half the total land area of the region;
- The largest proportions of land classified as permanent grassland are in Wales, the South West and the North West – 47.2%, 35.4% and 32.8% respectively of regional land area;
- Rough grazing land represents a very small proportion of total land area in most regions, with the exceptions of the North East, North West, Yorkshire and the Humber and Wales. This reflects the role of hill farming in these regions.

CHART 22

Land on agricultural holdings, 2003, English regions and Wales (% of regional area)



Source: Defra and National Assembly for Wales, 2005

[104] 'Other agricultural' includes woodland, land converted to recreational use or for non-agricultural uses, paths, roads, yards, buildings, ponds, etc.

Good quality soil is generally located in the east of the region. The fenlands along the eastern borders of the East Midlands are Britain's largest area of peat soils. Soil is a valuable resource within the region and is under pressure. In March 2005 the Environment Agency identified 74 contaminated land sites in the East Midlands. These sites are generally small with 59 having an area of less than 5 hectares.[105]

It is projected that 21,100 ha of land within the region is likely to change from rural to urban use to help accommodate the expected growth of 4.4 million new households that may potentially arise in England between 1991 and 2016.

10.5 Environmental asset density

Map 12 gives an indication of the density of environmental assets in the East Midlands.[106] Environmental and cultural assets can be anything that society places a value on. They are numerous and diverse, and not only valued by society for their landscape, biodiversity and heritage quality, but also their recreational, educational and tourism value. Planning and development must take these assets into consideration, but the large range and number of assets can make it difficult to gain a strategic overview of an area for planning purposes. The environmental asset density map is designed to help overcome this, by creating a single composite layer of a wide range of assets. Assets included in the Environmental Asset Density Map are as follows (but note that this includes only selected nationally designated sites, with listed buildings, for example, being excluded):

- Agricultural Land
- National Park
- Ancient Woodland
- Parks and Gardens of Historic Interest
- Areas of Outstanding Natural Beauty
- Ramsar Wetland Sites[107]
- Community Forests
- RSPB Important Bird Areas
- Doorstep Greens[108]
- RSPB Reserves
- Scheduled Ancient Monuments
- Local Nature Reserve
- Sites of Special Scientific Interest
- Millennium Greens[109]
- Special Areas of Conservation
- National Forest
- Special Protection Areas
- National Nature Reserve
- Woodland Trust Sites

Map 12 demonstrates that the areas with the largest number of assets are concentrated in the far North of Derbyshire and along the Lincolnshire coast.

> The largest concentrations of environmental assets are in the far North of Derbyshire and along the Lincolnshire coast

[105] Environment Agency, 2005.

[106] Environmental asset density mapping (which is also referred to as environmental sensitivity mapping) is a technique developed by the British Geological Survey to provide a strategic overview of the environmental and cultural assets in a region. See 'Strategic environmental assessment and future aggregates extraction in the East Midlands region', *BGS Commissioned Report CR/04/003N,* available for download at **http://www.bgs.ac.uk/mineralsuk/free_downloads/home.html** The darker colours on Map 12 indicate a higher number of environmental and cultural assets in an area. The map was created in a Geographical Information System (GIS) using a one-hectare grid to generalise the original data and enable analysis in the GIS. A listing of the environmental and cultural assets used to create this map can be accessed online at **http://www.bgs.ac.uk/mineralsuk/environment/envsens/assets.html**

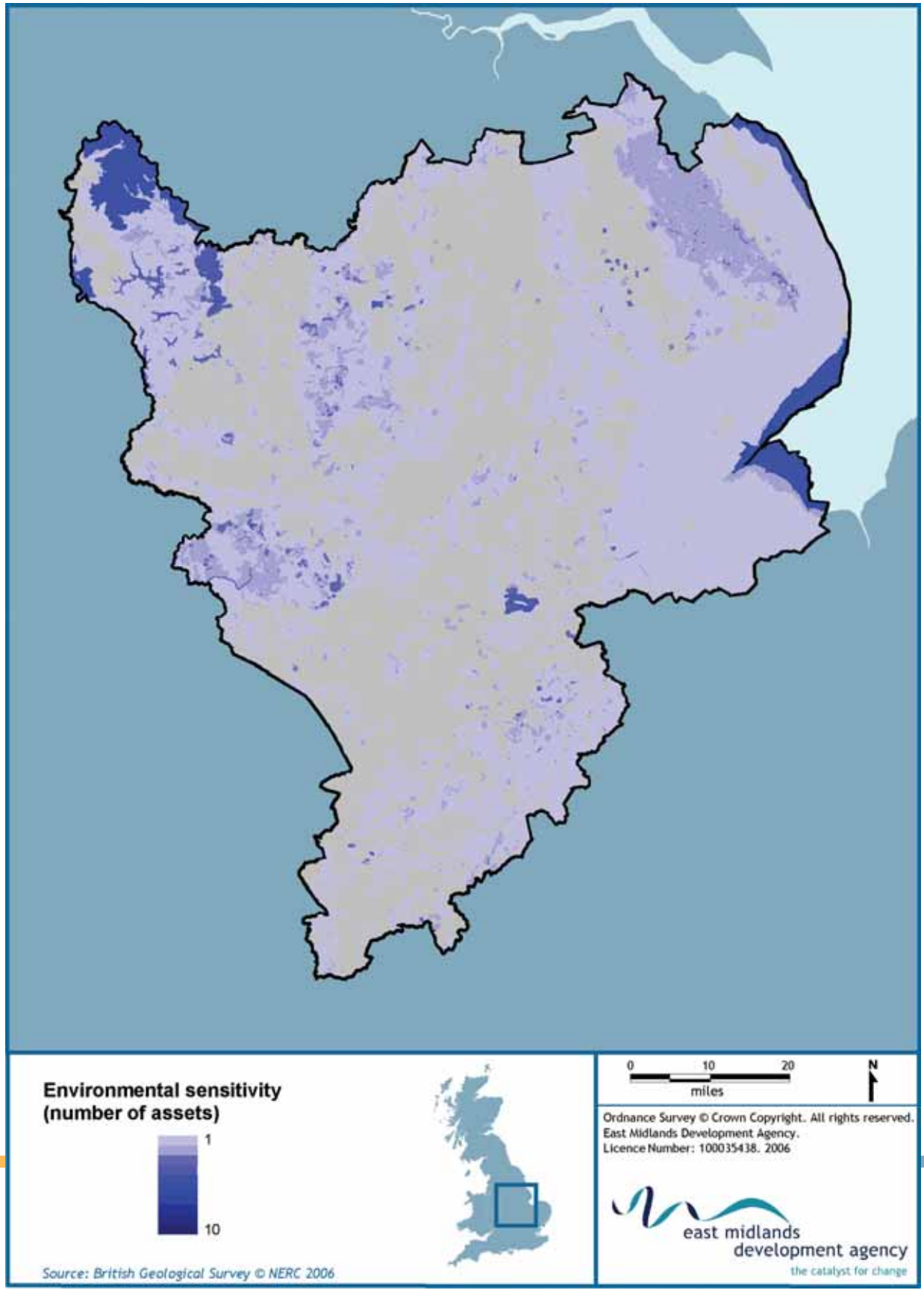
[107] Ramsar wetland sites are wetlands of international importance designated under the Ramsar Convention which came into effect in 1975.

[108] Doorstep Greens is a scheme organised by the Countryside Agency to help 200 disadvantaged communities improve their quality of life by creating or enhancing green spaces near to people's homes.

[109] Millennium Greens was an initiative begun in 1996 by the Countryside Agency to provide new areas of public open space close to people's homes. 245 had been created by December 2001 – all of which were developed by local people who had drawn up the plans, purchased the land and carried out the necessary work.

MAP 12

Environmental asset density of the East Midlands region



Summary

1. Introduction

This section of the evidence base focuses on some of the relationships that exist between economic development and the environment, looking at the way the environment is both affected by and affects economic growth and society. A substantial part of the evidence is based on data collated to inform the Strategic Environmental Assessment and Sustainability Appraisal of the RES.

2. Economic growth and environmental impact

The environment acts as a source of inputs for economic activity (raw materials and fuels for example), and a sink for some of the outputs (waste, air emissions and so on). Environmental hazards such as flooding can constrain economic growth in some areas, while the environment also provides amenities that contribute to individuals' quality of life.

3. Climate change

It is now without doubt that average global atmospheric and sea surface temperatures are rising. Average annual temperatures in central England have risen by almost 1°C over the last 100 years, with the three warmest years on record all occurring since 1998. Greenhouse gas emissions, a major contributor to climate change, have reduced since 1993 in a number of Western European countries, including the UK. Despite this, forecasts from Defra indicate that annual temperatures averaged across the UK may rise by between 2 and 3.5°C by the 2080s, with winters becoming wetter and summers drier, while sea levels around the UK will continue to rise. Climate change will have wide-ranging impacts, both on the natural environment and on economic and social activity. Adaptation to cope with more frequent weather extremes and to plan for the longer-term changes needs to begin now.

4. Greenhouse gas emissions

Changes to the climate in the East Midlands are expected to be amongst the most substantial in England. Daily average temperatures are projected to rise by up to 5°C by the 2080s, while summer rainfall could decrease by up to 60% in the south of the region with winter rainfall increasing by up to 30%. These changes could result in more flooding within the region, much of which is already low-lying. Crop production is also likely to be affected by warmer temperatures.

Greenhouse gas emissions in the East Midlands fell between 1990 and 1999, linked to the introduction of more efficient electricity generation processes. Fuel and Power Production contributes up to 80% of emissions in the region, while the second largest source of greenhouse gases is the minerals industry. Since 1998, emissions have exhibited little change, reflecting the continued demand for electrical power.

Carbon dioxide emissions in the East Midlands exceed the English average, and indeed the region has some of the largest point sources of CO_2 emissions in the UK.

5. Air quality and pollution incidents

Air quality in the East Midlands is generally better than the national average, although less good along main road routes. The level of road traffic within the region has increased by 1.2 billion vehicle kilometres since 2001 and has grown more quickly than in any other English region during the last 10 years.

Total emissions of PM10s and sulphur oxides have fallen substantially since 1998, driven by reductions in emissions from the Fuel and Power Production and Associated Processes sector. Emissions of nitrogen oxides have tended to fluctuate since 1998, reflecting the fact that these emissions are much more difficult to control with technological improvements.

In 2003, 99 'major' or 'significant' pollution incidents took place in the East Midlands. The largest proportions where the source could be identified were from the waste management industry, general industry and water industry (sewage treatment). There were 433 confirmed pollution incidents affecting air in 2003, a reduction of almost 20% since 2002.

6. Energy

The majority of energy in the East Midlands is generated from fossil fuels. The region includes the Notts-Derby and Leicestershire Coalfields, which generate between a third and a quarter of national production. A number of so-called 'clean coal extraction technologies' exist to derive energy from coal without mining it, several of which are used in the region. The East Midlands coal-fired power stations account for 10-15% of UK generating capacity.

The East Midlands remains an important region for UK onshore oil production and also contains Britain's largest onshore gas field – the Saltfleetby Gas Field.

The region has seen a small increase in the generation of electricity from renewable sources in recent years but does not generate as much as other regions. Potential renewable energy projects include wind farms, biofuel production and ground source heat pumps.

7. Waste

The total waste arisings in the East Midlands were 20.4 million tonnes in 2002-3, 10.8% of the total for England. Forty-eight percent of this waste was produced by construction and demolition, 40% came from industry and commerce and 12% from municipal and household sources. The amount of waste deposited in landfill in the East Midlands is slightly higher than the average for all English regions, but the proportion of all waste which is recycled – 43% – is the same as in England as a whole. Approximately 40% of construction and demolition waste is recycled for use as aggregates, with pulverised fuel ash and furnace bottom ash produced by coal-fired power stations also being used for aggregates.

8. Water

Currently over 1,150 million litres of water per day (Ml/d) are abstracted for public water supplies in the East Midlands, 350 Ml/d for industrial uses and 90 Ml/d for spray irrigation. Population growth could lead to a 40% increase in demand for abstraction by 2025.

The percentage of rivers of good biological and chemical quality increased significantly in the East Midlands between 1990 and 2004, but the quality of river water in the region remained below the average for England.

Approximately 17% of the land area in the East Midlands is at risk of flooding, affecting over 350,000 people in 143,000 homes and significant numbers of businesses. Increased flooding as a result of climate change is a particular threat in the East Midlands since 20% of the region is low-lying and protected by drainage and flood defences, and over half of the best and most versatile agricultural land is situated less than five metres above sea level.

9. Geology and mineral resources

The geology of the East Midlands, in terms of the geological periods represented, is arguably without parallel elsewhere in southern Britain. The region's mineral wealth is a reflection of the diversity of the bedrocks, while the superficial geological deposits of sand and gravel are also of significant economic importance to the region.

Key 'geohazards' in the region include clays with shrinking and swelling properties, emission of radon gas, and landslides (particularly in the Pennines). The East Midlands contains some of the largest fault systems in England, with small to moderate earthquakes occurring every few years.

The East Midlands is the largest aggregates producer and exporter in the UK, reflecting its central location and the ready availability of suitable hard rocks in the region. Crushed rock, and to a lesser extent sand and gravel, is exported in large quantities to other regions, especially the South East, North West, West Midlands and East of England. The region is also a major national producer of limestone, sandstone, bricks, fireclay, gypsum, fluorspar and cement for the construction industry.

10. Biodiversity, landscape, cultural heritage and agriculture

Biodiversity has declined faster in the East Midlands than in any other English region, and continues to be threatened by intensive farming practices and climate change. A comparatively low proportion of the region's land area is designated as SSSIs, although the condition of these sites is improving. Over the last century one plant species became extinct every year in each county, and since 2001 there has been a decline in the number of birds in the region.

The total land area designated as national park or AONB in the East Midlands is the lowest of all English regions. Within the region, the highest concentrations of environmental and cultural assets are in the Peak District and along the Lincolnshire coast. The overall quality of the East Midlands landscape has declined in recent years, with a significant increase in light pollution and decline in areas of tranquillity.

The East Midlands has a rich and diverse historic environment, including former industrial sites such as the Derwent Valley Mills World Heritage Site, country houses, historic parks, and archaeological remains like Creswell Crags. There are over 1,500 Scheduled Ancient Monuments and almost 30,000 listed buildings in the region. However, this important heritage is often under-valued and under threat.

The East Midlands is a very productive area for agriculture, containing a significant percentage of the total national resource of the best and most versatile agricultural land. Over 1.2 million hectares of land are in agricultural use, employing over 40,000 people and supporting a range of ancillary rural businesses. However, it is projected that 21,100 ha of land within the region will change from rural to urban use to help accommodate the anticipated 4.4 million new households in England by 2016.