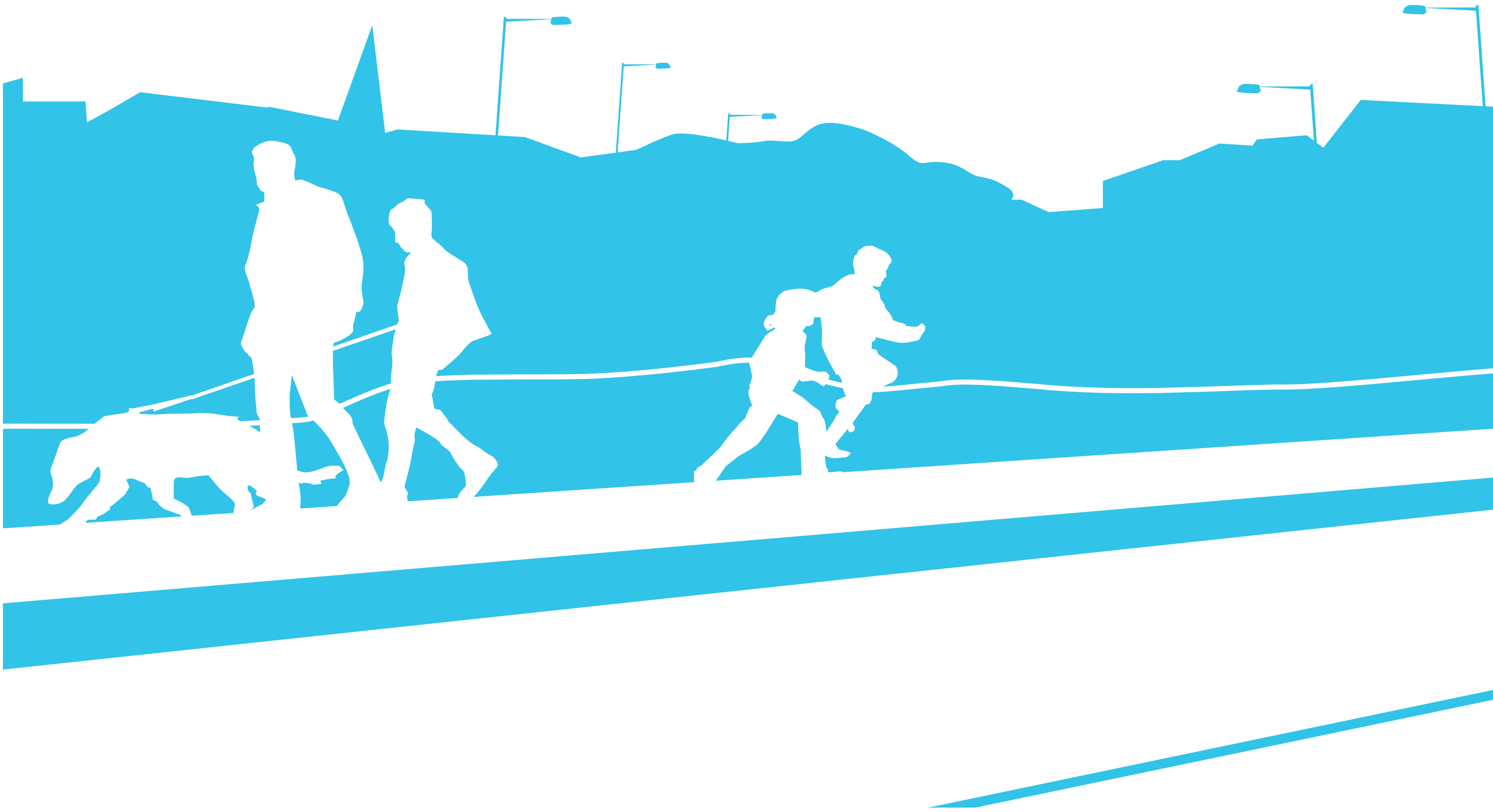
Environment Agency

working towards a better quality of life



Environmental Justice in South Yorkshire

August 2008

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

This report is the result of work commissioned and funded by the Environment Agency.

Published by:

Environment Agency, North East Region, Ridings Area, Phoenix House, Global Avenue, Leeds, West Yorkshire.

www.environment-agency.gov.uk

GENE0608BODZ-E-E

This report is printed on Cyclus Print, a 100% recycled stock, which is 100% post consumer waste and is totally chlorine free. Water used is treated and in most cases returned to source in better condition than removed.

Further copies of this report are available from:
The Environment Agency's National Customer Contact Centre by emailing enquiries@environment-agency.gov.uk or by telephoning 08708 506506.

Author(s):
Jon Fairburn, Graham Smith

Dissemination Status:
Publicly available

Keywords:
Justice, inequality, GIS, social deprivation, South Yorkshire

Research Contractor:
Jon Fairburn,
Institute for Environment and Sustainability Research,
Staffordshire University,
Stoke on Trent
ST4 2DE
Tel: 01782 294015
Email: jon.fairburn@staffs.ac.uk

Environment Agency's Project Manager:
Dr Bridget Butler, Principal Officer - Health
NE Regional Strategy Unit
Email: bridget.butler@environment.agency.gov.uk

Collaborator(s):
Peter Foulston – Principal Officer – Monitoring, Assessment & Reporting
NE Regional Strategy Unit
Email: peter.foulston@environment-agency.gov.uk

The digital version of this document has two main features to improve ease of use.

1. Bookmarks are fully enabled i.e. if you click on the bookmarks tab when open in Acrobat Reader you will see all the headings and sub headings in the document. By clicking on one these you will jump straight to that particular section.

2. The table of contents has also been enabled in the same way.

Executive Summary

Need and aims

This project (with its outputs) aims to provide a robust evidence base at the sub-regional level to enable the Environment Agency to deliver aspects of Creating a Better Place (the corporate strategy) that relate to Better Quality of Life issues. Specifically it details the level of environmental inequalities experienced by different groups in South Yorkshire. The outputs of the project could also be used to initiate a dialogue with local communities in South Yorkshire about the quality of their environment and therefore supports Defra's 'Improving Poor Environment programme'.

This work should also be of interest to local authorities, environmental organisations, regeneration agencies and the voluntary sector who are engaging with agendas of sustainable development, social inclusion, health and 'environmental justice'.

Populations in South Yorkshire were classified using the Index of Multiple Deprivation at the individual household level. The most deprived population is classified as those who live in the lowest ten per cent of areas nationally. Using a Geographical Information System the population living near to a range of environmental factors was analysed. Statistics on rural urban populations, clustering of sites and the multiple impact of different environmental factors are also included. **The outputs of the project allow South Yorkshire to be mapped for environmental inequalities at the most detailed level possible and as such hotspots or locations for area based interventions can be identified.**

Results

- The most deprived populations in South Yorkshire are two to three times more likely to be living near to a waste or landfill site than the rest of the population.
- The most deprived populations are most likely to be living next to multiple waste sites.
- The most deprived populations are most likely to be living near to non active landfill sites.
- The most deprived populations are most likely to be living near to a Pollution Inventory site (regulated by the Environment Agency) with emissions to air.
- Ambient air quality (Nitrogen dioxide and particulates PM10) is poorest in the most deprived areas.
- Populations in the most deprived areas are disproportionately represented in the areas with the very worst air quality.
- Of the population experiencing the very worst air quality in the most deprived areas at least 11,000 of them are children.
- The least deprived populations are two to three times more likely to be living near to a Local Nature Reserve than the rest of the population.
- The most deprived populations are the least likely to be living near to woodlands.

- More deprived communities in general appear more likely to be situated on a floodplain, but the evidence base is weak in this particular part of the study.

Two separate methodologies (using nine different measures) were used to assess multiple potential impacts in South Yorkshire. Both methodologies indicate that it is the most deprived populations experiencing the largest amount of multiple potential impacts.

This analysis primarily deals with proximity to waste and other sites (the exceptions are ambient air quality and flooding). Proximity to such sites has been shown in other studies to have economic impacts such as lower house prices (Cambridge Econometrics et al 2003) and may even deter investment in such areas. We do not clearly understand the relationship between proximity and causality in terms of potential health impacts of such sites on people living nearby, although it is an area of vigorous research, debate and argument (Defra 2004).

Conclusions and recommendations

The report repeatedly finds that it is the most deprived areas (i.e. areas in the bottom ten per cent nationally as classified by the Index of Deprivation) in particular which experience a disproportionate share of poor environments in South Yorkshire.

Suitable fora for progressing environmental justice on a regional basis include the North East Environment Forum (NEEF), the Way Forward Group, North East European Regional Development Fund Management Group, and the North East Sustainability and Environment Steering Group. The importance of environmental justice is illustrated by the inter-relatedness of the environment, economy and health of places as recognised by the UK Governments Sustainable Development Strategy (Defra, 2005) which states

'…inheritance of degraded resources has led to social and economic deprivation, as well as a poorer environment and ill health. Improving the local environment is therefore often a starting point for wider regeneration activities.'

Development of a policy is needed to address procedural aspects of environmental justice arising out of studies demonstrating inequalities in the distribution of environmental quality. For example, changes in regulations and procedures for siting of facilities should be considered if the aim is to reduce the level of environmental inequalities within the population. Such changes would need to be addressed through the planning system, possibly through the use of regional spatial strategies.

A series of data and research recommendations are made to aid the Environment Agency in delivering the environmental justice agenda.

Contents

List of Tables

List of Figures

1 The Research Project

1.1 Background and context

Social deprivation has long been an area of study in the UK identifying which groups of people lack money, opportunities or resources compared with the general population. Similarly there has been interest in environmental quality and particularly in poor environments. These two strands have come together under the heading of environmental justice which had examines which groups experience poor environments. There has been considerable interest in environmental justice from a range of government departments and agencies in the last five years. It has appeared in a range of Government Sustainable Development Strategies (Defra2004 & 2005), Sustainable Development Commission work and Social Exclusion Unit publications as well as a host of other government agencies, quangos and NGOs. Such interest is unsurprising as there are a range of agendas converging and overlapping within public policy. These include:

- Regeneration (and social exclusion)
- Health especially the Wanless report (2004) and its call to move more towards preventative actions to improve health. These recommendations were immediately taken up in the White Paper Choosing Health (2004).
- Environmental justice
- Sustainable development
- Well being

The convergence in agendas is illustrated in the UK Governments Sustainable Development Strategy (Defra, 2005 pg 110) which states

'…inheritance of degraded resources has led to social and economic deprivation, as well as a poorer environment and ill health. Improving the local environment is therefore often a starting point for wider regeneration activities.'

The Scottish Executive has been particularly active in promoting the concept of environmental justice and this has influenced the strategies of organisations such as Scottish Natural Heritage, Communities Scotland, Forestry Commission Scotland and the Scottish Environmental Protection Agency (Fairburn et al 2005).

OECD (2006) published a policy brief on the social dimension of environmental policy and in particular it identified the "need to know whether environmental policies affect households differently according to how well off they are,…". Furthermore it suggested that perceived differences in effect can be a significant political barrier to introducing environmental policies and that assessing such links are a precondition for implementing environmental policy in OECD countries. The EU has been a significant driver in this area through the 1998 Aarhus convention on the environment, and associated principles of access to environmental information, public participation in decisions and access to environmental justice.

The Environment Agency has been active in addressing the issue of environmental inequalities amongst the population since 1999 (Chalmers 2005) and has used research to develop an evidenced based policy to address these issues. For example, Walker et al (2003b, R & D technical Report E2-067/1/PR2) examined all of England and Wales for flooding, air pollution and industrial pollution using similar methods as in this study. This national study found large inequalities across the population with the most deprived more likely to experience poor air pollution, more likely to be situated near to an Integrated Pollution Control site and more likely to be living on a tidal floodplain. Walker et al (2003a) provides a thorough review of the international and UK literature, and details many of the methodological issues involved in this type of work. This national work aimed to inform the Environment Agency approach in addressing environmental inequalities and the wider debate on environmental justice, regeneration and social inclusion. The Environment Agency then published a series of position statements on these issues including Addressing Environmental Inequalities (Environment Agency 2004a), Environment and Health (Environment Agency 2004b), Local Environmental Quality and Liveability (Environment Agency 2004c) and Air Quality (Environment Agency 2005).

These issues now form a fundamental part of the Better Quality of Life theme of 'Creating a Better Place' (the Environment Agency Corporate Vision and Strategy which runs from 2006 until 2011) and will be embedded into how the Environment Agency implements the Corporate Strategy at the local level. Several recommendations were made as a result of the national project (E2-067/1/PR2), which have direct relevance to the Corporate Strategy and local implementation. At the local level the Agency needs to:

- further understand the nature and significance of the social distribution of pollution and risk
- identify critical 'pollution-poverty' hot spots so as to identify those communities most in need of remedial action
- undertake further research examining additional environmental and social indicators, causal relationships and the effectiveness of potential intervention strategies

Key themes under our Corporate Strategy that influence how we will manage environmental and social inequalities include:

1. "A better quality of life for people" a key priority is to "Help to improve local environments, particularly in disadvantaged areas" (pg 8). Furthermore this section specifically mentions the close links between environment and people's physical and mental health.

2. "Cleaner air for everyone" (pg 15) recognising that nationally, deprived areas suffer poor air quality. A key priority is to "Minimise the impact of poor air quality on people's health, by advising on air quality issues that we do not regulate."

3. "Reducing flood risk" (pg 41)

4. "A greener business world (pg 27) and "wiser sustainable use of natural resources" (pg32).

It is also worth considering the five roles identified by the Environment Agency in the Corporate Strategy and how this work links to them. The five roles are:

1. *Efficient operator* - this study and its outputs (see Appendix 1) identifies hotspots of pollution which will allow the Environment Agency to more effectively target particular local areas.

2. *A modern regulator* – this study has highlighted several areas of data management that could be improved by the Environment Agency and has provided recommendations concerning collection and use of such data.

3. *An influential advisor* – this study provides as evidence base that will be of interest to partner organisations in the South Yorkshire area and will provide an initial starting point for the discussion of the impact of the environment on the people who live there i.e. environmental justice in the South Yorkshire. Furthermore it provides a methodology which would allow the monitoring of change over time so that action plans could be evaluated.

4. *An active communicator* – Outputs from this project could for example be used in community consultation as recommended in our 'Building Trust in Communities' programme.

5. *Champion of the environment* (in the context of sustainable development). Environmental justice is a rapidly developing body of work intimately linked to sustainable development.

The distribution of environmental factors amongst the general population is important due to impacts on health, social and economic spheres of the population. The link between the environment and health is the one most often raised in the environmental justice field although this is often the area most difficult to investigate and provide definitive proof for. The Department of Health 'Choosing Health' White Paper (2004) recognises the importance of this the link between health and the environment and makes a commitment to 'address environmental inequalities that can undermine those choices'.

Barton & Grant (2006) provide a very useful model 'The Health Map' to examine the links between the environment, health and other factors (see Figure 1.1). Importantly it recognises the role of individuals, lifestyle, community and the natural and built environment which can affect health and well being.

The link between environmental quality and its impact on economic factors is often more conclusive with hedonic modelling often being used to examine the impact of particular factors on house prices in the surrounding area.

England, Scotland and Wales all now use their own version of an Indices of Deprivation (IMD) to allocate resources and target policy on deprived areas in an attempt to reduce inequalities amongst the population. Details of the IMD for England and how it is used in this project is provided in section 2.1.2. However it is not the only socio-economic datasets that has been used within environmental justice, census data and other sources have also been used.

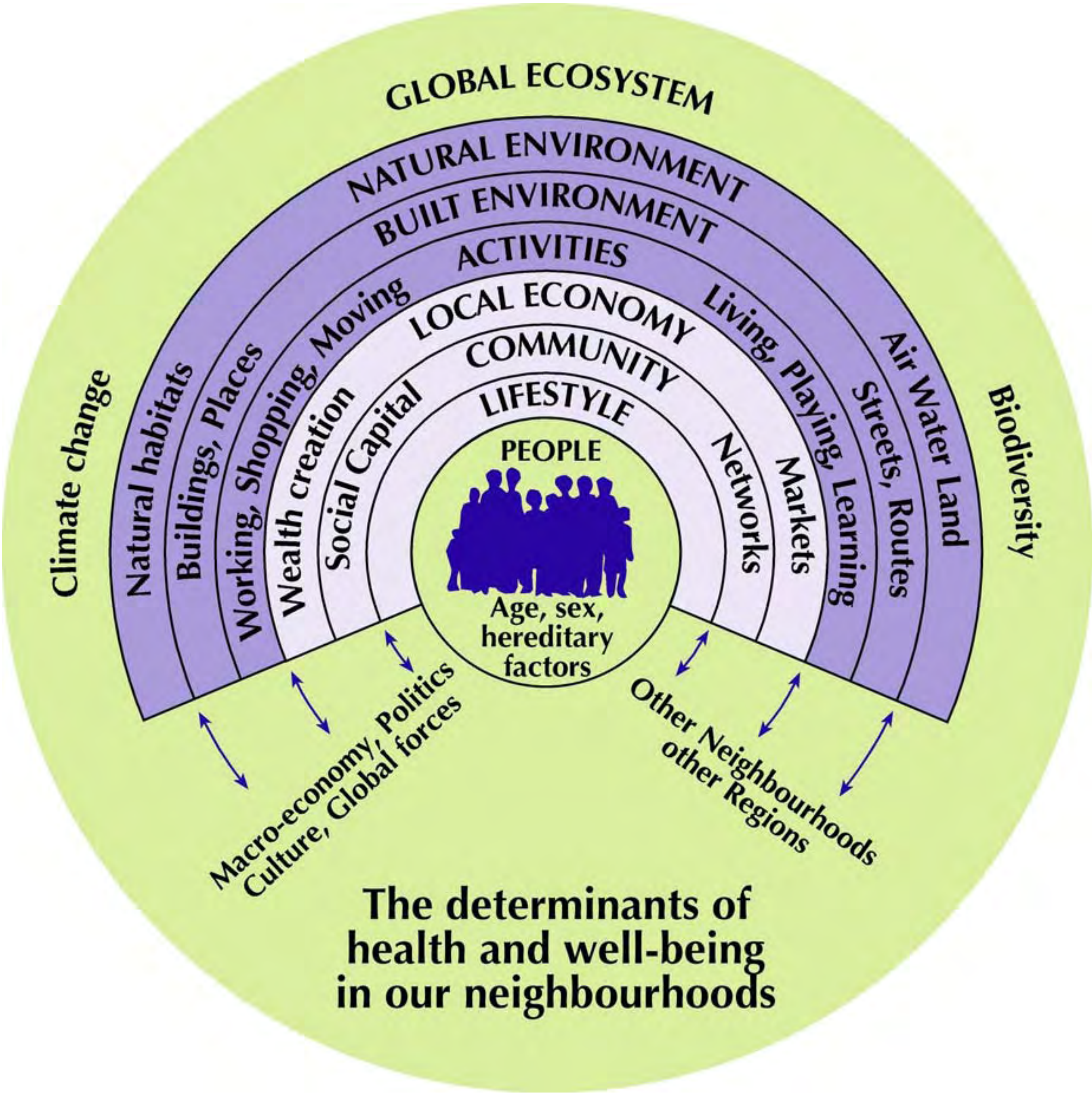


Figure 1.1 The Health Map (Barton and Grant 2006)

This Index of Multiple Deprivation is being used to investigate the issue of distributive environmental justice within South Yorkshire, which should then go onto inform the development of policy to support procedural environmental justice. Environmental justice consists of two main strands:

a). *'Distributive justice'* is the idea that no social group should be have to live in polluted areas more than any other group (disadvantaged disproportionately with negative environmental impacts). Distributive justice is also concerned with all social groups having equitable access to woodlands and green spaces (positive environments).
b). *'Procedural justice'* is a concern that all communities should have access to the information and mechanisms to allow them to participate fully in decisions affecting their environment.

1.1.1 Recent reviews of environmental justice

This section provides a brief introduction to some of the reviews of environmental justice work over the last few years. We are not aiming to produce a comprehensive account of the literature instead we highlight some of the major studies which are relevant to this project and put the work in context.

Walker et al (2003a) provides a thorough review of the international and UK literature mainly concerning distributive/proximity studies, and details many of the methodological issues involved in this type of work.

Lucas et al (2004) expanded the numbers of areas considered to include procedural aspects of environmental justice such as access to a range of services and facilities as well as planning and infrastructure issues.

Agyeman and Evans (2004) discuss the emergence of the environmental justice theme in the UK and the role played by academics and campaign groups. They link the concerns with environmental justice to sustainable development calling for a 'just sustainability' encompassing equity, justice, governance and democracy.

The two main themes of distributive and procedural justice are illustrated by two studies covering Scotland. Fairburn et al (2005) examined distributive justice for industrial pollution, derelict land, landfills, quarries, woodlands, river water quality and air quality. Poustie (2004) examined procedural justice issues such as the legal aspects, regulation, planning and enforcement for the environment.

The Health Protection Agency (2005) investigated the distribution of disease which could be attributed to environmental pollution and the impact of environmental inequalities. It states 'global estimates conservatively attribute about 8-9 percent of the total burden of disease to pollution.' (Health Protection Agency, 2005, pg1)

Huby et al (2005) have produced a comprehensive dataset for rural England and Wales which could be utilised in environmental justice studies. Little attention has been paid so far to environmental justice in rural settings.

1.2 Aims and objectives

This project aims to support the Ridings Area in implementing Creating a Better Place at the local level by providing an evidence-base for the relationship between social deprivation and environmental quality. This will ensure that the decisions made are robust and based on relevant evidence.

The overall objective of this project was to improve the understanding of the relationship between environmental quality and social deprivation – often referred to as 'environmental justice' in the South Yorkshire.

Specific objectives were to:

1). Provide a rapid review of suitability and availability of datasets for use from the Environment Agency, Local Authorities and Third Parties.

2). Assess the suitability of different types of analysis including options for rural/urban differentiation.

3). Provide a description and analysis of the social distribution of the environmental factors identified as a result of the rapid review. The following were key indicators for the Environment Agency: air quality, flood risk, proximity to IPPC sites, proximity to waste management sites.

4). Identify hot spots of poor environmental quality across South Yorkshire.

5). Identify additional environmental and social data sets that could be used to address issues of environmental justice e.g. green space designations and pilot an analysis in a subset of the study area using such additional environmental and social data sets.

6). Make appropriate recommendations for further work, especially in the area of data collection.

The results of this work may be used to aid the Environment Agency in delivering the corporate strategy and in particular help it to develop policy that meets procedural justice for environmental quality. This work is preliminary in nature and more sophisticated techniques may be developed to aid environmental justice in the future. Furthermore, this work has only examined the issue of social deprivation where as other variables such as age, gender or ethnicity could also be researched to examine how environmental justice impacts differentially within South Yorkshire.

2 Methods of data analysis

2.1 Socio-economic data

To examine the links between social deprivation and environmental factors we need to classify the population according to some socio-economic classification. In recent years the most authoritative and widely used dataset for classifying areas in terms of deprivation has been the Indices of Multiple Deprivation (2004) (section 2.1.2) at the level of Super Output Area.

2.1.1 Super Output Areas

Super Output Areas are available at three levels and this work used the Lower Level Super Output Area defined by the Office of National Statistics (ONS) as:

"Minimum population 1000; mean 1500. Built from groups of Output Areas (typically 4 to 6) and constrained by the boundaries of the Standard Table (ST) wards used for 2001 Census outputs." (ONS 2005)

This provides a detailed, consistent unit to use in the analysis and it was the unit of analysis used to create the Indices of Multiple Deprivation. Characteristics of Super Output Areas in South Yorkshire are provided in Table 2.1. This illustrates that 70 percent of the population occurs in just 17 percent of the land area.

Table 2.1 Characteristics of Super Output Areas in South Yorkshire

Size of Super Output Areas (hectares)	Total number Super Output Areas	Total Area (hectares)	Percentage of South Yorkshire Area	Total Population	Percentage of South Yorkshire Population
Less Than 50	411	13,083	8.43	615,770	48.67
50 to 100	185	12,983	8.37	278,330	22.00
100 to 500	202	41,881	26.98	302,070	23.88
500 to 1000	17	11,657	7.51	25,220	1.99
1000 to 3000	25	45,332	29.21	36,300	2.87
More Than 3000	5	30,270	19.50	7,480	0.59
South Yorkshire	845	155,205	100	1,265,170	100

2.1.2 Index of Multiple Deprivation (2004)

The Indices of Multiple Deprivation 2004 (IMD 2004) are based on Lower Level Super Output Area (SOA) data. There are 32,482 Super Output Areas in England, which is a geographical base covering between 1000-3000 people.

The index is made up of seven domains of deprivation. These are:

- Income deprivation
- Employment deprivation
- Health deprivation and disability
- Education, skills and training deprivation
- Barriers to housing and services
- Crime
- Living environment

Each of these domains is made up of a number of indicators, which reflect different dimensions of deprivation (see Appendix 3 for more details). The Index is based on 37 indicators in total, together with the two supplementary Indices (Income Deprivation Affecting Children and Income Deprivation Affecting Older People).

It was as a direct result of the work done in a previous Environment Agency project (Walker et al 2003 also known as R&D Project E2-067/1 on ‘Environmental Quality & Social Deprivation’), that the air quality information was added to the Living environment domain. Ironically the inclusion of this information now necessitates some manipulation of the IMD to avoid double counting or correlation when looking at some environmental variables in studies of this type.

In this study we removed the living environment domain altogether and reconstituted the IMD using the remaining six domains (as in their original ratio.)

It is important to realise that the IMD is a relative ranking of deprivation. As such it is possible to group the rankings in the IMD to produce deciles consisting of 10 groups containing 10% of the data in each group. The national decile information is produced in Table 2.2 and information for South Yorkshire in Table 2.3.

By dividing up the population according to where SOAs stand in the national rankings we can compare the differences between the groups in terms of environmental factors. In order to create the deciles the rank was used to place each SOA into a decile of equal population. Deciles of equal population are preferred to those of equal SOA count as the analysis gives a population-based distribution which is more meaningful for equity-based studies. Furthermore classifying all the SOAs depending on their national ranking in the IMD will allow us to make comparison with some other studies to see if the national pattern is replicated at the local level.

Table 2.2 National decile groupings for the IMD 2004

Decile	SOA Count	Rank From	To	Population	Population (%)
1	3,253	1	3,253	4,934,160	10
2	3,248	3,254	6,501	4,934,670	10
3	3,265	6,502	9,766	4,935,550	10
4	3,262	9,767	13,028	4,934,810	10
5	3,251	13,029	16,279	4,933,350	10
6	3,262	16,280	19,541	4,934,080	10
7	3,239	19,542	22,780	4,934,790	10
8	3,242	22,781	26,022	4,935,080	10
9	3,215	26,023	29,237	4,933,880	10
10	3,245	29,238	32,482	4,935,150	10
England	32,482			49,345,520	100

Table 2.3 Deciles in South Yorkshire based on the national ranking

Decile	SOA Count	Population	Population (%)
Most deprived 1	193	287,560	22.7
2	142	212,770	16.8
3	108	160,770	12.7
4	75	112,600	8.9
5	88	130,100	10.3
6	84	124,900	9.9
7	55	82,440	6.5
8	47	70,580	5.6
9	32	51,110	4.0
Least deprived10	21	32,340	2.6
South Yorkshire	845	1,265,170	100

Note: this is simply the national rankings data for South Yorkshire

In all cases decile 1 is the most deprived and decile 10 is the least deprived. It is important to understand what these deciles represent. Essentially decile 1 has the largest concentration of deprived people while decile 10 has the smallest concentration of deprived people. Decile 1 is not 'the poorest 10% of the population' as some of the poorest people will live within pockets within less deprived SOAs, nor is it 'the 10% most deprived SOAs' as a population weighting has been applied.

It is also important to realise that a population within a SOA and within a decile will vary in their characteristics. The IMD is providing a measure for a group of people, not a precise measure for every individual. Within area-based studies this is a well-known limitation known as the ecological fallacy which requires a caveat to be placed on any area-based analysis (although Spicker 2001 provides some interesting arguments when considering the issue of deprivation as in this report see section 2.7).

2.2 Locating the population

In most cases the analysis is concerned with *proximit*y to environmental factors. This is established by creating a buffer area around the environmental feature and then analysing the population which falls within it. To improve the accuracy of the study rather than just look at the extent of the SOAs within the buffer zone we examined the actual distribution of population attached to the households. To achieve this we uses a dataset known as 'Address Point' which locates all individual houses to 1metre accuracy. It is important to note that **proximity is not causality** and that the issues involved in proving causality are far more complicated in most cases. We then take the population size reported in the IMD for the SOA and, spreading it evenly across the Address Points in the SOA, allocated a population to every household. Again this is a modelled population, as it is not possible to know exactly how many people live at each house.

2.3 Comparative Environmental Risk Index

In order to help compare results (deprivation patterns) between various differentiations in the analysis use was made of the Comparative Environmental Risk Index (CERI) (Harner, Warner et al. 2002). This measure involves the calculation of a ratio of the population 'at-risk' as a proportion of the total population for any particular group over the ratio of the rest of the population 'at-risk' as a proportion of the total rest of the population.

The index produced is a quotient (a ratio of ratios). In terms of the deciles used in this study, the index can be represented by the following equation, where X is any particular decile:

$$\frac{DecileX^{at-risk} / DecileX}{Not-in-DecileX^{at-risk} / Not-in-DecileX}$$

When looking at the results of this study the group of people in question (Decile X) can refer to a group of deciles. A worked example is provided in Appendix 2.

If a decile has a CERI value of 1 that means it has an equitable distribution of the feature under consideration. A value of 1.5 would indicate for that the feature is 50 percent more likely to occur in that particular decile compared to the rest of the population. A value of 0.2 would indicate that a feature is 80 per cent less likely to occur in the decile compared to the rest of the population.

2.4 Rural urban classification

To increase the level of the analysis for some variables we provided a breakdown of statistics using the ONS Urban Rural Classification (produced in 2004). This data is available at a range of spatial units; output area, super output area and ward. Using this dataset the population can be classified as seen in Table 2.4.

Table 2.4 ONS Urban Rural Classification 2004

Type	Name	Description
1	Urban >10k, Sparse	Urban Settlements greater than 10,000 population located in sparsely populated areas
2	Town and Fringe, Sparse	Small Town and Fringe areas located in sparsely populated areas
3	Village, Hamlet and Isolated Dwellings, Sparse	Villages, Hamlets & Isolated Dwellings located in sparsely populated areas
4	Urban >10k, Less Sparse	Urban Settlements greater than 10,000 population located in less sparsely populated areas
5	Town and Fringe, Less Sparse	Small Town and Fringe areas located in less sparsely populated areas
6	Village, Hamlet & Isolated Dwellings, Less Sparse	Villages, Hamlets & Isolated Dwellings located in less sparsely populated areas

Not all of these classifications appear in the South Yorkshire and for some that do they have very small numbers. Therefore we have amalgamated groups 1 and 4 to form 'urban' and 2,3,5,6 to form 'rural' classifications.

By combining the information in the IMD and the Rural Urban classification we can produce Table 2.5.

Table 2.5 Combined IMD and rural urban classification for South Yorkshire

Decile	Total Population	Total population (%)	Urban Population	Rural Population	Urban Population (%)	Rural Population (%)
1	287,560	22.7	266,710	20,850	92.75	7.25
2	212,770	16.8	202,080	10,690	94.98	5.02
3	160,770	12.7	146,200	14,570	90.94	9.06
4	112,600	8.9	97,610	14,990	86.69	13.31
5	130,100	10.3	109,530	20,570	84.19	15.81
6	124,900	9.9	113,490	11,410	90.86	9.14
7	82,440	6.5	63,310	19,130	76.80	23.20
8	70,580	5.6	58,630	11,950	83.07	16.93
9	51,110	4.0	49,510	1,600	96.87	3.13
10	32,340	2.6	32,340	0	100	0
South Yorkshire	1,265,170		1,139,410	125,760	90.06	9.94

Urban populations dominate as would be expected, but it is also worth noting the large variability (0 to 23%) of the rural population between deciles. It is also apparent that **the population in South Yorkshire is very skewed towards the more deprived** with over 50 per cent of its population in the bottom third nationally and just under 20 percent of its population in the top 40 per cent nationally.

2.5 Spatial proximity measures

There are two general proximity measures:

a. Euclidean distance 'as the crow flies'
b. Network or pathway analysis.

For many environmental factors Euclidean distance may be the preferred option e.g. air quality. However in other studies concerned with physical access, such as green space analysis, a network approach would be better, but this is not always possible due to data constraints and processing time. All of the main analysis in this study uses the Euclidean approach. However in a sub sample area of Barnsley a network analysis of green space was trialled (see Chapter 10).

Regardless of which approach is used, a distance must be set for the proximity analysis. These distances vary, depending on the environmental factor under consideration, and have been chosen based on previous work and discussion with the Environment Agency (Walker et al 2003). One kilometre is the most commonly-used distance in impact assessments, and has been the most commonly-used distance in previous studies.

Distances for green space and woodlands can be selected with reference to previous studies and our knowledge of how people get to green space. A range of standards exist (see Table 2.6), and the distance chosen can vary depending on the green space under consideration (for example, people are prepared to travel further to a city park with many facilities as opposed to a neighbourhood park with fewer.)

Current thinking is that green space standards should be decided locally as opposed to any nationally. In the recent SNIFFER study (Fairburn et al 2005) we used the Euclidean distance of 600m for woodlands greater than 2 hectares. This is not dissimilar to other studies that have chosen 400m and 500m which are also often used.

However green spaces and woodlands provide a range of benefits such as modifying the local climate and filtering air pollution (although these effects vary depending on the size of the green space) so a 1km buffer was also used.

Table 2.6 Standards for green space

Study	Criteria suggested	Comments
Barker & Graf 1989	A minimum standard of 0.5ha/km for green spaces in urban areas. An objective that schools should have access to a wildlife area within 10 minutes walk.	This includes distance and time criteria.
Box & Harrison 1993	Two minimum targets: • Natural green space of at least 2 hectares and within 0.5Km for urban residents. • Provision of a local nature reserve in every urban area at a minimum level of 1 hectare per thousand population. Also guidelines: • At least one 20 ha site within 2 km of all residents. • At least one 100 ha site within 5 km of all residents. • At least one 500ha site within 10km of all residents	
Harrison et al 1995	Distance of 280 metres to accessible natural areas. Minimum size varies depending on purpose. Sites less than 2ha are fine for children's play. Sites of 2ha appear to provide areas with definable safe boundaries where children can play unsupervised.	After a review of children's home range studies.
Barton et al 1995	Playing fields 800-1000metres Park or open space on the green network 800-1000m Major natural green space 2 – 5km	
Europa 1998	Proportion of population within 15 minutes walking distance of urban green areas (%)	Guideline for the assessment of 58 European cities
Cole and Bussey 2000	2 ha the minimum size of an urban woodland that people would visit regularly Shape of woodland important in woods less than 5ha – blocks preferred to narrow belts. Walking distance of 5-6 minutes (100-400metres) suggested for parks; beyond this frequency of use drops. Maximum walking time 15 minutes.	Open structure woods preferred. No difference between ancient woodland and plantation.
NPFA 2001	The Association recommends as a minimum standard per 1000 population of: 4 acres (1.6 hectares) for outdoor sport, including pitches and greens; and 2 acres (0.8 hectares) for children's playing space.	
Scottish Planning Advice Note 65 (PAN 65 2003)	"this [NPFA 2001] may act as a useful starting point, but it should not substitute for standards developed locally which take into account existing and desired quality, quantity and accessibility of open space."	
Handley et al 2003	More in favour of a localised figure depending on circumstances.	Updates and reviews Harrison et al 1995
Miller et al 2004	Neighbourhood park less than 400m Local park less than 600m City park less than 1500m	In the Aberdeen draft plan. Used network analysis for calculation of distances.
Woodland Trust 2004	Woodland Access Standard 500m to a 2ha or greater wood. At least one 20ha accessible wood within 4km	

2.6 Collation of datasets

For the Environment Agency a list of their data holdings was assessed and a range of datasets requested for further investigation. The range and availability of datasets on the MAGIC website (www.magic.gov.uk) was also assessed and some of those datasets requested.

An initial trawl of datasets from the Environment Agency and other providers is detailed in Table 2.7. Almost all of these were in a suitable format (GIS suitable) for analysis; however there were two difficult issues:

a). A considerable number of green space designations were available so the two most suitable were selected. Further more detailed work was trialled in the sub study area of Barnsley for green space.

b). For some of the data there are just too few occurrences in South Yorkshire to justify an analysis.

To deal with edge effects for populations living close to the boundary we have collected environmental data that is up to 2km outside the study area. Edge effects can occur for example if there is pollution source that is outside the boundary of South Yorkshire but within the distance set for the population living within South Yorkshire.

Table 2.7 Summary of datasets

Name of Data Set	Data holder	Scale	Date	Format	Comments	Potentially useable (Y/N)
Doorstep Greens	Countryside Agency	1:25000	2005	Shape (Point)	Only 6 sites in the study area	Y
Woodland Trust	Woodland Trust	1:10000	2006	Shape (Polygon)	14 sites cover a total of 161 hectares in the study area	Y
National Inventory of Woodland and Trees	Forestry Commission	Various 1:10000, 1:25000	2002	Shape (Polygon)	Includes photo interpretation. Unclear on date of data 2002 or 2005	Y
Woodland Grant Scheme	Forestry Commission		2002	Shape (Polygon)	Subset of NIWT	Y
Community Forest	Countryside Agency	1:50000	2004	Shape (Polygon)	One large polygon	Y
Ancient Woodland	English Nature	1:25000	2003	Shape (Polygon)		Y
National Nature Reserves	English Nature	1:10000	2005	Shape (Polygon)	Too few occurrences	Y
Local Nature Reserves	English Nature	1:10000	2005	Shape (Polygon)		Y
Areas of Outstanding Natural beauty	Countryside Agency	1:50000	2004	Shape (Polygon)	None in the study area	N
Millennium Greens	Countryside Agency		2002	Shape (Point)	Only 6 sites in the study area	Y
RSPB Reserves	RSPB		2005	Shape (Point)	Re working polygon data. Only 1 in study area	Y
Special Areas of Conservation	English Nature	1:10000	2005			?
IPC sites	Environment Agency			Shape (Point)		Y
Waste sites (REGIS)	Environment Agency	Unknown	2006	Shape (Point)		Y
Active landfill sites	Environment Agency	1:10000	2005	Shape (Polygon)		Y
Non active landfills	Environment Agency	1:10000	2006	Shape (Polygon)		Y
Air Quality	DEFRA		2004	1km grid		Y
River water quality	Environment Agency			Shape (Line)		N
Empty or Brownfield land	NLUD	Unknown		Shape (Point)		N

2.7 General methodological limitations

This study is mainly a proximity study which is one of the most commonly used techniques in environmental justice especially when the population under consideration is large. The main limitation and criticism of proximity studies is that they are seen as being a poor substitute for a meaningful measure of actual exposure when considering health effects (Bowen 2002). However there are two main responses to this:

1. The epidemiological and toxicological research needed to even investigate health impacts are exceedingly complex, take years to complete and would be fantastically expensive for such a large population as we have in this study. To illustrate with reference to just Integrated Pollution Prevention & Control (IPPC) sites: the study would have to calculate emission rates for each site and substance, actual exposure for individuals (ingestion, inhalation & dermal contact), consider any effect of multiple or mixtures of substances, past exposure, deal with movement of people and separate any illness or effects from other potential causes such as genetics and lifestyle factors. Essentially proximity studies attempt to address the first part of any impact chain when ideally we would be examining the later stages such as actual health effects, as a basis for equity assessment. Before decisions can be made in terms of causality, the premise of proximity needs to be established to ensure a strong evidence base for that decision-making.

A report by Defra (2004) which reviewed research on the impacts of municipal waste on health sites makes a very similar point

"In the case of municipal waste, disposal activities can generate a range of potential emissions of substances causing contamination of air, soil and water media. Generally speaking, epidemiological studies have not sought to measure human exposure to specific pollutants. Indeed, rather few have made any measure of pollutant concentrations at all. Given the complexity of the pollutant mixture, the possibility of exposure through multiple pathways and the generally non-specific health outcomes which could be attributed to more than one pollutant, it is arguable that there would be rather little to be gained from trying to measure exposure directly. It would be immensely complex and expensive to evaluate experimentally the exposure of large numbers of people to a wide range of pollutants through multiple environmental media." (Defra 2004 pg 126).

Therefore when considering health and equity issues alternative scientifically more rigorous approaches to proximity studies whilst desirable are typically unattainable. The UK environmental justice movement needs to avoid the situation that has arisen in the USA where high profile illnesses especially cancer and any link they may have to sites and facilities has been vigorously disputed for twenty years. It would seem much more productive to explore issues surrounding general ill health or well being (particularly given the rise of the well being agenda within Defra).

In particular the issue of risk perception and effects on health need consideration. Understanding of risk and risk perception has developed significantly over the last decade. The Department of Health (1997) noted " a change since the 1960s from emphasising 'public misperceptions of risk' ('which tended to treat all deviations from expert estimates as products of ignorance or stupidity') towards seeing risk communication as a two-way process in which expert and lay perspectives should inform each other." Although there still seems to be an assumption from some professionals that public perception doesn't matter such judgements are themselves flawed.

Defra's (2002) current guidelines on environmental risk assessment and management state "While risk perceptions sometimes differ considerably from scientific probability estimates, individual and social responses to risk often represent rational and defensible judgements. While decisions about environmental risks should have a sound scientific basis it is also important to give explicit consideration to social dimensions.

Inequity in the distribution of risks and benefits is an important factor influencing attitudes to risk. It can result, for example, in a particular community having to bear the disadvantages of a facility or development while not necessarily gaining the benefits. Examples may include the siting of a waste incineration plant or a disposal facility for low-level radioactive wastes or a major road transport route. The community perceives that it will suffer from the consequences of such activities through both environmental degradation and stigmatisation of the locality, which in turn may have broader economic impacts such as loss of tourism or lowering property prices. Although sometimes dismissed as expressions of self-interest (the *Not In My Back Yard* - NIMBY - response), recent challenges about the distribution of risk have raised not only questions of location and scale but also the fundamental issue of necessity."

Scientific evidence is also emerging to identify **the links between perception and ill health**. For example, Gee and Payne-Sturges (2004) provide a framework for integrating psychosocial and environmental concepts regarding race in the USA (Payne-Sturges was writing in his capacity as an employee of the US Environmental Protection Agency). One example is how environmental hazards can produce community stressors; both physical and psychosocial (e.g. fear surrounding the siting of a new waste site). Such stressor can trigger the sympathoadrenal system and weaken the body's ability to defend itself against illness. This means that the perception that there is a hazard by the local community particularly one that is under stress due to social and economic factors could make them more vulnerable to illness or ill health. This mirrors the findings from fear of crime studies.

Bowling et al (2006) in a survey of people aged over 65 in the UK found that perceptions of problems in an area (noise, crime, air quality, rubbish litter, traffic, graffiti) **were also predictive of poorer health**. Bowling et al noted that "… few studies have included perceptions of the neighbourhood, and few have attempted to be contextual in terms of the characteristics of smaller sized neighbourhoods where people actually live. The results reported here support the potential importance of including perceptions of the neighbourhood in multilevel analyses of area and health, especially as there can be inverse correlations between levels of neighbourhood satisfaction and the social deprivation of the area."

Curtice et al (2005) found in Scotland that those who reported a higher level of street incivilities i.e. poor local environments (litter, dog mess, graffiti, dumped cars and fridges) also reported higher levels of anxiety and depression (23 percent compared to 13 percent in areas with lower incivilities). Furthermore of those living in deprived areas 45 percent said that the availability of safe places for children to play is a 'really big problem' compared to 4 percent in the least deprived areas.

However the Curtice study does illustrate the need for careful consideration of sampling strategy. According to their results infrastructural incivilities (such as landfills and pylons) did not provide as much concern as street level incivilities. Fairburn et al (2005) found that only 2 per cent of the population lived within 1 kilometre of a landfill site. It seems unsurprising that a random national survey would not pick up concern with such facilities when so few people live near to them. To fully understand the possible impacts of such facilities on well being and mental health is likely to require a case study approach which would examine similar areas with and without such features.

2. A second important issue is the need to consider the ‘Precautionary Principle’. This arose in part from the 1992 Rio Declaration on Environment and Development and has since been incorporated at various government levels. While there has been vigorous debate about the merits of the precautionary principle it would seem to be particularly relevant to some of the

subjects covered in this study, when considering health effects. The UK Interdepartmental Liaison Group on Risk Assessment (2002) state

"The precautionary principle should be invoked when:

a. there is good reason, based on empirical evidence or plausible causal hypothesis, to believe that harmful effects might occur, even if the likelihood of harm is remote; and

b. a scientific evaluation of the consequences and likelihoods reveals such uncertainty that it is impossible to assess the risk with sufficient confidence to inform decision-making."

It is important to remember that the **criticism of proximity studies in terms of exposure is only relevant when considering health effects** of particular sites or substances. Other detrimental effects can occur and these are documented in each individual chapter of this report. Furthermore when considering issues such as green space and woodlands, proximity is of major importance both in terms of access and its impact on house prices.

The precautionary principle is much debated, but it has been implemented in other areas of environmental policy notably the Habitats Directive for protected areas and is likely to be implemented under EU Registration, Evaluation and Authorisation of Chemicals (REACH) framework.

3. A general criticism of environmental justice studies concerns the data available. No data are collected to investigate environmental justice. Ideally we would find out which issues matter to local communities and other stakeholders, gather the relevant data and then assess the evidence. Environmental justice studies are reliant on existing datasets that have been collected for other purposes. As such there may be problems with formatting of the data and the type of information available. In this report we have stated particular limitations in each of the individual chapters.

4. The issue of the ecological fallacy (raised in 2.2) traditionally arises when the characteristics of the neighbourhood are projected on to the individual. For example if a neighbourhood is characterised as having low education qualifications it does not mean that everyone in the area has low educations qualifications. The ecological fallacy is a very well known concept and problem within area based studies. Spicker (2001) addresses the specific instance of deprivation and the ecological fallacy, noting that poor areas exacerbate poverty of those living there through a lack of collective resources and stigmatisation. Spicker states 'Poor areas are identifiable in terms of their characteristics as areas; they have poor housing, a run down environment, a lack of security and low status. The environment, the economic base, the social status of the area and the infrastructure of services are developed at an area level. The question to ask is not just whether individuals are poor, but whether areas are. There is a constellation of inter-related deprivations which has to be understood at the level of the area. It follows that there is such a thing as a poor area.' One of the key arguments Spicker makes is that poor areas are more than just the sum of experience of poor individuals. Better off people in deprived areas are also affected through a lack of resources in an area and they are also more likely to be a victim of crime than better off people in non-deprived areas. In fact as this study will show better off people in deprived areas are affected by poorer air quality and other environmental factors. Stafford and Marmot (2003) also found that both individual *and neighbourhood deprivation* (our italics) increased the risk of poor general and mental health.

3 Flooding

3.1 Introduction

Flooding is one of the major areas of work for the Environment Agency and it has a statutory responsibility under the 1991 Water Resources Act to identify areas at risk of flooding.

Creating A Better Place (Environment Agency Corporate Strategy 2006a), Foresight Future Flooding (DTI 2004), and Making Space for Water (Defra 2004) all illustrate the large policy and funding commitment to dealing with the issue of flooding in the UK. However it is not just about building more flood defences, it also involves working with natural processes, improving flood forecasting and planning ahead.

Creating a Better Place states ' We will need to consider the environmental, social and economic aspects of our work, and balance these areas to deliver the best outcome.' (Environment Agency 2006a pg 43) and this study aims to provide some evidence towards aiding that goal.

A recent national report on flooding specifically addressed the issue of social inequalities noting that

"People already experiencing social and economic deprivation are a significant proportion of the total numbers currently at risk from flooding and, for sea flooding; they constitute the majority of those at risk in England. This alone indicates that flood risk management will need to be increasingly responsive to the social distribution and social impacts of flood risk." (Environment Agency 2006 pg 6)

In the long term, the Foresight report indicated that the number of people at risk of flooding could double by 2080 (DTI 2004).

3.2 Data sources and methods

Flood zone data (March 2006) used by the Environment Agency contain two types of flood events which are defined as follows:

Flood Zone 3 shows areas with the highest probability of flooding, where the annual probability is greater than or equal to 1% or 1 in 100 for river (fluvial) flooding and greater than or equal to 0.5% or 1 in 200 for tidal flooding from the sea.

Flood Zone 2 shows areas with an annual probability of flooding of between 0.1% and 1 % in the case of river flooding, or 0.5% in relation to sea flooding.

Both of these datasets are worst case scenarios as no account is taken of flood defences, or structures such as bridges, culverts and rail and motorway embankments that may be in place. This is a **significant limitation** in this analysis.

All figures in this chapter need to be treated with extreme caution as the data have significant limitations. In particular it is recommended that the figures are used only to indicate the **relative difference** between groups; the absolute figures certainly over-estimate the population at risk. However they do have some useful purposes:

a) Once flood defence data has been completely collected it will be possible to calculate the remaining population still at risk.
b) It allows us to identify which groups have been prioritised for flood protection.
c) It identifies populations at risk from breaches that are less than a 1 per cent (fluvial) or 0.5 per cent tidal annual probability.

The flood defence data is an incomplete dataset as it only comprises of those defences constructed since 1999 and with a standard of protection equal to or better than 1% (1 in 100) for fluvial and 0.5% (1 in 200) for tidal. Areas which benefit from the above flood defences were also available (version 1.5 of the national dataset). Households falling within these areas were then extracted and analysed.

We have also used the historic flood dataset held by the Environment Agency to assess our results. This dataset contains the actual extent of floods; in particular it contains the extent of two very large fluvial floods from March 1947 and Autumn 2000.

3.3 Results

Table 3.1 Populations in flood zone 2

Decile	Decile Population	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
Most Deprived 1	287,560	17,461	10,799	471	6,191	11,270	6,662
2	212,770	17,363	8,697	1,059	7,607	9,756	8,666
3	160,770	12,738	7,585	93	5,060	7,678	5,153
4	112,600	7,664	5,085	10	2,569	5,095	2,579
5	130,100	6,875	5,695	0	1,180	5,695	1,180
6	124,900	6,864	6,377	0	487	6,377	487
7	82,440	3,474	2,843	0	631	2,843	631
8	70,580	2,933	2,933	0	0	2,933	0
9	51,110	853	734	0	119	734	119
Least Deprived 10	32,340	184	184	0	0	184	0
SouthYorkshire	**1,265,170**	**76,409**	**50,932**	**1,633**	**23,844**	**52,565**	**25,477**

Note: All fluvial is calculated by adding together Fluvial only and Both Fluvial and Tidal figures, (similarly for All Tidal).
Note: See data warning in section 3.2

Table 3.2 Percentages of each decile's population within flood zone 2

Decile	Population	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
1	287,560	6.07	3.76	0.16	2.15	3.92	2.32
2	212,770	8.16	4.09	0.50	3.58	4.59	4.07
3	160,770	7.92	4.72	0.06	3.15	4.78	3.21
4	112,600	6.81	4.52	0.01	2.28	4.52	2.29
5	130,100	5.28	4.38	0.00	0.91	4.38	0.91
6	124,900	5.50	5.11	0.00	0.39	5.11	0.39
7	82,440	4.21	3.45	0.00	0.77	3.45	0.77
8	70,580	4.16	4.16	0.00	0.00	4.16	0.00
9	51,110	1.67	1.44	0.00	0.23	1.44	0.23
10	32,340	0.57	0.57	0.00	0.00	0.57	0.00
Total	**1,265,170**	**6.04**	**4.03**	**0.13**	**1.88**	**4.15**	**2.01**

Table 3.3 CERI Index for flood zone 2

Decile	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
1	1.01	0.91	1.38	1.19	0.93	1.20
2	1.45	1.02	9.13	2.32	1.13	2.55
3	1.37	1.20	0.41	1.85	1.18	1.74
4	1.14	1.14	0.06	1.24	1.10	1.15
5	0.86	1.10	0.00	0.45	1.06	0.42
6	0.90	1.31	0.00	0.19	1.26	0.18
7	0.68	0.85	0.00	0.39	0.82	0.36
8	0.68	1.03	0.00	0.00	1.00	0.00
9	0.27	0.35	0.00	0.12	0.34	0.11
10	0.09	0.14	0.00	0.00	0.13	0.00

Note: See data warning in section 3.2

Table 3.4 Populations in flood zone 3

Decile	Decile Population	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
1	287,560	16,357	9,877	26	6,454	9,903	6,480
2	212,770	16,519	7,884	286	8,349	8,170	8,635
3	160,770	11,808	6,655	0	5,153	6,655	5,153
4	112,600	6,836	4,267	5	2,564	4,272	2,569
5	130,100	6,464	5,336	61	1,067	5,397	1,128
6	124,900	5,729	5,246	0	483	5,246	483
7	82,440	3,317	2,686	0	631	2,686	631
8	70,580	2,836	2,836	0	0	2,836	0
9	51,110	527	408	0	119	408	119
10	32,340	149	149	0	0	149	0
Total	**1,265,170**	**70,542**	**45,344**	**378**	**24,820**	**45,722**	**25,198**

Table 3.5 Percentages of each decile's population within flood zone 3

Decile	Population	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
1	287,560	5.69	3.43	0.01	2.24	3.44	2.25
2	212,770	7.76	3.71	0.13	3.92	3.84	4.06
3	160,770	7.34	4.14	0.00	3.21	4.14	3.21
4	112,600	6.07	3.79	0.00	2.28	3.79	2.28
5	130,100	4.97	4.10	0.05	0.82	4.15	0.87
6	124,900	4.59	4.20	0.00	0.39	4.20	0.39
7	82,440	4.02	3.26	0.00	0.77	3.26	0.77
8	70,580	4.02	4.02	0.00	0.00	4.02	0.00
9	51,110	1.03	0.80	0.00	0.23	0.80	0.23
10	32,340	0.46	0.46	0.00	0.00	0.46	0.00
Total	**1,265,170**	**5.58**	**3.58**	**0.03**	**1.96**	**3.61**	**1.99**

Note: See data warning in section 3.2

Table 3.6 CERI Index values for flood zone 3

Decile	All Floodplains	Fluvial only	Both Fluvial and Tidal	Tidal only	All Fluvial	All Tidal
1	1.03	0.95	0.25	1.19	0.94	1.18
2	1.51	1.04	15.38	2.51	1.08	2.58
3	1.38	1.18	0.00	1.80	1.17	1.77
4	1.10	1.06	0.14	1.18	1.05	1.16
5	0.88	1.16	1.68	0.39	1.17	0.41
6	0.81	1.19	0.00	0.18	1.18	0.18
7	0.71	0.90	0.00	0.37	0.90	0.37
8	0.71	1.13	0.00	0.00	1.12	0.00
9	0.18	0.22	0.00	0.11	0.21	0.11
10	0.08	0.13	0.00	0.00	0.12	0.00

Note: See data warning in section 3.2

Table 3.7 Population benefiting from flood defences

Decile	Total population in fluvial zone3	Population Benefiting	Percentage benefiting	Population still at risk	Percentage at risk in fluvial zone	As a percentage of the entire decile
1	9,903	4,015	40.5	5,888	59.5	2.0
2	8,170	4,297	52.6	3,873	47.4	1.8
3	6,655	5,462	82.1	1,193	17.9	0.7
4	4,272	3,013	70.5	1,259	29.5	1.1
5	5,397	3,124	57.9	2,273	42.1	1.7
6	5,246	3,293	62.8	1,953	37.2	1.6
7	2,686	2,374	88.4	312	11.6	0.4
8	2,836	620	21.9	2,216	78.1	3.1
9	408	0	0.0	408	100.0	0.8
10	149	0	0.0	149	100.0	0.5
Total	**45,722**	**26,198**	**57.3**	**19,524**	**42.7**	**1.5**

Notes. Within the study area there three areas close together which have benefited from flood defences. All areas are on a fluvial floodplain so the total fluvial population has been used to calculate the percentage of people in each decile who have benefited from the defences.

Table 3.8 Population living within historic fluvial floodplains

Decile	Decile population	Population affected	Percentage
1	287,560	7,593	2.6
2	212,770	8,333	3.9
3	160,770	5,776	3.6
4	112,600	3,785	3.4
5	130,100	139	0.1
6	124,900	835	0.7
7	82,440	633	0.8
8	70,580	0	0.0
9	51,110	118	0.2
10	32,340	0	0.0
	1,265,170	27,213	

3.4 Discussion

Given the very large caveats that were applied to the data in section 3.2 only a limited discussion is provided for Tables 3.1 to 3.6. They may prove of use when carrying out more detailed modelling to produce Catchment Flood Management Plans and Strategic Flood Risk Assessments in the area.

Tables 3.1, 3.2 and 3.3 suggest that a theoretical maximum of six per cent (76,000) of the population lives in a flood zone 2 area and just fewer than six per cent in flood zone 3 areas in South Yorkshire. Deprived populations in deciles 2 and 3 seem more likely to be living in a floodplain compared to the rest of the population.

Tables 3.4, 3.5 and 3.6 which analysed the 1 in 200 probability of a flood unsurprisingly show a similar pattern to Tables 3.1, 3.2 and 3.3 with deciles 2 and 3 more likely to be on a floodplain.

Of the 45,722 people who live in fluvial flood zone 3, 26,198 of them (57 per cent) have benefited from flood defences suggesting they may no longer be at risk (Table 3.7). The highest numbers of people still at risk live in decile1 although the highest percentage of people at risk lives in decile 8. While none of the population in decile 9 and 10 appear to have benefited from flood defences these populations are the least likely to be living in the flood zone.

Given that deciles 1 and 2 are least likely to have flood insurance and existing evidence that deprived people find it harder to cope with flooding (Environment Agency 2006b) there maybe some merit to re-assessing the areas that are prioritised for fluvial flood defences in South Yorkshire. More detailed work could be carried out as a result of a Catchment Flood Management Plan or the Strategic Flood Risk Assessment which could give a more accurate indication of the areas at risk of flooding.

Compared with the national statistics there are slightly fewer people than average living in floodplains in South Yorkshire, 6 percent compared to 8.3 percent nationally in flood zone 2) and 5.5 percent compared to 6.7 percent in flood zone 3.

Populations at risk of river flooding in South Yorkshire (both zones 2 and 3) show a different pattern compared to the national statistics. Nationally river flooding is very evenly distributed amongst the deciles, in South Yorkshire deciles 2 thru 6 are slightly more likely to be living in a flood zone.

Tidal flooding affects only a very small percentage of the population in South Yorkshire and such numbers are probably unreliable given the limitations identified in the data. However what patterns there are in South Yorkshire suggest that the more deprived are more likely to be living in a flood zone than the less deprived.

Using the extent of the historic flood events (mainly the March 1947 and Autumn 2000 events) Table 3.8 illustrates that there are 27,212 people living within these areas (an again it is the **currently** more deprived populations most affected). However the March 1947 event did lead to the construction of flood defences so again this number may be an over estimation. Use of the historic fluvial flood data suggests that within South Yorkshire simply using the flood zone data leads to an over-estimation of the population at risk of at least twice that which has happened historically. This level of fluvial flood over-estimation is specific to the South Yorkshire area and should not be used for other areas.

4 Waste management sites

4.1 Introduction

One of the key regulatory activities of the Environment Agency is to regulate waste management sites to prevent and control pollution. However the Environment Agency is not the only authority with such a duty and local authorities also play a large role in managing the waste sector. In this chapter active waste management sites covered under the Waste Management Licensing regulations are investigated. In chapter 5 active and non active landfills are investigated in further detail. Industrial processes with emissions to air are covered in chapter 6

Analysis has been presented separately for waste management sites in general and landfills specifically because although there are obvious areas of overlap in terms of possible impacts there are also issues which are specific to each category and the datasets used in the analysis.

Waste management sites such as recycling centres, waste transfer stations, landfill sites and treatment centres may impact on the local population in the following ways:

1. An economic impact through lower house prices for which there has been extensive evidence from the USA (Boyle & Kiel 2001).

2. Vrijheid (2000) provides a useful statement on the health impact of waste sites "An increased prevalence of self-reported health symptoms such as fatigue, sleepiness, and headaches among residents near waste sites has consistently been reported in more than 10 of the reviewed papers. It is difficult to conclude whether these symptoms are an effect of direct toxicologic action of chemicals present in waste sites, an effect of stress and fears related to the waste site, or an effect of reporting bias."

This illustrates that stress and fears may occur in a local population even if a direct impact from a local site has not been identified. Such stress and fear can lead to illness and more deprived communities are less equipped to handle such stress (see Gee and Payne-Sturges 2004 for an interesting discussion).

4.2 Data sources and methods

A subset of active waste sites (2005) covered under the Waste Management Licensing regulations (taken from the Regulation Information Systems, REGIS dataset) was used for this analysis. The data are in point format which is a limitation as obviously sites will vary in size and shape.

To decide which sites were **active** we used three categories from the licence status field- ‘issued’, ‘modified’ and ‘transferred’. The current status of the active sites identified was also confirmed by the Environment Agency.

The following analysis was carried out:

1). Populations living within 1km of active waste sites with a rural-urban breakdown.
2). Populations living within 1km of multiple sites including landfill sites.
3). Populations living within 1km of active waste sites by classification of waste management operation.

4.3 Results

Table 4.1 Population within 1 km of active waste sites

Decile	Decile Population	Total	Urban	Rural
Most deprived 1	287,560	154,707	148,247	6,460
2	212,770	91,420	88,077	3,343
3	160,770	66,207	62,070	4,137
4	112,600	32,618	31,868	751
5	130,100	44,453	39,624	4,829
6	124,900	36,182	35,387	795
7	82,440	13,323	11,990	1,333
8	70,580	11,847	10,328	1,519
9	51,110	6,583	6,583	
Least deprived 10	32,340			N/A
South Yorkshire	**1,265,170**	**457,339**	**434,173**	**23,166**

Table 4.2 Percentage within 1km of active waste sites

Decile	Decile Population	Total	Urban	Rural
1	287,560	53.8	55.6	31.0
2	212,770	43.0	43.6	31.3
3	160,770	41.2	42.5	28.4
4	112,600	29.0	32.6	5.0
5	130,100	34.2	36.2	23.5
6	124,900	29.0	31.2	7.0
7	82,440	16.2	18.9	7.0
8	70,580	16.8	17.6	12.7
9	51,110	12.9	13.3	0.0
10	32,340	0.0	0.0	N/A
South Yorkshire	**1,265,170**	**36.1**	**38.1**	**18.4**

Table 4.3 CERI Index for active waste sites within 1km

Decile	Total	Urban	Rural
1	1.74	1.70	1.95
2	1.24	1.18	1.82
3	1.16	1.13	1.66
4	0.79	0.85	0.25
5	0.94	0.94	1.35
6	0.78	0.80	0.36
7	0.43	0.48	0.34
8	0.45	0.45	0.67
9	0.35	0.34	0.00
10	0.00	0.00	N/A

Table 4.4 Cumulative population living within 1km of multiple active waste sites

Decile	Population	≥ 10 sites	≥ 5 sites	≥ 3 sites	≥ 2 sites	≥ 1 sites
1	287,560	9,978	41,917	71,368	112,147	154,707
2	212,770	2,169	17,630	39,563	57,473	91,420
3	160,770	401	6,840	21,333	43,043	66,207
4	112,600	316	2,278	6,916	16,720	32,618
5	130,100	0	4,836	10,319	20,367	44,453
6	124,900	0	632	2,788	12,205	36,182
7	82,440	0	77	653	4,368	13,323
8	70,580	0	20	1,200	4,834	11,847
9	51,110	0	0	12	1,042	6,583
10	32,340	0	0	0	0	0
South Yorkshire	**1,265,170**	**12,864**	**74,230**	**154,151**	**272,198**	**457,339**

Note maximum number of waste sites is 33

Table 4.5 Cumulative percentage of population living within 1km of multiple active waste sites

Decile	Population	≥ 10 sites	≥ 5 sites	≥ 3 sites	≥ 2 sites	≥ 1 sites
1	287,560	3.5	14.6	24.8	39.0	53.8
2	212,770	1.0	8.3	18.6	27.0	43.0
3	160,770	0.2	4.3	13.3	26.8	41.2
4	112,600	0.3	2.0	6.1	14.8	29.0
5	130,100	0.0	3.7	7.9	15.7	34.2
6	124,900	0.0	0.5	2.2	9.8	29.0
7	82,440	0.0	0.1	0.8	5.3	16.2
8	70,580	0.0	0.0	1.7	6.8	16.8
9	51,110	0.0	0.0	0.0	2.0	12.9
10	32,340	0.0	0.0	0.0	0.0	0.0
South Yorkshire	**1,265,170**	**1.0**	**5.9**	**12.2**	**21.5**	**36.1**

Note maximum number of waste sites is 33

Table 4.6 CERI Index for population living within 1km of multiple waste sites

Decile	≥ 10 sites	≥ 5 sites	≥ 3 sites	≥ 2 sites	≥ 1 sites
1	11.75	4.41	2.93	2.38	1.74
2	1.00	1.54	1.71	1.32	1.24
3	0.22	0.70	1.10	1.29	1.16
4	0.26	0.32	0.48	0.67	0.79
5	0.00	0.61	0.63	0.71	0.94
6	0.00	0.08	0.17	0.43	0.78
7	0.00	0.01	0.06	0.23	0.43
8	0.00	0.00	0.13	0.31	0.45
9	0.00	0.00	0.00	0.09	0.35
10	0.00	0.00	0.00	0.00	0.00

Table 4.7 Count of waste sites by type in South Yorkshire

Classification		Type of Site	Count	%
Landfill	A1	Co-Disposal Landfill Site	2	0.7
	A2	Other Landfill Site taking Special Waste	0	0.0
	A3	Borehole	0	0.0
	A4	Household, Commercial & Industrial Waste Landfill	5	1.6
	A5	Landfill taking Non-Biodegradeable Wastes	5	1.6
	A6	Landfill taking other wastes	3	1.0
	A7	Industrial Waste Landfill (Factory curtilage)	1	0.3
	A8	Lagoon	1	0.3
		Subtotal:	17	5.6
Waste Transfer	A9	Special Waste Transfer Station	14	4.6
	A10	In-House Storage Facility	3	1.0
	A11	Household, Commercial & Industrial Waste Transfer	57	18.8
	A12	Clinical Waste Transfer Station	0	0.0
		Subtotal:	74	24.3
Amenity Sites	A13	Household Waste Amenity Site	6	2.0
	A14	Transfer Station taking Non-Biodegradable Wastes	1	0.3
		Subtotal:	7	2.3
Recycling	A15	Material Recycling Treatment Facility	9	3.0
	A19	Metal Recycling Site (Vehicle Dismantler)	50	16.4
	A19a	ELV Facility	21	6.9
	A20	Metal Recycling Site (mixed MRS's)	110	36.2
		Subtotal:	190	62.5
Chemical	A16	Physical Treatment Facility	9	3.0
	A17	Physico-Chemical Treatment Facility	1	0.3
	A18	Incinerator	1	0.3
	A21	Chemical Treatment Facility	4	1.3
		Subtotal:	15	4.9
Biological	A22	Composting Facility	0	0.0
	A23	Biological Treatment Facility	1	0.3
		Subtotal:	1	0.3
		Total:	304	100

Table 4.8 Population within 1km of active waste site by site type

Decile	Decile Population	Total 1km	Amenity Sites	Biological Treatment	Chemical Treatment	Landfill	Recycling	Waste Transfer
1	287,560	154,707	22,816	3,378	13,358	8,531	115,562	90,698
2	212,770	91,420	7,253	12	8,038	4,006	68,768	42,610
3	160,770	66,207	3,980		6,819	3,723	50,208	31,372
4	112,600	32,618	1,138	24	4,295	2,919	20,436	16,020
5	130,100	44,453	200		3,405	1,366	30,331	22,437
6	124,900	36,182	1,713		3,693	1,694	19,041	17,263
7	82,440	13,323	851		4,169	629	6,197	4,664
8	70,580	11,847	1,472		2,384	289	6,953	4,292
9	51,110	6,583	3,602		727		1,713	555
10	32,340							
South Yorkshire	**1,265,170**	**457,339**	**43,024**	**3,414**	**46,888**	**23,156**	**319,208**	**229,912**

Note

Type of site	All	Amenity Sites	Biological Treatment	Chemical Treatment	Landfill	Recycling	Waste Transfer
Number of sites:	304	7	1	15	17	190	74

Note classification of sites based on Environment Agency designation:
Amenity Sites: A13, A14
Biological Treatment: A22, A23
Chemical Treatment: A16, A17, A18, A21
Landfill: A1, A2, A3, A4, A5, A6, A7, A8
Recycling: A15, A19, A19a, A20
Waste Transfer: A9, A10, A11, A12

Table 4.9 Percentage of population living within 1km of active waste sites by type of site

Decile	Population	Total	Amenity Sites	Biological Treatment	Chemical Treatment	Landfill	Recycling	Waste Transfer
1	287,560	53.8	7.9	1.2	4.6	3.0	40.2	31.5
2	212,770	43.0	3.4	0.0	3.8	1.9	32.3	20.0
3	160,770	41.2	2.5	0.0	4.2	2.3	31.2	19.5
4	112,600	29.0	1.0	0.0	3.8	2.6	18.1	14.2
5	130,100	34.2	0.2	0.0	2.6	1.1	23.3	17.2
6	124,900	29.0	1.4	0.0	3.0	1.4	15.2	13.8
7	82,440	16.2	1.0	0.0	5.1	0.8	7.5	5.7
8	70,580	16.8	2.1	0.0	3.4	0.4	9.9	6.1
9	51,110	12.9	7.0	0.0	1.4	0.0	3.4	1.1
10	32,340	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1,265,170**	**36.1**	**3.4**	**0.3**	**3.7**	**1.8**	**25.2**	**18.2**

Table 4.10 CERI Index for population living within 1km of active waste sites by type of site

Decile	Total 1km	Amenity Sites	Biological Treatment	Chemical Treatment	Landfill	Recycling	Waste Transfer
1	1.74	3.84	315.89	1.35	1.98	1.93	2.21
2	1.24	1.00	0.02	1.02	1.03	1.36	1.13
3	1.16	0.70	0.00	1.17	1.32	1.28	1.09
4	0.79	0.28	0.07	1.03	1.48	0.70	0.77
5	0.94	0.04	0.00	0.68	0.55	0.92	0.94
6	0.78	0.38	0.00	0.78	0.72	0.58	0.74
7	0.43	0.29	0.00	1.40	0.40	0.28	0.30
8	0.45	0.60	0.00	0.91	0.21	0.38	0.32
9	0.35	2.17	0.00	0.37	0.00	0.13	0.06
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.4 Discussion

Over a third of the population in South Yorkshire live within 1 kilometre of an active waste site. However there is a wide variation between the deciles ranging from 53 percent of decile 1 to zero per cent in decile 10. Active waste sites are disproportionally sited in decile 1 and to a lesser extent in deciles 2 and 3 (Tables 4.1, 4.2 and 4.3). Apart from decile 5 there is a straightforward decrease in the population living near an active waste site from decile 1 to decile 10 for the overall population.

The rural urban analysis produces two interesting results; firstly that overall urban populations are twice as likely to be living near to active waste sites compared to rural ones. However within rural areas it is deciles 1, 2, 3 and to some extent 5 which record the higher values. The CERI values (Table 4.3) confirm that **the more deprived areas in both rural and urban settings that are disproportionally closer to active waste sites than other deciles in those settings in South Yorkshire.**

Tables 4.4, 4.5 and 4.6 present the results of the population living within 1 kilometre of multiple active waste sites. Just over 21 percent of the population in South Yorkshire live within 1 kilometre of two or more sites, 6 percent of the population live within 1 kilometre of five or more sites and 1 per cent of the population live near to ten or more sites.

In all cases it is decile 1 which is most likely to be situated near to multiple sites (with some extreme cases of small numbers of people living near to more than 30 sites).

Table 4.5 illustrates that it is only deciles 1 through 4 that live near to ten or more sites. Decile 1 has 15 percent of the its population living near to five or more waste sites, decile 2 (8 percent) and decile 3 (4 percent) record the next highest values.

Decile 1 has a quarter of its population living near to three or more sites; there are also high values for deciles 2 and 3 before a sharp drop in the numbers for the remaining deciles.

The CERI values (Table 4.6) indicate that people in decile 1 are eleven times more likely to be living next to ten or more sites than the rest of the population, four times more likely to be living near to five or more sites, and three times more likely to be living near to three or more sites. In all cases the CERI values indicate that people in decile 1 are far more likely to be living near to active waste sites than even decile 2 which records the next highest values.

Table 4.7 provides a breakdown of sites by classification for South Yorkshire and indicates how sites were grouped together in this report. This grouping follows other reports that have been carried out for the Environment Agency.

Tables 4.8, 4.9 and 4.10 provide a breakdown of the population living near to different types of waste site. The most common type of sites in South Yorkshire are recycling centres (190) and waste transfer stations (74). Decile 1 records the highest percentage of people living within 1kilometre of every type of site except chemical treatment facilities. For recycling sites 40 percent of decile 1 live within 1 kilometre where as the highest value in decile 7 through 10 is only 7.5 percent. **People in decile 1 are twice as likely to be living next to a recycling site, a waste transfer site or a landfill site as the rest of the population and three times more likely to be living near to an amenity site.** It could easily be argued that it is good for society in general for much of the population to live near to waste facilities (minimising the distance the waste needs to travel). Therefore if enough facilities already exist to meet society's needs an argument could be made to relocate facilities into less deprived areas or for any new facilities to be located in such areas where they would serve a bigger catchment area and so benefit from nearby facilities.

This of course would be a politically controversial suggestion as while everyone wants their waste to be dealt with few people want to live next to a waste site.

Deciles 1 to 4 have disproportionate numbers of people living within 1 kilometre of these sites. Of the other deciles only decile 9 for amenity sites and decile 7 for chemical treatment sites record CERI values over 1 (meaning they have more than their share of facilities). All values less than 1 indicate they have fewer facilities near them than would be expected if they were evenly distributed.

These results present a conservative number of the population living close to waste sites as the sites were modelled as points.

Another Environment Agency study (Environment Agency in press a) discusses waste in a national context and provides an analysis similar to this one for the North West Government region. It is difficult to provide a comparison between the two studies as they cover different types of area and the distances reported differ. However similar sorts of results were found in that sites tended to occur disproportionally in the more deprived area.

5 Landfill sites

5.1 Introduction

Landfills have been one of the most controversial areas for environmental justice research due to the uncertain nature of their impact. Possible impacts include:

a). Health - through pathways such as contaminated water, releases to air or contaminated soil.
b). 'Nuisance' – e.g. dust and noise complaints, increased traffic levels, heavy vehicles
c). Negative impact on house prices through blight/stigma effects.

Relatively recently there have been a number of high profile studies looking at the potential health impacts of landfills (e.g. Dolk et al 1998, Vrijheid et al 2002); which have raised questions in Parliament and been used by groups such as Friends of the Earth in their campaigning. To some extent this illustrates both public concern over such sites in general and the importance of this issue to several NGO campaigns. The Dolk (1998) study suggested an increase in congenital birth defects with proximity to landfills. Pheby et al (2003) questioned the strength of evidence for this assertion particularly with regards to the major limitations of knowledge about environmental vectors. Elliot et al (2001) found that over 80 per cent of the population lived within 2km of a landfill site, open or closed and suggested confounding factors of social deprivation to explain increases in ill health. However by definition only 20 per cent of the country was available as a reference area which also raises methodological issues. In a later paper (Dolk & Vrijheid 2003) provided many of the methodological problems involved in trying to find out the health impacts of such sites.

Defra (2004) reviewed the evidence base for the impacts of municipal waste sites noting that insufficient was currently known about chemical emissions from landfills. In general the review appeared to give a clean bill of health to municipal waste sites, although there were significant caveats in parts of the report concerning the quality of the data, the assumptions that had to be made and overall uncertainties in the evidence base. It is important to note that the report did not report on the health effects of hazardous or co-disposal waste sites or which there are two in South Yorkshire.

The situation regarding the effect of landfills is further confused by the range of landfills and the different types of material that are disposed of in them. Several of the studies in the USA which appear to have found some link with impacts on health are usually dealing with 'hazardous waste sites' (as defined in the US legislative regime). As far as health impacts are concerned some studies appear to find a link and some don't. It is an area in need of more research before definitive statements on links between health and landfills can be made.

Landfills may still be an environmental justice issue due to their impact on house prices. Cambridge Econometrics et al (2003) found that those houses situated within half a mile of a landfill site were statistically significant to be less valuable in the UK. For houses within quarter of a mile they were on average £5,500 lower than the value of a similar house not situated near a landfill. Earlier work by Nelson et al (1992) had found similar results in Minnesota, and also Reichert et al (1992), a review of such studies is provided by Boyle and Kiel (2001).

5.2 Data sources and methods

The non-active landfill dataset was compiled from a range of sources including paper maps. This is a polygon dataset, but there are doubts over the accuracy for parts of the dataset as it came from various local authority sources. As such figures provided are indicative rather than definitive.

As many of these sites in this dataset are old, closed down and probably not visible the type of potential impact of these sites compared with active sites may be different. There is likely to be little noise, no traffic and possibly less impact on visual amenity. However regulations were laxer in the past and it is possible to have emissions from older landfills particularly if they were not capped.

This dataset could provide a useful illustration of siting policy for landfills in the past (this is discussed further is section 5.4.1).

Population within a 1km straight line (Euclidean) buffer were analysed with a rural/urban analysis.

The active landfill site data is a subset of the Waste Management Licences dataset which was also used in chapter 4. However there is a significant difference in terms of how the data is modelled. The Environment Agency has created a dataset which models the outline of the site and as such the data is in polygon/area format. This provides an interesting insight into the relative differences between using point and polygon data when carrying out proximity studies (see section 5.4.2 for further discussion).

5.3 Results

5.3.1 Non active landfill sites

Table 5.1 Population living with 1km of non active landfill sites

Decile	Decile Population	Total	Urban	Rural
Most deprived 1	287,560	235,866	222,257	13,609
2	212,770	155,097	150,613	4,484
3	160,770	134,215	125,950	8,265
4	112,600	75,535	67,992	7,543
5	130,100	101,045	85,872	15,173
6	124,900	95,021	85,053	9,968
7	82,440	57,289	44,702	12,587
8	70,580	41,904	31,896	10,008
9	51,110	22,049	20,452	1,597
Least deprived10	32,340	8,079	8,079	N/A
South Yorkshire	**1,265,170**	**926,100**	**842,866**	**83,234**

Table 5.2 Percentage of decile living within 1km of non active landfill sites

Decile	Population	Total	Urban	Rural
1	287,560	82.0	83.3	65.3
2	212,770	72.9	74.5	41.9
3	160,770	83.5	86.1	56.7
4	112,600	67.1	69.7	50.3
5	130,100	77.7	78.4	73.8
6	124,900	76.1	74.9	87.4
7	82,440	69.5	70.6	65.8
8	70,580	59.4	54.4	83.7
9	51,110	43.1	41.3	99.8
10	32,340	25.0	25.0	N/A
South Yorkshire	**1,265,170**	**73.2**	**74.0**	**66.2**

Table 5.3 CERI Index for populations within 1km of non-active landfill sites

Decile	Total	Urban	Rural
1	1.16	1.17	0.98
2	0.99	1.01	0.61
3	1.16	1.19	0.84
4	0.91	0.94	0.74
5	1.07	1.07	1.14
6	1.04	1.01	1.36
7	0.95	0.95	0.99
8	0.80	0.73	1.30
9	0.58	0.55	1.52
10	0.34	0.33	N/A

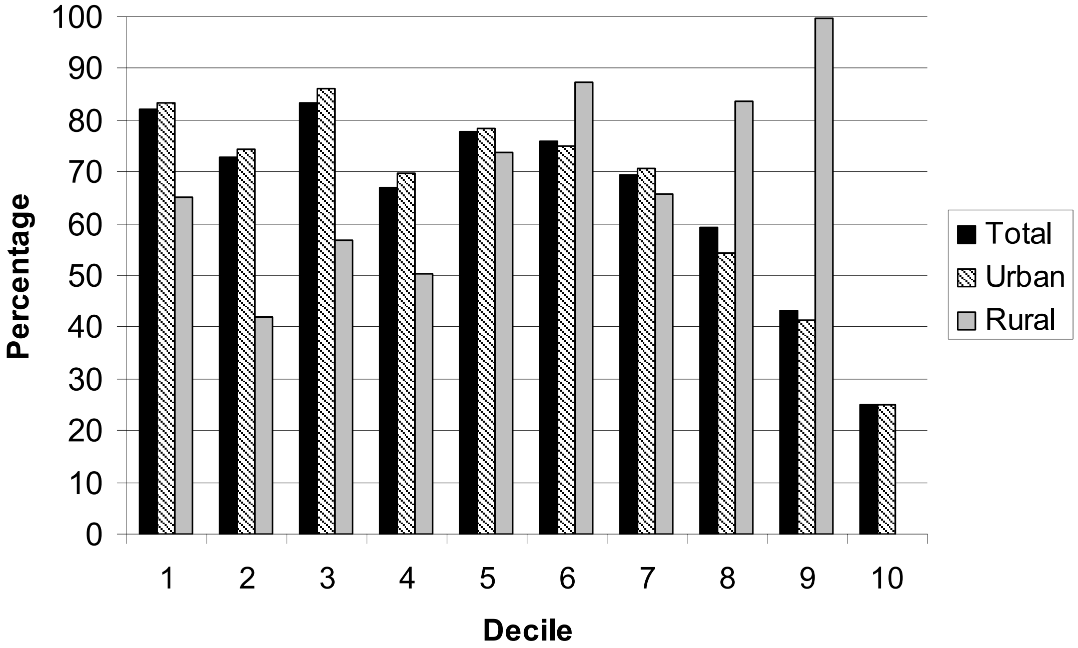


Figure 5.1 Percentage living within 1km of non active landfill sites

5.3.2 Active landfill sites

Table 5.4 Population within 1km of active landfill site with rural urban split

Decile	Decile Population	Total	Urban	Rural
1	287,560	10,313	10,308	5
2	212,770	7,780	7,780	
3	160,770	8,527	8,360	167
4	112,600	5,508	4,955	554
5	130,100	3,057	2,601	457
6	124,900	4,084	3,520	563
7	82,440	1,934	1,613	321
8	70,580	1,556	1,011	545
9	51,110	1,378	1,378	
10	32,340			N/A
South Yorkshire	**1,265,170**	**44,137**	**41,525**	**2,612**

Table 5.5 Percentage within 1km of active landfill sites with rural urban split

Decile	Decile Population	Total	Urban	Rural
1	287,560	3.6	3.9	0.0
2	212,770	3.7	3.9	0.0
3	160,770	5.3	5.7	1.1
4	112,600	4.9	5.1	3.7
5	130,100	2.4	2.4	2.2
6	124,900	3.3	3.1	4.9
7	82,440	2.3	2.5	1.7
8	70,580	2.2	1.7	4.6
9	51,110	2.7	2.8	0.0
10	32,340	0.0	0.0	N/A
South Yorkshire	**1,265,170**	**3.5**	**3.6**	**2.1**

Table 5.6 CERI Index for populations within 1km of active landfills

Decile	Total	Urban	Rural
1	1.04	1.08	0.01
2	1.06	1.07	0.00
3	1.64	1.71	0.52
4	1.46	1.45	1.99
5	0.65	0.63	1.08
6	0.93	0.84	2.76
7	0.66	0.69	0.78
8	0.62	0.46	2.51
9	0.77	0.76	0.00
10	0.00	0.00	N/A

Table 5.7 Cumulative population living within 1km of multiple active landfill sites

Decile	Decile Population	≥ 2 sites	≥ 1 sites
1	287,560	579	10,313
2	212,770	1,548	7,780
3	160,770	924	8,527
4	112,600	92	5,508
5	130,100	0	3,057
6	124,900	0	4,084
7	82,440	0	1,934
8	70,580	0	1,556
9	51,110	0	1,378
10	32,340	0	0
South Yorkshire	**1,265,170**	**3,143**	**44,137**

Note maximum number of sites is 2

Table 5.8 Cumulative percentage of population living within 1km of multiple active landfill sites

Decile	Decile Population	≥ 2 sites	≥ 1 sites
1	287,560	0.2	3.6
2	212,770	0.7	3.7
3	160,770	0.6	5.3
4	112,600	0.1	4.9
5	130,100	0.0	2.4
6	124,900	0.0	3.3
7	82,440	0.0	2.3
8	70,580	0.0	2.2
9	51,110	0.0	2.7
10	32,340	0.0	0.0
South Yorkshire	**1,265,170**	**0.2**	**3.5**

Table 5.9 CERI Index for population living within multiple active landfill sites

Decile	≥ 2 sites	≥ 1 sites
1	0.77	1.04
2	4.80	1.06
3	2.86	1.64
4	0.31	1.46
5	0.00	0.65
6	0.00	0.93
7	0.00	0.66
8	0.00	0.62
9	0.00	0.77
10	0.00	0.00

Table 5.10 Populations living within 1km of active landfill by site type

Decile	Decile Population	Total	A1	A4	A5	A6	A7
1	287,560	10,313	7,427	1,786	5		1,095
2	212,770	7,780	1,821	5,538	416		5
3	160,770	8,527	4,023	4,465	39		
4	112,600	5,508	445	4,534	529		
5	130,100	3,057	2,330	171	99	457	
6	124,900	4,084	864	1,826	7	1,387	
7	82,440	1,934		682	387	866	
8	70,580	1,556		83	622	851	
9	51,110	1,378				1,378	
10	32,340						
South Yorkshire	**1,265,170**	**44,137**	**16,911**	**19,086**	**2,103**	**4,938**	**1,100**

Note:
A1 Co-disposal sites licensed to receive ranges of commercial, household and or industrial waste which require special precautions in their handling including that which is classed as special under the Special Waste Regulations 1996.

A4 Household, commercial and industrial sites licensed to receive controlled waste from any source excluding those licensed to receive purely non-biodegradable waste and/or licensed to accept special or other wastes which require special precautions in their handling.

A5 Non-biodegradable landfill. Sites licensed to accept purely non-biodegradable waste for landfill. This category would not include waste from construction, demolition and canal dredgings.

A6 Other waste. Licensed to accept construction, demolition and canal dredgings.

A7 Factory Curtilage Landfill. Sites within curtilage of industrial premises licensed to accept waste only arising from those premises or premises not on site but accepted as part of the licence.

5.4 Discussion

5.4.1 Non active landfill sites

Three quarters of the population in South Yorkshire are living within 1km of a non-active landfill site illustrating the historical industrialisation of the region (Table 5.1, 5.2)

Overall the more deprived areas are more likely to be near non-active landfill sites. People in decile 1-5 are 25 per cent more likely to be near to a non-active landfill than people in deciles 6-10. Given that in general the location of deprived areas only moves slowly this does indicate that historical siting of landfills may have been skewed towards the more deprived. However more detailed longitudinal analysis would be needed to be carried out to definitively prove this assertion.

Population living within 1 kilometre of a non active landfill range from 82 per cent (decile 1) to 25 per cent in decile 10 (Table 5.2, Figure 5.1). There is some fluctuation in values between deciles 1-4 and then values decline from decile 5 onwards.

The urban rural analysis shows that urban populations are slightly more likely to be living near to non-active landfills than rural populations. Interestingly within rural areas it is deciles 5-9 which are more likely to be near to non active landfills (Table 5.2)

CERI values indicate that deciles 1 and 3 are most likely to be near to non-active landfills (Table 5.3).

5.4.2 Active landfill sites

In chapter 4 landfill sites were modelled as point data producing a figure of 23,156 people in South Yorkshire living within 1 kilometre of such a site. In this chapter where landfill sites have been modelled as areas 44,137 people are calculated to be living within 1km of an active site. This raises two issues:

1. Use of point data (the most common format) will produce a conservative number (underestimate) of total people living within proximity of the environmental factor under consideration.

2. Does the difference in the way the data is modelled affect the distribution of the environmental factor between the deciles? There are several parts to the answer. Firstly, the earlier work (Walker et al 2003) showed that despite using a range of buffer sizes on the IPC sites the relationship between the deciles stayed fairly similar. Secondly more recent work on waste sites in the North West (Environment Agency in press a) used a range of buffer distances and noted that the overall nature of the association between deprivation and waste sites was not sensitive to distance. However the proportional strength of the association did decrease with a 2 kilometre buffer.

In this particular case of South Yorkshire there is also the issue of the small numbers involved (less than four percent of the population) which is further clouding the picture. However the CERI values for both sets of data (Tables 4.9 and 5.6) indicate that landfill sites are more likely to be in deciles 1 through 4 rather than 5 through 10.

Table 5.5 indicates that overall 3.5 percent of the population lives within 1 kilometre of an active landfill (3.6 percent in urban and 2.1 percent in rural areas). The highest value 5.3 percent is recorded for decile 3 and the second highest 4.9 percent is recorded for decile 4, the lowest value is zero recorded for decile 10.

The CERI values do indicate that it is deciles 3, 4 and very marginally 1 and 2 that have more landfills, but it is difficult to give too much weight to the final statistics due to the small numbers overall involved.

Tables 5.7, 5.8 and 5.9 record the small amount of population (3,143) that is living near to two active landfill sites (which occurs only in deciles 1 through 4).

Given the small numbers the results of this chapter are probably most useful in contributing to Chapter 11 dealing with cumulative impacts in South Yorkshire.

Table 5.10 gives a breakdown by type of waste site.

6 Industrial Air Pollution

6.1 Introduction

The impacts of industrial pollution are similar to those described for waste sites (chapter 4) and landfill sites (chapter 5). In this chapter we analyse only those sites that have emissions to air i.e. they are a point source of local pollution. This at least identifies a possible exposure pathway although not necessarily an impact.

The Pollution Inventory dataset records information data for a range of regulatory activities. These include activities which:

- are regulated under Integrated Pollution Control (IPC)
- are regulated under Pollution Prevention and Control (PPC)
- are subject to the Radioactive Substances Act 1993
- have waste management licences which are moving to PPC
- are sewage treatment works in England subject to a Ministerial Direction under the Water Industries Act.

Integrated Pollution Prevention and Control was introduced in 1999 (Defra, 2002) as a result of European legislation. Previously the regime was known as Integrated Pollution Control. IPPC takes a wider range of environmental impacts into account than IPC. The previous system of IPC regulates emissions to land, water and air. The IPPC regime additionally takes into account; waste avoidance or minimisation, energy efficiency, accident avoidance and minimisation of noise, heat and vibrations.

IPPC also applies to a wider range of industries than IPC. These industries include all installations that were regulated under IPC, some installations currently under Local Air Pollution Control, and some installations that were not under either regime such as: landfill sites, intensive agriculture (large pig and poultry units), and food and drink manufacturers.

Under IPPC, regulated industries are referred to as 'installations' as opposed to 'processes' which is the term used for IPC. This change in terminology enables a more integrated approach to regulation; a whole installation must be permitted rather than just individual processes within the installation.

For existing installations IPC permits will continue to be in force until IPPC permits are phased in on a sectoral basis by October 2007.

In the UK, Pollution Prevention Control (PPC) is the implementation of the IPPC, the terms are synonymous and both are commonly used.

It is important to understand how this regime works as it is comprised of three distinct parts – ‘sites’, ‘authorisations’ and ‘emissions’. Sites are the physical location where authorisation(s) can take place; a site can have more than one authorisation. Authorisations allow emissions to occur; an authorisation can allow one or many emissions to occur.

6.2 Data sources and methods

The analysis in this chapter is only concerned with sites that have emissions to air (the dataset is for 2004). Other types of sites such as landfill are covered in other chapters.

The site data has been recorded as a point location which is a limitation of the analysis as sites will vary in shape and size.

Analysis is provided for:

a). Populations within 1km and 2km of sites.
b). Populations within 1km of sites by site type.
c). Populations within 1km of multiple sites.
d). Populations within 1km of multiple emissions.

6.3 Results

Table 6.1 Population within 1km and 2km of a Pollution Inventory site with emissions to air

Decile	Decile Population	Total population within 2km	Total population within 1km
Most deprived 1	287,560	145,472	61,239
2	212,770	95,715	35,699
3	160,770	72,419	28,016
4	112,600	41,427	10,501
5	130,100	47,357	15,776
6	124,900	49,718	10,051
7	82,440	28,655	9,096
8	70,580	35,170	10,350
9	51,110	24,628	3,828
Least deprived 10	32,340	6,781	2,428
South Yorkshire	**1,265,170**	**547,341**	**186,985**

Table 6.2 Percentage of decile within 1km and 2km of a Pollution Inventory site with emissions to air

Decile	Population	Percentage of decile within 2km	Percentage of decile within 1km
1	287,560	50.6	21.3
2	212,770	45.0	16.8
3	160,770	45.0	17.4
4	112,600	36.8	9.3
5	130,100	36.4	12.1
6	124,900	39.8	8.0
7	82,440	34.8	11.0
8	70,580	49.8	14.7
9	51,110	48.2	7.5
10	32,340	21.0	7.5
South Yorkshire	**1,265,170**	**43.3**	**14.8**

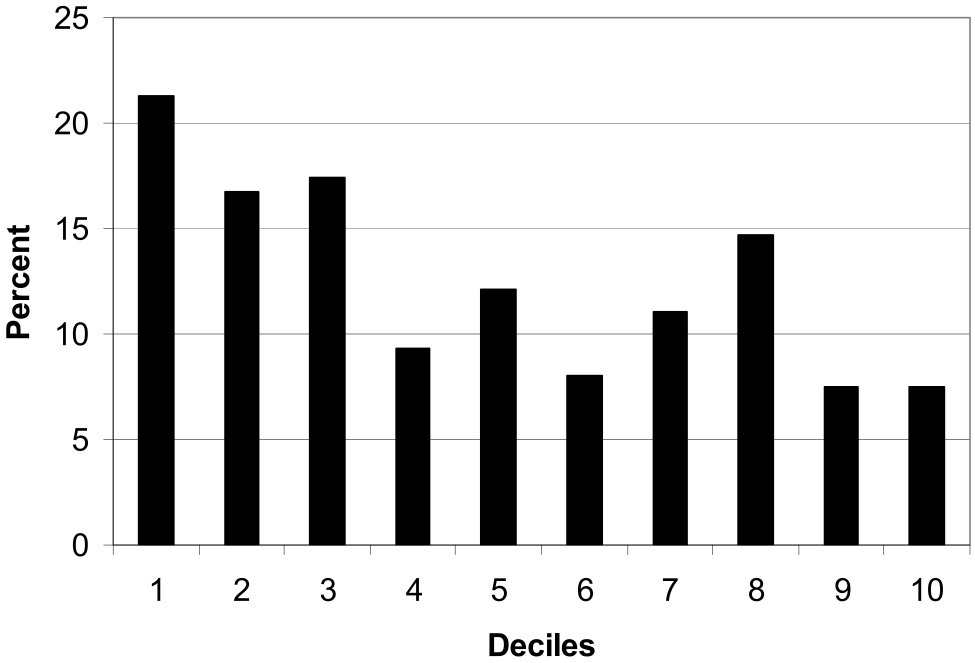


Figure 6.1 Percentage of population within 1km of a Pollution Inventory site with emissions to air

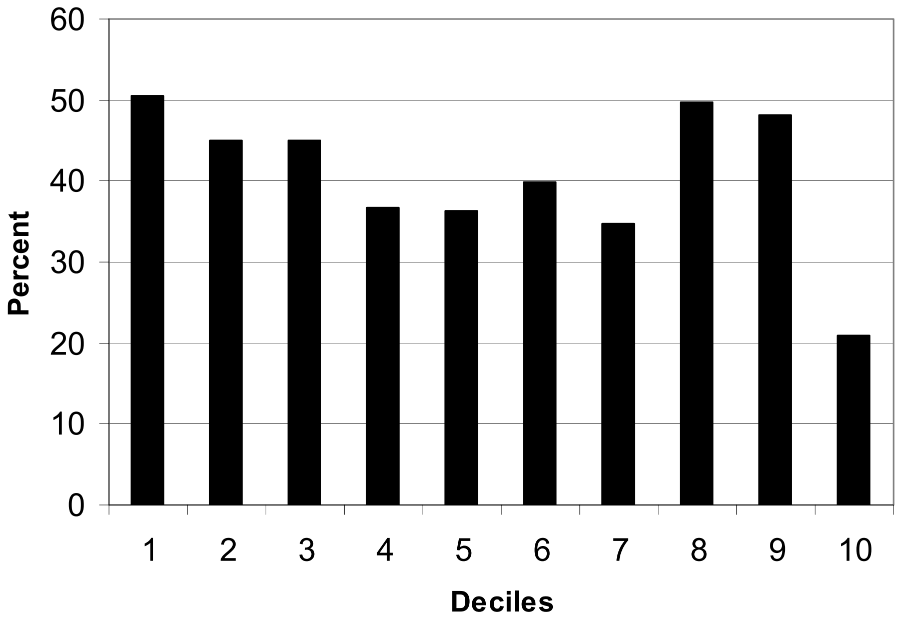


Figure 6.2 Percentage of population within 2km of a Pollution Inventory site with emissions to air

Table 6.3 CERI index for Pollution Inventory sites with emissions to air

Decile	Total 2km	Total 1km
1	1.23	1.66
2	1.05	1.17
3	1.05	1.21
4	0.84	0.61
5	0.83	0.80
6	0.91	0.52
7	0.79	0.73
8	1.16	0.99
9	1.12	0.50
10	0.48	0.50

Table 6.4 Cumulative population within 1km of multiple sites with emissions to air

Decile	Decile Population	≥ 3 sites	≥ 2 sites	≥ 1 sites
1	287,560	2,365	13,562	61,239
2	212,770	37	4,512	35,699
3	160,770	1,135	2,410	28,016
4	112,600	0	1,404	10,501
5	130,100	0	58	15,776
6	124,900	19	426	10,051
7	82,440	920	1,171	9,096
8	70,580	27	510	10,350
9	51,110	0	0	3,828
10	32,340	0	0	2,428
South Yorkshire	**1,265,170**	**4,502**	**24,053**	**186,985**

Table 6.5 Cumulative percentage within 1km of multiple sites with emissions to air

Decile	Decile Population	≥ 3 sites	≥ 2 sites	≥ 1 sites
1	287,560	0.8	4.7	21.3
2	212,770	0.0	2.1	16.8
3	160,770	0.7	1.5	17.4
4	112,600	0.0	1.2	9.3
5	130,100	0.0	0.0	12.1
6	124,900	0.0	0.3	8.0
7	82,440	1.1	1.4	11.0
8	70,580	0.0	0.7	14.7
9	51,110	0.0	0.0	7.5
10	32,340	0.0	0.0	7.5
South Yorkshire	**1,265,170**	**0.4**	**1.9**	**14.8**

Note maximum number of sites is 4

Table 6.6 Population within 1km of Pollution Inventory sites by type with emissions to air

Decile	Decile Population	Total within 1km	IPC	PPC	RAS	WML
1	287,560	61,239	35,268	15,523	13,798	10,024
2	212,770	35,699	21,504	6,761	7,848	7,138
3	160,770	28,016	19,709	7,060	4,041	4,719
4	112,600	10,501	8,889	2,981	0	2,032
5	130,100	15,776	9,613	5,154	2,835	3,028
6	124,900	10,051	8,323	900	0	1,558
7	82,440	9,096	6,733	950	1,956	1,548
8	70,580	10,350	5,817	648	2,272	2,235
9	51,110	3,828	1,939	0	1,889	0
10	32,340	2,428	2,428	0	0	0
Total	**1,265,170**	**186,985**	**120,223**	**39,977**	**34,639**	**32,283**

IPC Integrated Pollution Control (37 sites), PPC Pollution Prevention Control (5 sites), RAS Radio active substances (2 sites), WML waste management licence (9 sites)

Table 6.7 Percentage within 1km of Pollution Inventory sites by type with emissions to air

Decile	Decile Population	Total	IPC	PPC	RAS	WML
1	287,560	21.3	12.3	5.4	4.8	3.5
2	212,770	16.8	10.1	3.2	3.7	3.4
3	160,770	17.4	12.3	4.4	2.5	2.9
4	112,600	9.3	7.9	2.6	0.0	1.8
5	130,100	12.1	7.4	4.0	2.2	2.3
6	124,900	8.0	6.7	0.7	0.0	1.2
7	82,440	11.0	8.2	1.2	2.4	1.9
8	70,580	14.7	8.2	0.9	3.2	3.2
9	51,110	7.5	3.8	0.0	3.7	0.0
10	32,340	7.5	7.5	0.0	0.0	0.0
Total	**1,265,170**	**14.8**	**9.5**	**3.2**	**2.7**	**2.6**

Table 6.8 CERI Index for Pollution Inventory sites by type with emissions to air

Decile	Total 1km	IPC	PPC	RAS	WML
1	1.66	1.41	2.16	2.25	1.53
2	1.17	1.08	1.01	1.45	1.40
3	1.21	1.35	1.47	0.91	1.18
4	0.61	0.82	0.82	0.00	0.69
5	0.80	0.76	1.29	0.78	0.90
6	0.52	0.68	0.21	0.00	0.46
7	0.73	0.85	0.35	0.86	0.72
8	0.99	0.86	0.28	1.19	1.26
9	0.50	0.39	0.00	1.37	0.00
10	0.50	0.79	0.00	0.00	0.00

Table 6.9 Cumulative population for number of emissions within 1km

Decile	Decile Population	≥ 20	≥ 10	≥ 5	≥ 2	≥ 1
1	287,560	4,067	18,228	27,190	37,045	61,239
2	212,770	168	3,719	13,162	19,472	35,699
3	160,770	1,413	4,305	6,574	14,725	28,016
4	112,600	1,995	2,647	4,618	7,441	10,501
5	130,100	2,927	3,660	7,157	10,535	15,776
6	124,900	286	1,603	4,281	8,220	10,051
7	82,440	2	1,551	2,895	6,638	9,096
8	70,580	0	2,271	3,597	6,153	10,350
9	51,110	0	0	1,817	1,939	3,828
10	32,340	0	0	2,428	2,428	2,428
Total	**1,265,170**	**10,859**	**37,983**	**73,718**	**114,596**	**186,985**

Note maximum number of emissions is 59

Table 6.10 Cumulative percentage of population for number of emissions within 1km

Decile	Decile Population	≥ 20	≥ 10	≥ 5	≥ 2	≥ 1
1	287,560	1.4	6.3	9.5	12.9	21.3
2	212,770	0.1	1.7	6.2	9.2	16.8
3	160,770	0.9	2.7	4.1	9.2	17.4
4	112,600	1.8	2.4	4.1	6.6	9.3
5	130,100	2.2	2.8	5.5	8.1	12.1
6	124,900	0.2	1.3	3.4	6.6	8.0
7	82,440	0.003	1.9	3.5	8.1	11.0
8	70,580	0.0	3.2	5.1	8.7	14.7
9	51,110	0.0	0.0	3.6	3.8	7.5
10	32,340	0.0	0.0	7.5	7.5	7.5
Total	**1,265,170**	**0.9**	**3.0**	**5.8**	**9.1**	**14.8**

Table 6.11 CERI Index for cumulative population for number of emissions within 1km

Decile	≥ 20	≥ 10	≥ 5	≥ 2	≥ 1
1	2.04	3.14	1.99	1.62	1.66
2	0.08	0.54	1.08	1.01	1.17
3	1.03	0.88	0.67	1.01	1.21
4	2.30	0.77	0.68	0.71	0.61
5	3.22	0.93	0.94	0.88	0.80
6	0.25	0.40	0.56	0.71	0.52
7	0.00	0.61	0.59	0.88	0.73
8	0.00	1.08	0.87	0.96	0.99
9	0.00	0.00	0.60	0.41	0.50
10	0.00	0.00	1.30	0.83	0.50

6.4 Discussion

Just over 43 percent (547,000) of the population in South Yorkshire live within two kilometres of a Pollution Inventory site that has emissions to air. Just fewer than 15 percent of the population live within one kilometre of a Pollution Inventory site with emissions to air (Tables 6.1, 6.2).

Deciles 1 (most deprived), 8 and 9 have around 50 percent of the population living within two kilometres of a Pollution Inventory site (Table 6.2 and Figure 6.2). There is a rough U shaped distribution between deciles 1 and 9. Decile 10 (least deprived) has substantially less people living within the zone, 21 percent compared to all the other deciles.

Decile 1 has the highest percentage (21) of people living within 1km of the sites, with deciles 2 and 3 recording the next highest levels. The lowest values are recorded in deciles 9 and 10 with 7.5 percent. CERI values (Table 6.3) indicate that people in decile 1 are 66 per cent more likely to be living within one kilometre of a site compared to the rest of the population. Deciles 9 and 10 are only half as likely to be living next to such a site compared to the rest of the population.

Some of the population within South Yorkshire live near to a cluster of Pollution Inventory sites (Tables 6.4 and 6.5). The highest value occurs within decile 1, 4.7 percent of the population are living within one kilometre of two or more sites (in some cases up to four sites are within one kilometre).

Tables 6.6 and 6.7 illustrate that decile 1 has the highest number of people living within one kilometre for all four types of site. The CERI values (Table 6.8) also illustrate that it is deciles 1, 2 and 3 (especially 1) which are far more likely to live near to these sites than other deciles.

Table 6.9 provides a cumulative population who are exposed to multiple emissions from sites within one kilometre. The maximum number of emissions that any population is exposed to is 59. Table 6.9 shows that 4,067 (1.4 percent) people in decile 1 are exposed to 20 or more emissions, but the highest percentage is recorded for decile 5, 2.2 percent (2,927 people). **People in deciles 1, 4 and 5 are two to three times more likely to be exposed to 20 or more emissions from IPC sites compared to the rest of the population. However, the total population exposed to such emissions in South Yorkshire is under one percent.**

Decile 1 records the highest percentage (6.3) of people living within one kilometre of ten or more emissions (this figure includes the 1.4 exposed to 20 or more emissions as the figures are cumulative). Decile 8 records the second highest percentage with 3.2 and all of the deciles except 9 and 10 have some population exposed to ten or more different emissions. However the CERI values indicate that people in decile 1 are over three times more likely than the rest of the population to be exposed to ten or more emissions. Only one other decile (8) has a value over 1 demonstrating the large inequality experienced by decile 1. The total population living near to ten or more emissions is 37,983 which is three per cent of the total population of South Yorkshire.

Decile 1 also records the highest CERI values for 5 or more and 2 or more emissions. Interestingly for the 5 or more emissions, decile 10 records a value of 1.30 illustrating that there is a 30 percent greater chance of living near such emissions compared to the rest of the population.

Earlier work for the Environment Agency (Walker et al 2003) also found that sites, emissions and clustering of sites were more likely to be found in deprived areas. South Yorkshire has 15 percent of its population living within 1 kilometre of an IPC compared with 6 percent nationally (43 percent and 23 percent respectively are the figures for the 2 kilometre distance). Note there is a three year gap between the data used for these two studies. Deciles 1 and 2 in South

Yorkshire have more people living near to IPC sites than deciles 1 and 2 nationally, but the rest of the deciles in South Yorkshire show a similar pattern to the national picture.

7 Air quality

7.1 Introduction

Air quality provides one of the most interesting areas for environmental justice work.
As a result of EU directives (e.g. Air Quality Framework Directive 96/62/EC), government policy (particularly the Air Quality Strategy) is based on very strong scientific research and we can identify the effects of air quality on health to some degree.

In recent decades there have been significant improvements in air quality in the UK as a result of changes in fuel sources, improved cleaner technology, and decline in industrial processes. Unfortunately the improvement in air quality is most threatened by the transport sector, particularly increasing car use.

The National Air Quality Strategy sets Air Quality Standards (see Table 7.1) with reference to scientific evidence which are designed to pose a minimum risk to health. However, uncertainty exists in setting of standards, and that health impacts may still occur below the standard in some people is acknowledged. For example, WHO (2004:p8) notes that "Thresholds are in principle an appealing concept that has also been used in defining air quality policies such as justifying the numerical value of air quality limit values. Nevertheless, recent epidemiological studies in investigating large populations have been unable consistently to establish such thresholds, in particular for particulates and ozone. Rather they show effects at the level studied."

The absence of a dividing line between levels of pollution that do and do not pose a threat to health is exemplified by the COMEAP (Department of Health, 2000) disease burden study, in which the best available epidemiological evidence indicates that air quality dose-health response relationships are linear and through the origin. Recognition of this is illustrated within the AQS with the tightening of air quality standards over time.

Air quality as a subject has had more attention than most other environmental variable in environmental justice studies. Small area national studies have been completed (Environment Agency 2002; Mitchell and Dorling 2003; Walker *et al*. 2003, Fairburn et al 2005) which demonstrate that deprived communities bear a disproportionate share of the poorest air quality nationally. Other studies have been carried out at a regional or city level (King and Stedman 2000, Pye et al 2001, Wheeler 2004).

Table 7.1 National Air Quality Objectives (DETR 2000 and Defra 2003)

Pollutant	Level	Measured as	To be achieved by
Benzene	16.25 $\mu g/m^3$ (5 ppb) 3.25 $\mu g/m^3$ (1.54 ppb)	Running annual mean	31 Dec 2003 31 Dec 2010
Nitrogen dioxide	40 $\mu g/m^3$ (21 ppb)	Annual mean	31 Dec 2005
Particulates (PM_{10})	40 $\mu g/m^3$ 18 $\mu g/m^3$	Annual mean	31 Dec 2004 31 Dec 2010
Sulphur dioxide	350 $\mu g/m^3$ (132 ppb) not to be exceeded ≥ 24 times a year	1 hour mean	31 Dec 2004
	125 $\mu g/m^3$ (47 ppb) not to be exceeded ≥ 3 times a year	24 hour mean	31 Dec 2004
	266 $\mu g/m^3$ (100 ppb) not to be exceeded ≥ 35 times a year	15 minute mean	31 Dec 2005

Note only those standards relevant to this project have been included

7.2 Data sources and methods

This study has looked at four atmospheric pollutants nitrogen dioxide (NO_2), fine particulates (PM_{10}), sulphur dioxide (SO_2), and benzene for which an AQS has been set. The air quality data used is the annual mean concentration for each 1km grid cell centroid in South Yorkshire for 2004 provided by the National Environment Technology Centre (NETCEN). As sulphur dioxide does not have an AQS set we used the WHO guideline for annual mean of 50 $\mu g/m^3$.

The pollutant concentration maps are based upon emissions recorded in the National Atmospheric Emission Inventory (Goodwin *et al.* 2000). The inventory provides an estimate of total pollutant emission in a base year for a 1 x 1 km grid, based upon estimated emission in over 140 secondary sectors and nine principal sectors: residential, services, industry, road transport, off road vehicles, shipping, rail, aviation, and other.

NETCEN calculate atmospheric concentrations from emissions by application of a dispersion box model. For secondary pollutants additional modelling is required. For example, in the case of oxides of nitrogen (NO_x), which are oxidised in the atmosphere to form NO_2 (the only nitrogen oxide for which an NAQS objective applies) the model applies a dispersion coefficient derived from regression of NO_x emissions in the vicinity of monitoring sites, against the difference between measured NO_x at the monitoring site, and background NO_x taken from a nearby rural site. Annual mean NO_2 concentrations are then calculated using non-linear functions relating atmospheric annual mean NO_x to annual mean NO_2 for geographical areas with characteristically different atmospheric chemistry (rural and urban areas). Note that road traffic is estimated to account for 50% of total UK NO_x emission, rising to 75% in urban areas (Goodwin *et al.* 2000).

The data upon which the box model functions are based were collected from 1990 to 1999 using the national automated monitoring network. Verification of the modelled concentrations using an independent set of measured data collected from 1996 to 1999 shows generally good agreement between observed and estimated concentrations (Stedman and Handley, 2001). Further details of the air quality modelling procedures are described in Stedman *et al.* (1997) and Stedman *et al.* (2001a; 2001b).

Descriptive statistics were calculated for each SOA using a point in polygon analysis (i.e. an analysis of all points falling within a SOA). SOAs with no air quality data within their boundary were allocated air quality data from the air quality point nearest the SOA.

In correlating annual mean air quality with demographic data an assumption is made that an individual's exposure occurs entirely within the relevant SOA. Clearly this is a gross assumption and population movement (e.g. commuting), introduces a potentially significant bias in pollution exposure. The extent of this bias may differ between population groups depending upon their mobility.

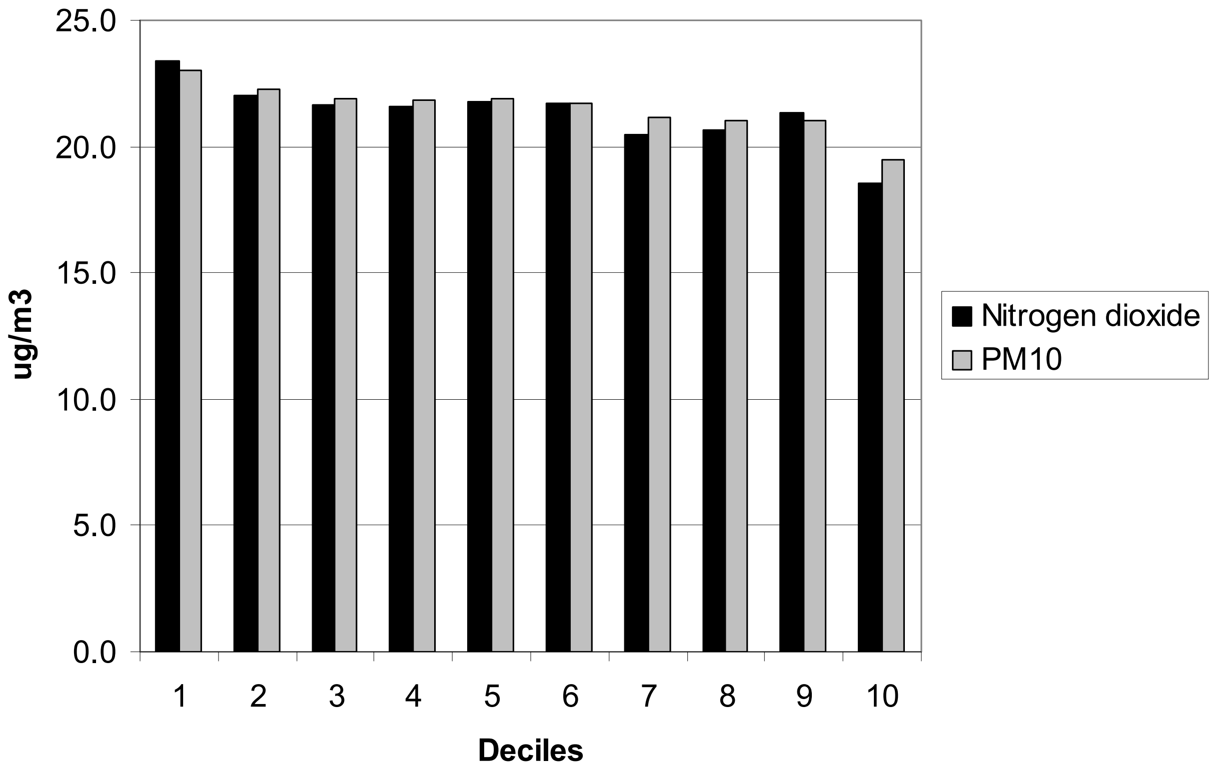
A further type of analysis has been carried out to examine which groups experience the very worst air quality. To achieve this, areas which have the highest 10% of values for nitrogen dioxide, PM_{10} and sulphur dioxide were also investigated. Some commentary on the populations under 16 and over 60 in these areas is also provided.

7.3 Results

Table 7.2 Annual mean air quality by decile

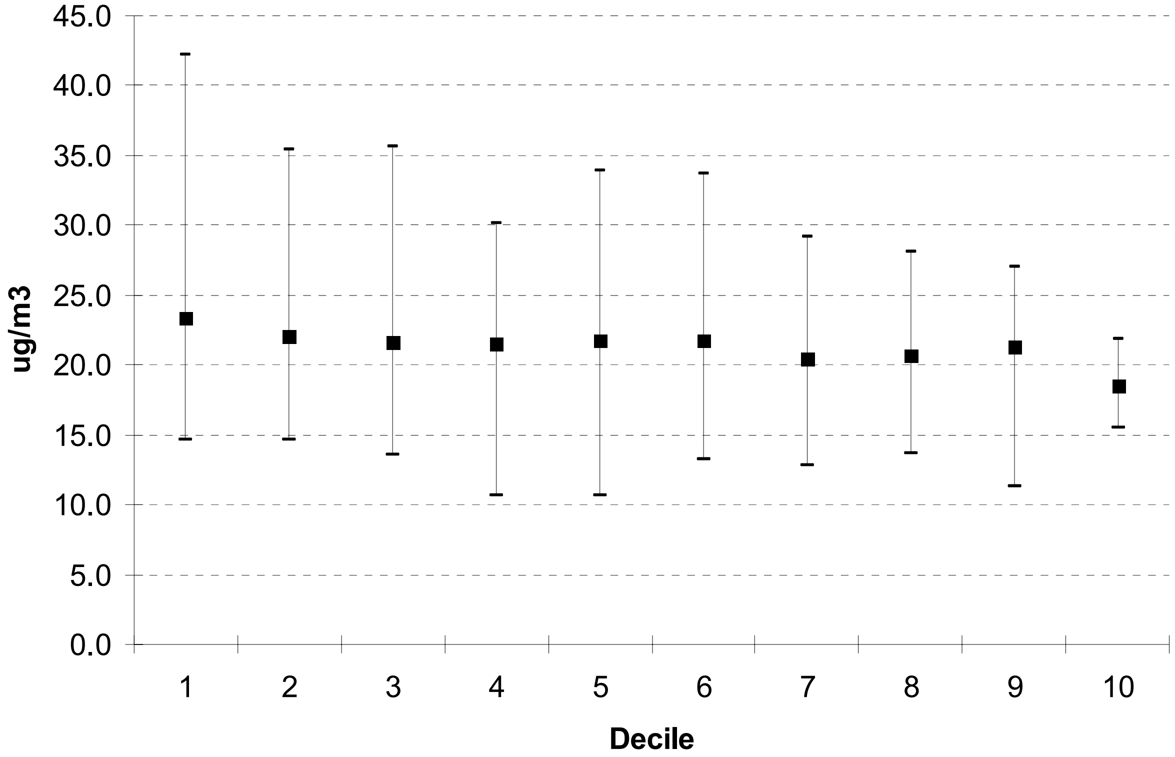
Decile	Nitrogen dioxide	PM10	Sulphur dioxide	Benzene
Most deprived 1	23.4	23.0	9.0	1.2
2	22.1	22.3	8.5	1.0
3	21.6	21.9	7.6	1.0
4	21.6	21.8	7.6	0.9
5	21.8	21.9	7.0	0.9
6	21.7	21.7	7.1	0.9
7	20.5	21.1	6.4	0.8
8	20.7	21.0	6.0	0.9
9	21.3	21.0	6.0	1.0
Least deprived 10	18.5	19.5	4.8	0.8

Note All units are $\mu g/m^3$



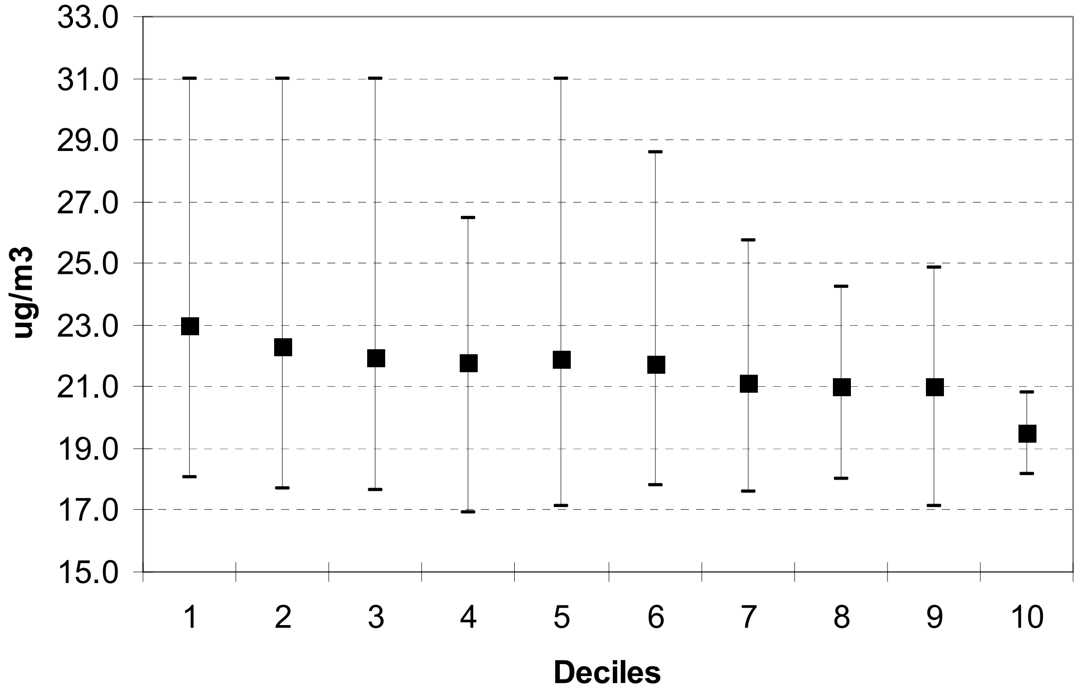
Note: Annual Air quality standard for PM10 and Nitrogen dioxide is 40 $\mu g/m^3$

Figure 7.1 Annual Mean concentrations of Nitrogen Dioxide and PM_{10} by decile



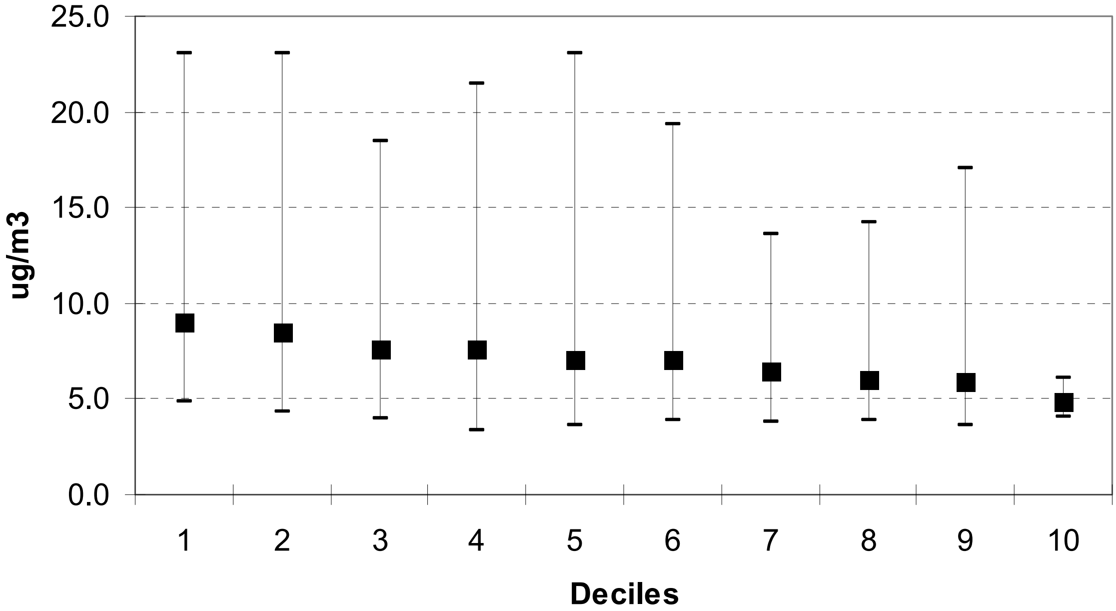
Note Bars denote full range of values within decile

Figure 7.2 Distribution of SOA mean Nitrogen dioxide 2004



Note Bars denote full range of values within decile.

Figure 7.3 Distribution of SOA mean PM10 2004



Note Bars denote full range of values within decile.

Figure 7.4 Distribution of SOA mean Sulphur Dioxide 2004

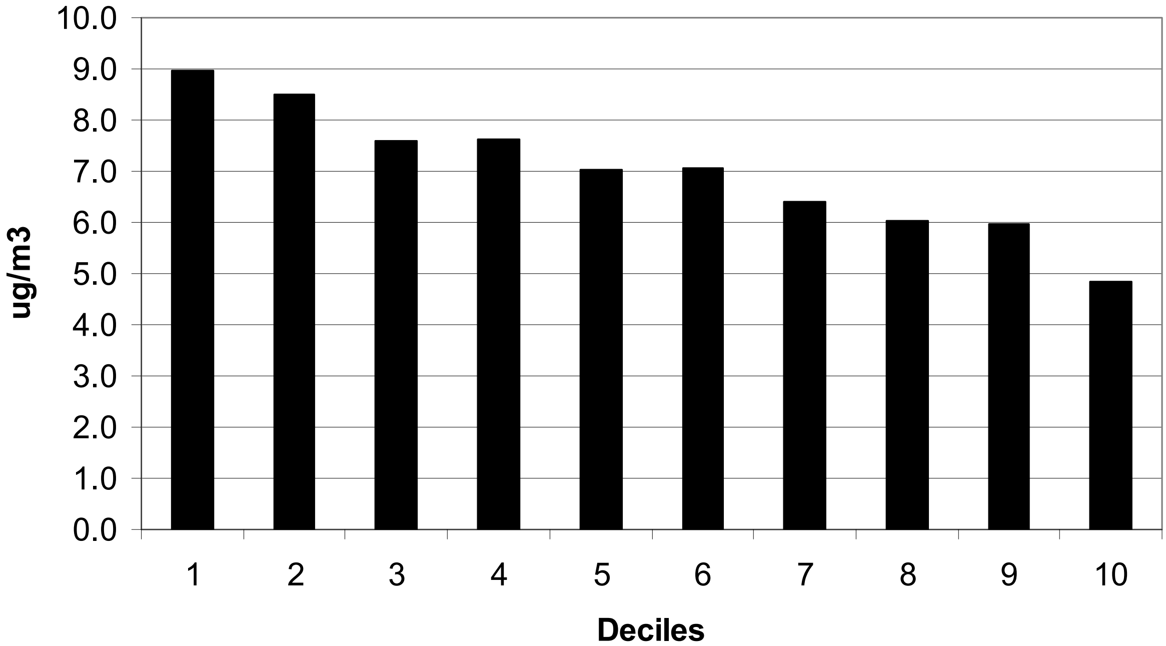


Figure 7.5 Annual mean (2004) concentrations of sulphur dioxide by decile

Table 7.3 Distribution of the highest concentrations of Nitrogen dioxide 2004

Decile	Total Population within area	Population under 16	Population over 60	Decile as a percentage of total population in South Yorkshire	Decile as a percentage of population in worst air quality areas
1	51,990	11,750	9,700	22.7	41
2	30,610	6,200	5,750	16.8	24
3	11,880	1,930	1,990	12.7	9
4	13,820	2,850	2,240	8.9	11
5	9,300	1,570	1,490	10.3	7
6	5,810	940	1,460	9.9	5
7	1,630	290	420	6.5	1
8	1,490	320	220	5.6	1
9	0	0	0	4.0	0
10	0	0	0	2.6	0
	126,530	25,850	23,270	100	100

Note value used to identify 10% of highest concentrations 27.3 $\mu g/m^3$

Table 7.4 Distribution of the highest concentrations of PM_{10} 2004

Decile	Total Population within area	Population under 16	Population over 60	Decile as a percentage of total population in South Yorkshire	Decile as a percentage of population in worst air quality areas
1	52,290	12,460	9,450	22.7	42
2	29,970	6,500	6,040	16.8	24
3	10,280	1,670	2,080	12.7	8
4	13,950	2,820	2,740	8.9	11
5	9,440	1,710	1,700	10.3	8
6	5,750	950	1,360	9.9	5
7	1,630	290	420	6.5	1
8	0	0	0	5.6	0
9	1,730	360	390	4.0	1
10	0	0	0	2.6	0
	125,040	26,760	24,180	100	100

Note value used to identify 10% of highest concentrations 24.6 $\mu g/m^3$

Table 7.5 Distribution of the highest concentrations of sulphur dioxide 2004

Decile	Total Population within area	Population under 16	Population over 60	Decile as a percentage of total population in South Yorkshire	Decile as a percentage of population in worst air quality areas
1	50,820	13,210	9,110	22.7	41
2	28,740	6,500	5,640	16.8	23
3	13,290	2,680	2,990	12.7	11
4	9,210	1,940	1,910	8.9	7
5	6,220	1,250	1,160	10.3	5
6	7,500	1,270	1,730	9.9	6
7	3,060	540	730	6.5	2
8	3,180	560	940	5.6	3
9	3,190	610	780	4.0	3
10	0	0	0	2.6	0
	125,210	28,560	24,990	100	100

Note value used to identify 10% of highest concentrations 11.21$\mu g/m^3$

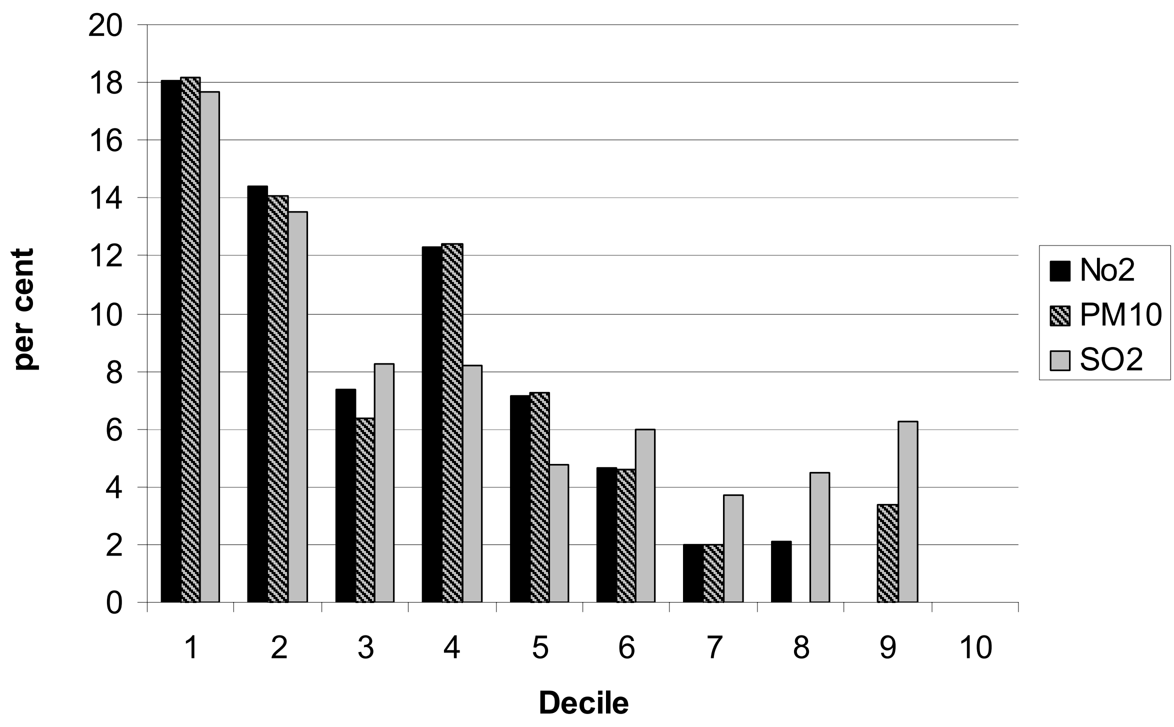


Figure 7.6 Percentage in each decile living in top 10 percent of most polluted areas.

7.4 Discussion

7.4.1 Annual Mean by deciles

Decile 1 (the most deprived) has the highest values for all four atmospheric pollutants experiencing the poorest air quality. (Table 7.2)

Nitrogen dioxide decile values range from 23.4 $\mu g/m^3$ (decile 1) to 18.5 $\mu g/m^3$ (decile 10), although the range is fairly small the highest values are in deciles 1 and 2. All values are below the standard of 40 $\mu g/m^3$ for annual mean concentrations. However individual values for SOAs range from 10.6 to 42.1 $\mu g/m^3$.

Compared nationally, South Yorkshire's air quality is in the mid range for nitrogen dioxide. The general pattern is also similar to the national situation with the exception that people in decile 10 in South Yorkshire experience better air quality than other decile 10 areas in England.

PM_{10} annual mean decile values range from 23 $\mu g/m^3$ (decile 1) to 19.5 $\mu g/m^3$ in decile 10. The more deprived areas suffer marginally poorer air quality. Individual SOA values range from 16 to 31$\mu g/m^3$.

PM_{10} values for many areas of South Yorkshire are high compared to the national average.

PM_{10} values meet the current standard of 40 $\mu g/m^3$ for annual mean concentrations. However in 2010 the standard is tightened to 18 $\mu g/m^3$ and therefore there will need to be considerable efforts just to meet the standard in many parts of South Yorkshire.
Many areas (and people in all deciles) are likely to experience poor air quality, as such this is not so much a question of equity or justice in South Yorkshire, but more an identification that action needs to be taken.

Sulphur dioxide provides the largest range of values from the highest in decile 1 9.0 to 4.8 in decile 10. There is a simple relationship between sulphur dioxide and deprivation, the more deprived the area the higher the sulphur dioxide values. Sulphur dioxide is slightly different from the other pollutants as local sources are particularly important especially around power stations. However, even though there is an inequality in South Yorkshire all values are well below the WHO guideline (50 $\mu g/m^3$ for annual mean concentrations).

Benzene values are very low compared with the standards set, although again decile 1 has the highest value.

7.4.2 Distribution of the highest concentrations of pollutants

Tables 7.3, 7.4 and 7.5 and figure 7.6 all demonstrate that the most deprived population are far more likely to be experiencing the highest level of pollutants.

For Nitrogen dioxide 18 percent of decile 1 live in the areas with the 10 percent of highest values and they make up 41 percent of all people experiencing the highest levels of pollution. Decile 2 has 14 percent of the decile living in the most polluted areas and 24 percent of all people experiencing the highest levels of pollution. People living in deciles 6 to 10 only account for 7 percent of all people living in the highest polluted areas and in fact deciles 9 and 10 have no people living in such areas.

Examination of the age of the population within these areas illustrates that more vulnerable populations (children and pensioners) comprise a significant part of the population. In decile 1 for example just under 12,000 children are living in the area with highest nitrogen dioxide levels. This raises an issue under environmental justice as children cannot easily take action such as moving house to avoid poor air quality. There are also 9,700 people over 60 from decile 1 living in the areas with the highest pollution.

The areas with the highest values for PM_{10} show a very similar pattern to Nitrogen dioxide. Deciles 1 and 2 account for 66 percent of all people living in the most polluted areas. Deciles 6 to 10 only account for 7 percent of the people in the most polluted areas.

Over 12,000 children in decile 1 live in the areas with the highest PM_{10} values. There will need to be a considerable improvement in air quality for PM_{10} values to meet the new standard in 2010 in all of these areas. Donaldson et al (2000) state "There is good epidemiological evidence that asthma symptoms can be worsened by increases in PM_{10} but less evidence at present that PM_{10} increases the likelihood of initial sensitisation and induction of disease, although this matter requires further study."

Decile 1 has the largest percentage of people experiencing the higher levels of sulphur dioxide, accounting for 41 percent of all such people. Deciles 6 to 10 only account for 15 percent of the population in the most polluted areas.

Decile 1 experiences very high levels of inequalities for air quality both in absolute and relative terms compared to the other deciles. Deciles 6 to 10 have very few people living in the areas with the poorest air quality.

8 Local nature reserves

8.1 Introduction

Local nature reserves (LNRs) may be established by local authorities under section 21 of the National Parks and Access to Countryside Act 1949. These habitats of local significance can make a useful contribution to both nature conservation and to opportunities for the public to see, learn about and enjoy wildlife. Local Authorities were required to consult English Nature (now Natural England) who can give practical help and in some circumstances grants and advice on byelaws. PPGs 9 (Nature Conservation) and 17 (Planning for Open Space, Sport and Recreation) are the relevant documents in this regard.

Green space analysis is slightly more complicated than the other datasets due to the multiple roles that green space can have. These include:

a). Providing a place for exercise and recreation – to analyse this function we should have data about access in the dataset. These types of spaces are increasingly important as exercise and recreation is a key method for build up preventative factors in the fight against obesity, cardio vascular disease and diabetes. Such spaces can and have been used for recuperation of patients (Interface NRM 2004, Kaplan 1995, Ulrich et al 1991)

b). Aesthetic qualities particularly linked to issues of mental well being for which access is not essential. Kuo (2001) appraised the effects of nearby nature in reducing mental fatigue for residents in public housing projects in the USA. Residents living in buildings without nearby trees and grass reported more procrastination in facing their major issues and assessed their issues as more severe, less soluble and more long-standing than did their counterparts living in greener surroundings. Aesthetic benefits should not be underestimated; significant differences in recovery times for patients have been noted between those who have a view of a green space compared to those with an internal room (see Kahn 1997 for a review).

c). Modification of the local climate through reducing wind speeds and absorbing radiation and generally reducing temperatures in urban areas (Stupnagel et al 1990).

d). Filtering pollution to improve local air quality for which there is extensive scientific evidence (Beckett et al 1998 provides a useful review). Due to the large leaf areas relative to the ground on which they stand and the physical properties of their surfaces, trees can act as biological filters to remove particulate matter. Particulate matter is an increasing concern of the EU with the recently revised Ambient Air Quality Directive requiring a limit for PM2.5 concentrations for the first time.

e). Increasing house prices in area (e.g. Tyrvainen 1997, Tajima 2003, Hobden et al 2004). Hobden et al (2004) examined house prices over 20 years in suburban Canada. They found that most types of green space increased the value of adjacent properties and that corridors in particular had a significant positive impact on adjacent property values.

8.2 Data sources and methods

Local nature reserve data is readily available. Populations within distances of 500metres and 1 kilometre using a straight line (Euclidean) buffer were analysed. Data was in polygon format and access to these sites is by definition available.

A rural urban analysis for 500m and 1 kilometre is also provided.

8.3 Results

Table 8.1 Populations within 500m of a Local Nature Reserve

Decile	Decile Population	Total	Urban	Rural
Most deprived 1	287,560	31,525	30,839	685
2	212,770	24,693	23,791	902
3	160,770	9,238	9,238	
4	112,600	10,330	10,099	231
5	130,100	10,562	9,434	1,128
6	124,900	11,530	11,527	3
7	82,440	6,611	6,582	28
8	70,580	5,827	5,825	2
9	51,110	18,503	18,503	
Least deprived 10	32,340	7,879	7,879	N/A
South Yorkshire	**1,265,170**	**136,696**	**133,717**	**2,980**

Table 8.2 Percentage within 500m of a Local Nature Reserve

Decile	Population	Total	Urban	Rural
1	287,560	11.0	11.6	3.3
2	212,770	11.6	11.8	8.4
3	160,770	5.7	6.3	0.0
4	112,600	9.2	10.3	1.5
5	130,100	8.1	8.6	5.5
6	124,900	9.2	10.2	0.0
7	82,440	8.0	10.4	0.1
8	70,580	8.3	9.9	0.0
9	51,110	36.2	37.4	0.0
10	32,340	24.4	24.4	N/A
South Yorkshire	**1,265,170**	**10.8**	**11.7**	**2.4**

Table 8.3 CERI Index values for populations within 500m of a Local Nature Reserve

Decile	Total	Urban	Rural
1	1.02	0.98	1.50
2	1.09	1.00	4.67
3	0.50	0.50	0.00
4	0.84	0.87	0.62
5	0.73	0.71	3.12
6	0.84	0.85	0.01
7	0.73	0.88	0.05
8	0.75	0.84	0.01
9	3.72	3.54	0.00
10	2.33	2.14	N/A

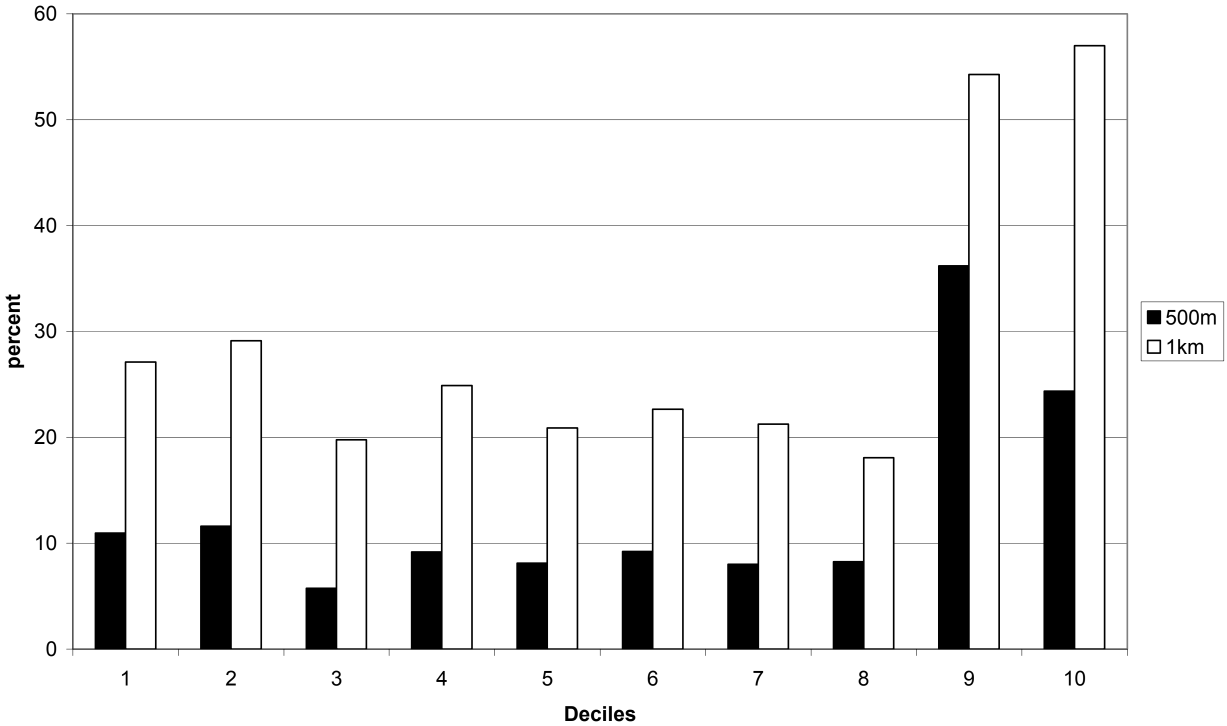


Figure 8.1 Percentage of population within 500 m and 1 km of a Local Nature Reserve

Table 8.4 Populations within 1km of a Local Nature Reserve

Decile	Decile Population	Total within 1km	Urban 1km Total	Rural 1km Total
1	287,560	77,971	76,393	1,578
2	212,770	61,964	60,398	1,566
3	160,770	31,781	31,778	3
4	112,600	28,037	26,789	1,248
5	130,100	27,169	21,143	6,026
6	124,900	28,309	28,219	90
7	82,440	17,532	16,848	684
8	70,580	12,758	12,438	320
9	51,110	27,744	27,744	0
10	32,340	18,429	18,429	N/A
South Yorkshire	**1,265,170**	**331,694**	**320,179**	**11,515**

Table 8.5 Percentage of urban/rural population within 1km of LNR

Decile	Population	Percentage within 1km	Urban %	Rural %
1	287,560	27.1	28.6	7.6
2	212,770	29.1	29.9	14.6
3	160,770	19.8	21.7	0.0
4	112,600	24.9	27.4	8.3
5	130,100	20.9	19.3	29.3
6	124,900	22.7	24.9	0.8
7	82,440	21.3	26.6	3.6
8	70,580	18.1	21.2	2.7
9	51,110	54.3	56.0	0.0
10	32,340	57.0	57.0	N/A
South Yorkshire	**1,265,170**	**26.2**	**28.1**	**9.2**

Table 8.6 CERI Index values for 1km Local Nature Reserves

Decile	Total 1km	Urban	Rural
1	1.04	1.03	0.80
2	1.14	1.08	1.69
3	0.73	0.75	0.00
4	0.95	0.97	0.90
5	0.78	0.66	5.61
6	0.85	0.87	0.08
7	0.80	0.94	0.35
8	0.68	0.75	0.27
9	2.17	2.09	0.00
10	2.24	2.09	N/A

8.4 Discussion

Local Nature Reserves are by definition accessible and ten per cent (136,000 people) of the population in South Yorkshire live within 500metres of one. The lowest value percentage is in decile 3 (5.7 percent) and the highest in decile 9 at 36.2 per cent. (Tables 8.1 and 8.2)

Examination of the CERI values (Table 8.3) indicates that deciles 1 and 2 have an equitable number of people living within 500 meters of a Local Nature Reserve. People living in decile 10 are more than twice as likely to be living near to a Local Nature Reserve. People in decile 9 are more than three times more likely to be living near to a Local Nature Reserve than the rest of the population.

Local Nature Reserve designation often seems to be used as a way of preserving green space in urban environments and this is reflected in the difference between the urban value (11.7 per cent of the population) and rural value (2.4 percent of the population) living near such reserves (Table 8.2).

Over 330,000 people live within 1 kilometre of a Local Nature Reserve in South Yorkshire (Table 8.4). This amounts to 26 per cent of the total population, values range from 18 percent in decile 8 to 57 per cent in decile 10. The pattern is fairly similar to that for the distance of 500 metres, Deciles 1 and 2 have an equitable share, deciles 3 to 8 have a less than equitable share. Deciles 9 and 10 are more than twice as likely to live within 1km of a Local Nature Reserve. The results in chapters 8, 9 and another studies (Fairburn et al 2005) all provide evidence to suggest that living near to green space is seen as desirable, and people having been willing to pay more for housing in such areas (GLA 2003).

9 Woodlands

9.1 Introduction

Woodlands are another type of green space which provides a multitude of benefits (see also chapter 8). Wooded areas in urban environments will be increasingly important as a means of modifying the local effects of climate change. Specifically they will help to lower the temperature in the surrounding neighbourhood (the effect will depend on the size, shape and other characteristics of the woodland) and will offer a place of refuge to escape to for those living outside any local affect. English Nature (2005) reports on early results of the ASCCUE project, this found that the surface temperature of woodland in Greater Manchester was 12.8 degrees cooler than that of a town centre.

Open access woodlands also provide a space for recreation and physical activity. This links in with the Governments agenda (specifically the Wanless Report and Choosing Health) on raising physical activity as a mean of preventing illness and reducing the occurrence of coronary heart diseases, diabetes and obesity. Healthy Environments (2005) was a joint statement from the Environment Agency, English Nature, Forestry Commission, RSPB, The Wildlife Trust and the Woodland Trust. This states that "All people wherever they live, whatever their age, their social background, their circumstances or their financial resources should have the opportunity to enjoy the benefits offered by the natural environment."

Woodlands also act as a trap for particulates and other pollution improving local air quality (Stupnagel et al 1990, Beckett et al 1998 provides a useful review). In urban areas they also absorb rainfall runoff and act as a store for flood water and so can form part of a sustainable urban drainage system (SUDS).

9.2 Data sources and methods

The National Inventory of Woodlands and Trees (NIWT) is the most definitive dataset for woodlands and is compiled by the Forestry Commission. Using the guidance in section 2.5 we have examined all woodland within 500m and 1km that is greater than 2 hectares. Limitations within the dataset mean there is no information on access therefore the figures produced are a theoretical maximum when considering recreation. However trees produce many other benefits which are not dependent on physical access.

The category Young Trees (Feat code 11) were also extracted to indicate new woodlands, no size criteria was used on this part of the analysis as so many of the parcels were smaller than 2 hectares.

Distance was calculated using a straight line (Euclidean) buffer, with a rural urban analysis also provided. A more sophisticated attempt at distance analysis is described in Chapter 10.

9.3 Results

Table 9.1 Population within 500m of woodlands greater than 2 hectares

Decile	Decile Population	Total 500m	Urban	Rural
Most deprived 1	287,560	93,049	85,812	7,237
2	212,770	82,431	78,025	4,406
3	160,770	50,585	46,412	4,173
4	112,600	46,770	40,359	6,411
5	130,100	62,982	51,312	11,670
6	124,900	65,719	59,299	6,420
7	82,440	50,076	40,087	9,989
8	70,580	50,306	42,177	8,129
9	51,110	38,555	37,216	1,339
Least deprived 10	32,340	26,297	26,297	N/A
South Yorkshire	**1,265,170**	**566,770**	**506,996**	**59,774**

Table 9.2 Percentage within 500m of woodlands greater than 2 hectares

Decile	Decile Population	Percentage 500m	Urban %	Rural %
1	287,560	32.4	32.2	34.7
2	212,770	38.7	38.6	41.2
3	160,770	31.5	31.7	28.6
4	112,600	41.5	41.3	42.8
5	130,100	48.4	46.8	56.7
6	124,900	52.6	52.3	56.3
7	82,440	60.7	63.3	52.2
8	70,580	71.3	71.9	68.0
9	51,110	75.4	75.2	83.7
10	32,340	81.3	81.3	N/A
South Yorkshire	**1,265,170**	**44.8**	**44.5**	**47.5**

Table 9.3 CERI Index for population with 500m of woodland greater than 2 hectares

Decile	Total 500m	Urban 500m	Total	Rural Total 500m
1	0.67		0.67	0.69
2	0.84		0.84	0.86
3	0.67		0.68	0.57
4	0.92		0.92	0.89
5	1.09		1.06	1.24
6	1.20		1.20	1.21
7	1.39		1.46	1.12
8	1.65		1.67	1.50
9	1.73		1.74	1.78
10	1.85		1.87	N/A

Table 9.4 Population within 1km of woodlands greater than 2 hectares

Decile	Decile Population	Total 1km	Urban	Rural
1	287,560	195,242	180,136	15,106
2	212,770	160,552	152,710	7,842
3	160,770	118,920	107,495	11,425
4	112,600	88,557	76,487	12,070
5	130,100	111,545	92,863	18,682
6	124,900	110,741	101,600	9,141
7	82,440	79,290	62,398	16,892
8	70,580	68,740	56,975	11,765
9	51,110	50,369	48,769	1,600
10	32,340	32,336	32,336	N/A
South Yorkshire	**1,265,170**	**1,016,292**	**911,769**	**104,523**

Table 9.5 Percentage within 1km of woodlands greater than 2 hectares

Decile	Decile Population	Total percentage 1km	Urban %	Rural %
1	287,560	67.9	67.5	72.5
2	212,770	75.5	75.6	73.4
3	160,770	74.0	73.5	78.4
4	112,600	78.6	78.4	80.5
5	130,100	85.7	84.8	90.8
6	124,900	88.7	89.5	80.1
7	82,440	96.2	98.6	88.3
8	70,580	97.4	97.2	98.5
9	51,110	98.6	98.5	100.0
10	32,340	100.0	100.0	N/A
South Yorkshire	**1,265,170**	**80.3**	**80.0**	**83.1**

Table 9.6 CERI Index for populations within 1km of woodland greater than 2 hectares

Decile	Total 1km	Urban Total 1km	Rural Total 1km
1	0.81	0.81	0.85
2	0.93	0.93	0.87
3	0.91	0.91	0.94
4	0.98	0.98	0.96
5	1.08	1.07	1.11
6	1.12	1.13	0.96
7	1.21	1.25	1.07
8	1.23	1.23	1.21
9	1.24	1.24	1.21
10	1.25	1.26	N/A

Table 9.7 Population within 500m of new woodlands

Decile	Decile Population	Total 500m	Urban 500m Total	Rural Total 500m
1	287,560	18,046	14,147	3,899
2	212,770	8,924	7,916	1,008
3	160,770	8,202	7,956	246
4	112,600	7,182	5,010	2,172
5	130,100	6,803	5,547	1,256
6	124,900	8,409	7,400	1,009
7	82,440	1,467	1,320	147
8	70,580	993	978	15
9	51,110	107	107	0
10	32,340	0	0	N/A
South Yorkshire	**1,265,170**	**60,133**	**50,381**	**9,752**

Table 9.8 Percentage within 500m of new woodlands

Decile	Decile Population	Total percentage	Urban %	Rural %
1	287,560	6.3	5.3	18.7
2	212,770	4.2	3.9	9.4
3	160,770	5.1	5.4	1.7
4	112,600	6.4	5.1	14.5
5	130,100	5.2	5.1	6.1
6	124,900	6.7	6.5	8.8
7	82,440	1.8	2.1	0.8
8	70,580	1.4	1.7	0.1
9	51,110	0.2	0.2	0.0
10	32,340	0.0	0.0	N/A
South Yorkshire	**1,265,170**	**4.8**	**4.4**	**7.8**

Table 9.9 CERI Index population within 500m of new woodlands

Decile	Total 500m	Urban Total 500m	Rural Total 500m
1	1.46	1.28	3.35
2	0.86	0.86	1.24
3	1.08	1.27	0.20
4	1.39	1.18	2.12
5	1.11	1.16	0.76
6	1.48	1.56	1.16
7	0.36	0.46	0.09
8	0.28	0.36	0.01
9	0.04	0.05	0.00
10	0.00	0.00	N/A

9.4 Discussion

Well over half a million people in South Yorkshire live within 500metres of a woodland greater than two hectares, although there is no indication of access.

Populations living within 500metres of woodlands greater than two hectares range from 32 percent in decile 1 to 81 per cent in decile 10 (Table 9.2). With the exception of decile 2, there is a straightforward link between woodland and deprivation, as deprivation increases woodland decreases.

The CERI values (Table 9.3) indicate that people in deciles 1 and 3 are a third less likely to be living near to such woodlands compared to the rest of the population. The highest value is recorded for decile 10 where people are 85 percent more likely to be living near such wooded areas.

There is little variation within deciles when examining the rural and urban populations; the biggest difference is ten percent in decile 5. Overall 44 percent of the urban population and 47 percent of the rural population live within 500 metres of woodlands that are greater than two hectares in size.

Eighty per cent of the population lives within 1 kilometre of a woodlands greater than two hectares (Table 9.5). Values range from 67.5 percent in decile 1 and increase up to 100 per cent in decile 10. Again there are only fairly small differences between the rural and urban population. The CERI values indicate that it is decile 1- 4 that are under provided and deciles 5 -10 that are more likely to be near such woodlands.

The new woodlands of all sizes (Tables 9.7, 9.8 and 9.9) are a subset of the dataset as describe in the methodology. The range of values is quite small from 0 per cent in decile 10 to 6.7 per cent in decile 6. The CERI values are very useful here in helping to explain what has happened. Firstly, decile 1 and 6 are 50 percent more likely to have such woodlands compared to the rest of the population. Secondly, looking at the overall values it is the more deprived deciles that have benefited from the planting of new woodlands.

We need to be careful when looking at the rural urban numbers due to the very small numbers involved. However we can say the following; in the rural population it is decile 1 that has benefited overwhelmingly from new woodlands (over three times as likely to be near to them compared to the rest of the population), decile 4 and decile 3 have also benefited.

The pattern of results for South Yorkshire are similar to the pattern that was found for Scotland (Fairburn et al 2005). Again it was the least deprived that had the lowest amounts of woodland near them, rural deprived areas had benefited most from new planting, but the actual numbers involved were fairly small.

10 Green space: a case study approach in Barnsley

10.1 Introduction

Barnsley was selected as a case study to explore methods of assessing environmental inequality in more detail for green space. Green space analysis in general is best done at the local authority level for the following reasons.

1. Local authorities tend to have the best datasets available.
2. Local authorities are responsible for devising green space standards in their authority.
3. Local authorities have many ways of influencing provision and use of green space.

10.2 Methodology

Use was made of the standards in Barnsley's Green Space Draft Strategy (see tables 10.1 and 10.2) to carry out two types of analysis. The first analysis was a straight line analysis which showed few patterns in the results. For the local green neighbourhood space there was some indication that the less deprived were less likely to meet the standard, but the numbers involved are fairly small. It may well be that this type of analysis starts to meet limitations once the absolute numbers of population become fairly small in individual deciles.

The second type of analysis used a network methodology to more accurately calculate the distance to the type of green spaces. This methodology is computationally intensive and requires a high degree of skill to set up. The urban population were assessed against three standards (the exception being local neighbourhood green space). An example in the outputs is provided illustrating how values can be calculated for individual wards and producing such values would allow some targeting of more deprived areas if that was the policy aim.

Table 10.1 Types of green space in Barnsley

Category of green space	
Local neighbourhood green space	A casual area of open space to meet local recreation needs. Whilst often not equipped, they may have some play equipment like goal posts, rebound walls, hard surfaces for basketball or skateboard ramps.
District green space	These typically serve more than one town or village and have facilities for formal and informal recreation.
Borough green space	These serve the whole borough and are major leisure attractions that can accommodate large numbers of visitors.
Regional/sub-regional green space	These serve the whole borough and areas beyond. They are our biggest leisure attractions and can accommodate very large numbers of people.

Table 10.2 Standards for green space in Barnsley

Category of green space	How far you should expect to travel from your house to get to the green space		Our standard for quality
	In urban areas	In rural areas	
Local neighbourhood green space	400metres	800 metres	Local standard. Minimum size: 0.2 hectares in size
District green space	800 metres	1,200 metres	Green flag standard. Minimum size: one hectare in area
Borough green space	3,000 metres	5,000 metres	Green flag standard
Regional/sub-regional green space	5,000 metres	5,000 metres	

Within Barnsley deciles 1 through 8 of population is present, but the population is very much skewed towards the more deprived (Table 10.3).

Table 10.3 Barnsley population classified by the Index of Deprivation and rural/urban categories

Decile	Total population	Urban	Rural	Percentage urban	Percentage rural
1	56,589	44,521	12,068	78.7	21.3
2	42,314	39,378	2,936	93.1	6.9
3	39,870	35,347	4,523	88.7	11.3
4	24,225	21,163	3,062	87.4	12.6
5	24,673	21,671	3,001	87.8	12.2
6	16,288	10,800	5,487	66.3	33.7
7	8,647	2,969	5,678	34.3	65.7
8	5,619	0	5,619	0.0	100.0
Barnsley	218,225	175,850	42,374	80.6	19.4

10.3 Results

Table 10.4 Urban population in Barnsley meeting green space standards

Decile	Decile Urban Population	800m of District, Borough or Regional green space	3000m of Borough or Regional green space	5000m of Regional green space
1	44,521	15,971	28,898	15,804
2	39,378	13,905	16,620	5,802
3	35,347	11,626	20,606	16,843
4	21,163	8,925	11,625	10,417
5	21,671	6,588	8,015	5,519
6	10,800	2,573	6,529	5,998
7	2,969	56	1,407	1,407
Barnsley	175,850	59,644	93,700	61,790

Table 10.5 Percentage of urban population in Barnsley meeting green space standards

Decile	Decile Urban Population	800m of District, Borough or Regional green space	3000m of Borough or Regional green space	5000m of Regional green space
1	44,521	35.9	64.9	35.5
2	39,378	35.3	42.2	14.7
3	35,347	32.9	58.3	47.7
4	21,163	42.2	54.9	49.2
5	21,671	30.4	37.0	25.5
6	10,800	23.8	60.5	55.5
7	2,969	1.9	47.4	47.4
Barnsley	**175,850**	**33.9**	**53.3**	**35.1**

Table 10.6 Ceri values for urban population meeting green space standards

Decile	800m of District, Borough or Regional Green space	3000m of Borough or Regional green space	5000m of Regional green space
1	1.08	1.32	1.01
2	1.05	0.75	0.36
3	0.96	1.12	1.49
4	1.29	1.04	1.48
5	0.88	0.67	0.70
6	0.69	1.14	1.64
7	0.05	0.89	1.36

10.4 Discussion

Table 10.4 and 10.5 illustrate that a third of the urban population is within the standard distance for district and regional green spaces, and over half the urban population is within distance of borough green space. There is not much of a consistent pattern in the overall results as is illustrated by the CERI values (Table 10.6)

For this methodology to be successful the following conditions need to be met
1. A large population within the local authority.
2. As many national deciles as possible represented in the local population.
3. Careful consideration of the absolute numbers of people in any decile.

This methodology will only be a preliminary step because proximity to green space is only one factor in determining use and attractiveness of green space. For two decades local authorities have tended to concentrate on producing quantity (exemplified by low maintenance grass area with little if any functionality) over quality in terms of green space provision. Such a policy was largely a result of repeated cuts to recreation and outdoor budgets within local authorities.

Fears of crime, design of green space, functionality are all important in terms of influencing the use of green space and so contributing to a public health agenda. Therefore studies which looked at usability issues and usability levels would be needed to fully assess the provision of green space for local populations.

11 Cumulative impacts in South Yorkshire

11.1 Introduction

The cumulative impact of poor environments on population has long been recognised as an area of concern in environmental justice studies. In the United States the "cocktail" impact of a local plant emitting hundreds of different emissions is regularly cited by campaigners as one of their biggest concerns. However there have been few studies examining this issue, Krieg and Faber 2004 state "the environmental justice literature is characterized by a failure to effectively measure overall impact from an extensive range of ecological hazards. Limitations on available data make this a serious problem for present and future studies." pg 667.

Krieg and Faber's 2004 research in the Commonwealth of Massachusetts has some interesting features. Firstly, it is one of the few attempts at assessing environmental justice in a cumulative manner. Secondly they provide a ranking of different hazards which they say were favourably reviewed by the regulator and other researchers, Table 11.1

Table 11.1 Hazard weightings for sites in Massachusetts

Type of hazard site	Points for severity of site
Hazardous waste site (general)	1
Hazardous waste site (Tier I – II)	5
EPA-NPL (Superfund) waste site	25
Large power plant –top 5 polluter	25
Small power plant	10
Proposed power plant	5
TURA industrial facility	5
Municipal incinerator	20
Resource recovery facility	10
Incinerator ash landfill	5
Demolition landfill	3
Illegal site	5
Sludge landfill	5
Tire Pile	5
Municipal solid waste landfill	5
Trash transfer station	5

Investigating cumulative impacts from an environmental justice perspective is no easier in the UK, a recent review stated "There are currently no standard definitions of 'cumulative' or 'multiple' impacts nor standard approaches to their measurement" Environment Agency (in press b pg 5).

In fact cumulative and multiple impacts are used interchangeably in the literature with little agreement on a clear definition. However a usable set of definitions is provided in Environment Agency (in press b):

1). Multiple: exposures to several different substances at the same time. Example, farm worker exposure to different pesticides at a single point in time.

2). Cumulative: exposure to the same substance over time leading to a cumulative outcome. Example the build up of PCBs in breast milk.

3). Multiple and cumulative: exposures to many different substances over time leading to multiple and cumulative outcomes e.g. housing on contaminated land.

One of the issues when investigating impacts is that even within single variables such as IPPC sites is that we have to assume that all sites have an equal impact, even though we know this is not the case.

Furthermore, although we know that some sites have more emissions than others and have the data it does not necessarily follow that more types of emissions is worse than a different smaller number of emissions in terms of health impacts.

Even greater difficulties are encountered when trying to assess different types of environmental variable. For example, which has the greater impact, living in a flood zone or living near to an old landfill site? The simple fact is that there is no definitive, scientific answer to such a question. Different groups will experience the impacts differentially, for example someone who cannot afford house insurance maybe more worried about the flood event than someone who has insurance. Furthermore, risk perception amongst the public is well known to often differ drastically from expert opinion (Slovic 2001).

In this study we have the additional issue of dealing with good and bad environmental impacts. To what extent does living near to green space or woodlands offset the impact of living near to a pollution source?

In the UK Ben Wheeler (2004) created an air quality index that was additive utilising government air quality standards. This work was adapted by Fairburn for the Indices of Multiple Deprivation (2004). There are only four components to the index which is based on annual mean standards and the index is heavily biased by the values for Nitrogen dioxide and PM_{10}. For this study we have reproduced the methodology used by Fairburn to bring the air quality index up to date, this data has been provided to the Environment Agency.

It may well be that concentrating on health impacts is itself part of the problem. The impacts of poor environments or facilities are often economic, impacting in particular on house prices. Hedonic pricing models have been used to examine the effects of landfills and green space on house prices (see other chapters).

11.2 Potential Methodologies

This is a preliminary study so we provide several potential approaches have been provided to examine the issue of multiple and cumulative impacts.

Every address has been 'tagged' in the study area to indicate whether it is affected by the features examined in this report. For example, a postcode is tagged to indicate whether it is within one kilometre of a landfill site.

Four potential methods of assessing cumulative/multiple impacts in South Yorkshire are suggested. Methods 1 and 2 are interim methods that were carried out during this study. Methods 3 and 4 are other more comprehensive approaches that could be developed after this project.

11.2.1 Method 1 – Impact intensity score

The first approach begins by assuming all environmental impacts are equal. We can calculate a maximum impact by calculating the following:

Number of households in super output area multiplied by the number of environmental impacts

we can also calculate

The sum of the number of affected households for each environmental impact.

Using these two calculations we can create a score for the super output area. A worked example illustrates the stages of calculation, assuming there were only five houses in an area and there are five different types of environmental impact.

a). Five houses multiplied by five impacts produces a maximum potential impact score of 25.

b). Calculate number of house affected by each impact

Environmental impact 1 – number of houses affected 2
Environmental impact 2 – number of houses affected 3
Environmental impact 3 – number of houses affected 1
Environmental impact 4 – number of houses affected 1
Environmental impact 5 – number of houses affected 3

c). Calculate sum of affected households, in this case 10.

d). Divide the sum of affected households (10) by the maximum potential impact score (25) and multiply by 100 to produce a score of 40.

Each SOA has a score between 0 and 100.

One feature of this method is that it produces a score for the SOA as a whole, but it may include some postcodes which were only affected by one environmental impact. This is still valid as the unit is the super output area and we are recording the total number of different environmental impacts.

Possible components of overall score

- Households in flood zone 2
- Households in flood zone 3
- Households within 1 kilometre of non active landfill sites
- Households within 1 kilometre of active waste sites
- Households within 1 kilometre of multiple active waste sites
- Households within 1 kilometre of industrial pollution sites
- Households within 1 kilometre of multiple industrial pollution sites
- Households in the top 10 percent for Nitrogen dioxide
- Households in the top 10 percent for PM_{10}

This provides nine environmental bads in total in calculating the score. Method 4 below may be a way of resolving how to deal with good and bad environmental factors together.

11.2.2 Method 2 – Percentage of households per SOA experiencing multiple impacts

The second approach assumes that all environmental impacts are equal. It involves a fairly simple calculation which is to provide the percentage of households in the SOA that are experiencing multiple impacts. Only addresses that experienced more than one impact are included in the calculation. This is a tighter definition than method two.

Methods one and two are very much interim approaches until a more comprehensive approach can be devised. As stated in method 3 this could encompass stakeholder consultation and participation, but such a process could be aided by presenting the results of methods one and two.

11.2.3 Method 3 – Incorporating public consultation

The data from this project has been made available to the Environment Agency (see Appendix 1). This could form the basis of public consultation and participation with the public and other stake holders. Through such a process it may be possible to arrive at a weighting or ranking for different variables according to their importance. These rankings or weightings could then be combined into an overall index or score. It would then be a fairly simple process to create a set of maps and lists indicating which areas are experiencing poor and good environments. Such a process would of course be limited by the data and variables that are available.

11.2.4 Method 4 – Beyond indices

It would be useful if this type of work could move beyond the use of indices. It is possible that too much emphasis has been placed on reducing complex situations to a single number to satisfy Treasury or other requirements. The problem with using an index is that very different areas may produce the same final value and as such working out the policy or strategy of such areas requires either for the index to be deconstructed or for the same policy to be applied across very different areas regardless.

Instead of using indices or scores it may be much more useful to group similar areas together based on a range of data. To achieve this we would need to evaluate use of a range clustering techniques such as:

1). Unsupervised neural networks (also known as self-organising map).
2). MIR-Max a two stage information theoretic clustering algorithm.
3). A probabilistic clustering method known as Generative Topographic Mapping.

The Environment Agency has already used such techniques to classify and manage river quality in the UK using a tool developed at Staffordshire University (see Walley et al 1998, Walley & O'Connor, 2001).

The advantage of this approach over indices is that it is likely to be very much more useful in management, monitoring and policy decisions if the experience of managing river systems is anything to go by. This last method is beyond the scope of this project, but should be considered for later projects.

11.3 Results

Table 11.2 Cumulative impact scores using Impact Intensity Score (method 1)

		SOA Score								
Decile	**Total SOAs**	**0**	**≥ 0 and < 10**	**≥ 10 and < 20**	**≥ 20 and < 30**	**≥ 30 and < 40**	**≥ 40 and < 50**	**≥ 50**	**Average Score**	**Maximum Score**
1	193	6	18	45	42	33	19	30	29.25	74.49
2	142	10	19	35	28	24	14	12	24.09	73.54
3	108	3	13	38	16	21	13	4	23.67	64.63
4	75		14	22	25	12		2	19.30	70.48
5	88	2	15	35	16	14	2	4	19.44	55.61
6	84	4	14	39	15	7	5		17.45	49.68
7	55	2	16	23	9	2	2	1	14.44	52.83
8	47	5	13	18	7	2	2		13.39	41.13
9	32	5	11	11	4	1			10.59	33.33
10	21	9	8	2	2				4.28	20.46
South Yorkshire	**845**	**46**	**141**	**268**	**164**	**116**	**57**	**53**	**21.42**	**74.49**

Figure 11.1 Impact Intensity Score (Method 1) for South Yorkshire

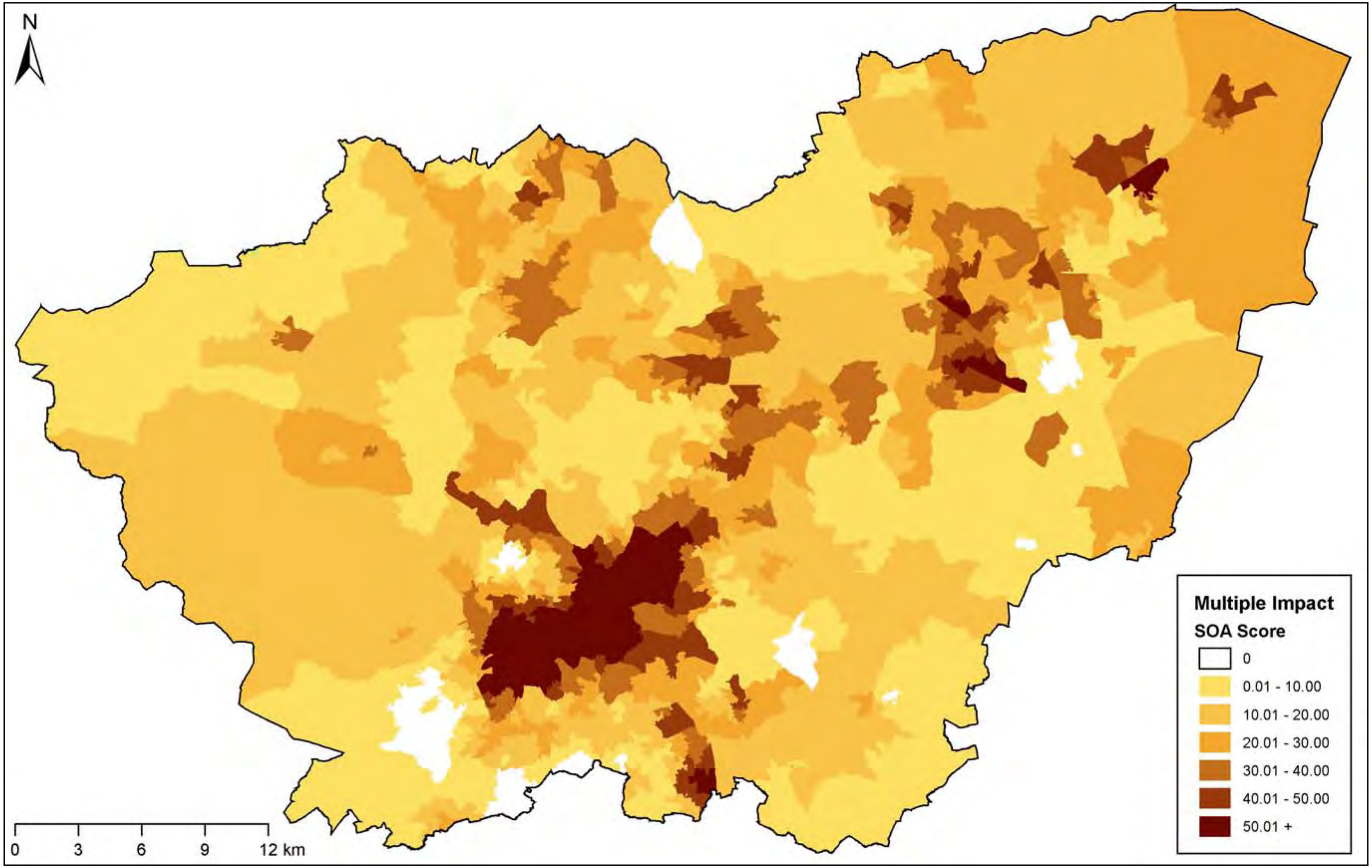


Figure 11.2 Percentage of households per SOA experiencing multiple impacts in South Yorkshire

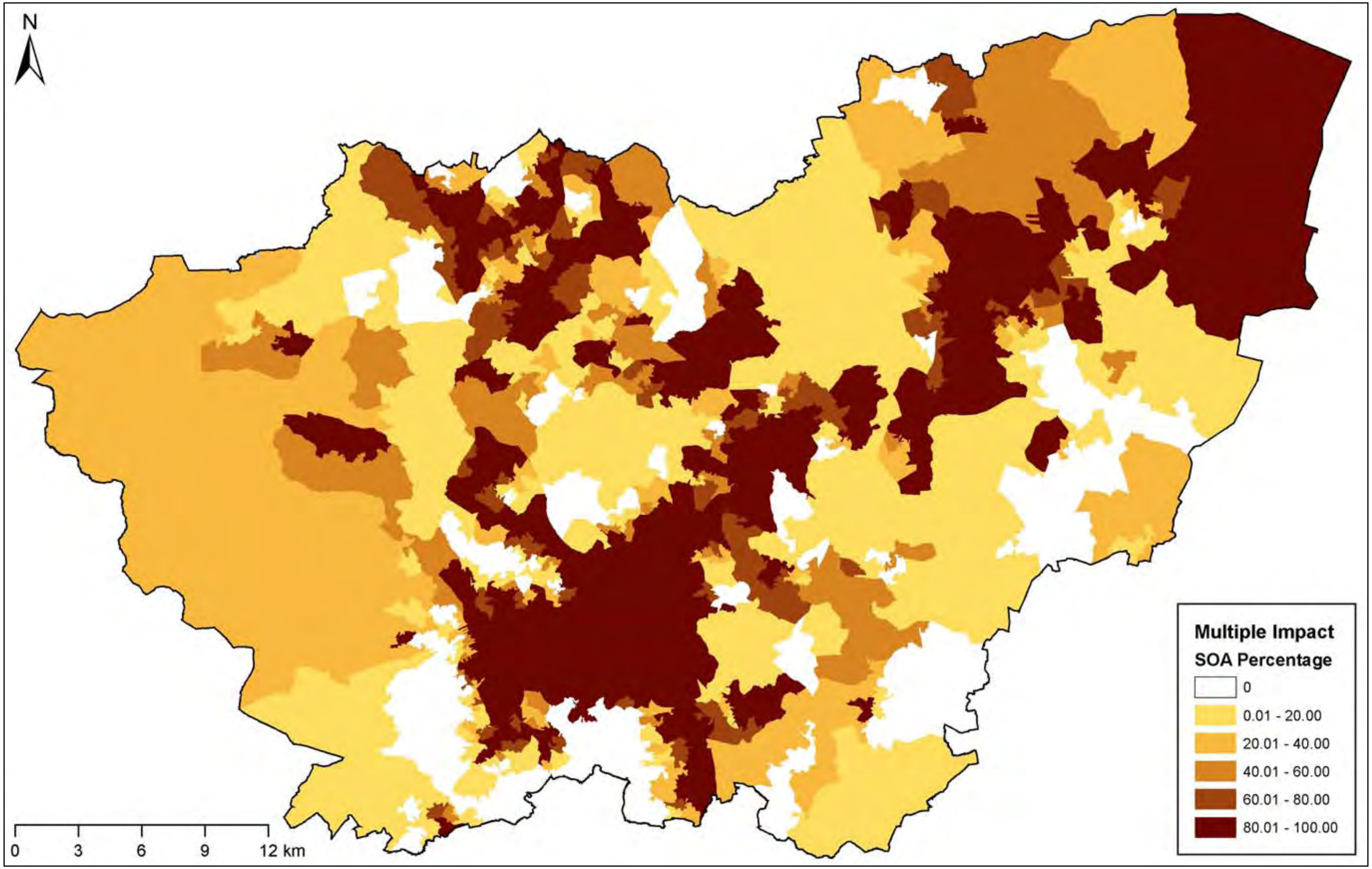


Figure 11.3 Addresses experiencing five or more impacts in South Yorkshire

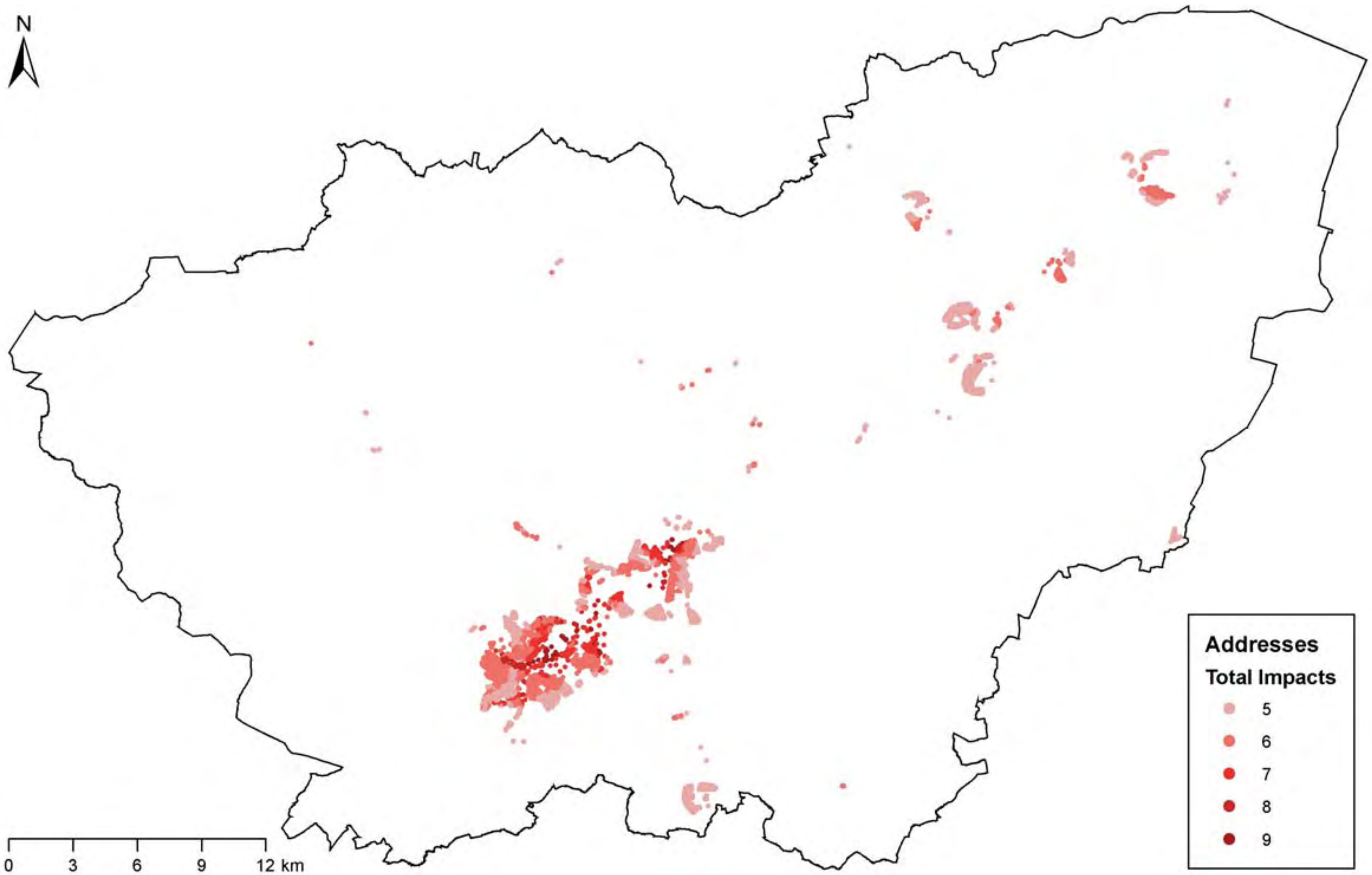


Table 11.3 Percentage of each deciles SOAs achieving different Impact Intensity Scores

Decile	Total SOAs	0	≥ 0 and < 10	≥ 10 and < 20	≥ 20 and < 30	≥ 30 and < 40	≥ 40 and < 50	≥ 50
1	193	3.1	9.3	23.3	21.8	17.1	9.8	15.5
2	142	7.0	13.4	24.6	19.7	16.9	9.9	8.5
3	108	2.8	12.0	35.2	14.8	19.4	12.0	3.7
4	75	0.0	18.7	29.3	33.3	16.0	0.0	2.7
5	88	2.3	17.0	39.8	18.2	15.9	2.3	4.5
6	84	4.8	16.7	46.4	17.9	8.3	6.0	0.0
7	55	3.6	29.1	41.8	16.4	3.6	3.6	1.8
8	47	10.6	27.7	38.3	14.9	4.3	4.3	0.0
9	32	15.6	34.4	34.4	12.5	3.1	0.0	0.0
10	21	42.9	38.1	9.5	9.5	0.0	0.0	0.0
South Yorkshire	**845**	**5.4**	**16.7**	**31.7**	**19.4**	**13.7**	**6.7**	**6.3**

Table 11.4 Scores for percentage of households per SOA experiencing multiple impacts (Method 2)

Populations

						Population affected by 'x' impacts			
Decile	**Decile Population**	**No Impacts**	**1 or more Impact**	**Single Impact**	**Multiple Impacts**	**2**	**3**	**4**	**5 to 9**
1	287,560	30,180	257,380	61,696	195,683	61,252	53,050	30,400	50,981
2	212,770	34,989	177,781	58,754	119,028	35,529	38,516	23,972	21,011
3	160,770	16,916	143,854	51,709	92,145	29,979	28,470	25,945	7,751
4	112,600	18,055	94,545	33,796	60,749	33,181	19,376	3,903	4,289
5	130,100	19,965	110,135	43,321	66,815	34,941	18,349	7,410	6,115
6	124,900	21,724	103,176	48,855	54,321	30,741	12,050	8,217	3,313
7	82,440	20,181	62,259	34,350	27,909	18,808	3,209	3,842	2,050
8	70,580	19,521	51,059	29,553	21,506	14,386	2,375	4,484	261
9	51,110	17,635	33,475	21,704	11,772	9,109	2,561	102	0
10	32,340	23,477	8,863	5,505	3,358	3,210	148	0	0
South Yorkshire	**1,265,170**	**222,643**	**1,042,527**	**389,242**	**653,285**	**271,134**	**178,102**	**108,275**	**95,773**

Table 11.5 Scores for percentage of households per SOA experiencing multiple impacts (percentage) (Method 2)

Decile	Population	No Impacts	1 or more Impact	Single Impact	Multiple Impacts	2	3	4	5 to 9
1	287,560	10.5	89.5	21.5	68.0	21.3	18.4	10.6	17.7
2	212,770	16.4	83.6	27.6	55.9	16.7	18.1	11.3	9.9
3	160,770	10.5	89.5	32.2	57.3	18.6	17.7	16.1	4.8
4	112,600	16.0	84.0	30.0	54.0	29.5	17.2	3.5	3.8
5	130,100	15.3	84.7	33.3	51.4	26.9	14.1	5.7	4.7
6	124,900	17.4	82.6	39.1	43.5	24.6	9.6	6.6	2.7
7	82,440	24.5	75.5	41.7	33.9	22.8	3.9	4.7	2.5
8	70,580	27.7	72.3	41.9	30.5	20.4	3.4	6.4	0.4
9	51,110	34.5	65.5	42.5	23.0	17.8	5.0	0.2	0.0
10	32,340	72.6	27.4	17.0	10.4	9.9	0.5	0.0	0.0
South Yorkshire	**1,265,170**	**17.6**	**82.4**	**30.8**	**51.6**	**21.4**	**14.1**	**8.6**	**7.6**

11.4 Discussion

Tables 11.2 and 11.3 provide the results for the Impact Intensity Score. There is an actual data range of 0 to 74.79 (a maximum score would be 100) where zero represents no impacts. Higher multiple impacts scores (greater than 30) are clearly skewed towards the more deprived in general and decile 1 in particular. Areas with low impact scores are clearly skewed toward the less deprived with nine of the super output areas in decile 10 recording a score of zero. This pattern is also reflected in the average score for the deciles with scores decreasing from decile 1 down to 10 (with a small exception between deciles 4 and 5).

Results for method 2 (percentage of households per SOA experiencing multiple impacts) are reported in Tables 11.4 and 11.5. This is a stricter definition of multiple impacts than method 1. The striking issue about the results is the **very wide range of values between deciles**. For example, only 10.5 percent of the population in decile 1 experience no impacts compared to 72.6 percent in decile 10. Within decile 1 68 percent of the population experience multiple impacts (the highest number) and there is a general decrease in the numbers affected down through to decile 10 at 10.4 percent. Within decile 1 17.7 percent of the population achieve a score of 5 to 9 impacts, with the next highest value in decile 2 at 9.9 percent.

Figures 11.1 and 11.2 illustrate the spatial distribution in South Yorkshire using the two methods.

Figure 11.2 can be slightly misleading in terms of the amount of population affected in parts of the map due to the large variation in the physical size of super output areas despite them having similar size populations. For example, the North East of the map is heavily shaded but has a fairly small population. Figure 11.3 provides another way of presenting the data by mapping individual addresses, however in urban areas this may also be misleading as due to the scale of the map many points can sit on top of each other. A series of inset maps showing greater detail is presented on the poster (See Appendix 1).

These results from methods 1 and 2 are a preliminary investigation into multiple impacts in South Yorkshire and could be improved upon by access to better and more data. Even then such methodologies would be open to critique; for example no account is taken of the severity of different impacts and some may disagree as to whether individual factors were having any impact at all or whether the correct distance was chosen when establishing a buffer size. Combining these methods with public consultation and qualitative methods could refine or even reject methods 1 or 2.

Multiple impacts using both methods (1 and 2) clearly illustrate that it is the more deprived populations experiencing most impacts and population in decile 1 (the most deprived) is particularly affected.

12 Conclusions

This project has provided an initial view of the spatial and social distribution of environmental quality in South Yorkshire. Although there are limitations to the study (see chapter 2 especially) **the evidence clearly indicates an unequal distribution of environment quality in South Yorkshire with more deprived areas experiencing poorer environments**.

In South Yorkshire the more deprived populations in general and the most deprived in particular are most likely to be experiencing a poor environment. These finding are similar to other environmental justice studies in the UK (e.g. Walker et al 2003, Fairburn et al 2005) which also found siting of facilities and poor air quality to occur disproportionately in deprived areas. Furthermore the population in South Yorkshire as a whole is very skewed towards the more deprived nationally in general.

Whilst the evidence of directly measurable health effects remains unclear, there is a common public perception that waste and polluting sites are generally seen as undesirable. Criticism of proximity studies often comes from a technical, expert point of view focusing on high profile epidemiological issues (such as cancer rates). As was reported in section 2.7 there is little chance of the detailed epidemiological studies being carried out that would resolve this question. If health is the focus for environmental justice then studies may well be need to be refocused to examine the environment as a stressor and its impact on psychosocial issues (Gee and Payne-Sturges 2004).

If environmental inequalities of the siting of facilities is to be reduced in South Yorkshire then consideration of the socio-economic characteristics of the population surrounding proposed sites needs to be part of the decision making process. A parallel report Addressing Environmental Inequalities: Waste Management (EA14426 Environment Agency in press b) addresses the social and policy implications of waste management in greater depth. To redress or correct inequalities around the siting of undesirable facilities would require some new thinking in terms of planning policy and the use of regional spatial strategies.

Proximity to woodlands in South Yorkshire shows a similar pattern to that which was found in Scotland (Fairburn et al 2005). Again the most deprived have the lowest levels of overall woodland near to them, but more recent planting is slowly redressing the situation. Although new woodlands are now being planted in more deprived areas, the overall results suggest that the amount of resources allocated to planting of new woodlands will need to be sustained (or more likely increased) if the inequality is to be further reduced.

Local Nature Reserves are just one type of green space, but they are particularly important as they are decided locally, have guaranteed access and provide an indicator of quality. Local Nature Reserves are two to three times more likely to occur in the least deprived areas (deciles 9 and 10) in South Yorkshire. For the equivalent sites in Scotland (known as local nature designated sites) decile 10 had a much higher value than the rest of the population (Fairburn et al 2005). However with South Yorkshire the two most deprived deciles do have a fair share of proximity to Local Nature Reserves.

Both the woodlands and Local Nature Reserve results would seem to indicate that the population at large values such facilities. Socio-economic status is often reflected in the housing market and while we have not been able to study house prices it would be surprising if South Yorkshire differ from other areas in this regard.

13 Recommendations

13.1 Developing and improving data

Similar to most environmental justice studies in the UK this study has been constrained to some extent by the availability of data to carry out this project. None of the datasets were designed or collected to aid environmental justice and in part this explains the caveats and limitations we have had to apply in the report.

Our understanding of environmental justice could be increased by improving the data in the following ways:

1. Modelling point data sources as areas. Spatial data is usually modelled as point data as it is quick and convenient. However as is shown in the report (see landfill chapter) it can significantly underestimate the population actually living near to the facility being modelled. The issues surrounding some of the datasets are as follows:

a). Integrated Pollution sites are generally long standing entities that will be regulated by the Environment Agency for the foreseeable future. There are currently 164 of these sites in South Yorkshire. Having these sites modelled correctly in a GIS would presumably aid other parts of the Environment Agency responsible for regulating them. Some of these sites are also probably of interest to the Health and Safety Executive and possible the Health Protection Agency.

b). Waste management sites from the REGIS database. There are currently 304 active sites in South Yorkshire used in this analysis. In total there are 387 sites in the database which includes past sites. Modelling these correctly would also aid later environmental justice studies as time analysis of population and sites may give greater insight into how the distribution of sites arose.

It should be fairly straight forward to use Ordnance Survey data (Mastermap) to pick out the polygons of the sites to create the new datasets. To convert the data to polygon it would make sense to collaborate with Leeds University geography department which runs postgraduate GIS courses, and take on some of the students as a work place project for their course. If Leeds is unable to help then Edinburgh, Leicester and Glasgow universities also offer similar high quality postgraduate GIS courses.

Once the new datasets are created the outputs of this project could be used to carry out an analysis with the new data.

2. There are a number of other environmental factors that could be investigate for environmental justice if suitable data is created or can be acquired from other sources. Examples could include:

a). Derelict land – datasets for derelict land in England are generally poor. However derelict land in a neighbourhood can have clearly negative effects including visual and aesthetic impact on the local area and contributing through this to a poor and stigmatised living environment. In Scotland one third of derelict land is also contaminated and there is a very strong correlation between deprivation and derelict land. Hoke and Burghardt (2001) examined the role of derelict land in Germany finding that it was a source of pollution contributing to PM10 particles in the air.

b). Quarries – When they are working they are generally seen as having a negative environmental impact. However when they come to the end of their working lives many quarries have been converted to either landfill sites or nature reserves.

c). Environmental complaints from the public. There are often problems with trying to make use of this type of data not least locating where the complaint took place, but there may be some useful data in the dataset.

d). Noise mapping has been carried out in some parts of the country, but little if any work has been carried out from an environmental justice perspective.

e). Green space analysis is probably best carried out at the local authority level. Data on access to and utilisation of woodlands could be done at a regional level, but as yet neither of these datasets exists.

f). Air quality, including ozone and examination of air quality data held by local authorities including acute episodes of high pollution concentrations.

3. Further analysis could be carried out on the attribute data held in existing datasets. For example, there are details in the IPC data of when licences were first granted (for use in time-analysis) and the types of emissions or substances allowed.

4. Other methodologies and techniques can be used to investigate environmental justice. For example satisfaction surveys can find out how people feel about their local neighbourhood (liveability) and environmental concerns in general. Focus groups can also be a useful means of finding out what people think are the issues in their local environment.

13.2 Monitoring change over time

If the Environment Agency wants to monitor the effectiveness of policies to reduce environmental inequalities it should be fairly simple to monitor change over time by repeating the types of analysis carried out in this study. It is unlikely that an annual update would be needed as the rate of change on environmental quality is fairly slow.

13.3 Progressing environmental justice in South Yorkshire

The Environment Agency can and should lead on environmental justice in South Yorkshire and help implement Defra's agenda on environmental inequalities (Chapter 6 of Securing Our Future, Defra 2005 is a key driver). However it will achieve greater progress on environmental justice by collaborating with other organisations. Overlapping public agendas such as health, social inclusion, regeneration and environmental justice increasingly require a range of public organisations to collaborate if these issues are to be resolved on a sustainable long term basis for the good of the community. Middleton (2003) writing from a practitioners viewpoint in a local health authority in the West Midlands states

'health, environmental and economic sustainability are inextricably linked and … professionals of different disciplines can work together with the communities they serve to improve local health and quality of life.'

The importance of environmental justice is illustrated by the inter-relatedness of the environment, economy and health of places as recognised by the UK Governments Sustainable Development Strategy (Defra, 2005) which states

'…inheritance of degraded resources has led to social and economic deprivation, as well as a poorer environment and ill health. Improving the local environment is therefore often a starting point for wider regeneration activities.'

1. The Environment Agency should initiate a series of presentations and workshops to disseminate the results of this report and develop environmental justice in South Yorkshire. Existing fora suitable for dissemination of this work include the environment fora in Yorkshire and Humber and the North East, Yorkshire Futures and the North East Regional Information Partnership (the regional observatories) and the Environment Agency's as-hoc Health and Environment Group.

2. Either establish a **technical working group** in the region to examine issues surrounding data, information sharing, and use of GIS for environmental data **or** try and incorporate it into the work of Yorkshire Futures and the North East Regional Information Partnership. NERIP have recently employed Jon Mooney who studied under Gordon Walker and Jon Fairburn for his Phd. He is familiar with many of the technical aspects of this type of work and would prove a useful first contact.

3. Develop a policy to deal with the procedural aspects (communication, consultation and decision making) of environmental justice to address issues arising out of the inequalities found (Poustie 2004 may provide some useful comparative lessons from Scotland). The Environment Agency is currently finalising guidance for staff on how to build trust and work with communities. The Environment Agency is also completing risk research in South Yorkshire which should help communication and public participation in the future.

4. The Environment Agency should also consider exploring the issue of using good neighbour agreements (commonly used in the USA) with existing or any new sites that are generally considered as negative. Illsley (2002) describes one such good neighbour agreement that was used for a waste to energy plant in Dundee.

5. Initiate contact with organisations the Environment Agency can most affectively engage with to promote environmental justice. Organisations which should be considered include:
a). Health Protection Agency
b). The Housing Market Renewal project for Hull and the East Riding of Yorkshire (http://www.gatewaypathfinder.net/).
c). The Health and Safety Executive.
d). The Forestry Commission.
e). Natural England.
f). English Partnerships.
g). Local strategic partnerships.
h). Local authorities.
i). The Regional Development Agency (Yorkshire Forward).

Collaboration will vary between organisations, in many cases it could first involve exchanging datasets and collaborating on technical aspects, joint research projects and possibly joint delivery.

13.4 Future research

Areas for future research by the Environment Agency concerning environmental justice could include the following topics:

1. Investigation of issues surrounding age particularly children. Environmental justice impacts on children are likely to be more significant than adults for the following reasons. Firstly, children's bodies are still forming so exposure to pollution can have a bigger effect than on an adult. Secondly, children have very little opportunity to mitigate any impact, unlike adults who can in many cases choose to move away from an area.

The Children's Health and Environment Action Plan for Europe (CEHAPE) run by the World Health Organisation provides one such driver for action. One starting point for research could be the location of schools with respect to environmental goods and bads. Use could also be made of the Income Deprivation Affecting Children Index (2004) produced for the then ODPM in 2004. A new child well-being index is currently being developed for the Neighbourhood Renewal Unit by Jonathan Bradshaw (York University) and Michael Noble (Oxford University) which should be delivered in June 2007.

2. Investigation of issues surrounding ethnicity and diversity. Results from the 2001 census indicate that the ethnic minority population in Barnsley, Doncaster, and Rotherham is very small totalling only 16,000 across all three authorities. Within Sheffield 45,017 people classified themselves as belonging to an ethnic minority in the last census. Consultation and research with these groups may help to identify environmental concerns and whether they are different from the majority population. Yorkshire Forward has an inclusion project manager (Jasbir Chana) who may be a useful partner for this area of work. The Forestry Commission (David Edwards at Forest Research is the contact) is also finalising guidance for staff on how to engage with diversity issues which may be useful.

3. Investigation of issues surrounding gender. Women are less likely to use green space in general than men due to fear of crime or antisocial behaviour. Policies and strategies to deal with this issue may also address the issue amongst older ages groups who are also less frequent users of green space. Women are also less likely to possess a driving licence than men (61 per cent compared to 81 per cent in 2004) so accessibility to local facilities will be more important to them.

4. In-depth research on hot spots identified by this research would be useful as a means of considering policy formation. This may involve focus groups and other community consultation in affected communities, examination in more detail of the facilities identified in this report and further discussion with local Environment Agency staff.

5. Continue to research the effectiveness of Environment Agency communication and engagement specifically with deprived populations in South Yorkshire.

Appendix 1 Outputs of the project

A range of outputs have been presented to the Environment Agency to develop and extend this work if they wish to. These include

1. An excel spreadsheet of all the results. This is actually larger than the results in the report and includes other calculations such as different groupings of CERI values.

2. A GIS layer in ESRI format of all the addresses for South Yorkshire with associated data generated by this study. This includes distance to different facilities and at different distances. As this data is in the rawest format possible it would be possible to aggregate SOME of the data to other spatial units. **Users should not aggregate the deprivation data to any unit other than super output area**. However all information regarding distance to facilities can be aggregated to other units (e.g. wards). The actual population attached to each point can be aggregated to other units, but users should be aware of the issue of the ecological fallacy and how the data was originally constructed. If a spatial unit larger than a super output area this is a lesser problem due to the low variation in household size over larger areas.

3. A GIS layer for air quality with a cumulative air quality index for South Yorkshire

4. A GIS layer with the multiple impact method scores for each super output area.

5. A pdf document of the report with bookmarks enabled to increase ease of use.

6. A A0 poster (pdf format) providing a summary of results and maps which can be used for public display.

Appendix 2: CERI Index: a worked example

The formula for calculating CERI values is:

$$\frac{DecileX^{at-risk} / DecileX}{Not-in-DecileX^{at-risk} / Not-in-DecileX}$$

The following example shows the calculation of the CERI value for Decile 1 when looking at the population living within 1km of an active waste site. Table Appendix 2.1 shows the results by decile for the population living within 1km of an active waste site.

Table Appendix 2.1 Population within 1km of an active waste site

Decile	Decile Population	Total 1km of active waste site	CERI value for 1km of active waste
1	287,560	154,707	1.74
2	212,770	91,420	1.24
3	160,770	66,207	1.16
4	112,600	32,618	0.79
5	130,100	44,453	0.94
6	124,900	36,182	0.78
7	82,440	13,323	0.43
8	70,580	11,847	0.45
9	51,110	6,583	0.35
10	32,340	0	
South Yorkshire	1,265,170	457,339	

$$\frac{\left(Decile1^{pop1km\_active\_waste} / Decile1^{Total\_pop}\right)}{\left(NotDecile1^{pop1km\_active\_waste} / NotDecile1^{Total\_pop}\right)}$$

$Decile1^{pop1km\_active\_waste}$: This is the population of decile 1 that is within 1km of an active waste site. In this example the population is 154,707.

$Decile1^{Total\_pop}$: This is the total population of decile 1 which is 287,560.

$NotDecile1^{pop1km\_active\_waste}$: This is the sum of the populations within 1km of an active waste site in all deciles other than decile 1. In this example the population is 302,632.

$NotDecile1^{Total\_pop}$: This is the sum of the total populations of all deciles other than decile 1 which is 977,610.

Step 1 in the calculation is to divide $Decile1^{pop1km\_active\_waste}$ by $Decile1^{Total\_pop}$. This gives the proportion of decile 1 that is within 1km of an active waste site. This is as follows:

154,707 / 287,560 = 0.537999

Step 2 is to divide $NotDecile1^{pop1km\_active\_waste}$ by $NotDecile1^{Total\_pop}$. This gives the proportion of the 'total population not in decile 1' that is within 1km of an active waste site. This is as follows:

302,632 / 977,610 = 0.309563

The final step is to divide the result of step 1 by the result of step 2. This is dividing the 'proportion of population in decile 1 within 1km of an active waste site' by the 'proportion of population in all deciles other that decile 1 within 1km of an active waste site'. This is as follows:

0.537999 / 0.309563 = 1.74 (2 decimal places)

This result means that people living in decile 1 are 74% more likely to be within 1km of an active waste site than the combined number of people not living in decile 1.

Appendix 3 Index of Deprivation Domains

Income Deprivation Domain
The purpose of this Domain is to capture the proportion of the population experiencing income deprivation in an area.

- Adults and children in Income Support households (2001).
- Adults and children in Income Based Job Seekers Allowance households (2001).
- Adults and children in Working Families Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
- Adults and children in Disabled Person's Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
- National Asylum Support Service supported asylum seekers in England in receipt of subsistence only and accommodation support (2002).
- In addition, an Income Deprivation Affecting Children Index and an Income Deprivation Affecting Older People Index were created.

Employment Deprivation Domain
This domain measures employment deprivation conceptualised as involuntary exclusion of the working age population from the world of work.

- Unemployment claimant count (JUVOS) of women aged 18-59 and men aged 18-64 averaged over 4 quarters (2001).
- Incapacity Benefit claimants women aged 18-59 and men aged 18-64 (2001).
- Severe Disablement Allowance claimants women aged 18-59 and men aged 18-64 (2001).
- Participants in New Deal for the 18-24s who are not included in the claimant count (2001).
- Participants in New Deal for 25+ who are not included in the claimant count (2001).
- Participants in New Deal for Lone Parents aged 18 and over (2001).

Health Deprivation and Disability Domain
This domain identifies areas with relatively high rates of people who die prematurely or whose quality of life is impaired by poor health or who are disabled, across the whole population.

- Years of Potential Life Lost (1997-2001).
- Comparative Illness and Disability Ratio (2001).
- Measures of emergency admissions to hospital (1999-2002).
- Adults under 60 suffering from mood or anxiety disorders (1997-2002).

Education, Skills and Training Deprivation Domain
This Domain captures the extent of deprivation in terms of education, skills and training in a local area. The indicators fall into two sub domains: one relating to education deprivation for children/young people in the area and one relating to lack of skills and qualifications among the working age adult population.

- Sub Domain: Children/young people
- Average points score of children at Key Stage 2 (2002).
- Average points score of children at Key Stage 3 (2002).
- Average points score of children at Key Stage 4 (2002).
- Proportion of young people *not* staying on in school or school level education above 16 (2001).
- Proportion of those aged under 21 not entering Higher Education (1999-2002).

- Secondary school absence rate (2001-2002).

Sub Domain: Skills
Proportions of working age adults (aged 25-54) in the area with no or low qualifications (2001).

Barriers to Housing and Services Domain
The purpose of this Domain is to measure barriers to housing and key local services. The indicators fall into two sub-domains: 'geographical barriers' and 'wider barriers' which also includes issues relating to *access* to housing, such as affordability.

Sub Domain: Wider Barriers
- Household overcrowding (2001).
- LA level percentage of households for whom a decision on their application for assistance under the homeless provisions of housing legislation has been made, assigned to SOAs (2002).
- Difficulty of Access to owner-occupation (2002).

Sub Domain: Geographical Barriers
- Road distance to GP premises (2003).
- Road distance to a supermarket or convenience store (2002).
- Road distance to a primary school (2001-2002).
- Road distance to a Post Office (2003).

Crime Domain
This Domain measures the incidence of recorded crime for four major crime themes, representing the occurrence of personal and material victimisation at a small area level.
- Burglary (4 recorded crime offence types, April 2002-March 2003).
- Theft (5 recorded crime offence types, April 2002-March 2003, constrained to CDRP level).
- Criminal damage (10 recorded crime offence types, April 2002-March 2003).
- Violence (14 recorded crime offence types, April 2002-March 2003).

The Living Environment Deprivation Domain
This Domain focuses on deprivation with respect to the characteristics of the living environment. It comprises two sub-domains: the 'indoors' living environment which measures the quality of housing and the 'outdoors' living environment which contains two measures about air quality and road traffic accidents.
Sub-Domain: The 'indoors' living environment
- Social and private housing in poor condition (2001).
- Houses without central heating (2001).

Sub-Domain: The 'outdoors' living environment
- Air quality (2001).
- Road traffic accidents involving injury to pedestrians and cyclists (2000-2002).

The methodological steps that were taken to create the IMD 2004 are described in the full report, available at http://www.communities.gov.uk/index.asp?id=1128442

References

Agyeman and Evans (2004) 'Just sustainability': the emerging discourse of environmental justice in Britain? **Geographical Journal** Vol. 170 (2) pp 155-164

Barker G and Graf A (1989) **Principles for nature conservation in towns and cities.** Peterborough, Nature Conservancy Council

Barton H and Grant M (2006) The Health Map, presented at Healthy Communities: Convergence of Public Health and Sustainability Agendas? Seminar UWE Bristol 26th April 2006.

Beckett K P, Freer-Smith P H, Taylor G (1998) Urban woodlands: their role in reducing the effects of particulate pollution. **Environmental Pollution**, 99, 347-360

Bowen W (2002) An analytical review of environmental justice research: what do we really know? **Environmental Management**, 29 (1), 3-15.

Bowling A, Barber J, Morris R and Ebrahim S (2006) Do perceptions of neighbourhood environment influence health? Baseline findings from a British survey of aging. **Journal of Epidemiology and Community Health** Vol. 60 pp 476-483

Box J and Harrison C (1993) Natural spaces in urban places. **Town and Country Planning**, 62 (9), 231-235

Boyle MA &, Kiel KA (2001) A Survey of House Price Hedonic Studies of the Impact of Environmental Externalities. **Journal of Real Estate Literature**, 2001 Vol. 9 pp117-144

Brainard J S, Jones A P, Bateman I J, Lovett A A and Fallon P J (2002) Modelling environmental equity: access to air quality in Birmingham, UK. **Environment and Planning A**, 34, 695-716

Cambridge Econometrics, EFTEC and WRc (2003) **The disamenity costs of landfill**. London, Department of the Environment and Rural Affairs, HMSO.

Chalmers H (2005) Policy profile: addressing environmental inequalities through UK research and policy in **European Environment**. Vol. 15 (6) pp 374-390

Cole R W and Bussey S C (2000) Urban forest landscapes in the UK – progressing the social agenda. **Landscape and Urban Planning**, 52, 181-188

Defra (2002) **Guidelines for Environmental Risk Assessment and Management**. available at http://www.defra.gov.uk/ENVIRONMENT/risk/eramguide/index.htm

Defra (2003) **The Air Quality Strategy for England, Scotland and Northern Ireland**: Addendum.

Defra (2004) **Review of the environmental and health effects of waste management: municipal solid waste and similar wastes.**
Available at http://www.defra.gov.uk/environment/waste/research/health/index.htm

Defra (2005) **Securing the Future – UK Government Sustainable Development Strategy.** The Stationery Office, London.

Defra (2002) **Integrated Pollution Prevention and Control Guidance** available at http://www.defra.gov.uk/environment/ppc/ippc.htm Accessed June 2006

Department of Health (1997) **Communicating About Risks to Public Health: Pointers to Good Practice**

Department of Health (2000) **The health effects of air pollutants**. COMEAP http://www.advisorybodies.doh.gov.uk/comeap/statementsreports/healtheffects.htm

Department of Health (2004) **Choosing Health: Making Healthy Choices Easier**

DETR (2000) **The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Working Together for Clean Air**. HMSO, London.

Dolk H, Vrijheid M, Armstrong B, Abramsky L, Bianchi F, Garne E, Nelen V, Robert E, Scott J E S, Stone D, Tenconi R (1998) Risk of congenital abnormalities near hazardous waste landfill sites in Europe: the EUROHAZCON study. **The Lancet**, 352, 423-427

Dolk H & Vrijheid M (2003) The impact of environmental pollution on congenital anomalies. **British Medical Bulletin** 68:25-45

Donaldson K, Gilmour I M, and William MacNee (2000) Asthma and PM_{10} . **Respiratory Research.** Vol (1): 12–15.

Elliott P, Morris S, Briggs D, Hurt C, de Hoogh C, Maitland I, Richardson S, Wakefield J and Jarup L. (2001) **Birth outcomes and selected cancers in populations living near landfill sites.** Report to the Department of Health, (Imperial College, London). London, Department of Health.

English Nature (2003) **Accessible natural greenspace standards in towns and cities: a review and toolkit for their implementation**. Report number 526. Peterborough, English Nature.

English Nature (Autumn 2005) **Urbio: Urban biodiversity and human nature**. Available at http://www.english-nature.org.uk/pubs/publication/PDF/Urbio10.pdf

Environment Agency (2002) **The urban environment in England and Wales – a detailed assessment.** Bristol, Environment Agency.

Environment Agency (2004) **Environmental Quality & Social Deprivation** (R&D Project E2-067/1/PR 1 & PR2).

Environment Agency (2004a) **Addressing Environmental Inequalities**. Position Statement

Environment Agency (2004b) **Environment and Health**. Position Statement.

Environment Agency (2004c) **Local environmental quality and 'liveability'**. Position Statement

Environment Agency (2005) **Air Quality.** Position Statement

Environment Agency (2006) **Addressing Environmental Inequalities: Flood risk**

Environment Agency (in press a) **Addressing Environmental Inequalities: Waste Management**

Environment Agency (in press b) **Addressing Environmental Inequalities: Cumulative environmental impacts.**

Fairburn J, Walker G, Smith G and Mitchell G (2005) **Investigating environmental justice in Scotland: links between measures of environmental quality and social deprivation**. SNIFFER Available at www.sniffer.org.uk

Gee G and Payne-Sturges D C (2004) Environmental health disparities: A framework integrating psychosocial and environmental concepts. **Environmental Health Perspectives** Vol 112 No 17 pp1645 –1653 Available at http://www.ehponline.org/members/2004/7074/7074.pdf

GLA (2003) **Valuing greenness: greenspaces, house prices and Londoners' priorities**. GLA Economics. London, GLA.

Goodwin J W L, Salway A G, Murrells T P, Dore C J, Passant N R and Eggleston H S (2000) **UK emissions of air pollutants 1970-1998**. National Atmospheric Emissions Inventory. AEA Technology Report AEAT/R/EN/0270. Culham, National Environmental Technology Centre.

Handley J, Pauleit S, Slinn P, Barber A, Baker M, Jones C and Lindley S (2003) Accessible natural green spaces standards in towns and cities. English Nature Research Report 526. Peterborough, English Nature.

Harrison C, Burgess J, Millward A and Dawe G (1995) **Accessible natural green space in towns and cities: a review of appropriate size and distance criteria.** English Nature Research Report 153. Peterborough, English Nature.

Harner J, Warner K, Pierce J & Huber T (2002) Urban environmental justice indices. **Professional Geographer** Vol. 54 (3) 318-331

Health Protection Agency (2005) **Understanding the Burden of Disease; Preparing for the future**. See part 7 for work relevant to this report. Available at http://www.hpa.org.uk/publications/2005/burden_disease/default.htm

Hobden D, Laughton G and Morgan K (2004) Green space borders – a tangible benefit? Evidence from four neighbourhoods in Surrey, British Columbia, 1980 – 2001. **Land Use Policy**, 21, 129-138

Huby M, Cinderby S and Owen A (2005) **Social and environmental conditions in rural areas**.

Illsley B (2002) Good Neighbour Agreements: the first step to environmental justice? **Local Environment** Vol. 7. (1)pp 69-79

Interface NRM (2004) **West Midlands Woodland and Health Pilot Evaluation**

Kaplan S (1995) The restorative effects of nature: toward an integrative framework. **Journal of Environmental Psychology**, 16, 169-182

King K and Stedman J, (2000) **Analysis of air pollution and social deprivation**. Report AEAT/R/ENV/0241. Didcot, AEA Technology Environment.

Kuo F (2001) Coping with poverty – impacts of environment and attention in the inner city. **Environment and Behaviour**, 33, 5-34

Kreig E & Faber D (2004) Not so Black and White: environmental justice and cumulative impact assessments **Environmental Impact Assessment Review** Vol. 24 pp667-694

Lucas K, Walker G, Eames M, Fay, H and Poustie, M (2004) **Environment and Social Justice: rapid research and evidence review**. Sustainable Development Research Network. London, Policy Studies Institute

Middleton J D (2003) Health, environment and social justice. **Local Environment**. Vol. 8, no. 2, pp. 155-165.

Miller D, Adam W, Laing R, Horne P and Morrice J (2004) Decision support tools for strategic planning of greenspaces. **Proceeding of GISRUK 12**, University of East Anglia.

Mitchell G and Dorling D (2003) An environmental justice analysis of British air quality. **Environment and Planning A**, 35, 909-929

Nelson A C, Genereux J, Genereux M (1992) Price Effects of Landfills on House Values **Land Economics**, Vol. 68, No. 4 , pp. 359-365

ONS (Office National Statistics) 2005

OECD (June 2006) **The Social Dimension of Environmental Policy**. Policy Brief

Pheby D, Grey M, Giusti L and Saffron L (2002) Waste management and public health: the state of the evidence - A review of the epidemiological research on the impact of waste management activities on health. Bristol, South West Public Health Observatory.

Planning Policy Guidance 9: Nature Conservation. HMSO

Planning Policy Guidance 17: Planning for open space, sport and recreation. HMSO

Poustie, M. (2004) **Environmental Justice in SEPA's Environmental Protection Activities: A Report for the Scottish Environment Protection Agency.** Glasgow: University of Strathclyde Law School.

Pye S, Stedman J, Adams M and King K (2001) **Further analysis of NO_2 and PM_{10} air pollution and social deprivation**. A report produced for DEFRA, The National Assembly for Wales and The Northern Ireland Department of the Environment. Report AEAT/ENV/R/0865. Didcot, AEA Technology

Reichert A K, Small M & Mohanty S (1992) The impact of landfills on residential property values. **Journal of Real Estate Research** Vol. 7 (3) pp297 - 314

Slovic P (2001) **The Perception of Risk**, Earthscan, London

Spicker P (2001) Poor areas and the Ecological Fallacy. **Radical Statistics** Available on line at http://www.radstats.org.uk/no076/spicker.htm

Stafford M and Marmot M (2003) Neighbourhood deprivation and health: does it affect us all equally? **International Journal of Epidemiology** Vol. 32 (3) pp357 - 366

Stedman J R and Handley C (2001) **A comparison of national maps of NO_2 and PM_{10} concentrations with data from the NETCEN 'Calibration Club'.** AEA Technology Report AEAT/ENV/R/0725. Didcot, AEA Technology Environment, National Environmental Technology Centre.

Stedman J R, Vincent K J, Campbell G W, Goodwin J W L and Downing C E H (1997) New high resolution maps of estimated background ambient NO_X and NO_2 concentrations in the UK. **Atmospheric Environment** , 31, 3591-3602

Stedman J R, Bush T J, Murrells T P and King K (2001a) **Baseline PM_{10} and NO_x projections for PM_{10} objective analysis.** Report AEAT/ENV/R/0726. Didcot, AEA Technology Environment, National Environmental Technology Centre.

Stedman J R, Bush T J, Murrells T P, Hobson, M and Handley C (2001b) **Projections of PM_{10} and NO_x for concentrations in 2010 for additional measures.** Report AEAT/ENV/R/0727. Didcot, AEA Technology Environment, National Environmental Technology Centre.

Stülpnagel A von, Horbert M and Sukopp H (1990) The importance of vegetation for the urban climate. In: Sukopp H (ed.), **Urban Ecology**, 175-193. The Hague: SPB Academic Publishing.

Tajima K (2003) New estimates of the demand for urban green space: implications for valuing the environmental benefits of Boston's big dig project. **Journal of Urban Affairs**, 25, 641-655

Tyrvainen L (1997) The amenity value of the urban forest: an application of the hedonic pricing method. **Landscape and Urban Planning**, 37, 211-222

Tyrvainen L and Miettinen A (2000) Property prices and urban forest amenities. **Journal of Environmental Economics and Management** 39, 205-223

Ulrich R S, Simons R F, Losito B D, Fiorito E, Miles M A and Zelson M (1991) Stress recovery during exposure to natural and urban environments. **Journal of Environmental Psychology**, 11**,** 201–230

United Kingdom Interdepartmental Liaison Group on Risk Assessment (2002) The Precautionary Principle: Policy and Application. Available at http://www.hse.gov.uk/aboutus/meetings/ilgra/pppa.htm#3 accessed May 2006

Vrijheid M. (2000) Health effects of residence near hazardous waste landfill sites: a review of epidemiologic literature. **Environmental Health Perspectives** Vol. 108 pp101-112

Vrijheid M, H. Dolk, B. Armstrong, L. Abramsky, F. Bianchi, I. Fazarinc, E. Garne, R. Ide, V. Nelen, E. Robert (2002) Chromosomal congenital anomalies and residence near hazardous waste landfill sites. **The Lancet**, Vol. 359, Issue 9303, pp 320-322

Walker G P, Mitchell G, Fairburn J and Smith G (2003) **Environmental Quality and Social Deprivation. Phase II: National Analysis of Flood Hazard, IPC Industries and Air Quality.** R&D Project Record E2-067/1/PR1., Bristol, The Environment Agency, 133pp, ISBN 1 8443 222X

Walley WJ & O'Connor MA (2001) Unsupervised pattern recognition for the interpretation of ecological data. **Ecological Modelling** 146, 219-230.

Walley W J, Fontama V N & Martin R W (1998) **Applications of artificial intelligence in river quality surveys.** R&D Technical Report E52 Environment Agency.

Wanless D (2004) **Securing Good Health for the Whole Population.** HMSO

Wheeler B (2004) Health-related environmental indices and deprivation in England and Wales. **Environment and Planning A**, 36, 803-822

World Health Organisation Europe (2004) **Health Aspects of Air Pollution**. Copenhagen, World Health Organisation.

Glossary of terms and abbreviations

Buffer Zone – A zone surrounding the defined feature

CERI - Comparative Environment Risk Index see Appendix 1 for a worked example

Dispersion box model

Decile - A group consisting of 10 per cent of the sample of a distribution when the data is ranked. The bottom 10 per cent would be the lowest decile.

Ecological fallacy - The mistake of assuming that where relationships are found among aggregate data, these relationships will also be found among individuals or households.

Euclidean distance - shortest straight distance between two points

Hedonic Modelling - The most common example of the hedonic pricing method is in the housing market: the price of a property is determined by the characteristics of the house (size, appearance, features, condition) as well as the characteristics of the surrounding neighborhood (accessibility to schools and shopping, level of water and air pollution, value of other homes, etc.) The hedonic pricing model would be used to estimate the extent to which each factor affects the price.

Index of Multiple Deprivation (IMD)

Integrated Pollution Control (IPC)

Office of National Statistics (ONS)

Pollution Prevention Control (PPC)

Polygon dataset - polygon models the extent of the feature under consideration.

Quintile – A group consisting of a particular 20 per cent of the sample of a distribution when the data is ranked. The bottom quintile would contain the first fifth of the sample set.

Radio active substances (RAS)

Scottish and Northern Ireland Forum for Environment Research (SNIFFER)

Super Output Area (SOA)

Tagged – Allocating characteristics to individual addresses or postcodes

Waste Management Licence (WML)

We welcome views from our users, stakeholders and the public, including comments about the content and presentation of this report. If you are happy with our service, please tell us about it. It helps us to identify good practice and rewards our staff. If you are unhappy with our service, please let us know how we can improve it.

GENE0608BODZ-E-E

Would you like to find out more about us, or about your environment?

Then call us on
08708 506 506 (Mon-Fri 8–6)

email
enquiries@environment-agency.gov.uk

or visit our website
www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188

GENE0608BODZ-E-E