The development and use of environmental health indicators for epidemiology and policy applications: a geographical analysis.

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Our discussion will be adequate if it has as much clearness as the subject-matter admits of, for precision is not to be sought for alike in all discussions.... It is the mark of an educated man to look for precision in each class of things just so far as the nature of the subject admits...

Aristotle
(Nicomachean Ethics, Book1, Chapter 2)

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Abstract

This thesis examines the development and use of environmental health indicators for epidemiology, risk assessment and policy applications from a geographical perspective. Although indicators have traditionally been used to examine temporal trends, the development of environmental health indicators (EHIs) may enable comparisons to be made between areas with contrasting environmental health conditions, support efforts to highlight 'hot spots' and facilitate the analysis of spatial patterns in environmental health conditions and health risk.

The use of environmental health indicators is relatively new and little research has been conducted in this area. In the light of this, this thesis examines EHIs in the context of contemporary developments in environmental indicators, health-related and quality of life indicators, and indicators of sustainable development. Essential characteristics and requirements for EHIs are identified and the main areas of application are discussed. In the second part of the thesis, the development and use of EHIs for evaluating exposure to traffic-related air pollution is examined, using GIS techniques. Potential indicators of exposure are identified and these are applied at a range of spatial scales, along with a number of additional measures.

The results of this exercise show that although exposure to traffic-related air pollution is both difficult and costly to evaluate, proxy measures may be used. Pollutant concentrations, for example are frequently used to assess exposure, yet the lack of suitable data may also frequently preclude their use. Whilst other, cruder measures may be used, the relationship between these indicators, measured concentration and exposure is often uncertain. Consequently, EHIs for exposure to traffic-related air pollution may not provide a reliable indication of exposure and health risk. Their use in this area should therefore be undertaken with great caution and attempts made to validate specific measures prior to their use.

At the same time, however, coarser 'upstream' indicators may provide relevant information in a policy context. For use in highlighting areas of concern, raising awareness about environmental health issues and encouraging policies which aim to improve environmental health conditions, ease of data collection and relation to policy may be more important than relation to specific health effects.

Chapter 1: Information and Indicators

Upon this gifted age, in its dark hour
Rains from the sky a meteoric shower
Of facts --; they lie unquestioned, uncombined,
Wisdom enough to leech us of our ill
Is daily spun, but there exists no loom
To weave it into fabric.

Edna St. Vincent Millay (Sonnet CXL)

1.1 The need for information

Reliable, valid, up-to-date information and statistics are essential for supporting policy, monitoring the effectiveness of management, directing research and informing the general public. This is particularly true in the area of environment and health. Recent trends towards public liability and the development of the 'polluter pays' principle have heightened awareness of environmental health issues. Similarly, increased public and private accountability and recognition of the costs of environmental health problems (both the cost of inaction and the cost of inappropriate policy) highlight the need for accurate and reliable information on environmental health issues. Information is required in many different circumstances and applications relating to environmental health. As Quarrie (1992), states:

> "The need for information arises at all levels, from that of senior decision-makers at the national and international levels to the grass-roots and individual levels" (Quarrie 1992 p237).

In line with this increased demand, the past few decades have seen a significant increase in the provision of information relating to the environment and health . The establishment of global, regional and national monitoring networks has greatly improved our ability to observe changes in a wide number of conditions and to assess long-term trends (WHO 1993a). The development of remote-sensing techniques has significantly eased the collection of environmental data in many previously inaccessible areas and has greatly increased the volume of information available. The provision of health data has been similarly improved by the development of computer-based health reporting systems and the evolution of international reporting and classification standards (Corvalán *et al.* 1996). As the availability of raw data has increased, however, members of the public and decision-makers are frequently overwhelmed by its volume and variety. This problem has been referred to as the 'Data-Rich-Information-Poor Syndrome' (DRIPS). MacGillivray (1994), for example, states:

> "There is a lack of information, but, as this report argues, the deficiency lies more in the selection of subjects covered and the quality of the data than the total volume of information. In fact there is an information overload. .....while there is already enough information to understand whether we are moving in the right direction or not, the information needs to be organised, simplified and communicated" (MacGillivray 1994 pp. 7-8).

More appropriate methods of sorting, collating and interpreting information are therefore required. In particular, there is a need to ensure that routinely collected information is appropriate for its intended use and can be condensed or summarised in order to convey the appropriate message. Meeting these needs within time and resource constraints, however, is a major challenge (Corvalán *et al.* 1996).

1.2 An introduction to indicators

Indicators are one means of meeting this information requirement and represent the end product of a lengthy information chain. Measurements produce raw data, combination and publication of data leads to statistics, statistics are translated and applied as indicators (Bakkes *et al.* 1994). The term indicator is derived from the Latin *indicare*, meaning to announce, point out or indicate. Indicators consist of raw data plus a relationship between that data and the issue which the indicator addresses. Indicators therefore represent more than the raw data or statistics on which they are based - they have the power to inform and convey a message about an issue or problem which is not being directly measured. This point is reflected in several definitions of indicators. The Norwegian Environment Ministry, for example, describe an environmental indicator as:

> "A parameter, or a value derived from parameters, which points to/provides information about/describes the state of a phenomenon/environment/area with a significance extending beyond that obtained directly from the observed properties" (Ministry of Environment 1992 p 2).

Similarly, Murnighan (1981) describes health indicators as:

> "statistics selected from a larger pool because they have the power to summarise, to represent a larger body of statistics, or to serve as indirect or proxy measures for information that is lacking" (Murnighan 1981 p 304).

Whilst indicators may be constructed in many different forms, three basic functions can be identified:

- *simplification* - the ability to simplify and condense complex information and ideas;
- *quantification* - the ability to express issues and conditions in quantitative terms;
- *communication* - the ability to tell a story or convey a message about complex ideas and issues.

(after Adriaanse 1993)

Far from being a new concept, indicators are widely used in everyday life. In economics, for example, indicators are used to measure performance and to direct policy (HMSO 1996). The use of indicators is also well-established in many other fields: for example, in the areas of poverty, deprivation, social policy (Jarman 1990, Townsend 1987), ecology and nature conservation (Kent *et al.* 1992, Ludwig & Tongway 1992). Social indicators include direct measures, such as educational expenditure per student or the percentage of households living below the poverty line (Jacksonville Community Council 1993a & 1993b, Alexander 1994) and indirect measures, such as composite deprivation indices (Townsend 1987). In all these areas, indicators are used to fulfil a variety of functions at the community, regional, national and international levels for a wide audience, which includes members of the public, the media, researchers and decision-makers (Hammond *et al.* 1995). These functions include providing objective baseline information, demonstrating spatial and temporal variation in conditions, promoting specific issues and monitoring the effectiveness of policy actions.

Indicators thus have many different uses and applications. In the process of developing indicators, however, three common stages or requirements can be identified:

1. Information which is relevant to the issue in question must be identified and *selected*;
2. The selected information must be *translated* into a coherent form;
3. This information must then be *presented* in a way which is appropriate and accessible.

(Corvalán *et al.* 1996)

Consequently, the choice of indicator must be relevant to the issue under consideration. Most indicators are therefore tied to a specific process or purpose. This may appear self-evident, but needs emphasising because it is related to the central issue of *what* a particular indicator is measuring (whether in fact it tells us about our issue of concern) and *how* it is being measured (whether it is accurate and meaningful). An effective indicator is one which actually indicates what it purports to indicate in terms which are readily understandable to the target audience (Corvalán 1994).

1.3 Environmental health indicators (EHIs)

In the environmental health field, indicators are needed to identify and quantify the environmental factors which impact on human health (WHO 1992a). In this context, the World Health Organisation (WHO) define an environmental health indicator as:

> "An expression of the link between environment and health, targeted at an issue of specific policy or management concern and presented in a form which facilitates interpretation for effective decision-making" (Corvalán *et al.* 1996 p25).

Whilst environmental indicators convey detailed information about environmental hazards, they make no direct or explicit reference to health. Similarly, health indicators describe health trends or health status without making any direct inferences about environmental conditions. What distinguishes EHIs from both environmental indicators and health indicators is the fact that they embody a relationship between environment and health. The extent to which this relationship is quantitative or qualitative depends largely on the intended purpose of the indicator. As previously mentioned, indicators must be relevant to the issue of concern and understandable to the target audience. An indicator designed for quantitative risk assessment, for example, will require accurate, quantitative information on the relationships between environment and health factors. On the other hand, more qualitative information may suffice for indicators designed to raise awareness about environmental health issues.

In evaluating the relationships between environment and health, it is clear that many environmental factors operate through the process of exposure to various physical pollutants, although exposure to other environmental hazards and the effect of numerous factors in the living and working environments are also clearly important. EHIs can therefore be developed from both environmental indicators and health indicators, provided that reference is made to a known or postulated exposure-health effect relationship:

> "It is only through knowledge of this link that an environmental indicator or a health indicator can be translated into an EHI. An EHI is thus an environmental indicator *or* a health indicator *plus* a known exposure-effect relationship" (Corvalán *et al.* 1996 p26).

In the light of this, two types of environmental health indicator can be identified:

- *Exposure indicators* or *Health-related environment indicators (HREIs)*, which give an estimated measure of risk based on knowledge about an environmental hazard and an exposure-effect relationship;
- *Health effect indicators* or *Environment-related health indicators (ERHIs)*, which point to the environmentally attributable portion of a health outcome based on knowledge about an exposure-effect relationship.

Both these types of indicator may be used for a variety of purposes. In recent years, for example, they have been used to support and direct both national and international environmental health policy, to promote local action and awareness in relation to environmental health, to assist in health risk assessment and to aid research in environmental epidemiology. The World Health Organisation has played an important role in this process, and has developed policy-level EHIs for a number of years through several different programmes (WHO 1992b & WHO 1995). This has included the use of EHIs for broad-scale policy (for example, in the Health For All programme and in the production of national indicator sets) (WHO 1985 & WHO 1990b), national and local priority setting and risk assessment (e.g. in National Environmental Health Action Plans - NEHAPs) (Department of the Environment & Department of Health 1996) and for detailed health risk assessment, environmental management and public empowerment (Stephens, Akerman & Maia 1995, Kolsky & Blumenthal 1995). Whilst the character of the indicators developed for these different purposes varies substantially, they all depend to some extent on knowledge about exposure to environmental hazards and their health effects. For many purposes, this understanding might only need to be qualitative. For many purposes, however, EHIs are likely to be more robust and reliable only if they are based upon known and quantified environment-health relationships. In these cases, the development and use of EHIs needs to be underpinned and validated by detailed epidemiological studies.

These relationships are nevertheless often difficult to establish. Many relationships between environment and health are complex, difficult to unravel and poorly understood. Apparent relationships may be confounded by socio-economic and other factors. The relationship between environment and health, and the effect of confounding, may also change over time and between contrasting geographic environments. In addition, the information needed to investigate relationships between environment and health are often scarce. This is especially so in relation to exposure data, which is both difficult and costly to collect. As a result, alternative or 'proxy' measures of exposure may be required (Zapponi 1996). However, the utility of these proxy measures depends on the level of their association with exposure, and many of the proxies currently used need to be tested and validated. In developing EHIs for the applications outlined earlier, therefore, many vital research questions still need to be addressed.

1.4 Medical geography

The study of the environment in relation to health is to a large degree a geographical problem. Environmental hazards vary over space in response to geographic variations in source activities, emissions and the processes of dispersion and accumulation. At the same time, human populations are highly mobile and distributed unevenly over space. Health risks depend on the intersection of these two geographies and the effect of numerous other social, economic and cultural factors which also vary over space. Medical geography is essentially the study of the geography of life and death (Stamp 1964). This includes the examination of geographical aspects of the social, economic and environmental causes of illness and disease and the analysis of geographical variations in the distribution, accessibility and consumption of health care (Howe & Phillips 1983, Jones & Moon 1987, Thomas 1992). The former relates to the traditions of epidemiology (Lilienfeld & Lilienfeld 1980) and disease ecology (Learmonth 1988), the roots of which lie as far back as the fourth century B.C. with the Hippocratic school of healers (Mc Glashan 1972):

> "He who wishes to study the art of healing must first and foremost observe the seasons and the influence each and every one of them exercises.... and further he shall take note of the warm and cold winds.... so should he also consider the properties of the water.... The healer shall thoroughly take the situation into consideration.... Also the way of life which most pleases the inhabitants; whether they are given to wine, good living and effeminancy, or are lovers of bodily exercises, industrious, have good appetites and are sober (Henschen 1966).

This aspect of medical geography is concerned with the spatial distribution of morbidity and mortality and the aetiology of disease (Thomas 1992). Within this area, there are three main types of study which examine geographical variation. Firstly, studies which simply aim to describe the distribution of disease, the results of which are usually presented on maps. Secondly, ecological (or geographical correlation) studies, which aim to describe the relationship between geographical variations in disease and exposure to environmental factors or life-style characteristics. These studies can produce estimates of the health risk associated with different levels of exposure, but these estimates are liable to the effects of confounding factors and only apply to populations, rather than individuals. The third type of study relates to the analysis of migrants. These studies aim to seperate the effects of the environment from individual genetic factors by examining whether risk changes after moving from an area with a certain level of risk to an area with a different level of risk (English 1986).

Analysis of the geography of health care is a more recent development, which stems from concerns over the impact of inequalities in health care and welfare services on morbidity and mortality (Jones & Moon 1987). It has also been fuelled by international comparisons of health, which highlight the differences in distribution and accessibility between alternative health care systems (Johnston 1981).

This thesis focuses on geographical aspects of the relationship between environment and health. Specifically, it is concerned with the development and use of environmental health indicators from a geographical perspective.

1.5 A geographic analysis

Much of the use of indicators has concentrated on the assessment and description of temporal trends, often in relation to policy targets and guidelines. Developing and using environmental health indicators within a geographic framework can help to improve our understanding of the relationships between environment and health and our effectiveness in policy making. It provides a basis, for example, for:

- comparing environmental health conditions in different areas;
- evaluating health risk;
- highlighting 'hot spots' and areas for further study;
- analysing spatial patterns in environmental health conditions;
- directing sparse resources.

In recent years, these sorts of analysis have been greatly facilitated by the development of Geographic Information Systems (GIS). A GIS can be defined as:

> "An organised collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information" (ESRI 1990).

In the context of environmental health, two main uses of GIS can be identified:

- mapping and display of spatial variations in exposure and health outcome;
- analysis of the relationships between environment and health which underpin EHIs.

Both mapping and analysis in environmental health have a long history (English 1996), dating back at least as far as John Snow's seminal study of cholera transmission in London (Snow 1854).

1.5.1 Mapping and display

The mapping and display of information on environmental risk and health outcome is one of the most straightforward uses of GIS. They are, for example, particularly well established in the field of environmental reporting. Europe's most recent report on the environment (the Dobris assessment) relied heavily on the use of the CORINE system, maintained by the European Environment Agency and the GISCO system managed by EUROSTAT (EEA 1995). Appropriate spatial data may be captured by scanning or digitising, whilst attribute data may be entered manually or by importing existing files. The cartographic facilities available in GIS also allow the resulting maps to be displayed in a variety of different ways, thus providing great flexibility in data presentation. In many instances, however, map generation involves more than simply displaying existing information.

Environmental mapping

One of the main areas for the application of GIS in mapping environmental hazards is spatial interpolation (Burrough 1986, Bailey & Gatrell 1995, Briggs 1996, Dunn & Kingham 1996, Briggs 1997). Much pollution data is available in the form of point measurements, for example from established monitoring stations. Spatial interpolation involves using these point values to estimate pollution levels in un-sampled areas. Many GIS packages offer a range of tools for this purpose, such as trend surface analysis (Bailey & Gatrell 1995), Thiessen tessellation (Gatrell & Rowlingson 1995), contouring (Muschett 1981, Bailey & Gatrell 1995) and kriging (Oliver & Webster 1991, Vincent & Gatrell 1991, Campbell *et al.*

1994, Bailey 1995). Liu *et al.* (1995), for example, use kriging in an attempt to estimate 12-hour average concentrations of ozone in Toronto.

The success of these methods, however, depends on a number of factors, including the spatial variability of the pollutant in question, the density of the sampling points used and their distribution. In many cases, spatial interpolation is unsatisfactory, because of the level of spatial variability, or the scale at which pollutant variables are being mapped (Briggs *et al.* 1994). In this event, the interpolation can be improved through the addition of exogenous or covariate information. Covariates are correlated with the pollutant being mapped, but are typically available at a higher density than the pollutant itself.

An extension of this approach is the use of regression modelling, where relationships are established between environmental factors and pollutant concentrations and these relationships are then used to predict pollutant levels in un-sampled areas (Mattson & Godfrey 1994, Wagner 1995, Briggs *et al.* 1997, Pikhart *et al.* 1997). Stedman (1995), for example, uses data on NO_2 concentrations at approximately 300 urban sites along with information on population density, land cover and latitude to estimate pollution levels for every 5 km grid square in the UK.

Another approach is the use of process models, such as dispersion models, to predict spatial variations in pollutants or other hazards. Although GIS would seem to offer powerful tools for such modelling, in practice relatively few attempts have been made to integrate dispersion models with GIS, largely because of the large processing requirements of many models. Collins *et al.* (1994), however, developed a GIS-based air pollution mapping system which integrates the CALINE line dispersion model with ARC/INFO to generate pollution surfaces. The newly developed ADMS pollution model does provide a direct link to the ArcView GIS.

Health mapping

There are numerous examples of the use of mapping in environmental health (Shimada 1981, Howe 1981, Holland 1991). One of the most recent is the European Atlas of Mortality (WHO 1997), which maps environment-related mortality in most of the World Health Organisation European region.

One of the main problems in displaying health data, however, is the fact that they typically relate to administrative areas which vary considerably in size (for example, between urban and rural areas). Some of the most important variations in health may be found in small, densely populated urban areas. If these areas are displayed on regional maps which include large, sparsely populated rural areas, some of the important messages in the data may be lost. GIS, being relatively scale-free (though dependent on the accuracy of the source data), can be used to display health data at the appropriate scale. Geographic techniques such as cartograms (Dorling 1991) may also be useful for displaying such data in a more readily interpretable form.

Nevertheless, it should also be noted that maps of health outcome are often difficult to interpret. In particular, rare health effects are susceptible to the influence of random variation and error, especially in large, sparsely populated areas (Brown *et al.* 1991, Briggs & Elliott 1995, Brown *et al.* 1995). Unless these are recognised, false patterns may be discerned within the maps. In addition, there is a danger that methodological differences and variations in standards between areas being mapped may lead to incomparability between datasets. However, this may only be a problem at larger spatial scales, where for example, data are being integrated from different countries.

The use of GIS to help look for spatial patterns in health outcome is none the less well developed. Individual (point) data, for example, may be distributed at random, or show some degree of clustering in relation to causes (McGlashan 1983, Selvin *et al.* 1988, Bithell 1990). Whilst the use of GIS in attempts to investigate health clusters is problematic (Elliott *et al.*

1995), several examples can be found. Openshaw *et al.* (1988) demonstrate the use of a Geographical Analysis Machine to search for leukaemia clusters in the North of England. In the case of area data, 'map smoothing' techniques may be used to determine whether there is any underlying spatial structure in the data (Clayton & Bernardinelli 1996, Cressie 1992, Bailey 1995). This approach is based on the principle that areas in close proximity to one another are also likely to be similar in terms of health outcome. Briggs et al (1993), for example, use this approach in an analysis of spatial variations of infant mortality in the Huddersfield area.

1.5.2 Environment and health analysis

Whilst environmental and health data may be mapped or displayed independently, they are more commonly used together in some form of overlay and analysis (Tamashiro *et al.* 1981, Thouez *et al.* 1981, Minowa *et al.* 1981). GIS can thus be used to examine the relationship between datasets on environmental hazards and health outcome. This may be on the basis of known or postulated environment-health relationships (Bhopal *et al.* 1994, Gatrell & Dunn 1995), or it may be investigative, with the aim of developing new hypotheses which can later be tested by epidemiological or other methods (Lloyd 1995, Glass *et al.* 1995, Gardner 1996, Elliott *et al.* 1996).

It should, however, be noted that these geographical or 'ecological' studies face a number of limitations. Firstly, in any analysis of health and pollution or exposure, the spatial structure of the two datasets is likely to be different (Briggs & Elliott 1995). GIS can certainly help in this context, for they provide a range of methods for integrating datasets which were constructed at different scales, or which relate to different spatial units, into a common spatial framework - e.g. through the use of generalisation, area weighted interpolation or redistricting techniques (Flowerdew & Green 1994, Fisher & Langford 1995). All such methods are, however, limited by the accuracy and resolution of the source data. In emphasising geographical patterns and spatial variation, geographical studies may also ignore significant variations which occur over time. Finally, geographical studies are affected by the so-called 'ecological fallacy' and the problem of confounding (Greenland & Morgenstern 1989, Richardson & Hémon 1990, Richardson 1996).

As has already been mentioned, exposure is influenced many different factors and is likely to vary considerably between individuals. Many analyses of environment-heath relationships, however, are undertaken at the area level, where measures of pollution or exposure are assigned to groups rather than individuals. As a result, associations in geographical or 'ecological' studies apply to groups rather than individuals. To assume that the relationship between exposure and health risk in groups also applies to individuals is to commit the 'ecological fallacy' (Stimson 1983, English 1996). It should be noted that without data at the individual level, it is not possible to evaluate individual level relationships between environment and health (Thomas 1992).

Ecological studies are also affected by the problem of confounding:

> "Confounding can be thought of as a mixing of the effect of the exposure under study on the disease with that of a third factor. This third factor must be associated with the exposure and, independent of that exposure, be a risk factor for the disease." (Hennekens & Buring 1987).

Observed variations in disease may therefore be due to the effect of confounding variables, rather than exposure. In many cases, the most significant confounding factors are socio-economic (Jolley *et al.* 1996). Lifestyle factors, however, may also be important. GIS can assist in the control of confounding factors by mapping their spatial variation and including them in analyses of exposure and health outcome. Whilst their importance should not be underestimated, ecological studies provide a valuable means of evaluating the relationship between environmental hazards and health outcome.

The importance of the geographical approach, and the advantages of GIS in the study of environmental hazards and health outcome, have been highlighted in this review. As this shows, much is to be gained from applying a geographic approach to the study of environmental health generally, and the development and use of environmental health indicators more specifically. In particular, GIS offer powerful tools for constructing and applying EHIs, both for research and policy purposes.

1.6 Aims and objectives

As the foregoing sections have indicated, Environmental Health Indicators are needed to support environmental health policies, raise awareness in relation to environmental health, assist in health risk assessment and facilitate research in environmental epidemiology. So-called 'exposure indicators' - i.e. measures of exposure which can be used to infer a health effect - have particular importance in this respect, both because they often hold the key to successful epidemiological investigation and because exposure is a vital point in the link between environment and health. Despite these needs, however, little research has been conducted on the concepts and requirements for EHIs. Whilst a wide range of indicators have been developed and applied, relatively few attempts have also yet been made to test and evaluate them.

The purpose of this research is therefore to explore the concepts of EHIs, and within this context, to examine the utility of exposure-based indicators for policy support and health risk assessment, using GIS techniques. Specifically, it aims to determine the extent to which exposure indicators, developed and validated at the local level, can be used to provide information for supporting and informing policy at the sub-national and international level, using the example of traffic-related air pollution and health.

The aims of this thesis are thus as follows:

- to review the development and use of environmental, health-related and quality of life indicators;
- to develop and discuss a conceptual framework for environmental health indicators, identify key selection criteria and outline the main areas of application;
- within this context, to review the use of exposure indicators in relation to one environmental health issue - traffic-related air pollution and health;
- to compare these different exposure indicators by examining their ability to predict monitored concentrations of NO_2 as a marker for traffic-related air pollution at different spatial scales;
- in the light of these results, to examine and discuss the implications of indicator performance on the utility of EHIs for policy support, local action and empowerment, health risk assessment and environmental epidemiology.

1.7 The arguments of the thesis

Following on from this introduction to indicators and EHIs, this thesis examines the development and use of EHIs in more detail. Chapter Two outlines the early development of environmental indicators and illustrates recent developments in the use of environmental, health-related and 'quality of life' indicators. Important issues are highlighted and discussed.

Chapter Three identifies the essential characteristics and requirements for environmental health indicators (EHIs). Attention is also drawn to the way in which EHIs can be used to support and direct national and international policy on environmental health, to promote local awareness and action in relation to environmental health, as part of health risk assessments and as tools for environmental epidemiology. Important issues relating to the use of EHIs are identified and discussed, and the particular importance of exposure as a link in the environment health chain is explored.

Chapter Four explores these issues in more detail by examining the use of exposure indicators in a specific policy area - traffic-related air pollution and health. There is growing evidence of a relationship between environmental factors and health effects: this chapter examines the utility of proxy indicators of exposure to traffic-related air pollution which have previously been used in a number of small scale epidemiological studies. A list of potential indicators which may be used to explore the relationships between traffic-related air pollution and health is presented and discussed.

Chapters Five, Six and Seven apply these indicators, and a number of additional measures, at three different spatial scales. Whilst the utility of many of these indicators has been evaluated at the local level, the extent to which they can be applied at levels of greater spatial aggregation and in other applications is uncertain. In these chapters, NO_2 is used as a marker for traffic-related air pollution, in order to assess the extent to which proxy measures for exposure can be developed. Chapter Five focuses on the use of EHIs at the local level in the Boroughs of Hammersmith and Ealing in London, UK. Chapter Six examines selected areas of England and Wales. Chapter Seven takes a pan-European perspective, drawing on data from across the European Union. The results of these case studies are discussed at the end of each respective chapter, along with implications for using EHIs at each of these spatial scales.

In Chapter Eight, I conclude the thesis by drawing conclusions from the development and application of EHIs. The following specific factors are also discussed: the availability of data to construct EHIs, the extent to which proxies for exposure can be developed, the relationship between EHIs, exposure and health outcome, and the effect of spatial aggregation on indicator utility.

Chapter 2: Environmental Indicators

As a net is made up by a series of ties, so everything in this world is connected by a series of ties. If anyone thinks that the mesh of a net is an independent, isolated thing he is mistaken. It is called a mesh because it is made up of a series of connected meshes and each mesh has its place and responsibilities in relation to other meshes.

Buddha Gautama (Shakyamuni) 6th Century BC.

2.1 Introduction

The contemporary development of environmental indicators stems partly from work which began in the United States and Canada in the late 1960s, centred largely on the construction of air and water quality indices (Inhaber 1976, Ott 1979 & Thomas 1972). The 1960s was a decade in which concern over the direction of development and the future of the environment increased greatly (Meadows *et al.* 1972, Carson 1962, Pepper 1984 & 1996). This concern was manifest in the desire to improve the state of the environment and reduce hazards to human health. There was also recognition of the importance of providing better information to decision-makers and the general public, both to guide policy and to evaluate progress. Ott (1979), for example, highlights the improvements in data availability gained through recent technological advances, and points to the potential use of computers to manage, analyse and process this data in more reliable and efficient ways. Environmental indicators and indices were seen as important instruments in this process by providing a focal point for particular issues and reducing the volume of data needed. According to Train (1972):

> "A limited number of environmental indices, obtained by aggregating and summarising available data, could be used to illustrate major trends and highlight the existence of significant environmental conditions. These indices could provide measures of the success of federal, state, local, and private programs in coping with environmental problems that must be solved" (Train 1972).

Much early work in this field focused on the use of composite indicators, or indices, whilst more recent developments have centred on specific indicators. The relative merits of specific and composite indictors are examined in more detail in the discussion. In explaining the distinction between these types, however, Ott (1979), states the following:

> "The term 'environmental indicator' refers to a single quantity derived from one pollutant variable and used to reflect some environmental attribute. For example, the number of days that observed atmospheric concentrations of sulphur dioxide exceed some fixed ambient air quality standard represents an indicator of sulphur dioxide levels. .....Environmental indicators can be presented individually or they can be mathematically aggregated in some fashion to form an 'environmental index'. An 'index' is a single number derived from two or more indicators" (Ott 1979 p8).

The Council on Environmental Quality (CEQ) was created under the US National Environmental Policy Act in 1969 and was required to produce regular reports on the state of the US environment, to demonstrate trends in environmental quality and describe environmental policy needs. The Council's third annual report included a chapter entitled "The quest for environmental indices" (Council on Environmental Quality 1972), which was based on a survey of indicator-related literature and several specially commissioned studies. It demonstrates increased interest both in measuring environmental conditions and providing useful, timely information.

The examples below are illustrative of the environmental indicators and indices developed during the 1960s and 1970s. They are intended to demonstrate the range of subjects covered, the methodological approaches used and the attendant problems.

2.1.1 The National Wildlife Federation Environmental Quality Index

In 1969, a poll commissioned by the US National Wildlife Federation (NWF) showed that the majority of Americans were concerned about the level of environmental degradation. The NWF's response was to launch an Environmental Quality Index (EQI), which aimed:

> "To reduce reams of information - much of it disjointed at best and some possibly erroneous at worst - into a simple, orderly, graphical representation of environmental conditions. We are persuaded that our EQ index enables the average reader to quickly grasp the overall environmental situation and to 'zero in' on the key issues" (Kimball 1972 pp. 8-9).

The first Index, published in late 1969, covered air, water, soil, forests, wildlife and minerals (living space was added in 1970), each theme being subjectively rated from 0 to 100 (0 being the worst and 100 the best). The themes were then given percentage weightings (20, 20, 30, 5, 5, 7.5 & 12.5 respectively) and combined into a single figure. The Index for 1971, for example, was 55.5. The Index also includes additional textual information which gives the reader background and supporting information on each theme. Whilst the index is clearly subjective in that it relies on expert judgements of conditions rather than objective measurements, it does serve its purpose of communicating general information on environmental conditions and illustrating trends:

> "The EQ is not really an index which aggregates variables but rather a narrative report which discusses the current status of environmental activities in each of these topic areas. Although graphs are presented to illustrate trends in each topic area, the curves are based on subjective estimates rather than actual observations, and the Federation does not claim the curves to be accurate measures of environmental conditions. Although not analytically rigorous, the EQ publication presents a number of striking, and often alarming, facts and illustrations, and the

text provides an instructive discussion of the problems and progress in each environmental topic area" (Ott 1979 pp. 324-325).

The Wildlife Federation Index was by no means the first such aggregated index. Single issue indices were common in newspapers during the 1960s and 1970s and usually related to air pollution. What was unique, was the aim to achieve national coverage, include a wide range of issues to give a more complete, holistic picture of environmental conditions and present the information in a consistent, accessible style (Inhaber 1976).

2.1.2 The National Sanitation Foundation Water Quality Index

In 1970, a Water Quality Index (WQI) was developed at the US National Sanitation Foundation. The aim of the index was to offer:

> "A defined, understandable unit of measure which responds to change in quality of water. The index method, by virtue of its function to combine the results of change in parameter levels, reflects a net quality value which can be observed and meaningfully interpreted (Brown *et al.* 1972 pp. 174-175).

A panel of 74 water quality experts was used to identify significant parameters, relative weightings and quality profiles. The resulting index consists of a number between 0 and 100, with overall quality being judged on a combination of 11 factors: dissolved oxygen, faecal coliforms, pH, 5-day BOD (biological oxygen demand), nitrate, phosphate, temperature, turbidity, total solids, toxic elements and pesticides (the last two being grouped variables). In developing the index, however, the panel found it very difficult to arrive at a measure of water quality without considering the intended use. Despite this, research by O'Connor (1971) and Deininger and Maciunas (1971) highlighted the shortcomings of purpose-specific quality indices and the need for an objective, sensitive general index to communicate water quality status to the general public. Whilst the index is clearly a 'general', rather than a 'specialist' index, it has been widely adopted by state and interstate agencies and is regarded as being effective in responding to changes in water quality and reflecting the success or failure of water quality improvement programmes (Ott 1978 & 1979).

2.1.3 The Canadian Environmental Quality Index

In 1972, a working group consisting of 50 scientists, engineers and administrators was established by the Canadian Federal Department of the Environment with the aim of devising an EQI. It was decided to express all data as a numerical index, with 0 indicating the best environmental conditions and increasing numbers showing increasing deterioration:

> "Accounts of man's environment have tended to be descriptive ("this is a smoggy day") or numerical ("there are x micrograms of sulphur dioxide per cubic meter of air today"). As our knowledge of the environment has become greater, more and more has been put on a numerical basis. The idea then comes to mind of presenting this information in the form of an index - that is, comparing one environmental state to another state, either an optimal state or one which is judged to pose hazards to human beings or other components of the environment. The states to which comparison is made are chosen on the basis of scientific judgement" (Inhaber 1974 p798).

The index was itself made up of sub-indices broken down into four main issues: air quality (in urban, sub-urban and rural areas), water quality (industrial and municipal effluent and ambient water quality), land quality (covering forestry, cities, erosion, access and sedimentation) and miscellaneous aspects of environmental quality (pesticide use and radioactivity). Whilst covering only a limited number of issues, it can be argued that the index fulfils its purpose of communicating information on the state of the environment and the threats to human health. The working group also recognised the changing nature of environmental hazards and saw the need for flexibility:

> "It is probable, even highly likely, that any EQI we devise now, in turn, leaves out areas which will later be incorporated. However, this does not obviate the use of an EQI for telling us that approximate state of the environment now" (Inhaber 1974 p798).

The data in each sub-index were combined using the root-mean-square method, which provides greater sensitivity to extreme values than linear averaging. Weighting of individual factors was based both on scientific opinion of the relative importance of different factors and on the size of the population likely to be affected. The four indices were then combined, giving a relative weighting of 0.3 to air, water and land and 0.1 to miscellaneous factors (i.e. a total value of 1). Although this has the advantage of producing a single number to indicate environmental quality, the remoteness of the final index from the original data questions its validity:

> "The farther we get from original data, the more nebulous the interpretation of the resultant index" (Inhaber 1974 p804).

On the other hand, it can be argued that similar assumptions are made in the construction of other widely accepted indicators and indices, such as GDP. It is therefore important to remember that indices can only provide subjective snapshots or overviews of environmental conditions, based on particular issues or concerns:

> "The value 0.74 for I_{EQI} does not represent *the* measure of the state of the Canadian environment, but rather *a* measure, based on the many assumptions we have made. An analogy to this concept can be drawn from the intelligence quotient and the gross national product. The first is *a* measure of some forms of intelligence, not *the* measure of total intelligence. Similarly, the latter is *a* measure of many goods and services, not *the* measure of all goods and services. However, both quantities can be useful if applied carefully" (Inhaber 1974 p804).

2.1.4 Problems and progress - the development of the Pollutant Standards Index

Whilst significant progress in developing environmental indicators was made during the 1960s and 1970s, a report by the National Academy of Sciences Planning Committee on Environmental Indices (National Academy of Sciences 1975) concluded that insufficient progress had been made thus far. The report called for further research and development work, although it nevertheless stressed the potential of indicators and indices to:

- assist in formulating policy;
- provide a means for judging the effectiveness of environmental protection programmes;
- assist in designing these programmes;
- facilitate communication with the public concerning conditions of the environment and progress towards its enhancement.

In their search to develop a nationally uniform air pollution index (later known as the PSI - or Pollutant Standards Index), the CEQ and EPA commissioned a review of air quality indices by Ott and Thom: *Air Pollution Indices: A Compendium and Assessment of Air Pollution Indices in the United States and Canada* (Thom & Ott 1976). This report examined 11 different air quality indices and found that there were wide variations in the methodologies and ranges used. Although the majority of indices were intended for comparing long-term trends in air quality between different cities, some concentrated on local and short-term variations. In highlighting the diversity between existing indices and the resulting dangers of confusion, they proposed 10 characteristics which a national index should possess:

- be easily understood by the public;
- include major pollutants and be capable of including future pollutants;
- relate to ambient air quality standards and episode criteria;
- relate to federal episode criteria;
- be calculated in a simple manner using reasonable assumptions;
- be based on a reasonable scientific premise;

- not be inconsistent with perceived air pollution levels;
- be spatially meaningful;
- exhibit day-to-day variation;
- have the potential to be forecast a day in advance (optional).

(Thom & Ott 1976)

Whilst a number of these criteria are specific to the purposes of the index in question, they emphasise the importance of ensuring that an indicator or index is capable of performing its intended task. The final version of the PSI included measurements of sulphur dioxide, total suspended particulates (TSP), oxidants, carbon monoxide and nitrogen dioxide. The five descriptor categories ('good', 'moderate', 'unhealthful', 'very unhealthful' and 'hazardous') reflect National Ambient Air Quality Standards (NAAQSs) which are themselves designed to prevent the adverse effects of air pollution on human health. In response to the Clean Air Act Amendments of 1977, the EPA introduced the mandatory use of the PSI in urban areas with over 250,000 inhabitants (Ott 1979).

Between the mid 1970s and the early 1990s, the development of environmental indicators has been less rapid and certainly less visible or audible. Whilst their development has continued in many institutions and organisations, it is only during the last few years that their development has once again been widely promoted and discussed. During this period, there has also been a shift in emphasis, from the development of composite indicators to the construction of indicator sets, comprising a suite of more specific, singular indicators. This shift has been due in part to difficulties in interpreting complex indices, and the need to develop specific policy-related indicators.

2.2 Indicators in the 1990s

A wide range of organisations and agencies at the local, regional, national and international level are now involved in developing environmental, health-related and 'quality of life' indicators. This activity is in response to the information needs outlined in the previous chapter, the requirements of particular policies, and in particular, the need to evaluate progress in achieving sustainable development and meeting the targets established under Agenda 21. A survey of many of these indicator projects can be found in Appendix One. The following review demonstrates the range of indicators currently under development and in use and identifies the main themes and trends.

International Indicators

2.2.1 The Organisation for Economic Cooperation and Development

On the international scene, the Organisation for Economic Cooperation and Development (OECD) has been at the forefront of developing environmental indicators. In response to a request from the G-7 Economic Summit in Paris, 1989, indicators are being developed to:

- measure environmental performance;
- integrate environmental concerns in sectoral policies;
- integrate environmental concerns in economic policies.

(OECD 1991a)

The first outcome from this work was the publication of "*Environmental Indicators: A Preliminary Set*" in 1991 (OECD 1991b). This included 18 environmental pressure indicators, each addressing specific issues (including air pollution, waste, land use, water quality global warming) and 7 sectoral indicators reflecting environmentally significant changes in economics, population, energy use, transport, industry and consumption. Each indicator demonstrates the current situation and, where data are available, shows trends in member countries since 1970. OECD's indicator programme has continued to evolve with the adoption of the Pressure-State-Response (PSR) framework. This is based on the premise that:

> "Human activities exert pressures on the environment and change its quality and the quantity of natural resources (state). Society responds to these changes

through environmental, general economic and sectoral policies (response). The latter form a feedback loop to pressures through human activities" (OECD 1993 p5).

This framework largely reflects the policy-oriented nature of these indicators; each stage echoes a part of the environmental policy cycle, from problem identification, to policy formulation, monitoring and policy evaluation. To ensure that individual indicators are valid for their intended purpose, a number of selection criteria have been identified, based on policy relevance, analytical soundness and measurability. These criteria are listed in Table 2.1.

Table 2.1: OECD Indicator Criteria

Policy relevance and utility for users
• provide a representative picture of environmental conditions, pressures on the environment and society's responses • be simple, easy to interpret and show trends over time • be responsive to changes in the environment and related human activities • provide a basis for international comparisons • be national in scope or applicable to regional issues of national significance • have a target or threshold against which they can be measured
Analytical soundness
• be theoretically well-founded in technical and scientific terms • be based on international standards and consensus about their validity • be capable of linkage with information systems, economic models and forecasting
Measurability
• be based on data which is available, or readily available at an acceptable cost/benefit ratio • be based on adequately documented data of a known quality • be based on data which is reliably updated at regular intervals

Whilst these criteria represent an ideal situation, it is recognised that current data availability falls some way short of this goal. The criteria also reflect OECD's emphasis on indicators to support policy. It should therefore be noted that selection criteria developed for one purpose may not be appropriate for another; in other words, they may be specific to the intended use (Bakkes 1994).

A second publication in 1993 (OECD 1993) outlines indicator development for a wide range of issues, including climate change, eutrophication, waste, urban environmental quality and water resources. For each issue, a range of indicators are listed which reflect the relevant pressures, state and responses. It is recognised that, due to data deficiencies, some of these indicators may only be available in the medium to long-term. Table 2.2 lists the indicators which have been identified for urban environmental quality.

Table 2.2: Urban Environmental Quality Indicators

Framework stage	*Indicators*
Environmental pressures	• urban air emissions; • degree of urbanisation.
Environmental conditions	• urban concentration of SO_2, NO_2, particulates and ground-level ozone; • noise.
Societal responses	• green space as a percentage of total urban area/total urban population; • expenditure on urban mass transit relative to total urban transport infrastructure expenditure; • expenditure on noise abatement.

2.2.2 The United Nations Commission on Sustainable Development

The concept of sustainable development has evolved over the past decade or so through the work of the Independent Commission on International Development Issues (Brandt 1980, Brandt 1983) and the World Commission on Environment and Development (WCED 1987). It is built on the need to develop a long-term approach to development and economic growth to address the growing issues of inequality, poverty and environmental destruction. The importance of human health in sustainable development is also recognised in much of the literature. The very first principle (1 of 27) of the Rio Declaration on Environment and Development, for example, states that:

> "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature" (Quarrie 1992 p.11).

The United Nations Commission on Sustainable Development (UNCSD) is involved in co-ordinating the development of environment and sustainable development indicators to fulfil the obligations described in Agenda 21. Chapter 40 of Agenda 21, which relates to the use of information to support decision-making, highlights the shortcomings of much existing environmental and economic data and lists the following activities which are required:

- development of indicators of sustainable development;
- promotion of global use of indicators of sustainable development;
- improvement of data collection and use;
- improvement of methods of data assessment and analysis.

The importance of information in all areas of application is also emphasised:

> "In sustainable development, everyone is a user and provider of information considered in the broad sense. That includes data, information, appropriately packaged experience and knowledge. The need for information arises at all levels, from that of senior decision-makers at the national and international levels to the grass-roots and individual levels" (Quarrie 1992 p237).

The UNCSD is currently developing a menu of approximately 150 indicators to reflect economic, social and environmental pressures, states and responses (although pressures are referred to here as 'driving forces'). In the longer-term, highly aggregated indicators similar to those advocated by the WRI and the Scientific Committee on Problems of the Environment (SCOPE) are also being developed. Individual indicators are selected on the condition that they are:

- national in scale or scope;
- relevant to assessing progress towards sustainable development;
- understandable - i.e. clear, simple and unambiguous;

- achievable given the constraints of time, logistics and resources;
- conceptually well founded;
- adaptable, open-ended and limited in number;
- broad in their coverage of all aspects of Agenda 21;
- representative of international consensus;
- dependent on readily or easily available good quality data which is updated regularly.

(United Nations 1995)

This work is highly international and involves a wide range of organisations, including the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Children's Fund (UNICEF), the United Nations Centre for Human Settlements (Habitat), the United Nations Conference on Trade and Development (UNCTAD), the International Labour Organisation (ILO), the United Nations Food and Agriculture Organisation (FAO), the World Bank, the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the World Health Organisation (WHO), national governments and both national and international non-governmental organisations (Federal Planning Office of Belgium 1995).

2.2.3 The United Nations Conference on Human Settlements

The 1996 United Nations Conference on Human Settlements (Habitat II) in Istanbul fully endorsed the use of indicators for country reporting as a means to analyse the quality, quantity, availability, accessibility and affordability of shelter. At the first preparatory committee meeting prior to the conference, the following objective was agreed:

> "To strengthen the capacity of institutions at all levels to monitor shelter conditions and urbanisation processes using a minimum set of substantially uniform and consistent indicators" (UNCHS 1995a p7).

The United Nations Centre for Human Settlements (UNCHS) indicators programme highlights the potential use of indicators by residents, city managers, commercial and business organisations, national government agencies, sectoral agencies, NGOs or CBOs and external support agencies. It aims to identify a set of key indicators to measure performance in a wide range of areas and ensure that indicators are regularly and routinely updated and applied (UNCHS 1995b). The indicators themselves are broken down into three main categories: background data, urban indicators (consisting of subsets of socio-economic, infrastructure, transport, environmental and local government indicators) and housing indicators. Within each category a range of key and extensive indicators are listed. Key indicators are those which are available more or less immediately and reflect the highest policy priorities, whilst extensive indicators are less policy relevant and more difficult to collect or define. Key environmental indicators include the percentage of wastewater treated and per capita solid waste generation (UNCHS 1995c). A set of criteria by which existing and alternative indicators may be evaluated has also been established:

- importance for policy - indicators should be relevant to existing or proposed policy;
- comprehensive - the complete 'package' of indicators should provide an overview of the economic, social and environmental health of the city;
- priority - indicators should be chosen to reflect two priority levels: key or extensive;
- easily understood - the indicators should be easily understandable to a wide, non-specialist audience;
- cost-effective and timely - it should be possible to collect the indicators in a cost-effective way on a regular basis;
- measurable - indicators should be able to show the true scale of problems;
- includes most disadvantaged - where equity is a concern, indicators should focus on the most disadvantaged groups, rather than on average income distribution;
- reliable - indicators should be based on sound observation and give a 'true' picture;
- sensitive - indicators should be sensitive enough to reflect real changes, but not fluctuate wildly with minor changes;

- unambiguous - indicators should be clearly defined and refer to a specific objective;
- independence - separate indicators should measure different outcomes;
- available for geographical areas or social groups - indicators which are capable of disaggregation are likely to be applied in a wider variety of circumstances.

2.2.4 The WHO Healthy Cities Project

The WHO Healthy Cities Project, which began in 1985, aims to apply the principles and strategies of Health For All in cities. Strategies for health promotion and models of good practice are developed through external networking and coordinated local action involving public and private agencies, local government and community organisations (Thunhurst 1989, Goldstein 1994). In the European region, agreement has been reached on a menu of suitable indicators through the Working Group on Indicators for a Healthy City (WHO 1990a). These are broken down into five categories: health indicators, health services indicators, environmental indicators, socio-economic indicators and general information. Health indicators include all cause mortality, cause of death and low birth weight. Environmental indicators include measures of air and water pollution, waste, perceived pollution levels, landuse, recreation and transport (WHO 1994a).

2.2.5 The European Union

Under the European Community programme of policy and action in relation to the environment and sustainable development, the European Union is committed to the development of environmental indicators and to improving the supply and quality of information relating to the environment (CEC 1992a). In the 1996 review of this programme, the scope of indicator development was expanded and reiterated:

> "Particular attention will be given to: Promoting the development of environmental indicators, performance indicators on all relevant policy issues as well as indicators for sustainable development as benchmark indicators to

measure progress towards sustainable development and to allow for the setting of objectives and operational targets" (CEC 1996).

The European Commission is now actively pursuing six interrelated actions which relate to indicators and indices:

1. creating a handbook on green accounting;
2. developing a European system of environmental pressure indices;
3. developing integrated economic and environmental indices;
4. developing environmental satellite accounts;
5. research on damage evaluation and monetization techniques;
6. ensuring horizontal coordination.

The environmental pressure indices programme has adopted the pressure-state-response framework and the indices are designed to reflect human activities which are damaging to the environment. Following the policy themes detailed in "*Towards Sustainability*", ten areas are covered: climate change; ozone layer depletion; loss of biodiversity; resource depletion; dispersion of toxics; waste; air pollution; marine environment and coastal zones; water pollution and water resources; urban problems, noise and odours. It is envisaged that between 50 and 100 indicators will be adopted, with weighting and combination methodologies being decided by scientific advisory groups (SAGs) (Eurostat 1994).

The integrated economic and environmental indices will work by combining different economic sectors with the appropriate sectors in the environmental pressure index to show the so-called "emission structure" in environmental pressure equivalents. Thus, for example, it will be possible to show the contributions from transport or agriculture to climate change and, vice versa, which economic sectors are responsible for the most significant proportion of climate change pressure (CEC & Eurostat 1996).

2.2.6 The World Resources Institute

The World Resources Institute (WRI) produces world resources reports every two years which address special topics in detail (WRI 1994, 1996). The 1994-95 report, for example, examined resource consumption, population growth and women, whilst the 1996-97 report concentrated on the urban environment. These reports also contain indicators which summarise essential global trends in eight areas: basic economic indicators, population and human development, forests and land cover, food and agriculture, biodiversity, energy and materials, water and fisheries, atmosphere and climate.

The WRI is currently involved in the development of indicators to support national and international-level decision-making. Highlighting the widespread use of economic and social indicators, they bemoan the lack of appropriate environment indicators and the implications this has for environmental policy issues:

> "There are virtually no comparable national environmental indicators to help decision-makers or the public evaluate environmental trends or assess the effectiveness of national efforts to maintain environmental quality. .....Consequently, environmental policy issues have often been overlooked at the highest levels of national and international decision-making, and virtually nowhere is accountability for environmental decision-making as high as it is for economic and social issues" (WRI 1995 p3).

In the same publication, a model of human interaction with the environment is proposed along with appropriate indicators:

- source - the minerals, food, energy etc. from the environment which are used in economic activity (measured by resource depletion indicators);
- sink - the environmental effects of converting natural resources into products and services through industrial activity (measured by pollution indicators);

- life support - the life-support mechanisms provided by the earth's ecosystems (measured by biodiversity indicators);
- impact on human welfare - effects of polluted air and water and contaminated food on human health and welfare (measured by human impact/exposure indicators).

The proposed methodology involves the selection of approximately 20 primary indicators (which may themselves be aggregations of other indicators). These indicators will be weighted according to expert judgement to reflect their relative importance. For example, the ozone depletion indicator needs to reflect the fact that, whilst the volume of Halon 1301 released is small, it is estimated to be ten times as damaging as CFC-11. In developing human impact/exposure indicators, the need to relate indicators to the size of population affected is emphasised, along with the distribution of exposure between different social and income groups.

The authors also stress the importance of ensuring that indicators are accurate and reliable. Indicators therefore need to be:

- user-driven - they must be suited to their intended purpose and meaningful to both decision-makers and the public;
- policy-relevant - they must relate to policy concerns, demonstrate environmental trends and be easy to relate to policy goals;
- highly-aggregated - they must be limited in number so decision-makers and the public can easily absorb them.

(WRI 1995)

<u>*National Indicators*</u>

Environmental indicators are being developed at the national level in response to both international and national policy developments. They have been in use in the Netherlands, Canada and Norway, for example, since the early 1990s, whilst their development in the UK is more recent.

2.2.7 Netherlands

In the Netherlands, aggregated environmental indicators are being developed which relate to the main issues identified by the National Environment Policy Plan (NEPP) in 1989 and the NEPP-Plus in 1990. Both the policy plans and the indicators share a common framework which consists of themes (i.e. key issues such as climate change or the dispersal of toxic substances) and target groups (i.e. sectors of socio-economic activity such as agriculture, industry or transport). Regional characteristics are described by a region-oriented approach which seeks to maintain the environmental functions of particular areas. This approach stems from recognition of the interrelated nature of environmental issues and the need to adopt a policy-related approach:

> "The current Dutch environmental policy, with its emphasis on the interconnectedness of problems, is characterised by an integrated method, in which the problems, causes and solutions are brought in relation to each other. Substantial additions were made to the compartment-oriented approach, that had so far been the most prevalent, whilst the traditional substance oriented approach was expanded and systematised. .....The sectors, designated as target groups of the environmental policy, are categories of socio-economic activities, which contribute significantly to the burden on the environment and create various forms of environmental pressure. There is a clear connection between themes and target groups. A theme is always influenced by various target groups, whilst, conversely, target groups contribute to more than one theme" (Adriaanse 1993 p3).

The policy plans also include targets for individual themes, target groups and regions based on estimated sustainability limits. These targets accompany the relevant indicators to illustrate trends and demonstrate the effectiveness of environmental policy. The primary audience for the indicators are decision-makers in the public and private sectors, but the aim is also to provide the general public with clear, concise and unambiguous information. The indicators are presented in a highly aggregated form. Themes are presented as a single graph for the main indicator, with secondary graphs showing any relevant sub-indices (which combine to form the main indicator). Detailed information is given both on the components of each sub-index and the means by which they are combined. The indicator for "eutrophication of the environment", for example, comprises combined annual emissions of phosphorus (P) and nitrogen (N) with a weighting factor of 1 for phosphorus and 0.1 for nitrogen. The same approach is also used for target groups, which show the contribution of each group to different policy themes in environmental pressure equivalents.

The Dutch indicators were developed explicitly as environmental policy performance indicators and therefore have certain specific requirements. These criteria have been divided into four areas:

- quality aspects (data quality, accuracy and acceptability of methodology);
- sensitivity in time (the ability to demonstrate trends which reflect medium to long-term effects);
- policy relevance (the indicator methodology must reflect the structure of relevant policies);
- recognisability and clarity (indicators which are simple and clear will have a wide appeal).

(Adriaanse 1993)

2.2.7 Canada

Canada is in the process of developing indicators which provide a comprehensive picture of the state of the environment and indicate trends towards the environmental goals of sustainable development. Three categories of indicator have been developed to reflect these goals:

- environmental component/ecosystem state indicators (which reflect the goal of assuring ecosystem viability);
- environment-related human health indicators (which reflect the goal of protecting and enhancing human health);
- natural economic resource indicators (which reflect the goal of protecting and maintaining the sustainability of natural resources).

(Kerr 1994)

Within each of these categories, issues have been selected from global and national concerns, *Canada's Green Plan* priorities (Canadian Ministry of Supply and Services 1990) and Department of the Environment policies, through consultation with the general public, stakeholders and specialists. Individual indicators have been selected to demonstrate:

- what is happening to the state of the environment and natural resources (measures of environmental conditions);
- why it is happening (measures of human activities or stress in the form of emissions and discharges);
- what is being done about it (measures of management responses, including policies, actions and programmes.

(Environment Canada 1991)

A preliminary set of 43 indicators divided predominantly by environmental media was published in 1991. Over the past few years, the conceptual framework has evolved into a more holistic 'bubble' or ecosystem approach to reflect the complexities and cyclical nature of environmental systems. Since 1992, indicator bulletins have been published which present key indicators for particular issues. These 3 or 4 page leaflets also give supporting information to explain why each issue is important, present background information and discuss trends. For example, the indicator bulletin for stratospheric ozone depletion describes the environmental route of ozone-depleting substances from supply to increased stratospheric ozone levels and finally to increased UV-B intensity, leading to increases in the incidence of skin cancer. The bulletin contains three indicators, which demonstrate environmental pressures and the state of the environment: "domestic supply of ozone-depleting substances", "global atmospheric concentrations of CFC-11 and CFC-12" and "stratospheric ozone levels over Canada" (Environment Canada 1992, 1993, 1994 & 1995).

Within the indicator programme, considerable emphasis is given to ensuring that indicators are effective, through the use of selection criteria. Based on the central need for indicators to be scientifically credible and understandable to the non-specialist, individual indicators should be:

- scientifically valid;
- based on adequate available data;
- responsive to change;
- representative;
- understandable;
- relevant and useful;
- comparable with an appropriate target or threshold;
- national or regional in scope.

(Kerr 1994)

2.2.8 Norway

Environmental quality indicators are being developed in Norway to convey information about the state of the environment and environmental trends to the general public and policy-level decision-makers. Development has centred on a limited number of aggregated indicators which describe environmental stresses and the state of the environment. In recognising that the connections between some stresses and effects are uncertain, some 'speculative' indicators have also been developed to reflect these postulated relationships. A set of provisional indicators broken down by issue was published in 1992. Since that time, quality indicators in particular have been refined. For example, the issue of urban environment, health and noise now includes the indicator 'person-episode-days' (the number of persons exposed to pollution levels above guideline values multiplied by the number of days during which such conditions prevailed). The conceptual framework has also evolved into a four-stage model showing indicators of causes (broad socio-economic driving forces such as road traffic), stress indicators (specific emissions and discharges), environmental quality indicators (for example, the number of people affected by pollutant exceedences) and speculative indicators (such as the number of excess hospital admissions for respiratory diseases postulated) (Alfsen & Saebø 1993). Indicator criteria have also been developed, based on those promoted by the OECD. These have been separated into necessary and recommended characteristics and criteria. The necessary criteria state that indicators should:

- provide a general picture of the environmental situation and any changes;
- provide a basis for international comparisons;
- provide information on long-term trends;
- reflect human-induced changes in the environment;
- function as a basis for environmental policy decisions;
- be sensitive to and give early warnings of changes in the state of the environment.

(Ministry of Environment 1992)

2.2.9 United Kingdom

In the UK, a set of sustainable development indicators has been developed based partly on the objectives set out in the Sustainable Development Strategy (HMSO 1994). The aim of these indicators is to focus both decision-makers and the general public on key issues and to promote environmentally-responsible behaviour. Key objectives, issues and indicators have been identified to reflect the four main aims of sustainable development:

- that a healthy economy should be maintained to promote quality of life while at the same time protecting human health and the environment;
- that non-renewable resources should be used optimally;
- that renewable resources should be used sustainably;
- that the damaging effects of economic activity on the carrying capacity of the environment and on risks to human health and biodiversity should be minimised.

(HMSO 1996)

The conceptual model which underlies the indicators is divided into three sectors: economic (including transport, energy and industry), environmental (including air, water and land) and actors (including administrators, households and enterprises). It is recognised that whilst positive flows in the form of wealth and welfare can pass between the different sectors, they can also exert pressures on one another. The effect of responses in one sector will also pass to the other sectors:

> "Sectors of the economy generate wealth and welfare for households, enterprises, government and other actors in this country and overseas. Economic activity, and indeed households themselves, can however create pressure on the environment, through consumption of resources and output of pollutants. The quality of the environment in turn can impact on the welfare of households and individuals and other actors. The actors respond to changes in the state of the environment, through behavioural and policy changes which either directly affect the environment, or alter the pressure on it from the economic sectors" (HMSO 1996 p9).

Some 120 indicators have been constructed, divided into 21 'families' of issues. Based on this large number, it is hoped to select a more limited number of 'core' indicators.

In outlining what makes a good indicator, a number of criteria are outlined, although it is recognised that it is unlikely that all of these criteria would be met in a single indicator. Ideally, indicators should:

- be representative;
- be scientifically valid;
- be simple and easy to interpret;
- show trends over time;
- give early warning about irreversible trends where possible;
- be sensitive to changes in the environment or the economy;
- be based on readily available data or be available at a reasonable cost;
- be based on data adequately documented and of known quality;
- be capable of being updated at regular intervals;
- have a target level or guideline against which to compare it.

(HMSO 1996)

Local Indicators

Local indicators tend to be oriented more towards quality of life and sustainability issues. They are being used increasingly by community groups, local decision-makers and interest groups, both to voice concerns about local environmental, health and socio-economic issues, and to evaluate progress in achieving sustainable development at the local level.

2.2.10 Sustainable Seattle

In Seattle, USA, sustainability indicators have been developed in response to the issues raised by studies of environmental risks and environmental stewardship (City of Seattle Planning Department 1991, 1992), the Seattle Comprehensive Plan (City of Seattle Planning Department 1993) and to reflect public concerns. It is recognised that sustainability cannot be achieved immediately and that a planned strategy with targets and a means of evaluating progress is needed. A voluntary network and civic forum called Sustainable Seattle has been established with this goal in mind and defines sustainability as the maintenance of the area's long-term cultural, economic and environmental health and vitality (Corson 1994). A report containing 40 proposed indicators of sustainable community was published in 1993 (Sustainable Seattle 1993a &1993b). These were broken down into four broad areas:

- environment (biodiversity, air quality, topsoil loss, wetlands);
- population and resources (population growth, water use, solid waste, energy, transportation, land use, food);
- economy (employment, income, poverty, housing affordability);
- culture and society (infant health, crime, community service, voting, literacy, library use, participation in the arts).

Data for the period 1980 to 1992 are presented for 20 of the indicators enabling long-term trends to be assessed. The trend for each indicator is described as moving towards sustainability (4 indicators), moving away from sustainability (11 indicators) or neither towards nor away (5 indicators). Information is also presented on indicator description definition, interpretation, evaluation and linkages with other aspects of the environment, thus enabling the general public both to understand individual issues and to gain a broader overview of sustainability issues. The public information nature of these indicators is reflected in the criteria which have been used to select individual indicators. They should:

- reflect a basic or fundamental aspect of the community's economic, social or environmental health;
- be understood and accepted by the community as valid;
- have interest and appeal for the local media in monitoring, reporting and analysing trends;
- be statistically measurable in the Seattle area and capable of being compared with other cities or communities.

2.2.11 Jacksonville

In Jacksonville, Florida, indicators have been developed through a quality of life project based on the desire to promote community improvement:

> "The project represents an effort to monitor Duval County's progress on an annual basis by means of selected representative quantitative indicators. Positive trends can be highlighted, recognised, and actively maintained; the beginnings of negative trends can be detected and action taken to ameliorate problems" (Jacksonville Community Council 1993a).

Whilst it is admitted that quality of life is a somewhat vague concept, it was taken to imply a feeling of well being, fulfilment or satisfaction resulting from factors in the external environment (Jacksonville Community Council 1993b). Based on this definition, a model consisting of 9 main elements was developed:

- education (public education, higher education and adult education);
- economy (individual economic well being and community economic health);
- public safety (personal safety, law enforcement, fire protection and rescue services);
- natural environment (the ecosystem, air and water quality and visual aesthetics);
- health (residents health and fitness, local medical and health care);
- social environment (equality of opportunity, racial harmony, family life, human services, philanthropy and volunteerism);
- government/politics (participation, information, leadership and performance);
- culture/recreation (the supply and use of sports, entertainment, the arts, public recreation and leisure activities);
- mobility (opportunities for and convenience of travel).

Between 6 and 10 indicators have been selected in each of these areas through consultation with volunteer groups - initially in 1985 and again in 1991, when the original indicators were reviewed. Each of the indicators now also has an associated target, so that members of the public can assess long-term trends in relation to desired goals. Within each area, one indicator has been identified as representing the most important single issue. For the natural environment, the priority indicator is the number of days with the air quality index in the 'good' range. The remaining priority indicators are river compliance with metals water standards, compliance with dissolved-oxygen standards, water level in the Floridian-aquifer wells, the number of new septic tank permits issued, the number of sign permits issued and tons of solid waste per capita. The importance of a local approach is emphasised by the recognition that, even at this small-area level, average trends hide significant geographic, socio-economic and racial differences within the community. Guidelines have also been established to ensure that indicators are appropriate and useful. They should be:

- valid (measure an issue or aspect of quality of life);
- available and timely (based on available or readily compilable data);
- stable and reliable (consistent over time);
- understandable (for use by the general user and public);
- responsive (respond quickly and noticeably to real changes);
- policy relevant (related to policy decisions or aspects which policy can act on);
- representative (the indicators for each group should cover the main aspects of each area).

2.2.12 LGMB

In the UK, the development of many local indicator initiatives has been aided by the Local Government Management Board (LGMB) Sustainability Indicators research project. This project aimed to promote the development of indicators of sustainability by defining frameworks and methods, and, subsequently, by implementing pilot projects in several local authorities to evaluate the effectiveness of the indicators used. The UK local government declaration on sustainable development (LGMB 1993) and the need to reflect the inter-related nature of issues of sustainability were taken as starting points. Two broad categories have been identified: carrying capacity, which refers to the provision of resources, the assimilation of waste and the provision of environmental services (amenities and the functions of life support and regulation) and quality of life (which includes basic needs, health and education). Within these categories, sustainability-related themes and societal goals have been identified:

- resource use - resources are used efficiently and waste is minimised;
- pollution - pollution is limited to non-damaging levels;
- biodiversity - the diversity of nature is valued and protected;
- basic needs - everyone should have access to good food, water, shelter and fuel at reasonable cost;
- information/education - everyone has access to adequate skills, knowledge and information;
- leisure and culture - opportunities for culture, leisure and recreation are readily available;
- freedom - everyone should have the freedom to participate in the decision-making process and be able to live without fear of personal, race, sexuality or gender-related crime;
- access - access to facilities, services, goods and other people is not achieved at the expense of the environment or those without cars;
- income - income should be adequate to meet basic needs and should be fairly distributed;
- work - everyone should have the opportunity to undertake satisfying work in a diverse economy;
- health - mental and physical health are protected by creating safe, clean and pleasant environments;
- beauty - places, spaces and objects combine meaning and beauty with utility.

(Touche Ross 1994)

A menu of indicators was developed for each of these themes (New Economics Foundation 1994). Based on consultation with local advisory groups and community consultations, pilot local authorities could then choose the indicators most suited to their particular area. Where additional information was required, pilot authorities were able to adapt and supplement the indicators, provided that they fulfilled the criteria of being:

- significant;
- related to global and local sustainability;
- relevant to local government and ordinary citizens;
- a reflection of local circumstances;
- based on easily collectable information;
- capable of showing medium to long-term trends;
- related to other sets of indicators;
- individually and collectively meaningful;
- informative and both clear and easy to understand;
- capable of provoking changes in policies, services and lifestyles;
- compatible with the establishment of targets and thresholds.

(LGMB 1995)

In Leicester, one of the original pilot authorities, the development of indicators has continued. Based on the experience gained during the LGMB pilot phase, indicator development has concentrated in the areas of the built environment, economy and work, energy, landscape and ecology, pollution, the social environment, transport and waste (Jeffcote & Allen 1995).

2.2.13 Lancashire

In Lancashire, a set of health-related indicators has been developed to investigate ways of measuring the relationship between environmental conditions and the health of the population. General environmental issues have been extensively reported and reviewed in Lancashire, but, prior to this project, there had been less direct recognition of the importance of health (Lancashire County Council 1991). Based on eight essential criteria, an initial list of 195 indicators was reduced to 67, split between the issues of air quality, housing, noise, radiation, waste and recycling, water quality, accessibility, aesthetic space, community, transport and mobility, food and nutrition, socio-economic status and clinical status (Alexander 1994a). The selection criteria stated that indictors should be:

- clearly health-related;
- objective;
- reliable;
- sensitive;
- specific;
- valid;
- able to provide possibilities for intervention;
- compatible with the setting of targets.

(Alexander 1994b)

From the short-list of 67 indicators, 13 were selected for immediate use through further evaluation and an assessment of data requirements, with an additional eight recommended for future use. The 13 are as follows:

- an indicator of homelessness and housing availability;
- a measure of housing quality;
- a measure of heating costs;
- a measure of water usage;
- a measure of drinking water provision;
- a measure of drinking water quality;
- a measure of adult literacy;
- a measure of pre-school places;
- a measure of investment in public transport;
- an indicator of children's mobility;
- a measure of the cost of a food basket;
- a measure of the proportion of people in receipt of income support;
- the proportion of children born with a low birth weight.

(Alexander 1994b)

2.3 Discussion

As the preceding sections show, in recent years, there has been a significant increase in the use of environmental indicators, both in terms of the number of applications and their scope. Several important points can be gleaned from the review above.

2.3.1 Indicator frameworks

Many indicator initiatives employ a conceptual framework to aid in the identification of issues and the selection of individual indicators. The majority, particularly at the national and international level, have adopted the pressure-state-response framework, developed by the OECD. Another widely-used framework is the DPSIR framework (driving force, pressure, state, impact, response), which has been adopted by the European Environment Agency (EEA). This framework is being applied in many areas of the EEA's activity and is being used as the basis for the 1998 European State of the Environment Report (a follow-up to the 1995 Dobris Assessment). Each stage in these frameworks echoes a part of the environmental policy cycle and reflects an emphasis on providing policy-related information. The PSR and DPSIR frameworks also highlight the different aspects of individual issues and clarify the interactions between issues. In developing policy-related indicators to address the issue of marine pollution, for example, an awareness of the sources of individual pollutants, current levels of these pollutant and their effects would be necessary. At the same time, an understanding of the relationship between marine pollution and other issues would also be required: for example, the effect of industrial emissions on marine pollutant levels, or the effect of pollution on fish stocks (and consequently, the effect on the fishing industry). In contrast, many local indicator initiatives aim to provide information on more general aspects of 'quality of life' and specific local issues. In these cases, the choice of both issue of concern and individual indicator is based on local priorities and concerns. There is consequently less of a need for a conceptual framework. Similarly, the WHO Healthy Cities Programme provides specific indicators targeted at different issues and there is consequently little requirement for a framework. It can therefore be said that both the need for a framework, and the nature of the framework required, depend to a great extent on the aims of the project concerned (Bakkes *et al.* 1994).

2.3.2 Indicator specificity

It can similarly be argued that indicators themselves are purpose specific. As the review above and the indicator survey in the appendix show, whilst some issues and indicators serve global or international purposes, others are only suitable for national or even local use (Ministry of Environment 1992). For example, the percentage of Seattle streets meeting 'pedestrian-friendly' criteria may be suitable as a local indicator of accessibility, but would be less meaningful at the national level and almost impossible to compile. As Bakkes *et al.* (1994) state:

> "Indicators suitable for one function may be totally inappropriate for others"
> (Bakkes *et al.* 1994 p2).

The issue of indicator specificity is echoed by many authors and cannot be over-stressed (OECD 1991). The main point behind the issue of indicator specificity is that indicators must be appropriate for their intended use and that their selection should occur as part of a clear and logical process. The issues or concerns of interest should first be identified, then, giving due consideration to the intended use of the information, potential indicators should be identified.

2.3.3 Selection criteria

The criteria on which individual indicators are selected are also purpose-specific. For example, the criteria for selecting indicators for the LGMB project include measures of 'acceptability' and the extent to which indicators are 'understandable' to the target audience. These criteria reflect the aim of providing indicators which inform people about their local environment. Conversely, indicators developed for international application, for example, by the OECD, include criteria to ensure international comparability and scientific validity. The objective of all selection criteria is to ensure that the indicators are valid for their intended purpose. Corvalan (1994) states that:

> "The indicator must be valid, that is, it measures what it was meant to measure with no systematic error and minimum random error".

Criteria therefore need to reflect the intended purpose of the indicator initiative and should be tailored to ensuring these aims are met.

2.3.4 Specific versus composite indicators

As has already been mentioned, indicators have the ability to reduce the volume of data required to convey a message. This is especially true in the case of composite indicators or indices, which have the potential to summarise many different aspects of a particular issue or problem by combining a number of different measures. However, indices also have many potential dangers and disadvantages. By definition, they require large volumes of source data and their construction may be susceptible to gaps or weaknesses in the data. Another important issue is the question of weighting the different components of indices. Individual components can be evenly or unevenly weighted, but decisions regarding weighting may be based on a partial understanding of the evidence and a subjective evaluation of the relationships involved. Different weighting regimes may have a major effect on the conclusions drawn from calculated indices. In this regard, indices should be interpreted with caution and they may be more suited to qualitative than quantitative analysis. Because of their compound nature, it is also difficult to identify the chain of cause and effect. Observed changes may be caused by any of the variables included in the index, and interpretation will be difficult in the absence of additional supporting information.

2.3.5 The function of indicators

As the previous chapter states, indicators consist of raw data plus a relationship between that data and the issue which the indicator addresses. This point is crucial to the functioning of indicators and cannot be over-stressed. If, however, the relationship between an indicator and its target issue is not well-established, it cannot be assumed that the measure indicates what it purports to indicate. Such an indicator is unlikely to perform the functions of simplification, quantification and communication. More importantly, it may mis-inform or mis-guide the target audience. In the case of policy-related indicators, this poses particular dangers. Decision-makers may base policy on incomplete or inaccurate information and trends in conditions will not be objectively presented. There is therefore a need to ensure that all indicators are well-founded and are based on sound evidence of relationships with target issues.

2.3.6 Data availability

In many cases, the information required to compile indicators is not available, or is difficult and costly to obtain. For example, the OECD indicator set published in 1993 lists a number of desirable indicators which may only be available in the medium and long-term. Similarly, the survey of indicator projects shown in the appendix includes several proposed indicators which would be very difficult to compile. Given these problems, purpose-designed monitoring or data collection may be undertaken. However, whilst this may be feasible in studies confined to small geographic areas and over limited time periods, this approach is likely to be costly and resource intensive. Another approach is the use of alternative indicators or 'proxy' measures. The advantage of such measures may be the ready availability of source data and the ease of interpretation. However, as the previous section argues, the utility of all indicators depends on the existence of well-established relationships with target issues. This is equally true for proxy indicators. An example of where such an alternative indicator might be required would be the urban environmental quality indicators outlined by the OECD in Table 2.2. One of the indicators listed for environmental conditions is noise. Whilst it would clearly be feasible to obtain noise measurements in a large number of urban areas, this would be both costly and resource intensive. As an alternative, the number of noise complaints or noise abatement orders could be used, provided that there was found to be a relationship between these measures and monitored levels of noise. Issues of data availability are clearly important and due regard needs to be given both to the cost of obtaining source information and the use of alternative indicators.

2.4 Conclusions

It is clear from the above review that environmental indicators may be developed for a number of different purposes at a wide range of different spatial scales: from international comparisons of greenhouse gas emissions to an assessment of the number of pre-school places in a local community. It is also apparent that the issues, criteria and individual indicators which are appropriate in a particular instance depend on the intended purpose of the indicator initiative and the type of application.

In reality, however, indicators may be chosen with little consideration of the scale at which they are being applied, or the extent to which they are appropriate. Given the fact that policy decisions may be based on indicator-derived information, there is a need to ensure that the message being conveyed by indicators is both accurate and consistent. Implicit in the use of indicators is the assumption that they communicate, simplify and quantify aspects of the issue of concern (Adriaanse 1993), and in particular, that there is a relationship between the indicator and the selected issue.

Yet, despite the recent growth in use of environmental indicators, very little testing and validation of them has been undertaken. As the number and range of indicator applications grows, however, so too does the need to evaluate their reliability. In particular, there is a need to verify the relationship between issue and indicator, to assess the validity of using the same indicator at different levels of spatial aggregation, the extent to which individual indicators can be used in contrasting circumstances and the reliability of proxy indicators. Chapter 3 outlines the essential requirements for environmental health indicators (EHIs) and examines their use in the light of some of these issues.

Chapter 3: Environmental Health Indicators

The scientist is still restricted by the properties of his instruments, the amounts of money available, the intelligence of his assistants, the attitudes of his colleagues, his playmates, he or she, is restricted by innumerable physical, physiological, sociological, historical constraints

Paul Feyerabend

3.1 Introduction

Whilst there has clearly been considerable progress in developing environmental indicators, the use of indicators to demonstrate relationships between environment and health is much less well developed. This chapter seeks to identify the essential characteristics and requirements for environmental health indicators (EHIs). It also outlines and discusses their main applications.

3.2 Developing concepts for environmental health indicators

In developing concepts for environmental health indicators, it is first necessary to unravel the relationships between environment and health. In doing so, there is a need to define what is meant by both environment and health. The World Health Organisation (WHO) adopts an holistic definition of health in its constitution:

> "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO 1992a p6).

Whilst there are difficulties in defining some of the concepts contained within this definition and, consequently, in measuring health itself (Noack 1987), the definition serves to demonstrate the fact that health is a complex, multi-faceted entity which is influenced by many different factors (Learmonth 1988).

Whereas other mammals and animals depend for survival on their ability to adapt to the environment, humans have the ability to change the environment around them through cultural development (Rowland & Cooper 1983). Although this ability has led to the development of many health-promoting factors such as improved housing, water supply and sanitation, it has also produced impacts which are damaging to health (Phillips 1990). Many human health conditions, including pollution-related diseases and diseases of affluence, can therefore be considered as 'man made' diseases of the socio-cultural environment (Stephens and Harpham 1992).

Howe (1982) defines the human environment as:

> "The sum total of his habitat, economy and society, and as such embraces not only his life-support systems (air, water, food, shelter), but also the multiplicity of provocative forces which bear down on him and affect his general well-being" (Howe 1982 p4).

In the light of this definition, environmental factors can be divided into three categories:

- physical factors, which include ambient temperature, weather, the availability and quality of water supplies and pollution in the ambient environment (from industrial and domestic sources);
- socio-cultural factors, which include employment status, the quality of housing and lifestyle factors such as smoking, diet, alcohol and drug addiction (WHO 1989);
- psychological factors, including depression, anxiety (for example, concern over employment or housing), nervous tension and fear, which diminish the effectiveness of the immune system and increase the likelihood of illness (Harrison 1984).

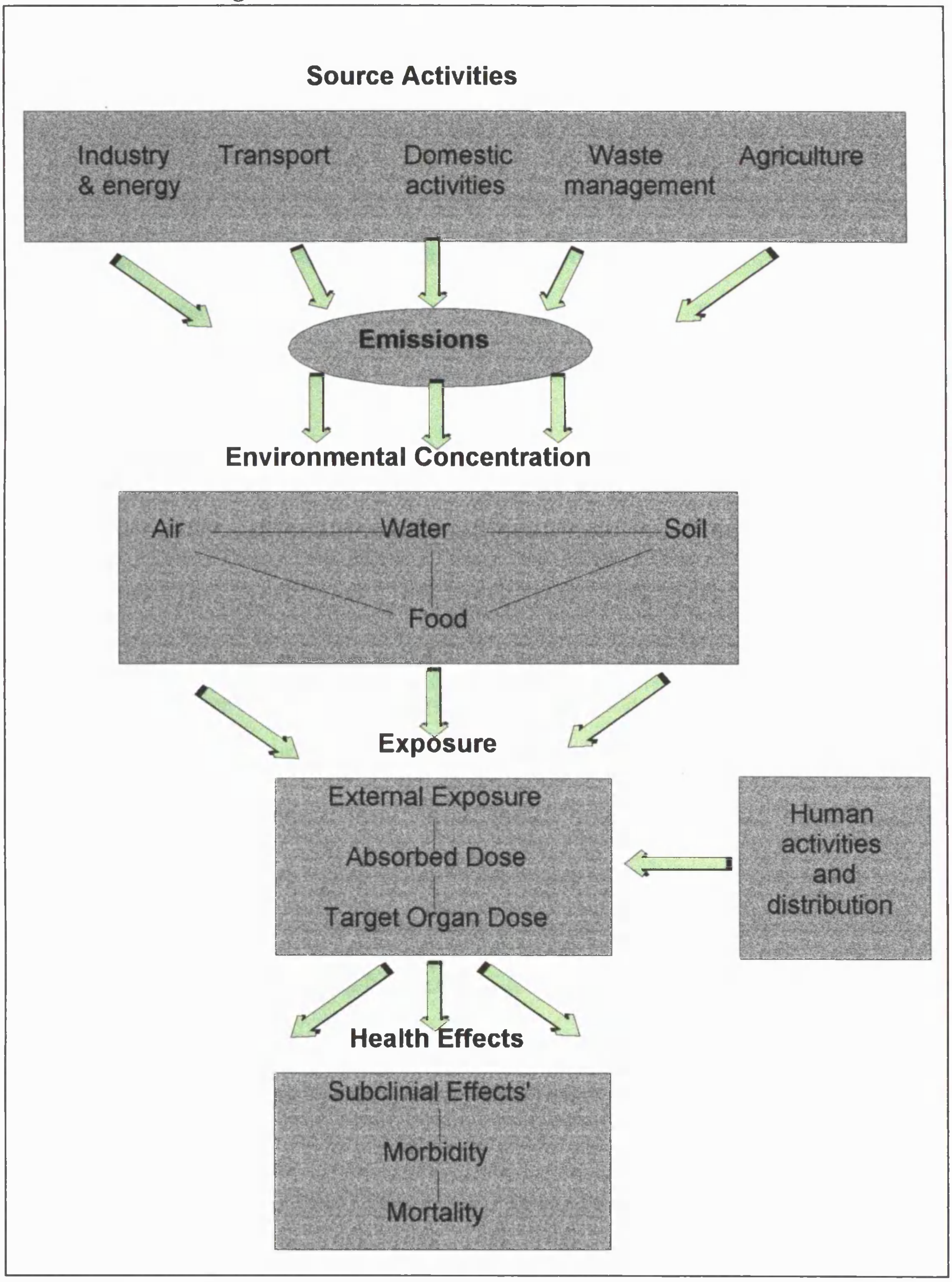
Health, then, is influenced by numerous factors in the physical, social, cultural and psychological environment. Rowland and Cooper (1983) refer to this as a complex 'web of causation'. The relationship between individual factors and health is highly complex - the links are rarely unitary or straightforward and in many cases are difficult to unravel (WHO 1989, Cutter 1993). Different factors may act in concert to affect health, single factors may contribute to a wide variety of possibly contradictory health outcomes; all these effects and relationships may vary from one area to another depending on local environmental, cultural and social conditions. The overall picture is, therefore, one of intense complexity and the relationships involved are often very difficult to unravel (Stern 1992).

In evaluating the factors which affect health, however, it is clear that many environmental impacts on human health operate through a broadly similar hazard pathway. In clarifying this pathway, Adriaanse (1993) identifies the following causal chain:

> "Sources or actors cause emissions to the environment, leading to certain concentrations in the living environment via dilution, dispersion and conversion reactions. Receptors (man, flora, fauna) are exposed to these concentrations, with harmful effects" (Adriaanse 1993 p10).

The link between environment and health is thus provided by the process of exposure (Corvalan *et al.* 1996). The conceptual model in Figure 3.1 illustrates the causal chain in more detail and highlights the crucial position of exposure in this chain. In this context, exposure is defined as the intersection of humans and hazards in the environment. It can occur by inhalation, ingestion or dermal absorption and may involve a number of different organs. This so-called environment-health chain is not an entirely new concept. Rather, it reflects existing models of the relationship between human activities and the environment (for example, the OECD pressure-state-response model) and an understanding of the process of exposure. It is based on an earlier model described in Wills and Briggs (1995) and has been used in a number of World Health Organisation publications (including Corvalán *et al.* 1996 and Corvalán *et al.* 1997).

Figure 3.1: The Environment - Health Chain



3.2.1 The environment-health chain explained

Human activities exert pressures on the environment through the use of raw materials, the production of goods and services and the generation of waste products. As a result of these industrial, economic and domestic activities (though also as a result of natural processes), pollutants are released into the environment in the form of emissions to air, water and land. These disperse through numerous environmental pathways and accumulate in different environmental media - air, water, soil and food. Ambient levels of these pollutants in the environment vary according to the volume and chemical composition of emissions, the environmental pathways involved, the topography of the surrounding area, meteorological conditions and other factors which may be relevant locally. The end result is a complex pollution surface which varies over both space and time.

Once in the ambient environment, the fate of pollutants is clearly beyond human control. Whilst the amount of pollution is therefore fixed, levels may vary greatly between different micro-environments - for example, between heavily industrialised areas and rural areas. People are inherently mobile and individual exposure can therefore be greatly affected by movement through these micro-environments. In other words, the frequency and duration of exposure depend on individual time-activity patterns at home, during commuting, at work and during leisure. Exposure also varies greatly depending upon physiological factors (including body weight) and intake parameters (e.g. inhalation rate) (Whitmyre *et al.* 1992). Exposure is therefore a highly complex process. It can occur in a variety of different ways - through absorption, ingestion or inhalation - and may be highly concentrated in a short space of time, or occur at a low intensity over a long time period. Within a given population, a wide range of individual exposures may therefore be observed.

During the course of a lifetime, humans may be exposed to literally thousands of different substances which occur both naturally and as a result of human activity. Single exposures may affect a wide range of organs, whilst different pollutants may have similar health effects. Absorbed dose refers to the amount of a particular pollutant which is absorbed by the body.

Target organ dose refers to the amount of a pollutant which reaches the organ where the relevant health effect can occur. The health effect of the pollutant is determined by the level and duration of exposure, the toxicity of the pollutant concerned, individual exposure history and individual susceptibility. Biological factors play an important role in determining the susceptibility of individuals to disease. Whilst diseases which depend entirely on inherited characteristics are rare, the genetic make up and the functioning of the body's different systems and structures greatly affect the likelihood of an individual succumbing to a particular illness or disease (Howe 1982). Given the level of individual variation, two different individuals in identical circumstances may experience different health outcomes (Rothman 1986). Other factors which influence individual susceptibility include age, sex and lifestyle. It should also be noted that the presence of disease represents the end of a much longer chain of cause (albeit often indirect and complex) and effect. At any one time in a given population there will be a large reservoir of people with less visible or tangible health problems which have yet to manifest themselves in the form of disease. There is also likely to be a time-lag between exposure and health outcome. In the case of asbestosis, for example, the delay between exposure to asbestos dust and the onset of disease may be between twenty and thirty years (WHO 1987).

3.2.2 Types of EHI

To recap then, both human activities and natural processes exert pressures on the environment and produce emissions of various pollutants. These pollutants disperse through various environmental pathways and accumulate in different environmental media. Human beings are exposed to these pollutants, with a range of health effects. As previously mentioned, many of the relationships between environment and health therefore operate through the processes of exposure. Whilst environmental health indicators may be developed from environmental indicators or health indicators, in either case, they depend upon knowledge about a proven or postulated exposure-effect relationship. Environmental indicators convey detailed information about environmental factors or hazards, but make no direct or explicit reference to health. Similarly, health indicators describe the status of, or trends in health without making any direct inferences about environmental conditions. Environmental health indicators are distinguished from both environmental indicators and health indicators by their reference to an exposure-health effect relationship:

> "It is only through knowledge of this link that an environmental indicator or a health indicator can be translated into an EHI. An EHI is thus an environmental indicator *or* a health indicator *plus* a known exposure-effect relationship" (Corvalán *et al.* 1996 p26).

Two distinct types of environmental health indicators can be identified:

- *Exposure indicators* or *Health-related environment indicators (HREIs)* give an estimated measure of risk based on knowledge about an environmental hazard and a known or postulated exposure-effect relationship. They may be developed at any point on the environment side of the environment-health chain. An example would be the estimated number of people exposed to particulate pollution above WHO guideline levels.

- *Health effect indicators* or *Environment-related health indicators (ERHIs)* suggest an environmental cause or point to the environmentally attributable portion of a health effect based on knowledge about a known or postulated exposure-effect relationship. An example would be the proportion of hospital admissions for respiratory illness attributable to exposure to traffic-related pollution.

The choice of indicator in a particular circumstance depends largely on whether one is attempting to evaluate environmental causes (i.e. the environmentally-attributable portion of a particular health outcome) or health risks (i.e. the effect of environmental hazards on human health). Indicator choice is, therefore, purpose driven, although data availability and accessibility may also be important factors. As section 3.3 shows, EHIs have many different uses and applications. Whilst all indicators must be appropriate for their intended use, relevant to the issue of concern and understandable to the target audience, it should also be noted that the extent to which known or postulated exposure-effect relationships need to be quantitative rather than merely qualitative depends on the intended use of the indicator. This point is discussed in more detail in section 3.8.8.

3.2.3 Definitions of EHIs

Several definitions of environmental health indicators have been proposed. In their work on the development of policy-related environmental health indicators, the World Health Organisation outlines some essential characteristics:

> "An *environmental health indicator* can be seen as a measure which summarises in easily understandable and relevant terms some aspect of the relationship between the environment and health. It is a way, in other words, of expressing scientific knowledge about the linkage between environment and health in a form which can help decision-makers to make more informed and more appropriate choices" (Corvalán *et al.* 1996 p21).

Whilst these characteristics reflect the WHO's emphasis on EHIs for policy support, some of them are common to all indicators. In particular, the need for indicators to summarise relationships in ways which are clearly understandable to the intended audience and the need for indicators to inform debate, discussion and decision-making. As the following sections illustrate, in all areas of application, EHIs serve to highlight the relationships between environment and health, and apprise end-users. In the light of the WHO's experience, the following definition has been proposed:

> "An environmental health indicator is an expression of the link between environment and health, targeted at an issue of specific policy or management

concern and presented in a form which facilitates effective decision-making" (Corvalán *et al.* 1996 p25).

Whilst different actors and agencies involved in the development of EHIs may use different definitions, depending on their intended use, it should be noted that EHIs are dependent on known or postulated exposure-health effect relationships.

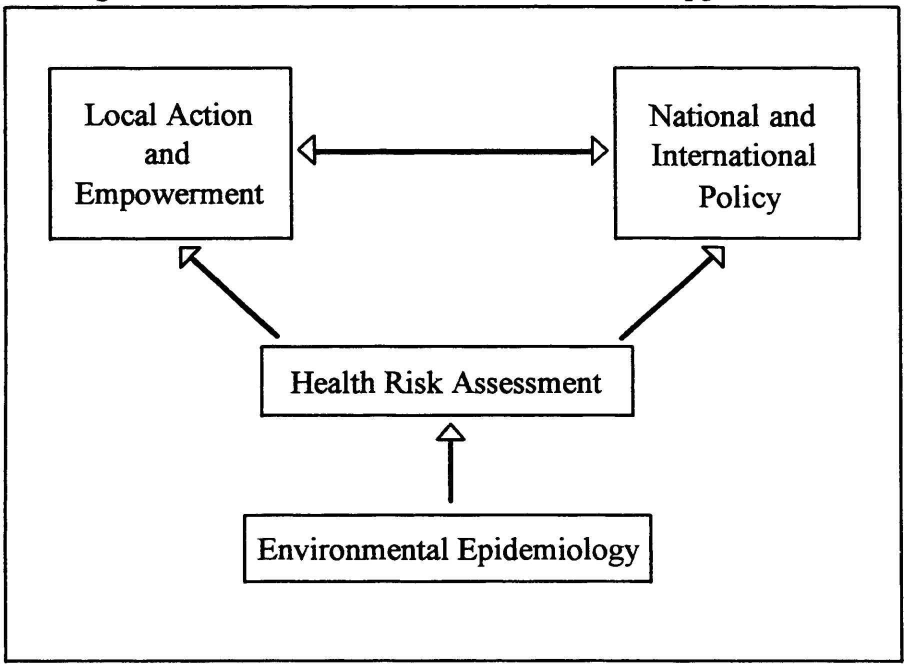
3.3 The application of environmental health indicators

Environmental health indicators clearly take many forms, may be targeted at many different issues, and may be related to different points in the exposure-health chain. They may also be used for different purposes. Four main applications of environmental health indicators can be identified:

- supporting and directing national and international policy on environmental health;
- promoting local awareness and action in relation to environmental health;
- as part of health risk assessments;
- as tools for environmental epidemiology.

These applications are closely linked. National and international policy, for example, needs to be cognisant of local attitudes and concerns. One of the main functions of EHIs is thus to provide a means of feeding local concerns into policy decisions. At the same time, local action and empowerment takes place within the context of national and international policies and priorities. Environmental health indicators can therefore help to inform local communities about wider policy issues. As previously mentioned, EHIs are a means of providing knowledge about the relationships between environment and health. Specifically, they provide an understanding of the environmental health risks which either exist, or are likely to emerge. However, understanding health risks, in turn, relies upon sound environmental epidemiology. Both local action and broad-scale policy need to be based upon environment-health relationships which have been validated at the local level through epidemiological studies. Environmental health indicators are thus a means of applying such information in a range of applications. The relationship between these applications is illustrated in Figure 3.2.

Figure 3.2: Environmental health indicator applications



The ability to translate or transfer information between these various applications is clearly important. Without that capability, mutual understanding is unlikely to be achieved, and decisions on environmental health at the national or local level may be based on a biased or inadequate understanding. Environmental health indicators provide a means to facilitate and support this process, providing the linkage or bridge between environmental epidemiology, risk assessment, local action and national policy. The extent to which EHIs meet this aim depends on how well they are designed, their fundamental validity, and their relevance to policy issues and health concerns. These issues are explored in greater detail in the following sections which address each of the applications outlined in turn.

3.4 Environmental health indicators for policy support

The development of environmental health indicators at the policy level has been ongoing for a number of years. In 1995, for example, a joint workshop on "Indicators of Sustainable Development for Decision-making" was held by the Belgian and Costa Rican governments, UNEP (the United Nations Environment Programme) and SCOPE (the Scientific Committee on Problems of the Environment) in Ghent, Belgium (SCOPE 1995). Part of this ongoing work involves the development of human impact/exposure indicators to identify the environmental conditions which undermine human welfare and the social equity of exposure distribution (Hammond *et al.* 1995). The World Health Organisation has been actively involved in developing policy-level environmental health indicators through a number of different programmes; for example, the global and European Health for All programmes and the Healthy Cities programme (WHO 1992b & WHO 1995). The rationale behind this work is as follows:

> "Studies of environment and health, and of the linkages between them, can produce large volumes of data. If they are to support and improve decision-making, however, these data need to be translated into a clear set of messages, targeted at issues capable of management and control..... indicators provide a means of converting the results into a language and form of direct relevance to decision-makers. In addition, once identified and established, the indicators provide a means of monitoring subsequent trends in environmental health, and hence of evaluating the effectiveness of any action taken" (Corvalán & Kjellström 1996 p13).

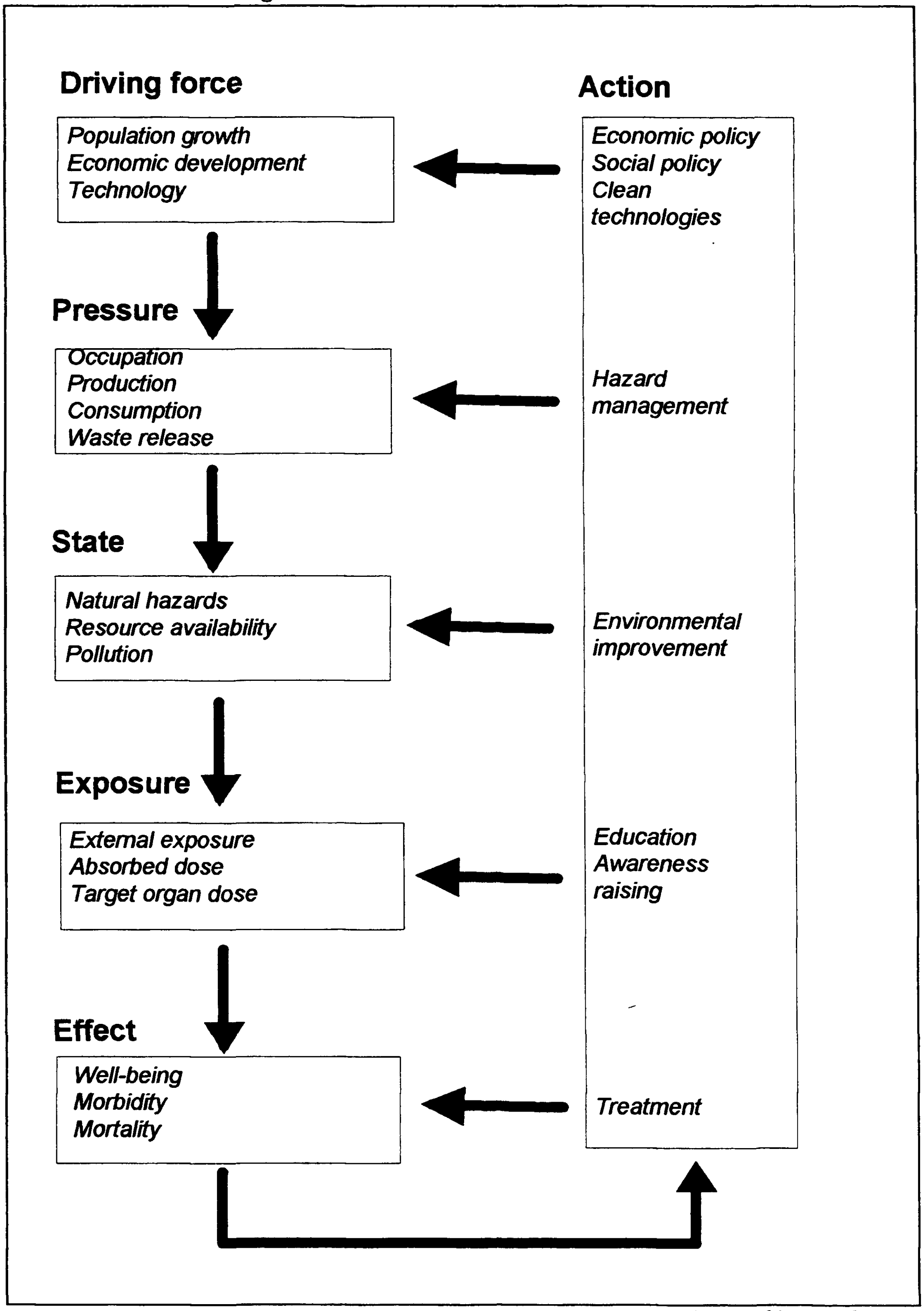
Since an initial meeting in Dusseldorf in 1992 (WHO 1993b), a number of consultations have been held on the development of policy-level environmental health indicators (WHO 1993c, WHO 1994b & WHO 1994c). As an active member of many of these meetings, the author has first-hand experience of the process of developing EHIs, and has been closely involved in discussions on their concepts and requirements. These consultations have also demonstrated the difficulty in defining 'core' indicators at the policy-level (see Wills & Briggs 1995). For example, as the earlier discussion shows, indicators need to be highly purpose-specific, yet frequently their exact purpose is not defined, relevant data are not available and many environment-health relationships are very uncertain. These problems are compounded by the need to construct indicators at high levels of spatial aggregation, where the problem of data availability is particularly acute. Despite this, the WHO is currently in the process of developing a set of 'core' environmental health indicators.

As the previous chapter shows, many indicator programmes, particularly those related to policy, are based on a conceptual framework. The most widely used of these frameworks is the pressure-state-response (PSR) framework developed by the OECD. The WHO have developed this framework to take account of the source activities or 'driving forces' which contribute to environmental pressures. The exposure and health effect dimensions have also been added to reflect the emphasis on environment and health policy. The so-called DPSEEA (driving force, pressure, state, exposure, effect, action) framework is shown in Figure 3.3.

The purpose of this framework is not to replace the exposure-health chain, but to express it in a way which provides a framework for the development of policy-related environmental health indicators. Indicators may therefore be developed to reflect each of the stages outlined in the framework. Examples of potential indicators for child lead exposure (chemical pollution), ionising radiation (physical pollution) and water contamination (microbiological pollution) are shown in Table 3.1.

Given the emphasis on environmental health policy and management, it is likely that indicator development will be concentrated towards the top of the DPSEEA framework. As previously stated, information is more readily available for indicators higher in the environment-health chain and these indicators reflect processes which can be more readily controlled by policy. Consequently, there is a need to ensure that the indicators used accurately represent exposure and provide reliable measures of risk. Unless environmental health indicators reflect real spatial and temporal variations in risk, they are likely to misinform policy.

Figure 3.3: The DPSEEA Framework



(Corvalán *et al.* 1996)

Table 3.1: Examples of environmental health indicators within the DPSEEA framework

		Pollutant type		
Stage	***Process***	***Chemical (e.g. lead)***	***Physical (e.g. ionising radiation)***	***Microbiological (e.g. water contamination)***
Driving Force	Type of development or human activities	Use of lead as a petrol additive	Shifts to use of nuclear energy generation	Population growth in areas of poor sewage treatment
Pressure	Source activity	Consumption of leaded petrol	Amount of radioactive material used	Amount of untreated waste produced
	Emissions	Tonnes of lead emitted from cars	Calculated emissions at nuclear facilities	Amount of untreated effluent
State	Environmental levels	Lead concentration in air	Radiation levels in air, water, food	Coliforms in water, food
Exposure	Human exposure	Calculated personal exposure to lead from all sources	Calculated exposures: Workers; Nearby residents	Estimated exposure to contaminated food/water
	Dose	Lead in blood	Personal dosimeters; Urine; Faeces	Serum analysis for Hep. A and typhoid; Faeces for cholera, shigella
Effects	Early effects	Behavioural disorders; Reduced IQ in children	Chromosomal abnormalities	Diarrhoea, fever, nausea
	Late effects	Anaemia; Increase in blood pressure	Genetic defects; Leukaemia; Cancer	Cholera, Hepatitis A, typhoid, dysentery, gastro-enteritis
	Death	Encephalopathy; Acute lead poisoning	Acute radiation sickness; Cancer	Death from dehydration

(Corvalán *et al.* 1996)

3.5 Environmental health indicators for local action and empowerment

The development of EHIs for local application is, inevitably, highly diverse and has been motivated by a wide range of concerns and issues. As noted in the previous chapter, several attempts to construct local indicators have evolved as a response to Local Agenda 21 and the growing demand for community involvement in the environment. Several of the indicators produced by these initiatives have focused on environmental health, reflecting the emphasis which communities typically place on health issues. The Sustainable Seattle project, for example, includes "the number of days per year air quality fails to meet air quality standards" and "the percentage of citizenry that can afford adequate housing" (Sustainable Seattle 1993a & 1993b). The Jacksonville Quality of Life Project contains indicators of resident's health and fitness and local medical/health care. The Local Government Management Board indicator project includes measures of pollution, basic needs (food, water, shelter and fuel) and health.

Community level environmental health indicators have also been developed in the attempt to lobby governments, industry and national authorities about local concerns. Whatever the purpose of community-based EHIs, however, a number of factors are clear. One is that - even more than at the national level - the indicators need to have relevance to the users concerned (what is often referred to as 'resonance') and be problem-specific. Another is that because of their local application, many community-based EHIs may be more qualitative than indicators developed at the national level. They can, for example, draw on local knowledge and experience and are less reliant on readily available and 'hard' data. These characteristics nevertheless pose severe difficulties for the use of EHIs in this context. They make it more difficult to achieve comparability either with national indicators or with the kinds of indicators used in health risk assessment or environmental epidemiology. Consequently, it is difficult to ensure that community environmental health indicators are based on valid environment-health relationships. At best, this may mean that community indicators do not carry weight with decision-makers; at worst, they may help to fan unnecessary concerns and prejudice. Developing valid yet relevant and acceptable EHIs at the local level is thus a major challenge.

3.6 Environmental health indicators for health risk assessment

Health risk assessment may be defined as the process of estimating the health consequences of exposure to a hazard, based on information about the level of exposure and an understanding of the dose-response relationship for the pollutant concerned (Terracini 1996). Assessment may be undertaken at the individual level, or for an entire population. Cutter (1993) identifies four stages in conducting a risk assessment: hazard identification, dose-response assessment, exposure assessment and risk characterisation. Hazard identification is the identification of the hazard or substance of concern (in the case of industrial air pollution, for example, this would involve identifying the major pollutants). Dose-response assessment involves quantifying the relationships between exposure and health effect. This would entail a review of existing clinical and epidemiological evidence to determine dose - response relationships for the hazards of concern. Exposure assessment involves the measurement or estimation of exposure. In other works, identifying the level and distribution of exposure to the hazards of concern among the study population. Risk characterisation is the description of the nature and magnitude of risk, based on the estimates of exposure and the dose-response relationship.

Methods of risk assessment are complex and based on a series of assumptions. Exposure-effect relationships established in one population may not be directly applicable in another population with contrasting socio-economic conditions or baseline health status. At the same time, obtaining reliable information on exposure is likely to be problematic. As previously mentioned, exposure data are both difficult and costly to collect. In addition, difficulties in quantifying the relationships between environment and health may arise in cases where individual pollutants are thought to affect more than one health outcome, or where single health effects are thought to be related to more than one environmental pollutant. Health risk assessments therefore depend on the availability of exposure indicators validated through epidemiological studies, and on relevant dose-response relationships.

When properly conceived and conducted, health risk assessments have the potential to analyse environmental health status rapidly and they represent a powerful means of informing decision-makers. At the same time, they feed into local and community applications by identifying and quantifying individual or groups of pollutants and health issues of concern.

3.7 Environmental health indicators for environmental epidemiology

As the preceding discussion has illustrated, the use of environmental health indicators requires knowledge of the dose-response relationship for the pollutant and population of interest. Knowledge about this relationship may derive from a number of sources, including clinical trials and chamber studies. Amongst the most important of these are epidemiological studies. The aim of environmental epidemiology is to determine the health effects of environmental factors which are beyond individual control: in other words, to quantify the effect of pollution in the ambient, living and working environments on human health (Rothman 1993). Within epidemiology, environmental health indicators may be used as a tool to calculate human exposure, or as a means to identify the environmentally attributable proportion of health outcomes. The use of environmental health indicators to estimate individual exposure offers several advantages over the population or community based classifications of exposure used in 'ecological' studies. However, as Nurminen *et al.* (1996) state, valid assessment of exposure requires detailed knowledge about the geographical distribution of the pollutants concerned, the temporal variations in pollutant levels and the processes of exposure. Exposure indicators therefore need to reflect spatial variations in exposure, be stable over time and account for major routes of exposure.

Epidemiological studies are typically carried out at the small-scale, local level. Purpose-designed surveys may therefore be undertaken to gather information on many of the possible risk factors involved; for example, on lifestyle variables, housing conditions, individual exposure and background exposure. The relationship between environment and health can therefore be examined in more detail, while taking account of potential confounding factors.

The use of environmental health indicators in epidemiological studies thus offers the opportunity to develop and validate exposure indicators. However, it should be noted that information is unlikely to be available on all possible contributory variables or confounding factors. In addition, two individuals who experience the same exposure may develop different health effects as a result of variations in individual susceptibility. Similarly, single pollutants may contribute to a number of different health effects, whilst individual health effects may be affected be several different pollutants. Analysis of the relationship between exposure and health effect should therefore be undertaken with care and the results interpreted carefully. Neither is it certain that exposure-effect relationships or exposure indicators validated in one location can be automatically be applied to areas with contrasting environmental, social and cultural conditions. Environmental health indicators, even when validated at the local-level, should therefore be used with caution.

3.8 Exposure-based environmental health indicators

As noted earlier, two types of environmental health indicator can be recognised on the basis of the exposure-health chain: health-based EHIs and exposure-based EHIs. The former use data on health outcome to infer an environmental cause and are perhaps best exemplified by sentinel diseases. The latter use information on exposure (or some proxy for it) to infer a health risk.

The remainder of this thesis concentrates on the development and use of exposure-based EHIs for policy support, health risk assessment and environmental epidemiological applications. EHIs are of particular importance in these contexts for two main reasons:

- exposure-based EHIs, being upstream from the health effect, offer the opportunity for an early warning of health risk;
- as such, they offer a clearer basis for targeting and monitoring preventative interventions.

As the previous discussion shows, exposure forms the point of intersection between environmental pollutants and humans; between the generation, release, dispersion and accumulation of pollutants in the environment and the movement of humans through that environment. As the last point on the environmental side of the environment-health chain, it is most closely related to absorbed dose, target organ dose and health outcome. Accurate information on exposure is therefore important in helping to unravel the relationship between environmental factors and health effects. In particular, it is essential in establishing dose-response relationships and performing health risk assessments based on those relationships. Measuring exposure is, however, complex and fraught with difficulties. The problems in assessing exposure stem from two main areas: the complexity of the exposure process and the lack of readily available data.

As Figure 3.1 demonstrates, the actual point of exposure itself may be an ideal stage at which to measure exposure; for example, through the use of personal exposure monitors or blood sampling. Whilst this is possible, in practice, it is both technically difficult and costly (Corvalan *et al.* 1996). Routine personal exposure monitoring is very rare and purpose-designed exposure surveys tend to target small population groups and limited numbers of pollutants. In the absence of appropriate data, there is consequently a need to develop alternative methods of measuring human exposure, whilst ensuring the accuracy and reliability of these approaches. Indeed, many epidemiological studies already rely on inferring exposure from indirect methods. Exposure is most frequently estimated from information on factors further up the environment-health chain - from data on ambient concentrations, modelled concentrations, emissions and source activities. For example, levels of atmospheric nitrogen dioxide pollution may be used as a marker for exposure to traffic-related air pollution. The optimum exposure indicator in this case may be the amount of NO_2 that an individual is exposed to during a given time period - at home, en route to work, at work and during leisure activities. However, whilst this information could be obtained by personal monitoring, it would be both difficult and costly to do so. The 'proxy' indicators for exposure shown in Table 3.2 could therefore be used.

Table 3.2: Potential proxy indicators

Indicator type	*Indicator description*
Source activity	The distribution and level of activity of major sources (including industry, power stations and traffic)
Emissions	Total emissions from major sources (including industry, power stations and traffic)
Concentration	The amount of NO_2 present at monitoring sites (actual amount of NO_2)

The use of proxy exposure indicators, however, is fraught with difficulties. With the recent growth in the development and use of environmental indicators, there are now a number of well-established criteria for selecting environmental indicators (OECD 1991b & 1993, UNCHS 1995b, Kerr 1994 & HMSO 1996). These have been further developed by the World Health Organisation for use in the context of environmental health. Environmental health indicators should therefore (Corvalan *et al.* 1996):

1. be based on a known linkage between environment and health
2. be sensitive to changes in the conditions of interest
3. be directly related to a specific question of environmental health concern
4. be related to environmental and/or health conditions which are amenable to control
5. be consistent and comparable over time and space
6. be robust and unaffected by minor changes in methodology/scale used for their construction.
7. be unbiased and representative of the conditions of concern
8. be scientifically credible, so that they cannot be easily challenged in terms of their reliability or validity
9. be easily understood and applicable by potential users
10. be available soon after the event or period to which it relates (so that policy decisions are not delayed)
11. be based on data which are available at an acceptable cost-benefit ratio
12. be based on data of a known and acceptable quality
13. be selective, so that they help to prioritise key issues in need of action

It should be recognised, however, that these criteria reflect the use of EHIs in policy-related applications. Moreover, the importance of individual criteria depends upon the particular application under consideration. Some of the wider issues raised by these criteria are discussed below.

3.8.1 Relation to exposure

Firstly, the selection of suitable proxies depends upon the existence of strong relationships between the proxy and exposure. In reality, these relationships are often weak and are diminished by the complexity of the processes involved: by the effects of confounding, and by poor data quality. The further removed from exposure the proxy is, the weaker it is likely to be as a reliable indicator of exposure. Total exposure, for example, is a product of many different exposure events at different times and in different locations. Simple measures of pollution levels (e.g. average annual concentration) at a broad geographic scale, or at monitoring stations far removed from the area of concern, are unlikely to provide a reliable indication of exposure. Indicators from yet further up the exposure chain, such as emission levels or industrial activity, are likely to be weaker still. To assess the reliability of a proxy indicator, it is therefore necessary to test the strength of its correlation with the relevant environmental exposure.

3.8.2 Policy relevance

However, at the same time, indicators from earlier in the exposure sequence reflect processes which can be more readily controlled by policy. Whilst little can be done to reduce pollutants once they have been emitted and dispersed in the environment, relatively rigorous control is feasible at source: for example by regulating emission levels or particular industrial processes. As a result, indicators earlier in the causal chain tend to be more immediately relevant to policy. Depending on the application for which particular environmental health indicators are being used, policy relevance may be a more important factor than relation to exposure. For example, EHIs used in the context of local action and empowerment aim to raise awareness of environmental health problems and promote policy action. As such, they must be easily understandable and relate closely to issues which can be addressed through policy or local action. Whilst they should embody a relationship between environment and health factors, this relationship may be qualitative rather than quantitative. The list of 'Healthy City Indicators' reviewed in Appendix 1, for example, includes "Pedestrian streets" (the total length of pedestrian streets divided by the surface area of the city) in the category of environmental indicators. The level of pedestrianisation clearly has an effect on health, through the number of pedestrian accidents (affected by the segregation of vehicles and pedestrians) and ambient levels of pollution (influenced by the relative numbers of people walking or driving), but quantifying this relationship would be very difficult. Nevertheless, this indicator may be useful for measuring progress towards targets on sustainable transport use, or the number of road-traffic accidents.

3.8.3 Data availability

Data are, in general, also more readily available for indicators higher in the exposure chain:

> "It is worth noting that, moving through the causal chain from emissions via deposits to effects it gradually becomes harder to obtain sufficient and reliable information for the development of indicators" (Adriaanse 1993 p12).

Whilst direct measurements of exposure are rare, data on pollution levels in different environmental media are more abundant, though still limited in geographic scope, range of pollutants and quality (Briggs 1995). Data on emissions are now widely available and many countries maintain national emissions inventories, while a number of international inventories also exist or are under development (Briggs 1993a). Data on source activities is also widely available and can be obtained from a number of different national and international agencies, for example, national statistical offices, EUROSTAT, the OECD and the UNEP.

3.8.4 Representativeness

There is a need to ensure that indicators at all stages in the environment-health chain are based on data which is accurate, reliable and representative. Indicators of pollutant concentrations, derived from limited numbers of monitoring stations, for example, are unlikely to provide a representative picture of complex pollution surfaces, particularly in urban areas. Similarly, relatively few emissions inventories provide a complete picture of emissions via all pathways and from all sources: the majority are concerned only with emissions to the air, and many relate only to industrial point sources. The reliability of many emissions estimates is therefore open to doubt, due in part to deficiencies in the input data and the emission models used (Briggs 1993b). Data on source activities may also prove unreliable. Identical processes used in different locations may produce different emissions over time, due to variations in climatic conditions and raw material quality. At the same time, different processes used in the same location are likely to produce different emissions.

3.8.5 Comparability

As previously stated, this thesis examines the use of indicators from a geographic perspective. However, the use of EHIs to identify spatial variation and trends in environmental health implies the need to ensure that indicators compiled in contrasting circumstances are similarly representative and comparable. Otherwise, indicators are unlikely to reflect actual variations in conditions and comparisons between areas are likely to be flawed. The use of EHIs to examine geographic trends therefore depends on ensuring that indicators are comparable.

3.8.6 Identifying appropriate indicators

Apart from being based on reliable, representative data, effective indicators also require thoughtful planning and development. Whilst indicators are intended to quantify, communicate and simplify (Adriaanse 1993), they may be far from simple to construct and represent highly complex underlying processes. Failure to recognise this may lead to the construction of poorly defined indicators which are only vaguely relevant to the issue of concern:

> "Often, it seems, there is a tendency to confuse indicators with the general issue or theme to which they relate. The consequence of this is likely to be the development of poorly conceived or inadequate indicators. These pose a double jeopardy. They are likely to be a waste of time and effort, and they are likely to misinform, rather than inform, the users" (Corvalan *et al.* 1996 p35).

Indicators at all stages of the environment-health chain therefore need to be well thought out, targeted at the issue of concern and appropriate for the intended purpose and target audience.

3.8.7 Chronic versus acute health effects

This point is illustrated by the example of selecting indicators to reflect chronic and acute exposure. Acute exposure entails a high relative risk, but is likely to affect a small number of people. It may therefore be detected by relatively crude exposure indicators. In contrast, chronic exposure involves a low relative risk, but may affect large numbers of people. Within this larger population, small and subtle variations in relative risk are likely to occur. Chronic exposure therefore tends to be characterised by spatial variation, whereas variations in acute exposure tend to occur over time. Consequently, the choice of appropriate exposure indicator will, to a large extent, be influenced by whether chronic or acute exposure is being investigated. For example, whilst mean annual average concentrations of fine particulates may be useful as a predictor of chronic respiratory illness (Dockery *et al.* 1993), information on short-term peak exposures would be needed for an investigation into acute respiratory illness.

3.8.8 Relation to health effect

As has been repeatedly stated, environmental health indicators depend on knowledge about exposure to environmental hazards and their health effects. They therefore embody a relationship between environment and health. Irrespective of the application, EHIs are likely to be more robust and reliable if they are based upon known and quantified environment-health relationships. Evidence from previous epidemiological studies may therefore be useful in helping to validate EHIs.

However, as has also been indicated, in some applications, a qualitative rather than a quantitative relationship between environment and health may suffice. Indeed, relationships between environmental factors and health effects are hard to detect and even more difficult to quantify. Environment-health relationships are rarely unitary or straightforward. The relationship between individual factors and particular health effects may be masked by the synergistic effects of other pollutants. Variations in individual susceptibility, age, sex and lifestyle may also have an effect on the observed relationship between environmental factors and health outcome. In addition, there may be a considerable time-lag between exposure and the presence of health effects.

Consideration must also be given to the influence of confounding factors. Failure to account for relevant confounding factors may lead to inaccurate interpretations of the relationships between environment and health factors. With the use of EHIs to support policy and decision-making, the costs of using inaccurate information are significant. Many studies of air pollution and health, for example, take into account the possible confounding effect of smoking, indoor pollution and socio-economic status. Without consideration of potential confounding factors, false assumptions may be made about the relationship between environmental factors and health effects; the so-called 'ecological fallacy' (Last 1995). The use of environmental health indicators must therefore proceed with caution. Every effort should be made to ensure that confounding factors are accounted for, and that indicators are valid and appropriate for their intended use.

3.9 Conclusions

This chapter has outlined the characteristics and requirements for environmental health indicators. Having examined the ways in which environmental factors affect health, the environment-health chain was identified. This chain provides a framework for constructing EHIs and a means to visualise environment-health relationships. Two types of environmental health indicator have been identified: exposure indicators (or HREIs) and health effect indictors or (ERHIs). This thesis centres on the development and application of exposure indicators.

As previously mentioned, EHIs embody a relationship between exposure and health effect. Whilst exposure represents the interface between environment and health, the scarcity of data forces a reliance on indicators from higher in the exposure-health chain. However, as the preceding discussion shows, there are important criteria to consider when using indicators at all points in the environment-health chain. Whilst indicators from higher in the chain may provide a measure of source activities and potential causes, their relation to exposure is uncertain. On the other hand, measures of pollutant concentrations, for example, may not provide a representative picture of complex pollution surfaces.

Based on the evidence presented and discussed in this chapter, the following key issues can be identified:

1. Whilst exposure may be regarded as the optimum environmental health indicator, data are rarely available. Proxies for exposure are therefore needed.
2. The relationship between proxy indicators and exposure is uncertain. The lack of independent exposure data makes it very difficult to validate indicators in terms of their ability to give reliable estimates of exposure.
3. The relationship between exposure and health outcome is similarly uncertain. This is due, amongst other things, to the problems of confounding, variations in individual susceptibility and time-lags between exposure and health effect.
4. The reliability of indicators and the stability of environment-health relationships over time is unknown.

5. The effects of compiling indicators at different levels of spatial aggregation are also uncertain. Whilst the scale at which indicators are compiled should be suited to the issue and the geographic area of concern, the effect of scale on the relationships between proxies, exposure and health outcome is unknown.

These issues have important implications for the use of environmental health indicators in all applications. As has already been mentioned, the use of EHIs at the broad scale depends on the availability of locally-validated indicators, whilst indicators at the local level should reflect wider policy issues and priorities. Used properly, with due regard to the limitations of source data and the complexity of confounding effects, EHIs can make a significant contribution to the management and protection of public health. However, they are not panaceas; the use of ill-conceived indicators based on unreliable or unrepresentative exposure-effect relationships are likely to lead to costly policy mistakes. This research aims to address the issues outlined above and explores the extent to which exposure indicators, developed and validated at the local level, can be used to provide information for policy support, using the example of traffic-related air pollution. The following chapter explores these issues in more detail by focusing upon the relationships between traffic-related air pollution and health, examining the exposure indicators which have previously been used.

Chapter 4: Traffic-related air pollution and health

Discovery consists of seeing what everybody has seen and thinking what nobody has thought

Albert von Szent-Györgyi

4.1 Introduction

The previous chapter provided a rationale for the development and use of environmental health indicators. In particular, attention was drawn to the way in which EHIs can be used:

- to support and direct national and international policy on environmental health;
- to promote local awareness and action in relation to environmental health;
- as part of health risk assessments;
- as tools for environmental epidemiology.

Having outlined their potential uses, essential requirements and key selection criteria, the purpose of this chapter is to examine the use of EHIs in a specific policy area - traffic-related air pollution and health. The choice of traffic-related air pollution and health provides an issue where there is growing evidence of a relationship between environmental factors and health effects. It is also a policy issue of increasing importance and information is required in a number of different areas. To date, proxy indicators of exposure to traffic-related air pollution have been used in a number of small scale epidemiological studies. This chapter explores this body of work and evaluates the utility of the indicators used. The indicators which are most frequently used are:

- Road density;
- Distance to road;
- Traffic volume;

- Pollutant concentrations of NO_2 (modelled) as a marker for exposure to traffic-related air pollution;
- Pollutant concentrations of NO_2 (measured) as a marker for exposure to traffic-related air pollution;

Whilst this chapter reviews the use of indicators of exposure to traffic-related air pollution in previous epidemiological studies, the remainder of this thesis applies these indicators, and a number of additional measures, at a range of different spatial scales. Although the utility of many of these indicators has been demonstrated at the local level, the extent to which they can be applied at levels of greater spatial aggregation and in other applications is uncertain. This thesis thus adopts a geographical perspective in the study of environmental health indicators. Each of the following chapters applies indicators of exposure to traffic-related air pollution at a different spatial scale. Chapter Five focuses on the Boroughs of Hammersmith and Ealing in London, UK. Chapter Six examines selected areas of England and Wales. Chapter Seven takes a pan-European perspective, drawing on data from across the European Union.

In the following text, the relationship between traffic-related air pollution and health is examined. A number of epidemiological studies are then reviewed in turn, before individual indicators are discussed and evaluated.

4.2 Traffic-related air pollution and health

Air pollution is widely acknowledged as a global issue which affects hundreds of millions of people (WHO 1992a). In Western Europe, air pollution has historically been an industrial problem, resulting largely from the activities of heavy industry and from the use of fossil fuel in domestic heating. In recent decades, however, with changes in domestic fuel use, the general decline in heavy industry and increasingly strict industrial air pollution legislation, these effects have been greatly reduced and mitigated. Transport now represents the single largest source of many air pollutants (Royal Commission on Environmental Pollution 1992).

Whilst increased mobility improves access to employment, education, shops, recreation, health services and recreation, there is growing concern over the possible health effects of traffic-related pollution. Apparent increases in levels of respiratory disease in recent years have been associated, particularly in the media, with increased levels of traffic and rising air pollution. This concern is reflected in the recently launched UK National Air Quality Strategy, which states that:

> "While healthy individuals are now unlikely to experience acute effects at typical air pollution levels, there is some evidence of associations with advanced mortality, chronic illness and discomfort for sensitive groups. In some local areas - particularly congested urban centres - emissions from traffic, industry and other sources can still affect the quality of life for all" (Department of the Environment 1996a p1).

At the same time, there is a growing body of literature which suggests that there may be an association between traffic-related air pollution and respiratory/cardiovascular morbidity and mortality (Schwartz 1993a, Pope *et al.* 1995a). A number of different studies have demonstrated a consistent and linear relationship between exposure to increased levels of PM_{10} (particulates smaller than 10 µm in diameter) and increased incidence of acute respiratory and cardiovascular mortality (Pope *et al.* 1995b). Similar associations have also been found for hospital admissions for respiratory diseases (Pope 1989), exacerbation of asthma (Roemer *et al.* 1993), upper and lower respiratory symptoms (Pope 1991, Pope & Dockery 1992, Roemer *et al.* 1993) and reduced lung function (Hoek & Brunekreef 1993, Pope & Dockery 1992) at ambient pollution levels. There is also growing concern over the effect of smaller particulates, notably $PM_{2.5}$ and PM_1. Associations have also been found for a range of chronic health outcomes, including mortality (Lave & Seskin 1970, Chappie &

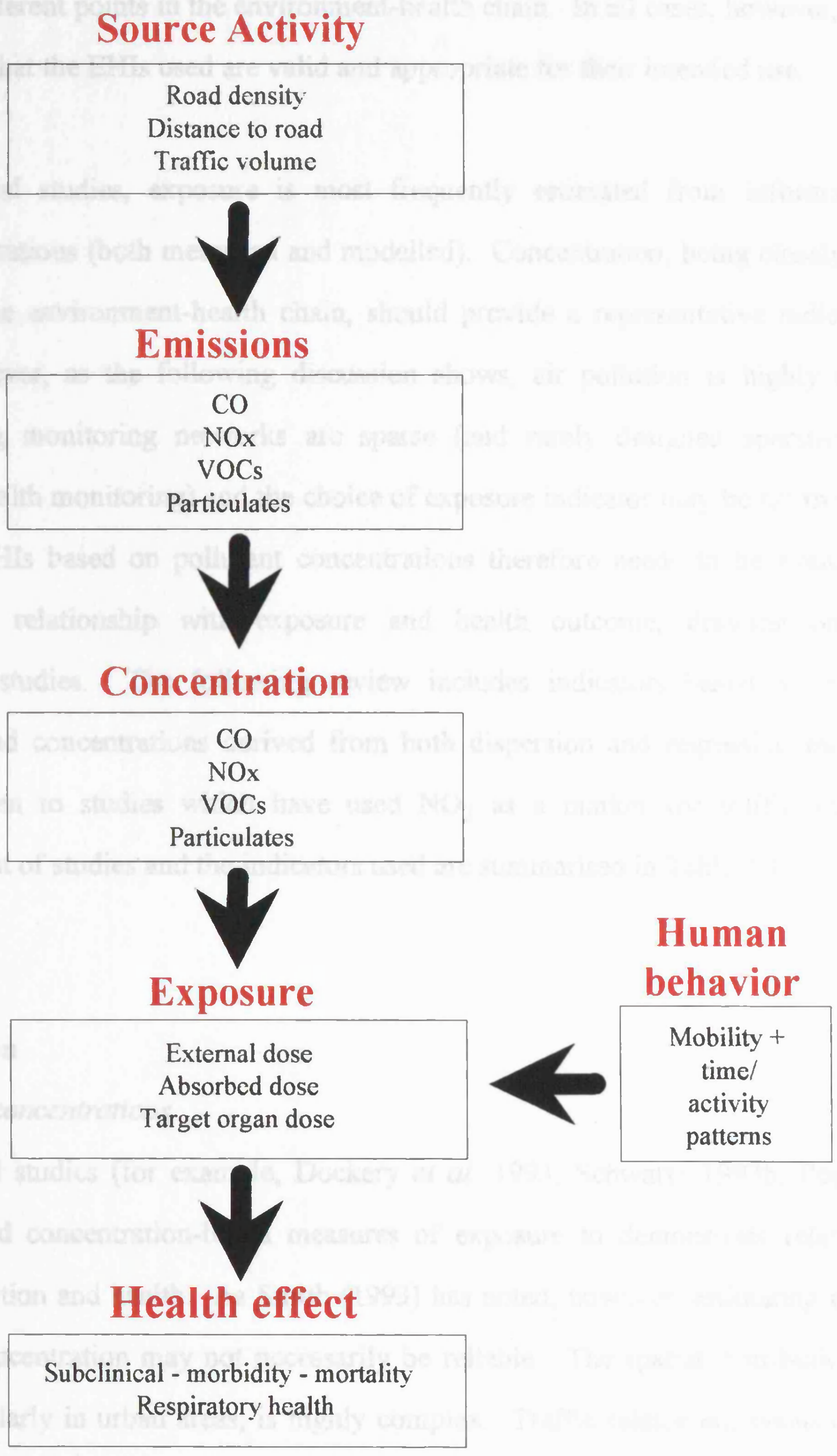
Lave 1982, Lipfert 1984, Evans *et al.* 1984, Ozkaynak & Thurston 1987, Lipfert *et al.* 1988, Archer 1990, Bobak & Leon 1992), reduced lung function (Dockery *et al.* 1989, Schwartz 1989, Chestnut *et al.* 1991, Raizenne *et al.* 1993), respiratory symptoms (Euler *et al.* 1987, Dockery *et al.* 1989, Portney & Mullahy 1990, Schwartz 1993b, Dockery *et al.* 1993) and mortality survival times (Pope *et al.* 1995c). Whilst there is still considerable uncertainty over the direct role of NO_2 in respiratory health (Department of the Environment 1996b), NO_2 has frequently been used in epidemiological studies as a marker for exposure to other traffic-related pollutants (see for example Nakai *et al* 1995, Murakami *et al* 1990, Oosterlee *et al* 1996).

Within Europe, transport is a growth sector. Between 1970 and 1990, car transport grew by more than 3.4 per cent per annum and there has been a similar rise in traffic-related pollution over the same period. In the UK, for example, emissions of volatile organic compounds (VOCs - 40% of which originates from the transport sector) rose by 73% between 1970 and 1990, whilst emissions of nitrogen dioxide (50% of which originates from the transport sector) rose by 120% over the same period (HMSO 1996). Despite advances in engine technology and design, further growth in the transport sector is likely to lead to stable or increased levels of emissions. Traffic-related air pollution is therefore likely to continue to be an important policy issue (EEA 1995). Moreover, emissions of traffic-related pollutants tend to be concentrated in urban areas, where the majority of people live. The potential for negative impacts on health is therefore great (Lebret *et al.* 1997).

4.3 Exposure indicators

The following review of epidemiological studies examines a number of exposure indicators from different points in the environment-health chain. The location of these different indicators can be seen more clearly in Figure 4.1, which illustrates the environment-health chain in relation to traffic-related air pollution and health. As previously mentioned, the lack of information on exposure means that proxy indicators may need to be used. Depending on

Figure 4.1: The Environment-Health Chain



the application concerned and the availability of appropriate data, indicators will need to be constructed at different points in the environment-health chain. In all cases, however, there is a need to ensure that the EHIs used are valid and appropriate for their intended use.

In epidemiological studies, exposure is most frequently estimated from information on pollutant concentrations (both measured and modelled). Concentration, being closely related to exposure in the environment-health chain, should provide a representative indication of exposure. However, as the following discussion shows, air pollution is highly spatially variable, existing monitoring networks are sparse (and rarely designed specifically for environmental health monitoring) and the choice of exposure indicator may be far from clear. The utility of EHIs based on pollutant concentrations therefore needs to be evaluated by examining their relationship with exposure and health outcome, drawing on recent epidemiological studies. The following review includes indicators based on measured concentrations and concentrations derived from both dispersion and regression modelling. Emphasis is given to studies which have used NO_2 as a marker for traffic-related air pollution. The list of studies and the indicators used are summarised in Table 4.1.

4.4 Concentration

4.4.1 Monitored concentrations

Many time-based studies (for example, Dockery *et al.* 1993, Schwartz 1993b, Pope *et al.* 1995c) have used concentration-based measures of exposure to demonstrate relationships between air pollution and health. As Smith (1993) has noted, however, estimating exposure from ambient concentration may not necessarily be reliable. The spatial distribution of air pollution, particularly in urban areas, is highly complex. Traffic-related emissions originate from a large number of different line sources which may intersect, converge, diverge and meander. Emissions may also vary considerably over relatively short distances, depending on

Table 4.1: Summary of the epidemiological studies reviewed

Source study	*Exposure indicators used*	*Health outcome*	*Association found*
	Monitored concentrations		
Brunekreef *et al.* 1997	• Indoor concentrations of PM_{10}, black smoke and NO_2 • Traffic volume (weekly counts) • Distance to road (motorway)	Lung function - FVC, FEV, PEF & FEF	Truck traffic density associated to FEV, PEF & FEF for children living within 1 km of a motorway. Black smoke, automobile traffic density and NO_2 associated with reductions in FEV & PEF. Effects were more pronounced in children living within 300m of a motorway.
Murakami, Ono & Tamura 1990	• Distance to road • Indoor concentrations of NO_2 and SPM • Outdoor concentrations of NO_2 and SPM	Respiratory symptoms (measured using the ATS-DLD questionnaire)	An association was found between distance from road and the prevalence of respiratory symptoms
Linaker *et al.* 1996	• Personal exposure to NO_2 • Indoor concentrations of NO_2 (living room & kitchen)	None	Personal exposure to NO_2 is relatively well correlated with concentrations measured in the kitchen and living room, though the relationship only accounts for between 30-60% of variation.
Nakai, Nitta & Maeda 1995	• Personal exposure to NO_2 • Distance to road • Indoor concentrations of NO_2 (living room) • Outdoor concentrations of NO_2 (exterior wall)	None	An association was found between personal exposure, indoor concentrations, outdoor concentrations and distance from road.
Raaschou-Nielsen *et al.* 1996	• Personal exposure to NO_2 • Indoor concentrations of NO_2 (bedroom) • Outdoor concentrations of NO_2	None	An association between personal exposure and outdoor concentrations was found in rural areas, but not in the urban area studied.
	Dispersion modelling		
Oosterlee *et al.* 1996	• Outdoor concentrations of NO_2 (calculated by dispersion modelling using the CAR model)	Respiratory symptoms - including asthma, chronic cough and wheeze (postal questionnaire)	The prevalence of most respiratory symptoms was higher in subjects living in exposed compared to control streets.

Pershagen *et al.* 1995	• Outdoor concentrations of NO_2 (calculated by dispersion modelling using the CALINE model)	Respiratory symptoms (questionnaire - home interviews)	An association was found between relative risk of wheezing bronchitis and mean time-weighted modelled NO_2 levels.
	Regression modelling		
Briggs *et al.* 1997	• Outdoor concentrations of NO_2 (calculated by regression modelling using the SAVIAH method)	None	The SAVIAH method was shown to give reliable predictions of measured mean NO_2.
Pikhart *et al.* 1997	• Outdoor concentrations of NO_2 (calculated by regression modelling using the SAVIAH method)	Respiratory symptoms (wheezing and chest 'whistling')	No statistically significant association was found between NO_2 and the respiratory symptoms assessed.
	Source-activity indicators		
Wjst *et al.* 1993	• Traffic volume (in main streets - measured)	Lung function - FVC, FEV, MEF & PEFR	An association was found between increased levels of traffic density and decreased PEFR & MEF.
Weiland *et al.* 1994	• Traffic density (residential streets - self-reported)	Wheezing and allergic rhinitis (written/video questionnaire)	Increased levels of truck traffic were associated with allergic rhinitis and wheezing (both being self-reported)
Edwards, Walters & Griffiths 1994	• Traffic density (major roads - measured) • Distance to nearest road (major roads)	Hospital admissions for asthma	A positive association was found between hospital admissions and both distance to road and traffic volume
Nitta *et al.* 1993	• Distance to nearest road (major roads)• Outdoor concentrations of NO_2 (measured)	Respiratory symptoms (postal questionnaire)	A positive association was found between distance to road and respiratory symptoms.
Livingstone *et al.* 1996	• Distance to nearest road (main roads)	Asthma diagnosis	Diagnosis rates for asthma were found to increase with increased distance from road.
Waldron, Pottle & Dod 1995	• Road density (motorways)	Asthma-related symptoms (ISAAC questionnaire)	A lower prevalence of asthma diagnosis was found in wards containing motorways
Landon 1996	• Road density (motorways)	Hospital admissions for asthma	No relationship was found between road density and asthma admissions.

traffic volumes, vehicle composition and vehicle speed. The emission surface is therefore characterised by a high degree of spatial variability. Whilst decay away from individual line sources is rapid, the process is greatly affected by meteorology, topography and surface roughness (i.e. obstruction and canyoning due to buildings and natural features) (Briggs *et al.* 1997). Pollutant concentrations may consequently be found to vary considerably over distances of less than a hundred metres (Hewitt 1991). In a study of commuter and pedestrian exposure in Hong Kong, Chan and Wu (1993), for example, observed variations of more than 60 percent between nitrogen dioxide concentrations in the lower deck of buses and at several points along the road side. It can therefore be argued that existing air pollution monitoring networks, which tend to be sparse and have large distances between sites, fail accurately to represent this spatial variability and may therefore fail to accurately represent human exposure. For example, within greater London, there are only 21 automatic monitoring stations from which to estimate exposure for a population of some 7 million people. It should also be noted that few existing monitoring networks have been developed with health considerations in mind. Most have been established to monitor ambient air quality or to check compliance with emissions limits. Their resulting distribution reflects these intended uses, with sampling sites being positioned near to power stations, industry, or in background locations accordingly. Whilst there is clearly a need for more specific health-related monitoring, it should be noted that networks are expensive both to develop and maintain.

When suitable data is available, as a result of routine or purpose-designed monitoring, there is also a question of which exposure indicator to use. This concerns both the form of the pollutant measured and the statistical format of the exposure indicator. For example, suspended particulate matter (SPM) may be measured as total suspended particles (TSP), black smoke, PM_{10}, $PM_{2.5}$ or other fractions. Each of these may be expressed as a mean value (hourly, daily or annual), as specific percentiles (e.g. 98th) of hourly or daily values, or in the form of exceedences (for example, the number of days or cumulative hours above guideline values). Each pollutant may therefore be expressed in a large number of different ways. Where there is a known relationship with health effects, or where guideline values have been established, the choice of indicator may be obvious. In other cases, however, the choice may be less clear.

Despite these difficulties, one notable study has demonstrated a relationship between concentration-derived measures of exposure and health outcome for traffic-related pollutants (Brunekreef *et al.* 1997). A number of studies have also compared concentration-based exposure estimates against data from personal exposure monitoring (including Linaker *et al.* 1996, Nakai, Nitta and Maeda 1995 and Raaschou-Nielsen *et al.* 1996).

In a recent Dutch study, Brunekreef *et al.* (1997), for example, examine lung function in children living near to major motorways. Six areas were selected with homes located near to motorways carrying between 80,000 and 152,000 vehicles per day. Distances between motorways and both homes and schools were measured using 1:1,000 scale maps, whilst traffic densities were taken from 1993 weekday traffic counts. Indoor concentrations of PM_{10} (using low-volume impactors), black smoke (using PM_{10} filter reflectance) and NO_2 (using Palmes' tubes) were measured in 12 of the 13 participating schools for two months. Data on wind direction was used to determine the amount of time each school was downwind of the motorway. Lung function was assessed using Vicatest-5 rolling seal spirometers and the following parameters were recorded: Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV), Peak Expiratory Flow (PEF) and Forced Expiratory Flow (FEF). Information on age, gender, parental respiratory symptoms, smoking in the home, pets, damp, ethnicity, household size, cooking fuel, unvented water heaters and socio-economic status were also recorded to allow for the control of potential confounders. Truck traffic density was found to be related to FEV, PEF and FEF for all children living within 1,000 metres of a motorway, with effects ranging from -2.5% for FEV to -8% for PEF per 10,000 trucks. Black smoke, automobile traffic density and NO_2 were also found to have a generally negative effect on FEV and PEF. The effect of black smoke on all lung functions, truck traffic density on FVC and FEV and both automobile traffic density and NO_2 on FEF was increased when the analysis was limited to children living within 300m of a motorway. After controlling for confounding and performing gender stratified analysis, the estimated effects were seen to be more marked in girls than boys. The estimated percentage change in FVC for girls living within 300m of a motorway, for example, was -6.3 per 10,000 trucks and -8.4 per 10μg/m^3. The same results for boys were -1.1 and 3.6 respectively.

In response to concerns over exceedences of NO_2 standards and noise levels at a number of Japanese monitoring stations, Murakami, Ono and Tamura (1990) conducted a study into the prevalence of respiratory symptoms near busy roads. 1,100 families were surveyed using the ATS-DLD respiratory symptom questionnaire. Three groups were identified, based on distance to the nearest busy road. These were group A, less than 20m from the nearest busy road; group B, 20-150m; and group C, more than 150m. Both indoor and outdoor NO_2 and SPM levels were measured at the 200 homes at five times through the year (covering all seasons) using portable aerosol samplers for four-day periods. Outdoor levels of NO_2 in groups B and C were found to correlate well with measurements from a nearby monitoring station for the same period. Both indoor and outdoor concentrations of NO_2 were approximately 10-20% higher at group A sites compared to group C sites, with an apparently linear rate of decay. Although less pronounced, concentrations of SPM also appear to be higher in roadside areas than in more distant areas. The prevalence of respiratory symptoms in both children and adults was found to be higher in group A compared to groups B and C. In group A children, for example, rates of wheezing, severe colds and asthma-like symptoms were between 1.5 and 2 times the rates for groups B and C. Similarly, in group A adults, persistent cough and phlegm were twice as common as in groups B and C. This pattern was also found to extend to previously recorded respiratory symptoms. Although the analysis did not include correlations between levels of pollution and prevalence rates, pollutant levels are clearly higher in roadside areas. Whilst it is therefore possible to argue that this study demonstrates the effectiveness of using concentration-based exposure estimates, it would be necessary to undertake further analysis to verify this claim.

In a study on the distribution of NO_2 exposure and determining factors, Linaker *et al.* (1996) measured the personal exposure of 46 children aged between 9 and 11 years in Southampton. Palmes tubes were worn by the children for three seven-day periods between January and March 1994, with additional tubes placed in the kitchen and living room of each child's home during the same periods. Information on potential exposures to NO_2 from gas appliances in the home, the number of smokers in the household and the means of travel to and from school was collected by questionnaire. Whilst there was some variation in the results for individual children from weeks one, two and three, the differences were small compared to the variation between children. In most cases, levels declined from week one to week three. The geometric mean of all personal exposure measurements was 36 $\mu g/m^3$ (range 11-257 $\mu g/m^3$). Correlation coefficients between personal exposure concentrations and both kitchen and living room measurements were respectively, 0.76 ($P<0.01$) and 0.64 ($P<0.01$) for week one, 0.53 ($P<0.05$) and 0.61 ($P<0.01$) for week two and 0.74 ($P<0.01$) and 0.65 ($P<0.05$) for week three. While personal exposure therefore seems to be better correlated to concentrations in kitchens than living rooms, the relationship accounts for no more than 30-60% of variation in monitored personal exposure. It was also found that the use of gas appliances in the home, living with one or more smokers and travelling to school by cycle, bus or on foot influenced exposure, although these factors only accounted for a small proportion of the total variation. Whilst these findings seem to support the use of exposure estimates based on indoor pollutant concentrations, it should be noted that this was a particularly small study, both in terms of the numbers of subjects and the time periods involved.

In a similar approach to that used by Murakami *et al.* (1990), Nakai, Nitta and Maeda (1995) examined differences in personal exposure along heavily-trafficked roads in Tokyo. The 50 subjects selected were all non-smoking females aged between 40 and 60 years who used gas cooking stoves with electric ignition. Zone A contained subjects living less than 20 metres from the road, zone B between 20 and 150 metres and a residential district in the suburbs with low traffic densities was used as zone C. Personal NO_2 exposure was measured using Yanagisawa badges worn on the chest or collar. Badges were also used to monitor indoor (living room) and outdoor (exterior wall) concentrations. All monitoring was conducted on two consecutive days per month over ten months between November 1987 and February 1990. Traffic volume on the roads in areas A and B was reported to be between 30,000 and 34,000 vehicles per 12 hours, with approximately 20% being heavy goods vehicles. Due to the failure of many participants to complete the entire monitoring period, results were presented for each of the ten monitoring periods individually. Outdoor concentrations were consistently highest in zone A and lowest in zone C. The results for both indoor concentration and personal exposure appear to be similar, with levels being generally highest in zone A and lowest in zone C during seasons when heating was not required. During periods when heating was required, personal exposure in homes with a vented heater followed this pattern, whilst this was not always the case in homes with an unvented heater. In these homes, however, there was generally a good correlation between personal and indoor levels. Further adjustments to allow for house structure showed that levels were usually higher in residences constructed from reinforced concrete, possibly due in part to reduced rates of air exchange. Thus while this study demonstrates the decay of NO_2 away from busy roads and the potential utility of using indoor or outdoor pollutant concentrations to estimate exposure, it also highlights the importance of other determinants of exposure - most notably, the use of unvented heaters and varying rates of air exchange.

Raaschou-Nielsen *et al.* (1996) conducted a study involving 100 children living near to busy roads in Copenhagen and 100 children living in rural areas, to assess whether NO_2 concentration outside the home is a good marker of personal exposure. All children were between 4 and 12 years old and were monitored for one-week periods over seven weeks, 15 subjects being measured in each area simultaneously. Busy roads were defined as those carrying more than 5000 vehicles per day. Outdoor levels of NO_2 were measured over a six-month period using Palmes tubes, whilst personal exposure and bedroom concentrations were measured using Advantec, Toyo Roshi Kaisha badges. Preliminary results for 26 measurements in Copenhagen and 24 in rural areas demonstrate that all concentrations were much higher in Copenhagen than in the rural areas. Whilst there was a good level of correlation between personal exposure and outdoor concentrations in the rural areas (Pearson correlation coefficient = 0.6, P=0.003), the relationship was weak in Copenhagen (Pearson correlation coefficient = 0.21, P=0.3). Although this evidence could be used to question the usefulness of exposure estimates derived from outdoor concentrations, the researchers themselves point out that all measurements were taken in October, when Danish children spend most of their time indoors. It is therefore difficult to draw any concrete conclusions before the full results of the study are available.

4.4.2 Dispersion modelling

In the absence of adequate concentration data, dispersion modelling may be used to calculate exposure. This involves obtaining information on the main factors which influence a particular pollution field (for example, emission sources, meteorology and decay rates) and constructing a dynamic model of the dispersion process. This approach has traditionally been used to evaluate point-source pollution; the ISC (Industrial Source Complex) dispersion models developed by the US Environmental Protection Agency have been widely used for many years. More recently, a number of line-source models have been developed for traffic-related pollution. These include the CALINE models (Benson 1992), the CAR model developed in the Netherlands (Eerens *et al.* 1993), the UK Highways Agency Design Manual for Roads and Bridges (DMRB) and ADMS, which has been developed from the DMRB by Cambridge Environmental Research Consultants Ltd. Dispersion modelling enables rapid exposure assessments to be made for a number of different pollutants in a wide range of different geographic areas, whilst avoiding the need for direct monitoring. However, the data requirements of some of these models are high. CALINE-4, for example, requires accurate data on the location and width of road segments (referred to as links), the speed, volume and composition of traffic, pollutant emission factors, wind speed and direction, mixing height, atmospheric stability, and surface roughness. It is unlikely that all of these data will be available in all areas of concern, with the result that estimates or proxies for some of these variables will need to be used, with uncertain consequences. Alternatively, it may prove impossible to undertake the modelling in some areas. Line dispersion models are also geared towards localised pollution, with the result that they are unable to provide information on background pollutant levels. The CAR model, for example, only provides estimates for a distance of up to 35 metres from roads, whilst the CALINE models are effective up to 200 metres from roads. In addition, many of the models require considerable computing power and human resources to operate. CALINE 3 and 4, for example, only permit the input of up to 20 links and receptors (points at which pollutant estimates will be provided - for example, houses, or schools) at a time. This limits the use of some models to very small geographic areas, or requires the models to be run a great number of times. It should also be noted that the models are precisely that - models of actual processes, rather than measurements. Careful validation and calibration is therefore required to ensure that pollution surfaces are accurately represented and reliable estimates of exposure are given.

The two following studies demonstrate the use of modelled NO_2 concentrations to calculate exposure to traffic-related pollution.

In an investigation into respiratory health in Haarlem, Oosterlee *et al.* (1996) compare the prevalence of symptoms in people living along busy roads with those of people living along quiet streets. The study included both adults and children: 673 adults and 106 children along busy streets, 812 adults and 185 children in control streets. Information on a wide range of respiratory symptoms, including asthma, chronic cough and wheeze was collected through a postal questionnaire. Information on potential confounders, including housing conditions and lifestyle factors was also collected. Both exposed and control streets were selected by using maps of NO_2 concentrations derived from the CAR line dispersion model. CAR uses information on vehicle type (i.e. the proportion of cars, buses etc.), mean traffic density, emission rates for different vehicle types, local topography, street canyons, background concentrations and regional variations in meteorology. The model was developed in the Netherlands and has been both internally and externally validated. It is also calibrated on a yearly basis using updated input variables. The concentration in selected exposed streets ranged from 116 $\mu g/m^3$ (62 ppb) to 150 $\mu g/m^3$ (80 ppb), corresponding to estimated traffic volumes of between 10,000 and 30,000 vehicles per day. The results show a higher prevalence of most symptoms in exposed children compared to those in the control streets. After controlling for confounding, this difference was still evident, though only significant for respiratory medication, and wheezing ever. When stratified by gender, the results also showed that effects were more pronounced for girls than for boys. In adults, only dyspnoea was reported significantly more in exposed areas. Thus, whilst this study does not include correlations between actual modelled concentrations and prevalence rates, it demonstrates both the utility of using dispersion models to identify exposed populations and the relationship between traffic-related pollution and health.

Pershagen *et al.* (1995) used modelled concentrations of NO_2 to assess the relationship between ambient air pollution and the development of wheezing bronchitis in children aged between 4 months and 4 years in a population-based case-control study. Detailed information on both respiratory symptoms and potential confounders was collected through a detailed questionnaire using home interviews. Outdoor levels of NO_2 at home addresses and day-care centres were estimated using two models. In urban and suburban areas, a well validated model developed for the Nordic Council was used. In rural areas, due to the more rapid formation of NO_2 from NO, the CALINE-4 model was used. The models included data on traffic density and velocity, street width, street type, distance to the middle of the nearest street, risk of traffic congestion and distance to the nearest pedestrian crossing. Background levels for each parish were estimated using data from continuous monitoring stations. Concentrations were expressed as 99th percentiles of 1 hour values. Individual exposure was calculated by weighting NO_2 levels to reflect the amount of time spent at each residential address in months. The same approach was used for day care centres. In girls, there appeared to be a statistically significant relationship between relative risk of wheezing bronchitis and mean time-weighted NO_2 levels (Confidence interval = 95%, P = 0.02) after controlling for maternal smoking and parental asthma. No association was found in boys. The presence of a gas stove in the home also appeared to be a significant risk factor for girls, though not for boys. By including direct correlations between modelled NO_2 concentrations and health effects, this study highlights the role of combustion products containing NO_2 in the development of wheezing bronchitis and the utility of modelled NO_2 concentrations as a marker for traffic-related pollution.

4.4.3 Regression-modelling

In areas where data availability is restricted, or where very rapid exposure assessments are required, more simple models may be used. One of these is the SAVIAH method (Small Area Variations In Air quality and Health), developed by Briggs *et al.* (1997). The model uses a regression equation combining data on traffic volume, landuse and altitude to calculate annual average nitrogen dioxide concentrations. The model was constructed with data from three two-week monitoring surveys using Palmes tubes in Huddersfield, West Yorkshire, during October 1993, February/March 1994 and May/June 1994. Each of these surveys consisted of 80 'core' sites (i.e. fixed locations throughout all monitoring periods) and 40 'variable' sites (i.e. locations which were changed between monitoring periods). The data from these surveys were entered into a multiple regression analysis, along with a weighted traffic volume factor and a compound land cover factor for the 300 metre buffer around each monitoring site. The traffic volume and landuse data were calculated in a GIS environment, using the FOCALSUM command in the grid module of ARC/INFO. Information on altitude and sampler height were also included in the regression analysis. The best-fit equation, which is described below, gave an r^2 value of 0.607, all variables being significant at the 0.05 level.

$$\text{Mean } NO_2 = 11.83 + (0.00398 * Tvol_{300}) + (0.268 * Land_{300}) - (0.0355 * RSAlt) + (6.777 * \text{Sampler height})$$

where:

- $Tvol_{300} = 15 * Tvol_{0\text{-}40} + Tvol_{40\text{-}300}$ (Tvol = daytime traffic volumes in vehicle km/hr)

- $Land_{300} = 1.8 * HDH_{0-300} + Ind_{0-300}$ (HDH = High Density Housing (hectares), Ind = Industry (hectares))
- RSAlt = 1/sine(altitude)

In validating the model, data from 8 'reference' sites was used. Monitoring at these sites was conducted on a monthly basis over the whole study period to give an indication of longer-term pollution concentrations. The average r^2 correlation value between 'reference' sites and modelled values was 0.82, with a standard error of the estimate value of 3.69 $\mu g/m^3$. In addition, data from a subset of 20 sites for the following year (21 consecutive two-week periods from October 1994 to September 1995) were analysed to compare modelled with actual pollution levels. Whilst the r^2 value was lower at 0.59, this is thought to be due in part to the relatively hot summer and prevailing still conditions, which produced higher than expected pollution levels. The model does therefore appear to provide reliable estimates of long-term air quality.

In a study by Pikhart *et al.* (1997), the SAVIAH method was applied to an assessment of childhood respiratory health in Prague. 3680 children between 7 and 10 years old were surveyed using a questionnaire completed by parents. Information on socio-economic circumstances, housing, parental smoking and family history of atopy was collected along with the prevalence of wheezing or chest 'whistling'. Aggregated data on cooking and heating methods, education level, overcrowding, water and gas supplies, sanitation and car ownership was collected from the 1991 Census. Information on traffic density, land use and altitude was provided by local planning agencies. Individual exposure scores for SO_2 and NO_2 were produced using outdoor estimates of levels at home and school. SO_2 was modelled using kriging in ARC/INFO, based on the nearest 20 sampling points. NO_2 was modelled using the variation on the original SAVIAH equation shown below:

$$\text{Log Mean } NO_2 = 3.46 + (1.17 * Tvol_{0-60}) + (0.110 * Tvol_{60-120}) + (0.000569 * Land_{60}) - (0.00155) * Alt).$$

No statistically significant association between NO_2 or SO_2 and wheezing was found in individual logistic regression, small-area weighted least squares regression or multivariate modelling. Whilst failing to find any significant relationship, the authors believe that the spatial distribution of both NO_2 and SO_2 have been accurately represented, although they recognise that the interpolation of individual exposure is problematic.

4.5 Source-activity indicators

The papers discussed above demonstrate the use of indicators based on measured and modelled concentrations. The following studies rely on the use of proxy measures of exposure from higher in the exposure-health chain. The most frequently used proxies are traffic volume, distance to road and road density. These indicators are based on data which is generally more readily available and they are more closely related to the policy process. They provide a means to rapidly compile and communicate information on environmental health risk. However, as previously mentioned, being further removed from the point of exposure, their relationship to exposure is uncertain. The use of these indicators alongside other measures of exposure in some of the studies outlined earlier makes it possible to evaluate the extent to which they provide reliable indications of exposure. Brunekreef *et al.* (1997) use distance to road and traffic volume along with indoor concentrations of PM_{10}, black smoke and NO_2. Murakami, Ono & Tamura (1990) use distance to road alongside indoor and outdoor concentrations of NO_2 and SPM. Nakai, Nitta & Maeda (1995) use distance to road in conjunction with personal exposure to NO_2 and both indoor and outdoor concentrations of NO_2. These indicators are discussed in more detail in the concluding part of this chapter and can be seen more clearly in Table 4.1.

4.5.1 Traffic volume

Wjst *et al.* (1993) use traffic density as a proxy for exposure to assess the effect of traffic-related pollution on pulmonary function and respiratory symptoms in Munich. Questionnaires including questions on demographics, upper respiratory infections and medical history were distributed to over 7000 children. Lung function tests, which included FVC, FEV, maximal expiratory flow (MEF) and peak expiratory flow rate (PEFR) were performed in schools by randomly selected field technicians. Traffic volume data for main streets were obtained by using automatic induction loops, whilst manual counts were used in smaller streets. The 117 primary school districts in the city, which are approximately 2 km in diameter, were then allocated the volume of the most densely trafficked street within the district. Multiple logistic regression was used to evaluate the effect of traffic volume on respiratory symptoms, whilst controlling for parental asthma history, education and smoking, the number of people in the household, heating and cooking fuels used, time of year and the person filling in the questionnaire. Only those children who had lived at the same residence for the last five years were included in the analysis. The results show that PEFR and MEF reduce with increased levels of traffic density. When traffic volumes were stratified into three classes (low = < 26,000 per 24 hours, medium > 26,000 < 48,000, high > 48,000), the effects were seen to be more pronounced in the higher exposed children. Adjusted mean peak flow reduced by 0.86% in the medium group and 2.18% in the high group. Whilst the authors admit that carrying out personal exposure monitoring would have had possible advantages, it was not feasible in a study of this size. They also point out that whilst traffic counts were found to correlate poorly with measured background NO_2 concentrations in the city, traffic density is an important indicator of the synergistic effects of traffic-related air pollution.

In a study of self-reported wheezing and allergic rhinitis in children in Bochum, Weiland *et al.* (1994) compared the prevalence of symptoms with traffic characteristics around the point of residence. Both self-completed and video questionnaires were used to assess the frequency and severity of wheezing and allergic rhinitis in 2050 12 to 16 year olds. Traffic density on residential streets was assessed by the following two questions:

(a) Do you live on a main road or on a side street?

(b) How often do trucks pass through your residential street on weekdays? (never, seldom, frequently or constantly)

From these questions, responses were ordered according to street type, truck density and traffic density. Information on demographic, socio-economic and confounding factors was also collected. The results showed an increased prevalence of self-reported wheezing and allergic rhinitis assessed by written and video questionnaire in larger streets and with increases in both traffic and truck density. Sex, age, nationality, passive smoking, active smoking, parental history of asthma, number of siblings, single bedroom, house pets and bedroom carpets were identified as potential confounders and controlled for in the subsequent analyses. Adjusted odds-ratios for frequency of truck density were 1.00 for those who never experience truck traffic during weekdays, compared to 1.67 for those reporting constant traffic in written questionnaires. The corresponding results for video questionnaires were 1.00 and 1.94 and for allergic rhinitis were 1.00 and 1.54 respectively. All odds ratios were calculated at the 95% confidence level. Whilst the authors accept the inherent limitations of a study which relies entirely on self-reporting and may therefore suffer from mis-classification of both exposure and symptoms, the results support the hypothesis that traffic-related pollution is associated with both wheezing and allergic rhinitis.

Edwards, Walters and Griffiths (1994) used a combination of traffic density and distance to road to examine the effect of traffic-related pollution on hospital admissions for asthma. Grid-references for home postcodes (accurate to approximately 100 metres) were used to determine the distance to the nearest major road. Based on this information, three distance zones were identified: those living within 200m of a road, those between 201 and 500m and those over 500m. Traffic data for the main roads in the form of 24 hour flows were produced from local measurement stations. The study involved 2187 children aged under five years, who were divided into three groups: cases (those admitted to hospital for asthma), hospital controls (randomly selected non-respiratory emergency hospital admissions) and a community control group (a random selection of children registered with general practitioners in Birmingham). Analysis showed that children admitted for asthma were significantly more likely to have high traffic volumes along their nearest road. This relationship was found to be linear in those living within 500m of a main road. For example, children admitted for asthma were between 22% and 90% more likely to live less than 200m from a road with high traffic volume than in the general community. It was also found that cases were significantly more likely to live within 200m of a main road, regardless of traffic volume. Whilst this study included no actual measurements of personal exposure and failed to take account of any confounding factors, it appears to support both the use of traffic volume and distance to road as proxies for exposure and the hypothesis that traffic-related pollution may be associated with the prevalence of asthma.

4.5.2 Distance to road

In a study of the relationship between respiratory symptoms and traffic-related pollutants, Nitta *et al.* (1993) used distance to road as a proxy for measured exposure. Three cross-sectional studies were performed in 1979, 1982 and 1983. Survey areas were selected to contain roads with heavy traffic volume. In a similar approach to that used by Murakami *et al.* (1990) and Nakai, Nitta and Maeda (1995), subjects were divided into those living less than 20m from a major road and those living between 20 and 150m. The 1982 survey divided subjects into three categories; < 20m, 20-50m and 50-150m. The subjects used in the study were all females aged over 40 years who spent much of their time indoors. Data on symptoms and potential confounders was obtained through a standard postal questionnaire. The utility of distance to road as a relevant proxy was confirmed by a series of ambient air pollution measurements at increasing distances from main roads. In all three survey periods, a gradient for NO_2 concentration according to distance to road was observed. The results of the 1979 survey show a positive association with distance to road for chronic cough, chronic phlegm, chronic wheeze and chest cold with phlegm. The 1982 survey also demonstrated a gradient according to distance to road, odds ratios being significant for chronic cough and chronic phlegm across all three categories. In the 1983 survey, only the odds ratio for shortness of breath was significant, although the results for chronic cough and chronic phlegm approached significance. Whilst this study produces some evidence that traffic-related pollution is associated with respiratory symptoms, the authors believe that the contribution of indoor exposure may exceed the contribution of outdoor pollution.

Livingstone *et al.* (1996) use distance from residence to the nearest main road in an analysis of the relationship between traffic-related pollution and asthma in Tower Hamlets, London. Using records from two computerised general practices, cases were selected as those having received a diagnosis of asthma and prescriptions for asthma-related drugs in the previous year. Controls had neither of these. Based on residential postcode, grid references for both cases and controls were identified and the distance to the nearest main road (i.e. carrying more than 1000 vehicles per hour) calculated using the ARC/INFO GIS program. Information on confounding factors was also collected from GP records and it was noted that the majority of both cases and controls came from the lowest 20% of the Carstairs deprivation index. Half of the cases were also current smokers, although the prevalence of smoking was not found to vary with distance from road. In under 16 children, it was found that the odds ratio for living within 150m of a main road compared to living more than 150m away and being treated for asthma was 0.94 (95% confidence). In adults, the odds ratio was 0.81. The results were not found to vary greatly after adjusting for age (age group in adults), sex and practice. Thus, the results seem to imply a negative relationship between traffic-related pollution and asthma, with diagnosis rates decreasing according to distance from a main road. However, as the authors point out, distance from road is a crude proxy and takes no account of exposure at work and during commuting.

4.5.3 Road density

In response to local fears over the effect of the M25 motorway on children's health, Waldron, Pottle and Dod (1995) used road density as a proxy for traffic-related pollution. 2387 children between the ages of 13 and 14 in East Surrey were surveyed for asthma-related symptoms using the core asthma questionnaire of the International Survey on Asthma and Allergies in Childhood (ISAAC). Children were then grouped according to their electoral wards. Those wards having a population density of more than 15 persons per hectare were defined as urban, those with under 15, as rural. Wards were then defined as motorway or non-motorway, according to whether any part of the M25 motorway fell in that ward. Differences between wards were examined using the x^2 test. 40% of children reported having wheezed, more than half of these (24% of the total) having wheezed in the past year. 16% reported having being diagnosed as suffering from asthma. A tendency for lower reporting of symptoms was found in motorway wards, the results being significant in the case of wheezing at any time and wheezing in the last year. Thus the evidence from this study suggests that current levels of asthma are not associated with the nearby motorway. However, the authors highlight the fact that the statistically significant variation between motorway and non-motorway wards is only in the region of 5%. They also question the reliability of using parental questionnaires and the failure of road density as an exposure proxy to take account of regionally distributed pollutants such as ozone.

Landon (1996) also uses road density in a study of health differentials in three boroughs in London. Using hospital episode statistics and information from the 1991 census, the impact of overcrowding, deprivation, ethnicity and road density on hospital admissions for asthma in Hammersmith, Ealing and Hounslow was examined. Road density was calculated at ward level in a GIS environment and was found to have a negative association with admissions. In contrast a positive association was found for unemployment (r = 0.5) and social class (r = 0.51). All results were significant at the 95% confidence level. In general, admissions were found to be higher in areas with greater proportions of New Commonwealth households and more overcrowding. Thus, it may be that there is no relationship between traffic-related pollution and asthma or that the effects of other factors are more significant, or that road density is a poor proxy for exposure.

4.6 Potential indicators

The preceding review of existing epidemiological studies suggests that four of the five key sets of indicators examined may be used to explore the relationships between traffic-related air pollution and health (see Table 4.2). In this section, each of the indicators reviewed is evaluated in turn.

Table 4.2: Potential exposure indicators

1	Road density (in a buffer or surrounding ED/ward)
2	Distance to nearest road
3	Traffic volume (measured/self-reported)
4	Modelled concentrations of NO_2, PM_{10}, SPM (dispersion/regression modelling)
5	Monitored concentrations of NO_2, PM_{10}, SPM

4.6.1 Road density

Road density was used in two of the studies reviewed (Waldron, Pottle & Dod 1995, Landon 1996). Neither of these studies identified a statistically significant association between road density and the prevalence of respiratory symptoms. Indeed, Waldron, Pottle & Dod (1995) identify a tendency for lower reporting of symptoms in wards containing motorways. The failure to detect a statistically significant relationship between road density and the prevalence of respiratory symptoms may be due to several factors. Firstly, road density may not accurately reflect human exposure to traffic-related pollution. Secondly, there may not be a relationship between traffic-related air pollution and the respiratory symptoms studied. In order to assess the utility of road density as an indicator, it will be necessary to examine its relationship with traffic volume, pollutant concentration, exposure and health outcome. Based on the epidemiological studies reviewed here, it does not appear to be a reliable indicator of exposure to traffic-related air pollution or traffic-related health risks.

4.6.2 Distance to nearest road

Distance to nearest road is more frequently used as a proxy indicator and was used in five of the studies reviewed (Brunekreef *et al.* 1997, Murakami, Ono & Tamura 1990, Nitta *et al.* 1993, Livingstone *et al.* 1996 and Nakai, Nitta & Maeda 1995). The first four of these studies included an examination of the relationship between traffic-related air pollution and health. In all cases, a positive association was found between distance to road and the prevalence of respiratory symptoms. Whilst the last study did not include measures of health effects, it demonstrated a relationship between distance to road, both indoor and outdoor pollutant concentrations and personal exposure. It therefore appears that distance to road may be a useful indicator of exposure to traffic-related air pollution.

4.6.3 Traffic volume

Traffic volume is also frequently used as a proxy indicator for exposure. It was used in four of the studies reviewed (Brunekreef *et al.* 1997, Wjst *et al.* 1993, Weiland *et al.* 1994 and Edwards, Walters & Griffiths 1994). In all of these studies, a positive association was found between traffic-related air pollution and health. In the first two studies increased levels of traffic density were found to be related to reduced lung function, whilst the last two studies identified positive associations with respiratory symptoms and hospital admissions respectively. Traffic volume therefore appears to be an effective indicator of exposure to traffic-related air pollution and health risk.

4.6.4 Modelled concentrations

Pollutant concentrations derived from modelling were used in four of the studies reviewed (Oosterlee *et al.* 1996, Pershagen *et al.* 1995, Briggs *et al.* 1997 and Pikhart *et al.* 1997). The first two of these studies use pollutant concentrations based on dispersion modelling (using the CAR and CALINE models respectively). In both studies, an association was found between the prevalence of respiratory symptoms and modelled pollution concentrations (although the relationship was significant only for girls in the second study). Pollutant concentrations modelled using the CAR and CALINE models therefore appear to be useful indicators of exposure to traffic-related air pollution and health risk. The last two studies demonstrate the use of pollutant concentrations derived from regression modelling. Briggs *et al.* (1997) do not include measures of health outcome, although they demonstrate the effectiveness of the SAVIAH model in predicting measured concentration. Pikhart *et al.*

(1997) include measures of childhood respiratory health, but found no association with SAVIAH-derived pollutant concentrations. Whilst the SAVIAH model appears to provide reliable estimates of measured pollutant concentrations, its utility in predicting health risk is less certain.

4.6.5 Measured concentrations

Measured pollutant concentrations are very frequently used to predict exposure and were used in six of the studies reviewed (Nitta *et al.* 1993, Murakami, Ono & Tamura 1990, Brunekreef *et al.* 1997, Linker *et al.* 1996, Raaschou-Nielsen *et al.* 1996 and Nakai, Nitta & Maeda 1995). The first three of these studies included measures of respiratory health. Nitta *et al.* (1993) and Murakami, Ono & Tamura (1990) illustrate the decay of NO_2 concentrations away from roads and also identify a relationship between distance to road and the prevalence of respiratory symptoms. Brunekreef *et al.* (1997) identify an association between indoor concentrations of both black smoke and NO_2 and lung function. Linker *et al.* (1996), Raaschou-Nielsen *et al.* (1996) and Nakai, Nitta & Maeda (1995) all demonstrate an association between measured concentrations of NO_2 and personal exposure (for indoor, outdoor and both indoor and outdoor NO_2 concentrations respectively).

4.7 Conclusions

This chapter has examined the use of environmental health indicators in a specific policy area - traffic-related air pollution. The utility of proxy indicators of exposure has been evaluated, based on a review of the indicators used in a number of small scale epidemiological studies. The indicators which appear to offer the greatest potential for identifying the relationships between traffic-related air pollution and health are:

- Distance to road;
- Traffic volume;
- Concentrations of NO_2 (modelled) as a marker for exposure to traffic-related pollution;

- Concentrations of NO_2 (measured) as a marker for exposure to traffic-related pollution;

As previously mentioned, the use of proxy indicators is partly necessitated by the difficulty and cost of obtaining information on exposure. In many cases, the availability of information to compile the proxy indicators above may also be limited. In certain circumstances, it will therefore be necessary to augment these indicators with additional measures to reflect conditions at various points in the environment-health chain. For example, many European countries now have well-established national emissions inventories and these may be used to compile additional proxy indicators of exposure where information on measured concentrations is lacking. An explanation of these additional measures is given in chapters Five, Six and Seven, which apply a range of indicators at different spatial scales. The indicators which have been used in these chapters are outlined in Table 4.3 and are explained in more detail in the respective chapters.

Table 4.3: Indicators used in chapters 5, 7 and 7

No.	*Indicator description*	*Chapter 5*	*Chapter 6*	*Chapter 7*
	Source activity			
1	Population density	*	*	*
2	Car ownership		*	
3	Car usage		*	
4	Road density	*	*	*
5	Distance to road	*		
6	Traffic volume (measured)	*		
7	Traffic volume divided by distance to road	*		
	Emissions			
8	Emissions of NO_X	*	*	*
9	Emissions of VOCs	*	*	*
	Concentration			
10	Modelled concentrations of NO_2 (dispersion modelling)	*		
11	Modelled concentrations of NO_2 (regression modelling)	*		
12	Monitored concentrations of NO_2	*	*	
	Health effect			
13	Morbidity - hospital admissions for respiratory illness	*		
14	Mortality - pneumonia, bronchitis & asthma / road traffic accidents.			*

Chapter 5: Exposure Indicators for Small-Area Studies

If a man will begin in certainties, he shall end in doubt; but if he be content to begin with doubts, he shall end in certainties.

Francis Bacon

5.1 Introduction

The purpose of this chapter is to assess the utility of different proxy indicators of exposure at the small-area level and to examine the association between traffic-related air pollution and respiratory health. Although these may appear to be relatively straightforward and transparent aims, in fact, the physical processes and methodological issues involved are highly complex and difficult to unravel.

Whilst the fate of pollutants after their release depends on the natural processes of dispersion and accumulation, the task of measuring human exposure to these pollutants is hampered both by the complexity of the exposure process and the lack of readily available data. Exposure varies according to individual movement patterns through differently polluted micro-environments and also depends on numerous physiological, social, cultural and lifestyle factors. Exposure is rarely monitored routinely and data are sparse. As previously mentioned, researchers and decision-makers must therefore frequently rely on proxy measures of exposure. However, this approach is also complex and involves a number of important stages. Firstly, an assessment of what data are available at the appropriate scale must be made, to decide whether proxies for exposure can be readily constructed. A decision must then be made about which indicators are relevant, based on the particular circumstances and existing knowledge about the health effects of exposure to environmental hazards. The selected proxies must then be developed; the difficulty of this task depending on the number and type of indicators selected and the size of the study area. Finally, where sufficient data is available, the relationship between proxy indicators and measures of health outcome should also be examined, in order to assess the utility of the indicators used and the relationship between traffic-related air pollution and health.

In the light of this process, three main issues or questions arise:

1. Does the choice of exposure proxy matter? In other words, do they all tell the same story, or do some appear to be more accurate or reliable predictors of exposure?
2. Which, if any, are the 'best' proxies and are they consistent?
3. Does the position of the exposure proxy in the environment-health chain have any effect? In other words, are proxies better as one goes up, or down, the chain?

Answering these questions is clearly difficult, given the lack of exposure data and the relative paucity of information on measured pollutant concentrations. This study assesses the utility of proxy measures of exposure by examining their relationship to both measured and modelled NO_2.

The use of NO_2 as a marker for exposure to traffic-related air pollution can be justified on a number of grounds. First and foremost, as the previous chapter shows, a number of epidemiological studies have shown a relationship between measures of NO_2 and respiratory health (e.g. Brunekreef *et al.* 1997, Osterlee *et al.* 1996, Pershagen *et al.* 1995). Transport is also the single largest source of NO_2 emissions, accounting for between 45 and 50 per cent (Department of the Environment 1995). Much of the variation observed in levels of NO_2 therefore results from variations in traffic-related pollution. NO_2 is also relatively easy to measure. There are now a number of low-cost methods available, including passive diffusion tubes and badges, which allow the rapid monitoring of large areas (van Reeuwijk *et al.* 1995). In addition, a number of policy targets, both at the European and national level, relate specifically to NO_2. European targets include the stabilisation of emissions at 1990 levels by 1994 and a 30% reduction by the year 2000 (EEA 1995). In the UK, the NO_2 pollution standard has been set at 104.6 ppb for the 1-hour mean (measured as the 99.9th percentile) and 20 ppb for the annual mean (Department of the Environment 1997, Pullen 1997). The use of NO_2 as a marker for exposure to traffic-related pollution therefore also provides useful information in a policy context.

However, at the same time, there are a number of problems associated with using NO_2. Whilst NO_2 is relatively easy to measure, the accuracy of low-cost sampling methods is uncertain. Estimates of exposure may also be heavily influenced by the siting of air quality monitoring sites (Laxan & Noordally 1987). As previously mentioned, air pollution is highly variable over relatively short distances (Hewitt 1991). Mapping NO_2 concentrations is also complicated by the chemical processes through which it is formed. Nitric oxide (NO) is produced as a result of the high temperature combination of atmospheric nitrogen (N_2O) and oxygen in the combustion process. It is, however, rapidly oxidised by oxygen to produce NO_2 (though even more rapidly by ozone). It therefore rarely persists in the atmosphere in high concentrations, except in the immediate vicinity of emission sources. NO_2, in contrast, is more persistent and may disperse widely, or accumulate in high concentrations. In the absence of N_2O, NO may react with sunlight, oxygen (O_2) and hydrocarbons (HC's) to produce tropospheric ozone. Concentrations of NO_2 are clearly influenced by the complex interplay of these different chemicals as well as the processes of dispersion and accumulation. It is therefore difficult to produce reliable estimates of NO_2 exposure. It should also be noted that measurements of NO_2 do not account for the influence of other traffic-related factors on health, including, noise, particulate pollution, accidents, congestion and disturbance to local communities (Elkin 1991). Similarly, whilst transport is the largest single source of NO_2, it is obvious that not all of the variation in NO_2 concentrations is traffic related.

At the same time, relationships between traffic-related air pollution and respiratory health are affected by variations in age and sex, and are confounded by socio-economic factors. Moreover, the relationship between NO_2 and respiratory health identified in previous epidemiological studies only relates to chronic health effects. The extent to which NO_2

provides a reliable measure of the health risks associated with exposure to traffic-related air pollution is therefore uncertain.

Despite these shortcomings, however, this study offers the opportunity to test the validity of various exposure proxies, and to further explore the relationship between traffic-related air pollution and respiratory health at the small-area level.

The study covers the boroughs of Hammersmith and Ealing in West London, a busy, mainly residential area covering approximately 80 km^2. The study area was selected from a parent study of hospital admissions for asthma and respiratory illness in the North Thames (West) Health Region between April 1992 and March 1994, conducted at the London School of Hygiene and Tropical Medicine. This study is described in detail by Wilkinson *et al.* (1997). From the hospital admissions database used in that study, a random-stratified selection of 500 individuals was made comprising 250 cases and 250 controls. A number of proxy exposure indicators were then developed, based on the residential location of these individuals.

5.2 Study aims

Based on the above, the specific aims of this study were:

- to construct a number of proxy indicators for exposure, based on the potential indicators identified in Chapter Four;
- to examine the relationship between these proxies following on from points 1-3 above;
- to examine the relationship between the proxy indicators and measures of health outcome;
- to evaluate the utility of these proxy exposure indicators for small-area studies.

5.3 Selected proxy exposure indicators

Based on the literature review and discussion in Chapter Four, the following indicators have been selected for inclusion in this study. The methodologies involved in their construction are explained in detail in section 5.5:

1. Population density in the surrounding enumeration district (ED) (people/km^2);
2. Road density in the surrounding ED (km/km^2);
3. Distance to nearest road (metres);
4. Peak hour traffic volume of nearest road (vehicles/hour);
5. Traffic volume of nearest road divided by distance to nearest road;
6. NO_x emissions in 1990 (kg/year);
7. VOC emissions in 1990 (kg/year);
8. Modelled NO_2 using the SAVIAH regression equation (mean annual concentration - µg/m^3);
9. Modelled NO_2 using CALINE-3 (mean annual concentration and 98th percentile of daily values - µg/m^3).
10. Measured mean annual NO_2.

5.4 GIS development

In order to construct each of the above indicators and to provide an environment for subsequent mapping and analysis, a GIS was constructed of the study area, using ARC/INFO 7.0.2 running on a SUN Sparc5. The GIS was based on Bartholomew's 1:5000 London roads data, which is derived from aerial photography. Estimated average peak hour weekday traffic volumes for major roads were added at the London School of Hygiene and Tropical Medicine as part of the parent study, based on the London Research Centre's traffic flow model for London. Minor roads and urban streets were assigned traffic volumes based on the Department of Transport's 1991 traffic report, which gives average traffic volumes for outer, inner and central London zones.

The 500 individuals selected from the hospital admissions database consisted of an equal number of cases and controls. Cases represent people admitted to hospital for respiratory illness during the period April 1992-March 1994, whilst controls represent those admitted for all other reasons, excluding traffic-related accidents, within the same period. The postcodes of home residence for these individuals were extracted from the admissions database in order to calculate their geographic locations. Address-weighted centroids for each unit postcode were then calculated at the Ordnance Survey (OS) by finding the location of all addresses within each unit postcode (using the OS Address Point database), for example, N12 7QU, then estimating the centre of these points. Although Address Point is accurate to within 1 metre, the address-weighted centroids were generalised by the OS to +/- 10 metre. This work was carried out as part of the parent study for the London School of Hygiene and Tropical Medicine.

Whilst home residence can therefore theoretically be calculated to a notional accuracy of +/- 10 metres, it should be remembered that the centroids represent 'average' location for each postcode, rather than the actual place of residence. Determining the actual point of residence requires information on house name or number and these were not present in the original database. The degree to which the address-weighted centroid represents the location of residence depends upon the size and shape of the unit postcode concerned, and the position of the home within this area. It should therefore be noted that the proxy exposure indicators based on these estimated locations of residence may not accurately reflect the real exposure experienced by the individuals involved. Whilst this will not affect the relationship between proxy indicators (because all proxy indicators are based on the same locations), it may affect the results of the analysis between exposure and health effects (because the accuracy of the exposure indicators is uncertain).

In addition to the indicators constructed for the 500 cases and controls outlined above, 17 sites from the South East Institute of Public Health (SEIPH) NO_2 diffusion tube monitoring network were found to fall within the study area. Proxy exposure indicators were also constructed for these points, thus enabling comparisons to be made between the proxies and measured NO_2. Monthly average concentration data for the period January to December 1994 were obtained from SEIPH. Mean annual concentrations were then calculated by averaging the monthly data over the whole year. In the case of six of these sites, less than 6 months of data were available (the minimum considered sufficient to give a reasonably accurate measure of the annual mean). Measured mean annual NO_2 concentrations were therefore only available in 11 locations.

ID numbers, x-coordinates and y-coordinates of case/control points and NO_2 sites were entered into separate text files. These were read as input files using the GENERATE command to create two separate coverages. The proxy indicators were then calculated for both coverages according to the methods outlined below. Those indicators which required the use of EXCEL for their calculation were stored in EXCEL before being saved as text files and re-joined to the case/control and NO_2 coverage attribute tables using the JOINITEM command.

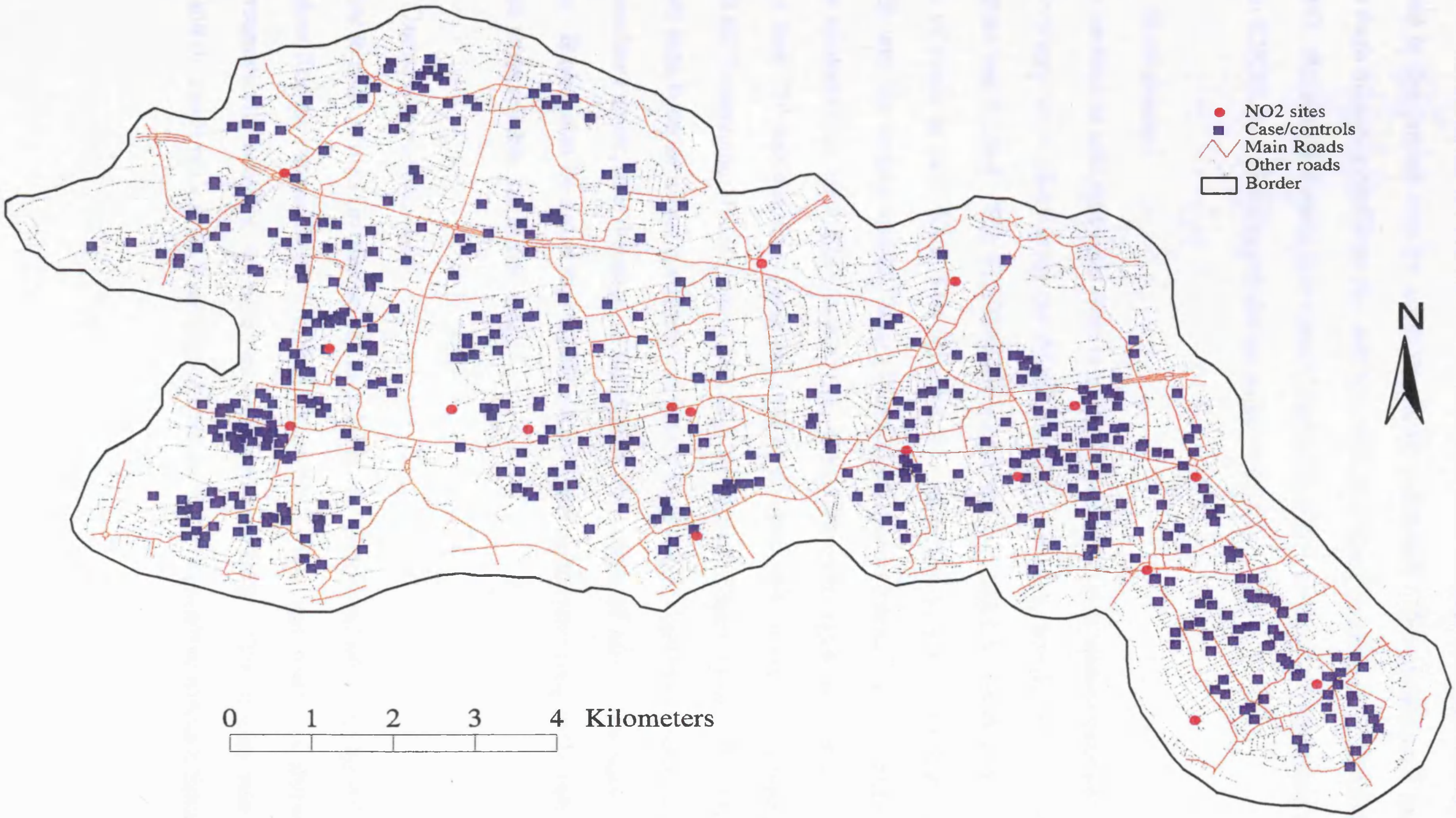
The location of the study area, roads, cases and controls and NO_2 sites are shown in Figure 5.1.

5.5 Indicator construction

5.5.1. Population density

Population density has been selected for inclusion in this study because it is thought to be a general indicator of socio-economic development and may be associated with various source activities (for example, general levels of car ownership and road density) and emissions. Population data for London EDs were extracted from the 1991 census CD-ROM and saved as a text file. This is the smallest geographic unit for which census data are available. Meanwhile, the EDline dataset, which consists of digitised boundary data for the 113,196 EDs in England and Wales was obtained from MIDAS (Manchester Information Datasets and

Figure 5.1: The Study Area - Hammersmith and Ealing, West London



Maps produced by The London School of Hygeine and Tropical Medicine - point data is copyrighted by Ordnance Survey

Associated Services) in Arc/Info GENERATE format. Inner and outer London coverages were combined using the MAPJOIN command. This Greater London coverage was then cropped to the project area by using the CLIP command. The surface area (m^2) and ED labels were then exported from the attribute table to a text file using the EXPORT command in INFO. Population density (per square kilometre) was calculated by combining the two text files in EXCEL and dividing population by surface area.

5.5.2. Road density

It was decided to calculate road density in the EDs around each case/control site. Road and ED coverages were joined using the INTERSECT command to identify the ED within which each road was located. The STATISTICS command in TABLES was then used to sum the length of roads in each ED. This information was stored in a text file and combined in EXCEL with the surface area/ED label file produced above to calculate the length of road per square kilometre for each ED. A coverage containing only roads with traffic volumes of greater than 750 vehicles/hour (later referred to as main roads) was then created using the RESELECT command. Road density was also calculated for these roads. This threshold was selected both because it was considered to give a meaningful distinction between busy roads and less busy roads, and because it lies within the range of thresholds used in previous studies. It may also be noted that traffic counts tend to be more frequently conducted, and thus are more reliable, for busier roads.

5.5.3. Distance to nearest road

Distance to nearest road (in metres) for each point was calculated using the NEAR command. This identifies the nearest feature in the near_cover; in this case roads. A distance field is then automatically added to the point coverage attribute table. This process was run for all roads and for roads with more than 750 vehicles per hour to give two distance figures.

5.5.4. Traffic volume

The NEAR command used above also attaches the ID number of the nearest road to each point in a coverage. It is therefore possible to determine the traffic volume of the nearest road, since this information is stored in the attribute table of the roads coverage and the ID number forms a link between the two. Using the JOINITEM command, the road attributes were added to the case/control and NO_2 coverage attribute tables. All additional attributes (i.e. all those apart from traffic volume) were then deleted using the DROPITEM command. This exercise was repeated for main roads to give traffic volumes for nearest main road. All traffic volumes are for estimated average peak-hour weekday flows.

5.5.5. Traffic volume divided by distance to nearest road

This indicator has been included because both traffic volume and distance to road have been identified as potential proxy indicators of exposure. Pollutant concentrations at a particular location are likely to be influenced by the distance to the nearest road and the volume of traffic on that road. By combining these two indicators in a single measure, it will be possible to account for their combined effects. The indicator was calculated by extracting the distance and traffic volume fields using the EXPORT command and dividing traffic volume by distance to road in EXCEL. This indicator was calculated for all roads and main roads.

5.5.6. Emissions data

Emissions form the link between source activities and pollutant concentrations in the environment-health chain. Their inclusion in this study will allow this relationship to be examined in more detail, along with their utility as a proxy for exposure. Data from the 1990 National Atmospheric Emissions Inventory (NAEI) was obtained from the National Environment Technology Centre (NETCEN). Emissions are calculated annually for a number of global pollutants (for example, carbon dioxide), regional pollutants (i.e. pollutants of regional significance) and metals (lead, cadmium and mercury). Annual emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs) and carbon monoxide (CO) are calculated nationally on a 10 kilometre square grid and for every square kilometre in Greater London. Information on area sources (including road, rail, air and agriculture) and point sources (including refineries, waste incinerators and power stations) is included. The methods used are described in Gillam *et al.* (1992).

The data were obtained as text files with emissions in grams per second for each cell. The units were converted into kilograms per year and the centre point of each cell calculated by starting from the grid origin. A point coverage was then made using the GENERATE command and the data added as labels. Using the POINTGRID command, the data were rasterised to create separate grids for NO_x and VOC's. Because GRID automatically creates floating-point values, it was necessary to convert the values back to integers using the INT command. The grids were then converted into polygon coverages with the GRIDPOLY command and clipped to the size of the project area. Points in the case/control and NO_2 coverages were then assigned emissions values according to which cell they are located in (using the INTERSECT command). NO_x emissions can be seen in Figure 5.2.

5.5.7. Modelled NO_2 using the SAVIAH regression equation

Modelled mean annual concentrations of NO_2 (in μg/m^3) were calculated using the SAVIAH method outlined in Chapter Four. Firstly the roads coverage was converted into a 10m by 10m grid with traffic volume figures as grid attributes, using the LINEGRID command. Traffic volume in the 40m and 300m buffer zones around each cell was then calculated by using the FOCALSUM command in GRID, which adds the values of cells within a specified distance and sends the sum value to the corresponding location on a new grid. The resulting grids were then intersected with the case/control and NO_2 coverages (using the LATTICESPOT command) to determine the 40m and 300m traffic volume buffer values for each point. Using the digitised landuse map created for the CALINE-3 modelling, which can be seen in Figure 5.3, and is described below, separate coverages were created for high density housing (HDH) and industrial land (CI) by using the RESELECT command. These were then converted into 10m^2 grids and the FOCALSUM command used to determine the

Figure 5.2: Nitrogen oxide (NO_x) Emissions for 1990 (kg per km^2 per year)

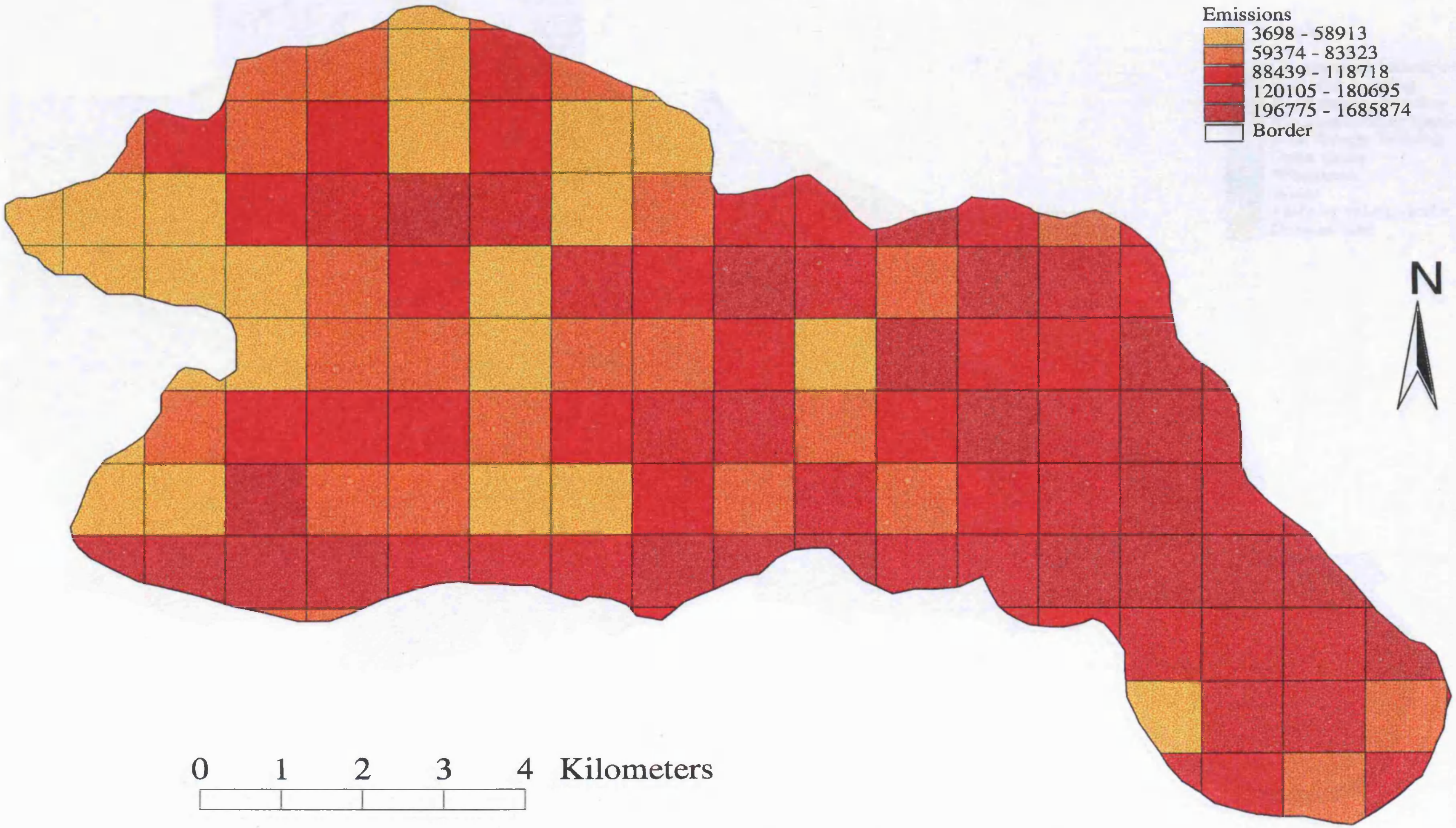


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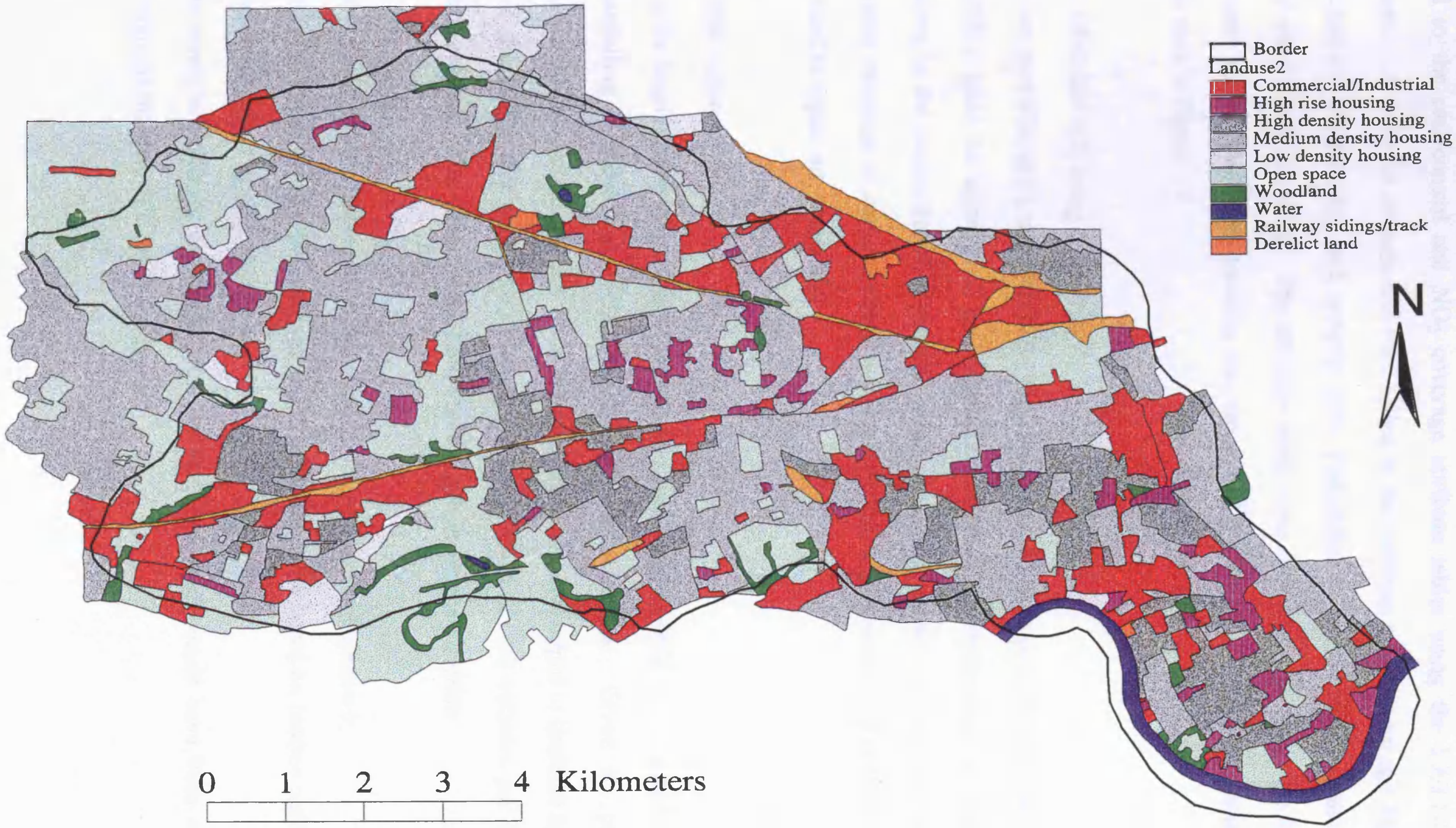
Figure 5.3: Landuse Classification



Maps produced by The London School of Hygeine and Tropical Medicine - point data is copyrighted by Ordnance Survey

amount of HDH and CI land in the 300 metres around each cell. These values were then added to the case/control and NO_2 coverage attribute tables using the LATTICESPOT command. A field for altitude was then added to the attribute tables using the ADDITEM command and altitudes for each receptor point (calculated from 1:25,000 Ordnance Survey maps) were added manually. The attribute tables were then extracted using the EXPORT command and the SAVIAH equation was calculated in EXCEL. Modelled concentrations can be seen in Figure 5.4

5.5.8. Modelled NO_2 using CALINE-3

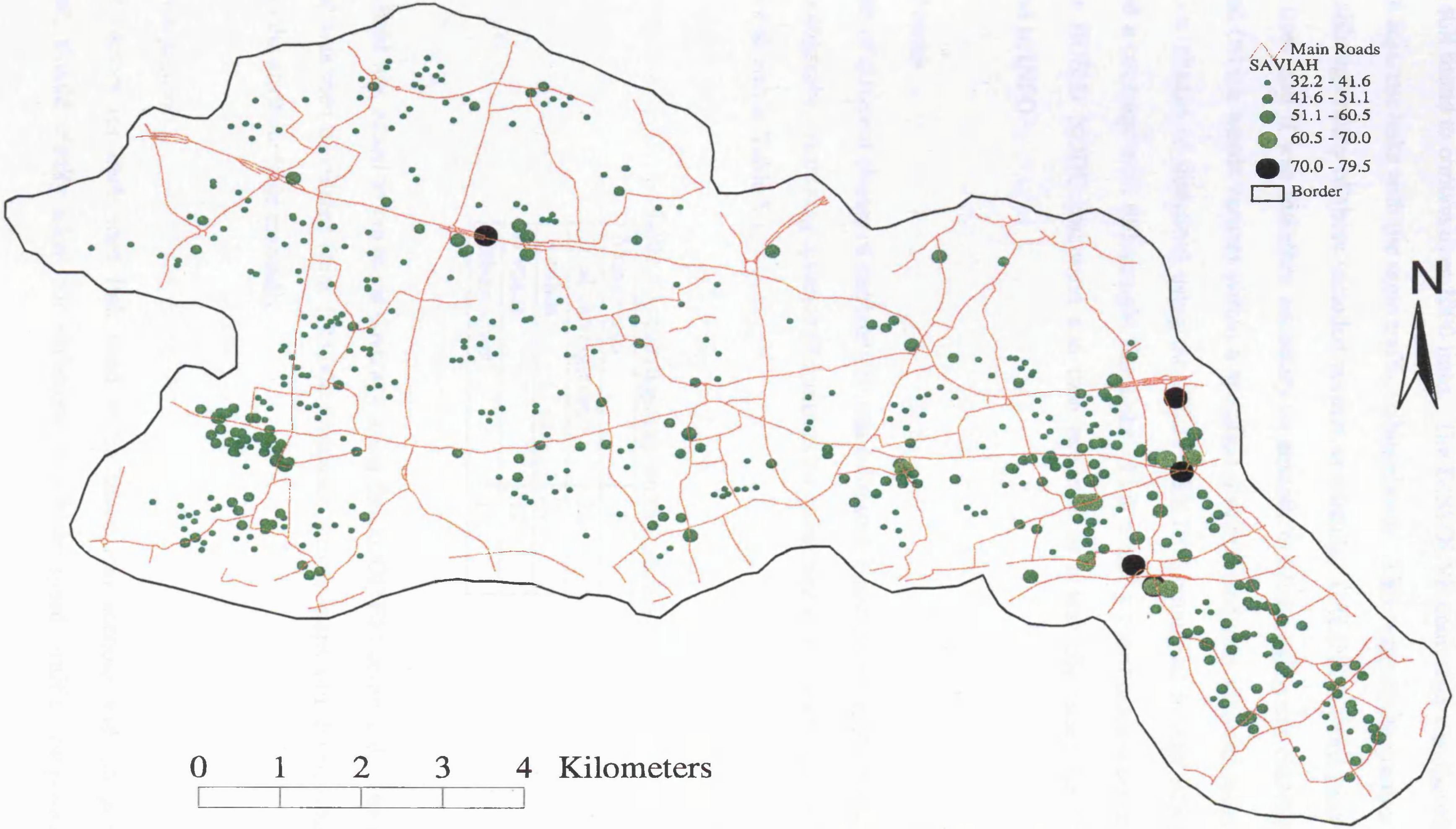
NO_2 was modelled using the CALINE-3 dispersion model outlined in Chapter Four. Whilst CALINE-3 takes no account of the effects of acceleration, deceleration or stopping on emissions, or the precise nature of chemical reactions during dispersion, it can be used to give first order estimates of concentrations in complex urban environments. The following data were used as inputs into the model:

(a) Traffic volume

Due to the large number of road links in the study area (circa 14,000), it was decided to limit the modelling to those links with the highest traffic volumes. Given the previously mentioned 20 link and 20 receptor limit in the model, it was also hoped to limit the number of runs of the model that would be required. A lower limit of 750 vehicles per hour was therefore selected. The effect of this limit was thought to be small because:

- all major roads are included (representing the largest emission sources);
- traffic volumes for smaller roads are either estimates or are based on limited traffic counts and are therefore open to doubt;
- the levels of pollution associated with the excluded roads would have been small and within the margins of error of the model.

Figure 5.4: Modelled Mean Annual Concentrations using the SAVIAH method (μg/m^3)



Maps produced by The London School of Hygeine and Tropical Medicine - point data is copyrighted by Ordnance Survey

The main roads coverage created earlier was used as a source for the road link information, but was still found to contain over 2000 links. The DISSOLVE command was therefore used to merge adjacent links with the same traffic volume value. This reduced the number of links to 470, although many of these included corners and bends. CALINE-3 treats road links as straight lines and it was therefore necessary to smooth the links using the GENERALIZE command (which weeds vertices within a specified distance) and then split the links at each vertex (i.e. change of direction) using the SPLIT VERTEX command in ARCEDIT. This produced a coverage with 682 straight line links. Link x and y coordinates were calculated with the BUILD NODE command and then exported to a text file using the EXPORT command in INFO.

(b)Road width

The width of different classes of carriageway was estimated, based on a sample of roads from aerial photographs. A mixing distance of 3 metres on either side of the road was added. The widths are shown in Table 5.1.

Table 5.1: Carriageway width (metres)

Motorways	36
Dual carriageways	26
A roads	20
B roads	17
Urban street	17

A width field was added to the roads coverage using the ADDITEM command. The class of each road was then calculated from 1:25,000 Ordnance Survey maps and the relevant value entered in the attribute table manually.

(c)Emission factors

Emission factors for each road link need to be taken into account and, as previously mentioned, should ideally allow for variations in vehicle speed, traffic composition etc.

Whilst these factors have a significant effect on emissions, obtaining accurate, representative data is both difficult and costly. Although purpose-designed monitoring can be undertaken for short-term modelling, in the longer term, this approach is less practicable. In the light of this, 'standard' traffic compositions must be used. For this study, traffic composition was assumed to comprise 90% light vehicles and 10% heavy goods vehicles, with an average speed of 50 km/hr. This represents an average for urban areas in the UK, based on national traffic statistics. Emission factors for these conditions were taken from the Design Manual for Roads and Bridges (Department of Transport 1994).

(d)Meteorological conditions

CALINE-3 requires meteorological data on four variables - wind speed and direction, atmospheric stability and mixing height. In urban areas, wind speed and direction, in particular, may vary widely over relatively short distances, due to building obstruction and street canyoning. Ideally, therefore, data are needed for a number of meteorological stations within the study area. In practice, however, the nearest station is at Kew Gardens in West London and data on wind speed and wind direction over the survey period are missing for approximately 10% of days. Data were therefore also obtained from the station at Heathrow (HR), to allow for estimation of missing values. Values for the 8-9 am period were extracted from both datasets to match the peak hour traffic data period. To calculate the missing values in the Kew dataset, regression analysis was performed. For wind speed, the r^2 value for the two datasets was 0.675 ($p<0.000$), values in West London (WL) being:

$$WL = 0.742 \times (HR + 2.924)$$

For wind direction, the data were transformed relative to an arbitrary direction prior to regression analysis, which involved recording the direction of the dependent site (West London) in degrees relative to the Heathrow site in the direction which represented the smallest difference. The r^2 value between the datasets was 0.88 ($p<0.001$), values in West London being:

WL = -2.29 + (0.945 x HR)

The final data were stored in separate text files for each of the years to be modelled.

(e) Surface roughness

CALINE-3 uses a measure of surface roughness for each road link to estimate the restriction to dispersion caused by buildings and vegetation at the roadside. Whilst roughness figures could not be obtained individually for all road links in this study due to time and resource constraints, estimates were made based on 1:10,000 aerial photographs. These were interpreted to produce a land cover map, based on a pre-defined land cover classification (see Table 5.2).

Table 5.2: Land Cover and Surface Roughness Classification

Land Cover Class	*Roughness Factor (cm)*
High rise buildings	370
Commercial	325
Industrial	175
High density housing	125
Medium density housing	108
Low density housing	100
Woodland	127
Open land	127

(based on Trinity Consultants Inc. 1979)

The land cover map was validated through a field survey in which 88 locations were visited. Sample sites were chosen on a random-stratified basis to ensure that representative samples of all major land classes were covered. Discrimination between two of the original land cover classes - industry and commercial land - was found to be poor, so these two classes were subsequently combined. For the remaining land cover classes, validation was positive, with at least 85% of the sites falling in the predicted land cover class.

To operate the model, it is necessary to identify the links which lie within approximately 200m of each receptor (links beyond this distance will have a negligible effect on modelled pollution). To this end, all 517 (500 cases/controls and 17 NO_2 monitoring sites) points were individually buffered (using the BUFFER command) and intersected with the roads data (using the INTERSECT command). The point ID and associated roads IDs were then exported as a text file and the appropriate road and point coordinates pasted in. This exercise was repeated for each of the 517 points to be modelled. Bearing in mind the 20 receptor/20 link limit in CALINE-3, wherever possible, the receptor points were grouped to minimise the number of runs needed, whilst ensuring that none exceeded the 20 limit. Despite this, it was necessary to run the model 226 times - 206 for the cases and controls, 20 for the NO_2 sites. This large number was partly due to the need to run the model twice for each receptor; once for year one (1/4/92 - 31/3/93) and once for year two (1/4/93 - 31/3/94). To ease the problem of sorting and combining the resulting list files, a series of programs were written in Dbase-4 to extract the daily values calculated by CALINE and calculate mean annual concentration and 98th percentile of daily values in $\mu g/m^3$.

From these results, two indicators were computed: the mean peak hour NO_2 concentrations and the 98th percentile of peak hour concentrations. Modelled mean peak hour annual concentrations can be seen in Figure 5.5. It should be noted that these reflect traffic-related concentrations only and do not include background values, unlike the SAVIAH-derived concentrations. It should also be noted that they are averages for a two-year period (i.e. the same period as the hospital admissions data), whereas the SAVIAH-derived values are for one-year only.

5.6 Results

The final indicators were exported to EXCEL using the EXPORT command in INFO and were then converted into Dbase-4 format. SPSS was then used to perform one-tailed Spearman's rank correlations (to assess the relationship between indicators) and cross-tabulations (to assess the consistency of exposure classification by quintile). The results are summarised in Tables 5.3, 5.4, 5.5 and 5.6.

Figure 5.5: Modelled Mean Annual Concentrations using CALINE-3 ($\mu g/m^3$)

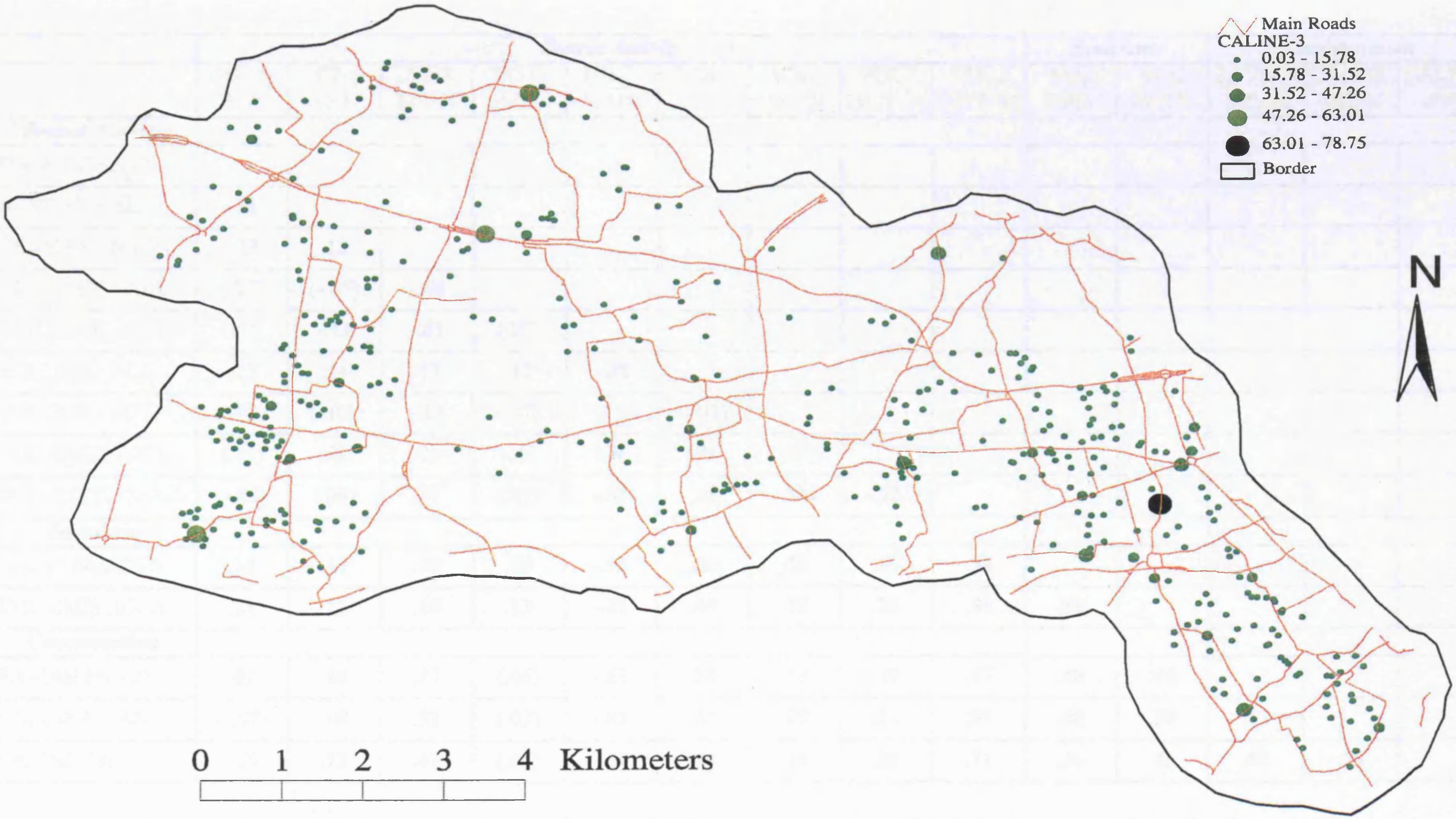


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TABLE 5.3: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

Case/Control sites

	Source Activity									*Emissions*		*Concentration*		
	POP'N DENS.	DENS. ALL	DENS. MAIN	DIST. ALL	DIST. MAIN	VOL. ALL	VOL. MAIN	VOL./ DIST. A	VOL./ DIST. M	NO_x EMIS.	VOC EMIS.	SAVIAH MEAN	CALINE MEAN	CALINE P98
Source Activity														
POP'N DENSITY														
DENSITY - ALL	**.38**													
DENSITY - MAIN	**-.19**	**.13**												
DISTANCE - ALL	(.07)	(-.05)	*-.08*											
DISTANCE - MAIN	(.02)	**-.11**	**-.61**	(.03)										
VOLUME - ALL	**.15**	**.14**	**.13**	**.17**	**-.32**									
VOLUME - MAIN	(-.02)	(-.07)	**-.12**	(.07)	**.11**	(-.01)								
VOL./DIST. - ALL	(.04)	*.09*	**.20**	**-.43**	**-.36**	**.72**	(-.04)							
VOL./DIST. - MAIN	(-.05)	(.06)	**.54**	(.02)	**-.89**	**.31**	**.30**	**.32**						
Emissions														
NO_x EMISSIONS	**.18**	**.14**	**.22**	*.09*	**-.33**	**.33**	**.16**	**.19**	**.38**					
VOC EMISSIONS	**.21**	**.22**	**.16**	**.13**	**-.31**	**.43**	**.12**	**.26**	**.34**	**.89**				
Concentration														
SAVIAH MEAN	*.07*	**.18**	**.37**	(.06)	**-.65**	**.50**	**.13**	**.40**	**.67**	**.48**	**.45**			
CALINE MEAN	(-.07)	*.08*	**.52**	(.02)	**-.81**	**.31**	*.09*	**.31**	**.81**	**.40**	**.39**	**.67**		
CALINE P98	*-.09*	**.12**	**.47**	(.07)	**-.69**	**.38**	**.14**	**.33**	**.71**	**.36**	**.45**	**.62**	**.79**	

Note: all correlations based on n=500; figures in italics significant at 0.025 level in the predicted direction; figures in bold significant at 0.005 level in the predicted direction; figures in brackets not significant

TABLE 5.4: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

NO_2 monitoring sites

	Source Activity									***Emissions***		***Concentration***		
	POP'N DENS.	DENS. ALL	DENS. MAIN	DIST. ALL	DIST. MAIN	VOL. ALL	VOL. MAIN	VOL./ DIST. A	VOL./ DIST. M	NO_x EMIS.	VOC EMIS.	SAVIAH MEAN	CALINE MEAN	CALINE P98
Source Activity														
POP'N DENSITY														
DENSITY - ALL	*.43*													
DENSITY - MAIN	(-.18)	*.45*												
DISTANCE - ALL	*-.45*	(-.19)	(.11)											
DISTANCE - MAIN	(-.10)	(-.40)	**-.66**	(0)										
VOLUME - ALL	(-.10)	**.57**	**.70**	(.11)	**-.69**									
VOLUME - MAIN	(.10)	(-.02)	(.39)	(-.19)	(-.21)	(.01)								
VOL./DIST. - ALL	(.10)	**.56**	**.64**	(-.17)	**.74**	**.92**	(.11)							
VOL./DIST. - MAIN	(.15)	(.35)	**.66**	(-.09)	**-.94**	**.60**	*.51*	**.69**						
Emissions														
NO_x EMISSIONS	(.05)	(.15)	*.61*	(.02)	*-.49*	*.41*	**.60**	(.38)	**.63**					
VOC EMISSIONS	(.23)	(.17)	*.43*	(-.19)	(-.35)	(.30)	**.60**	(.35)	*.51*	**.93**				
Concentration														
SAVIAH MEAN	(.29)	**.71**	**.72**	(-.04)	**-.84**	**.73**	(.30)	**.74**	**.81**	*.50*	(.41)			
CALINE MEAN	(.19)	*.52*	**.72**	(0)	**-.97**	**.71**	(.33)	**.75**	**.95**	*.55*	*.42*	**.92**		
CALINE P98	(.19)	*.47*	**.72**	(.02)	**-.96**	**.72**	(.37)	**.77**	**.95**	**.57**	*.45*	**.89**	**.98**	
MEASURED NO_2	(.24)	*.67*	(.49)	(.02)	**-.76**	**.76**	(-.32)	**.82**	*.62*	(.30)	(.21)	**.95**	**.84**	**.82**

*Note: * Measured NO_2 n = 11; all other correlations based on n = 17; figures in italics significant at 0.025 level in the predicted direction; figures in bold significant at 0.005 level in the predicted direction; figures in brackets not significant*

TABLE 5.5: CROSS-TABULATION OF INDICATORS: PERCENTAGE OF SITES CLASSIFIED IN THE SAME QUINTILE

Case/Control sites

	Source Activity									*Emissions*		*Concentration*		
	POP'N DENS.	DENS. ALL	DENS. MAIN	DIST. ALL	DIST. MAIN	VOL. ALL	VOL. MAIN	VOL./ DIST. A	VOL./ DIST. M	NO_x EMIS.	VOC EMIS.	SAVIAH MEAN	CALINE MEAN	CALINE P98
Source Activity														
POP'N DENSITY														
DENSITY - ALL	**35**													
DENSITY - MAIN	**14**	**18**												
DISTANCE - ALL	**19**	**19**	**21**											
DISTANCE - MAIN	**19**	**25**	**35**	**20**										
VOLUME - ALL	**21**	**22**	**23**	**19**	**31**									
VOLUME - MAIN	**22**	**16**	**17**	**20**	**19**	**18**								
VOL./DIST. - ALL	**21**	**20**	**22**	**33**	**34**	**47**	**19**							
VOL./DIST. - MAIN	**16**	**21**	**33**	**20**	**58**	**31**	**26**	**32**						
Emissions														
NO_x EMISSIONS	**21**	**22**	**21**	**18**	**28**	**29**	**25**	**26**	**30**					
VOC EMISSIONS	**26**	**28**	**20**	**19**	**27**	**29**	**27**	**26**	**24**	**62**				
Concentration														
SAVIAH MEAN	**20**	**22**	**27**	**17**	**37**	**36**	**25**	**31**	**40**	**32**	**25**			
CALINE MEAN	**18**	**21**	**32**	**19**	**56**	**33**	**23**	**31**	**58**	**31**	**29**	**39**		
CALINE P98	**16**	**22**	**34**	**18**	**51**	**31**	**25**	**28**	**52**	**30**	**28**	**35**	**63**	

Note: all cross-tabs based on n = 500

TABLE 5.6: CROSS-TABULATION OF INDICATORS: PERCENTAGE OF SITES CLASSIFIED IN THE SAME QUINTILE

NO_2 sites

	Source Activity									*Emissions*		*Concentration*		
	POP'N DENS.	DENS. ALL	DENS. MAIN	DIST. ALL	DIST. MAIN	VOL. ALL	VOL. MAIN	VOL./ DIST. A	VOL./ DIST. M	NO_x EMIS.	VOC EMIS.	SAVIAH MEAN	CALINE MEAN	CALINE P98
Source Activity														
POP'N DENSITY														
DENSITY - ALL	**35**													
DENSITY - MAIN	**24**	**29**												
DISTANCE - ALL	**35**	**35**	**18**											
DISTANCE - MAIN	**6**	**29**	**35**	**18**										
VOLUME - ALL	**12**	**29**	**41**	**12**	**35**									
VOLUME - MAIN	**18**	**24**	**29**	**18**	**35**	**24**								
VOL./DIST. - ALL	**12**	**29**	**24**	**12**	**47**	**71**	**18**							
VOL./DIST. - MAIN	**18**	**29**	**29**	**12**	**76**	**41**	**47**	**65**						
Emissions														
NO_x EMISSIONS	**24**	**24**	**24**	**12**	**24**	**29**	**29**	**24**	**24**					
VOC EMISSIONS	**24**	**35**	**12**	**12**	**29**	**24**	**35**	**24**	**24**	**76**				
Concentration														
SAVIAH MEAN	**12**	**53**	**35**	**24**	**35**	**35**	**29**	**41**	**35**	**29**	**24**			
CALINE MEAN	**12**	**29**	**29**	**18**	**88**	**47**	**41**	**59**	**88**	**18**	**24**	**41**		
CALINE P98	**18**	**12**	**35**	**18**	**65**	**41**	**24**	**53**	**65**	**29**	**24**	**53**	**76**	
MEASURED NO_2	**9**	**36**	**9**	**9**	**45**	**45**	**18**	**64**	**55**	**27**	**27**	**55**	**64**	**73**

*Note: *Measured NO_2 n = 11; all other cross-tabs based on n = 17*

Table 5.3 shows Spearman's rank correlation coefficients for the 500 case/control points. As can be seen, whilst many of the correlations are significant, they are generally weak and tend to be strongest when the indicators are based on similar data, are different measures of the same variable, or represent subsets of the same features. For example, the r value between NO_x and VOC emissions is 0.89, and that between CALINE mean and P98 NO_2 concentrations is 0.79. There is also a relatively strong negative association between main road density and distance to nearest main road (r = -0.61). This simply reflects the circumstance that people living in areas of higher road density are more likely to live near to a main road. Between source-related indicators and modelled NO_2 concentrations, both distance to main road and traffic volume divided by distance to main road appear to be relatively strongly associated with SAVIAH modelled NO_2 and CALINE modelled NO_2. These relationships can be seen more clearly in Figures 5.6, 5.7, 5.8 and 5.9. Note that single outliers have been removed in Figures 5.8 and 5.9. Modelled mean annual NO_2 concentrations from the SAVIAH and CALINE-3 methods also appear to be strongly correlated, as shown by Figure 5.10, although it should be noted that the CALINE-3 concentrations do not account for background levels and are therefore generally lower than those derived from the SAVIAH method.

Table 5.4 shows correlation coefficients for the 17 NO_2 sites. The trend for stronger correlations between indicators based on similar data or on complimentary indicators is repeated, although, because of the smaller sample size, the r values tend to be higher: for example, .73 for all road traffic volume and SAVIAH-derived mean NO_2, .93 between NO_x and VOC emissions and .98 between CALINE mean and P98 NO_2 concentrations. Between source-activity and emission-based indicators, traffic volume on all roads appears to be relatively well correlated with main road density (r = 0.70) and distance to nearest main road (r = -0.69); main road traffic volume with NO_x and VOC emissions (both r = 0.60); and main road traffic volume over distance to nearest main road with NO_x emissions (r = 0.63). Between source-activity indicators and modelled concentrations, main road density, distance to nearest main road, traffic volume on all roads and traffic volume divided by distance to nearest road (all roads and main roads) were found to be strongly associated with SAVIAH and CALINE modelled NO_2. The results for main road density, all-road traffic volume and traffic volume divided by distance to nearest road (all roads) can be seen in more detail in Figures 5.11, 5.12 and 5.13. A number of indicators also appear to be strongly correlated with measured NO_2. In particular, distance to main road (r = -0.76), traffic volume of nearest road (all roads) (r = 0.76) and traffic volume of nearest road divided by distance (all roads) (r = 0.82), SAVIAH modelled mean annual NO_2 (r = 0.95) and CALINE-3 modelled mean annual NO_2 (r = 0.84). These results can be seen in detail in Figures 5.14 to 5.19.

Whilst Spearman's rank correlations can be used to examine the relationship between indicators, possibly a more effective way of assessing the consistency of indicators is to compare the exposure quintile of classification using cross-tabulation. Tables 5.5 and 5.6 show these results for case/control sites and NO_2 sites respectively. Class 1 represents the least exposed 20%, class 5 represents the most exposed. In considering these results, it should be noted that 20% of sites may be expected to be classified in the same quintile by chance. The percentage of sites classified in the same quintile is low for both datasets, but there are exceptions. For example, for case/control sites, traffic volume divided by distance (main roads) and CALINE mean NO_2 classified 58% of sites in the same quintile, distance to nearest main road and CALINE mean NO_2 classified 56% of sites in the same quintile. For NO_2 sites, notable results between source-activity indicators, emission indicators and modelled pollutant concentrations were traffic volume divided by distance to nearest road (all roads and main roads) and CALINE mean NO_2 (595% and 88% respectively). Between source-activity indicators, emission indicators and measured NO_2, notable results were distance to nearest main road (45%), all road traffic volume (45%), all road traffic volume divided by distance to nearest road (64%) and traffic volume divided by distance to nearest main road (55%). Between modelled concentrations and measured NO_2, SAVIAH classifies 55% of sites in the same quintile, whilst the figures for CALINE mean and P98 are 64% and 73% respectively.

Figure 5.6: Distance from main road against SAVIAH NO_2 ($\mu g/m^3$)

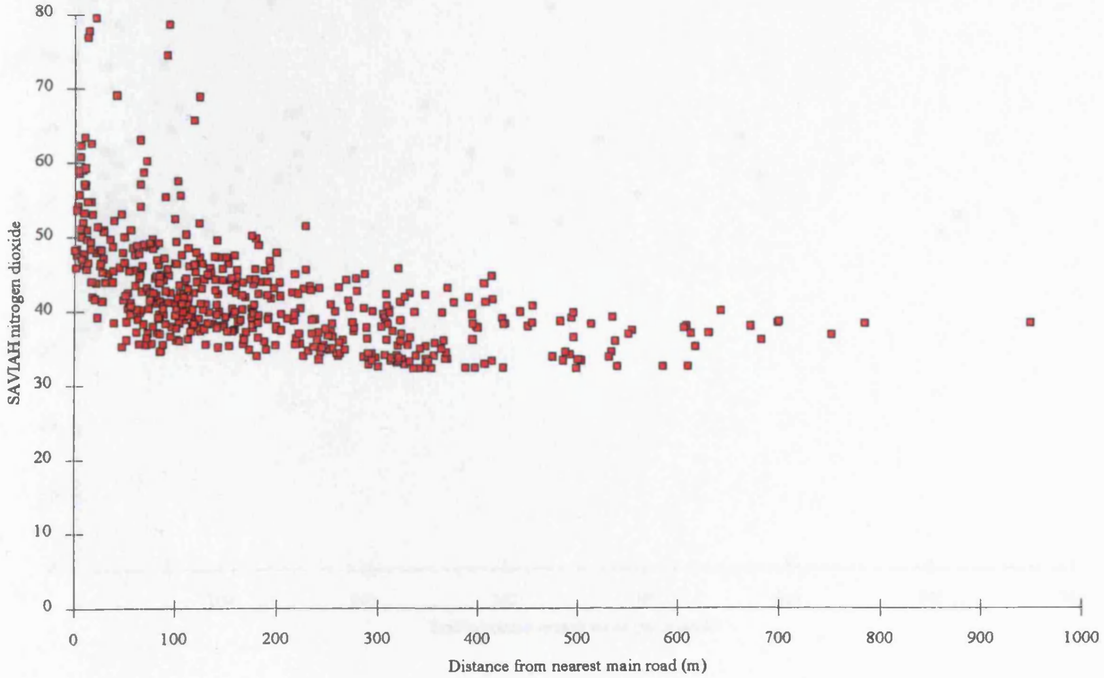


Figure 5.7: Distance from main road against CALINE-3 NO_2 ($\mu g/m^3$)

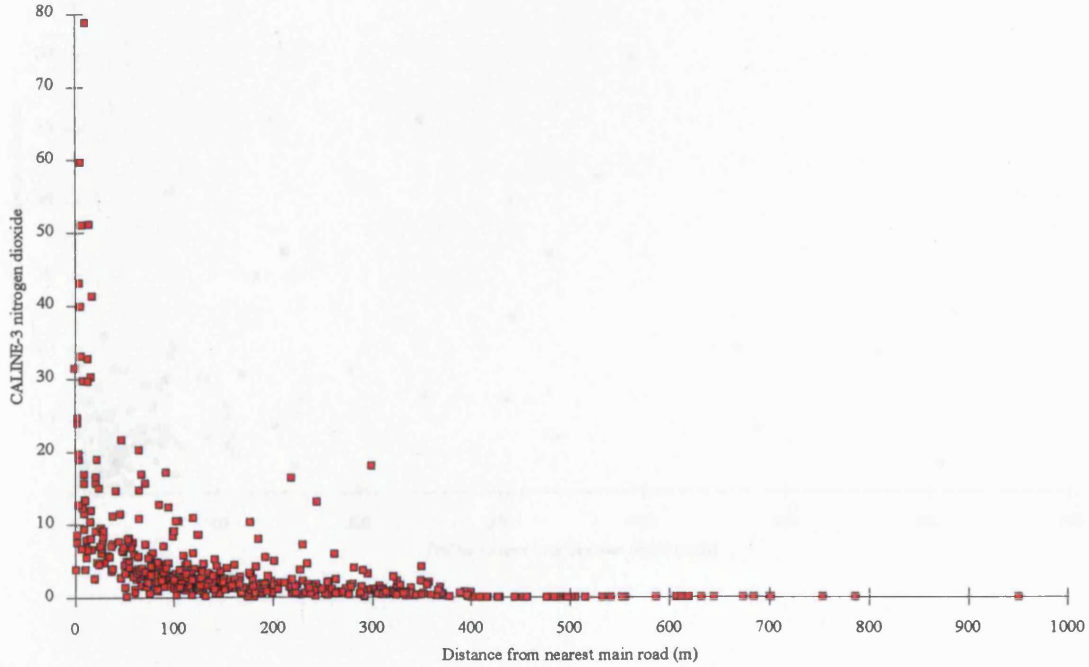


Figure 5.8: Traffic volume over distance (main roads) against SAVIAH NO_2 ($\mu g/m^3$)

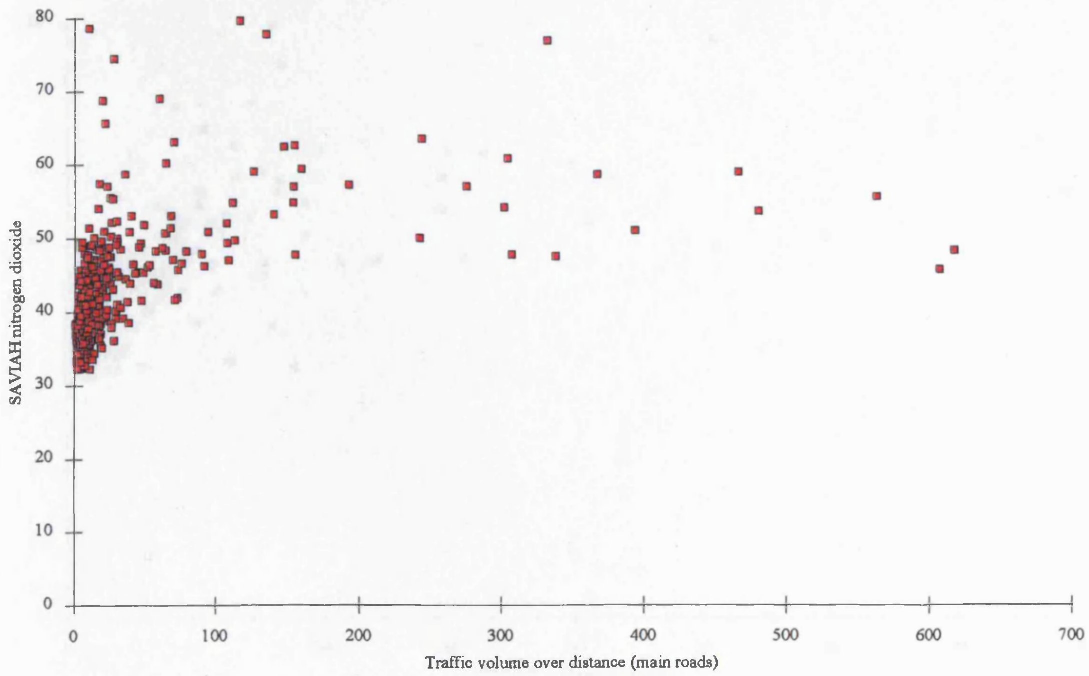


Figure 5.9: Traffic volume over distance (main roads) against CALINE-3 NO_2 ($\mu g/m^3$)

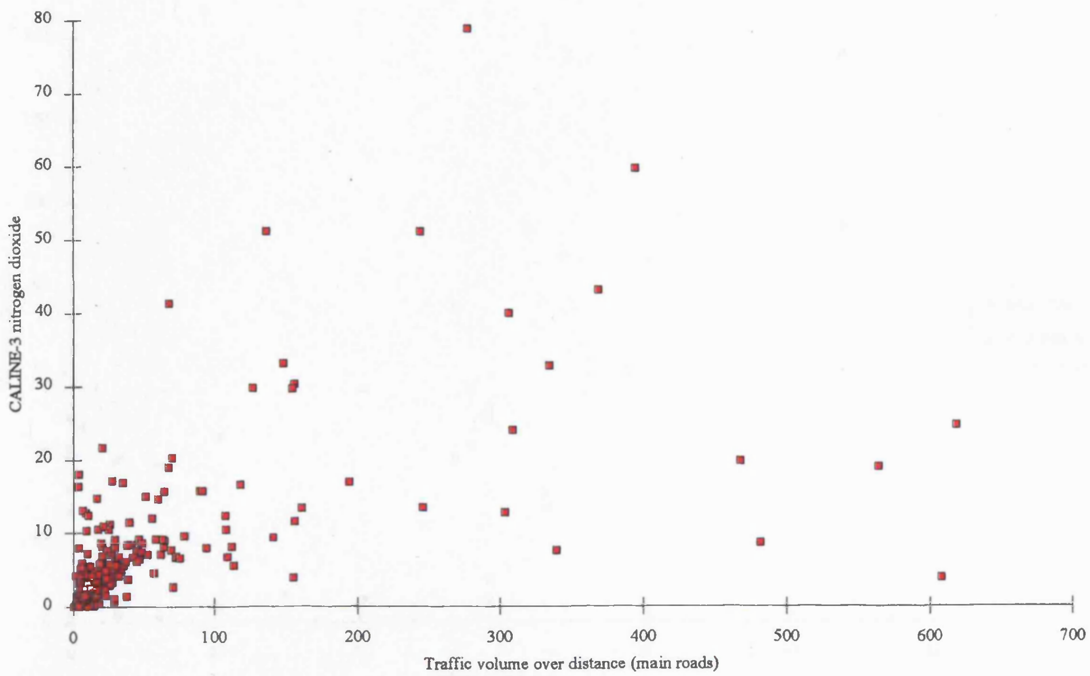


Figure 5.10: SAVIAH mean annual NO_2 against CALINE-3 mean annual NO_2 ($\mu g/m^3$)

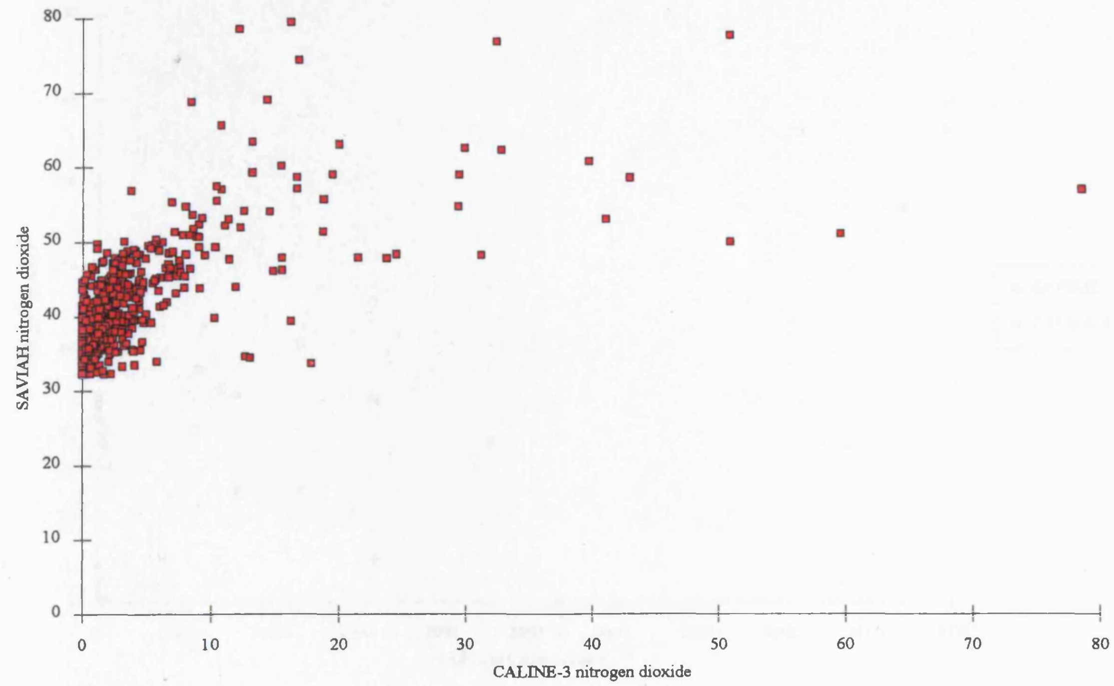


Figure 5.11: Main road density against mean annual SAVIAH and CALINE-3 NO_2 ($\mu g/m^3$)

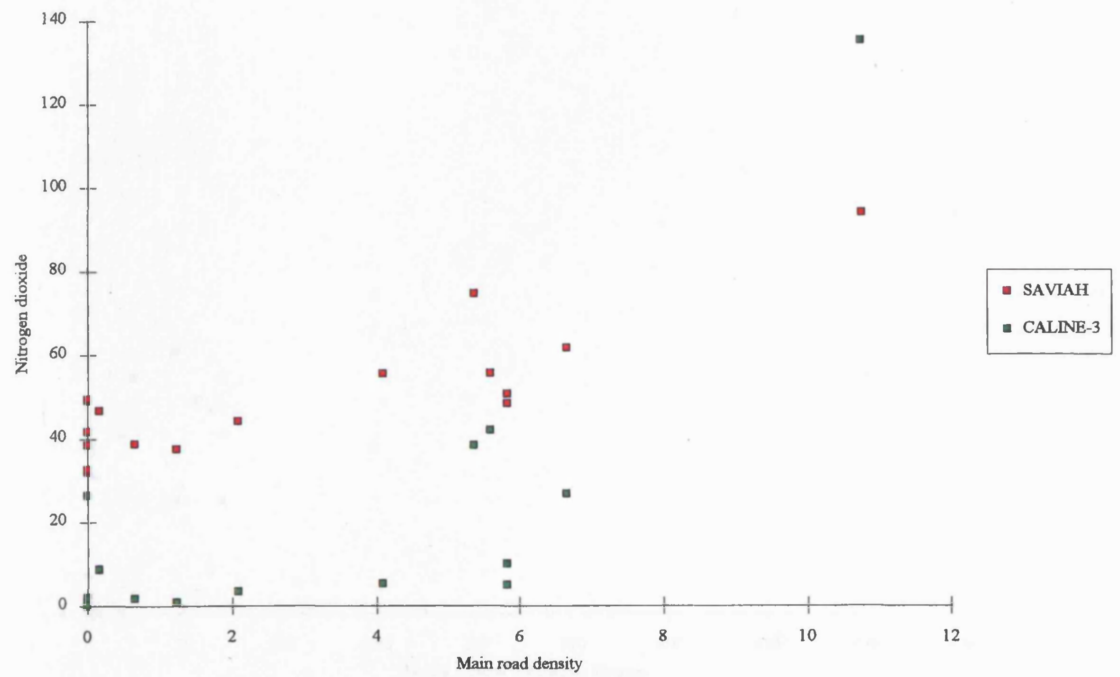


Figure 5.12: Traffic volume (all roads) against mean annual SAVIAH and CALINE-3 NO_2 ($\mu g/m^3$)

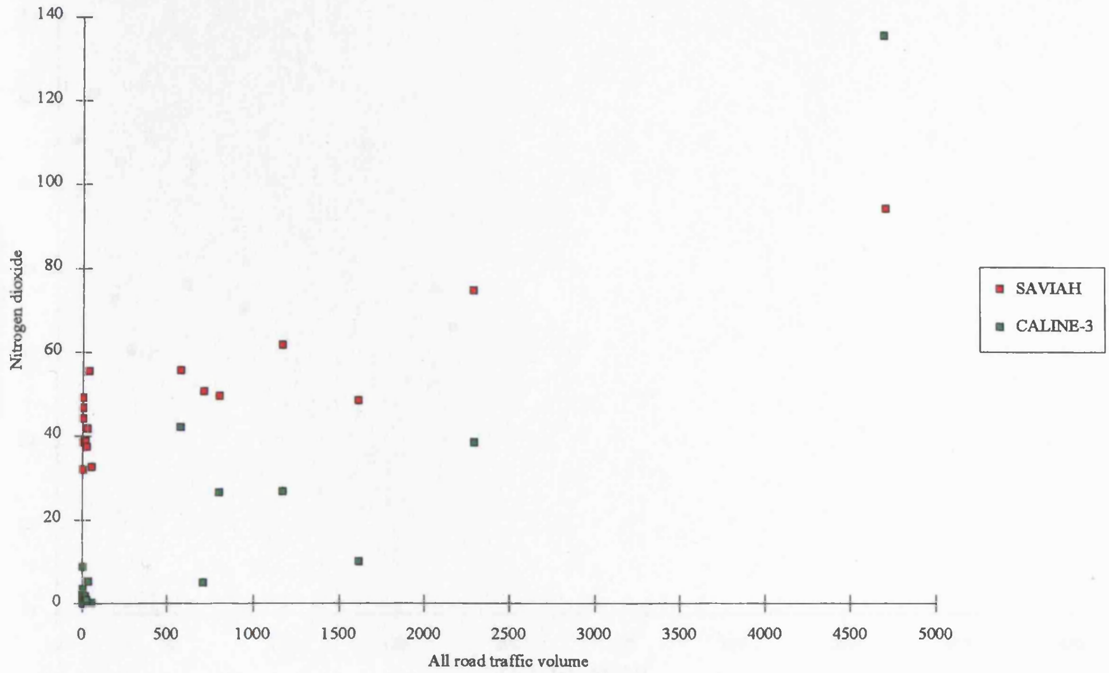


Figure 5.13: Traffic volume divided by distance (all roads) against mean annual SAVIAH and CALINE-3 NO_2 ($\mu g/m^3$)

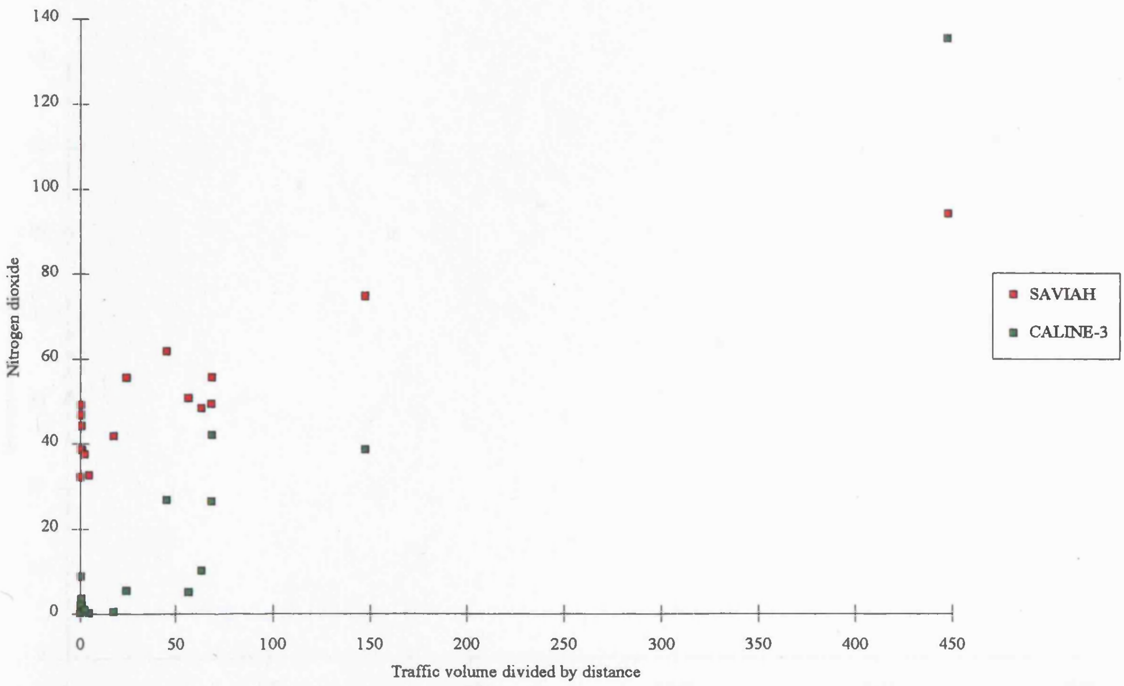


Figure 5.14: Distance from main road against measured NO_2 (µg/m^3)

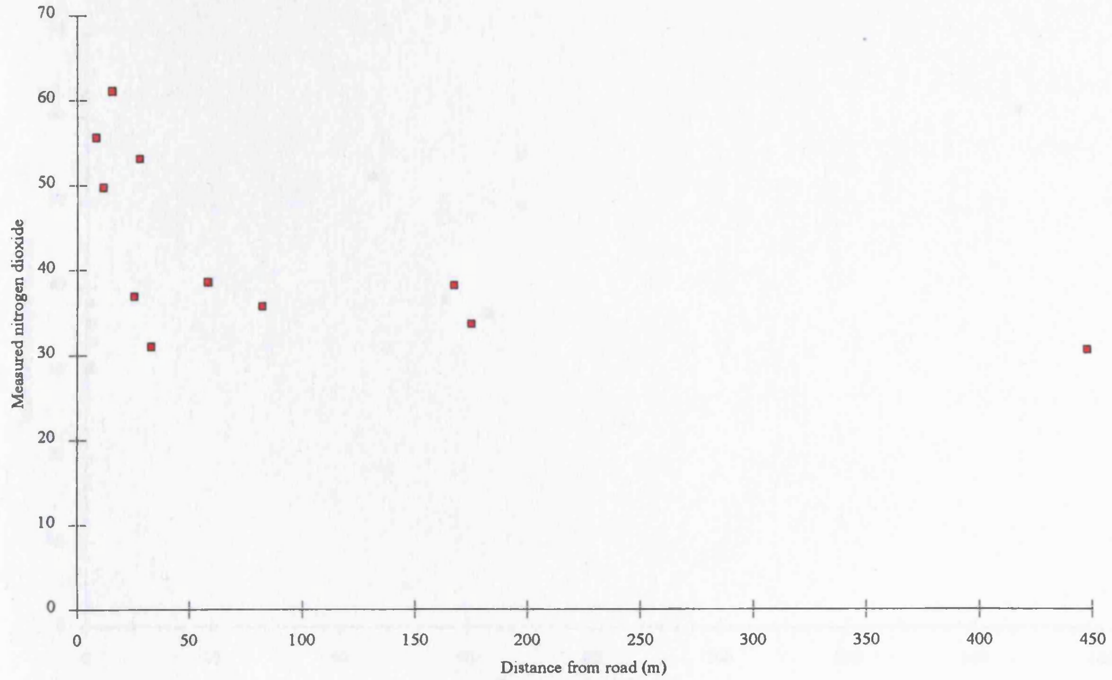


Figure 5.15: Traffic volume of nearest road (all roads) against measured NO_2 (µg/m^3)

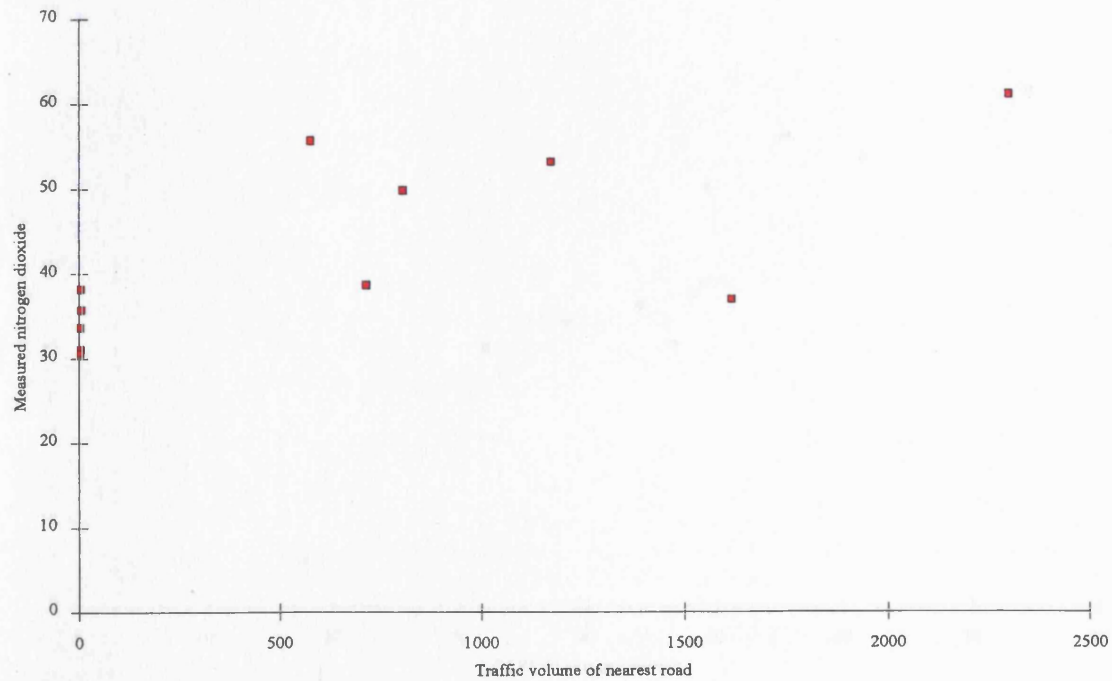


Figure 5.16: Traffic volume of nearest road divided by distance to nearest road (all roads) against measured NO_2 ($\mu g/m^3$)

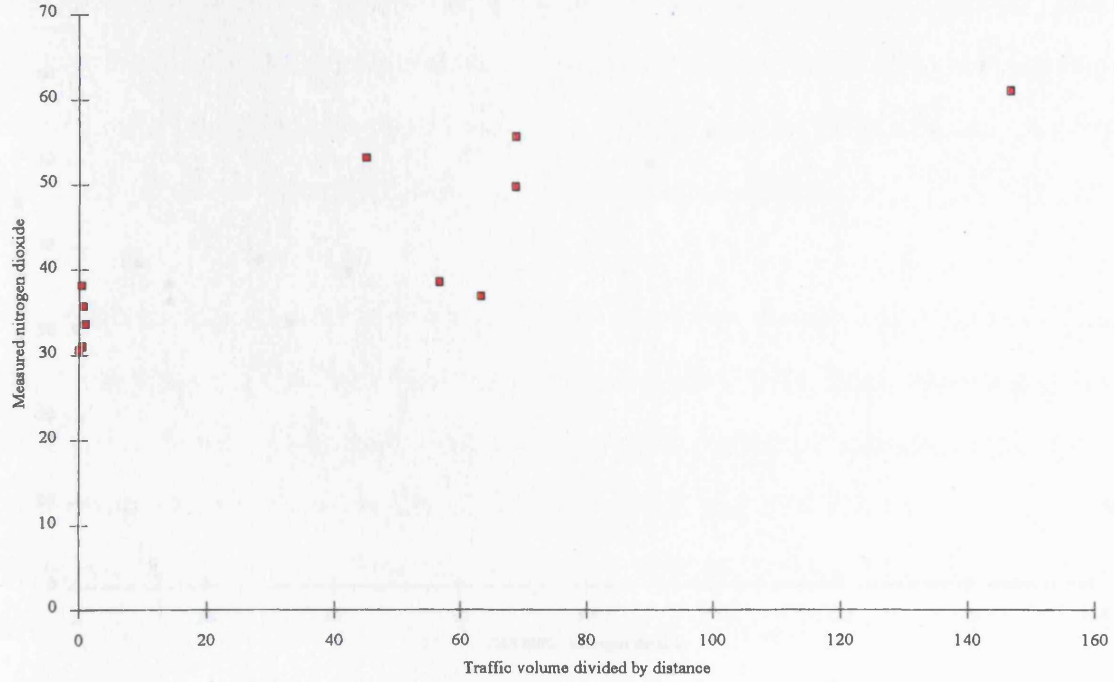


Figure 5.17: Modelled mean NO_2 (SAVIAH) against measured NO_2 ($\mu g/m^3$)

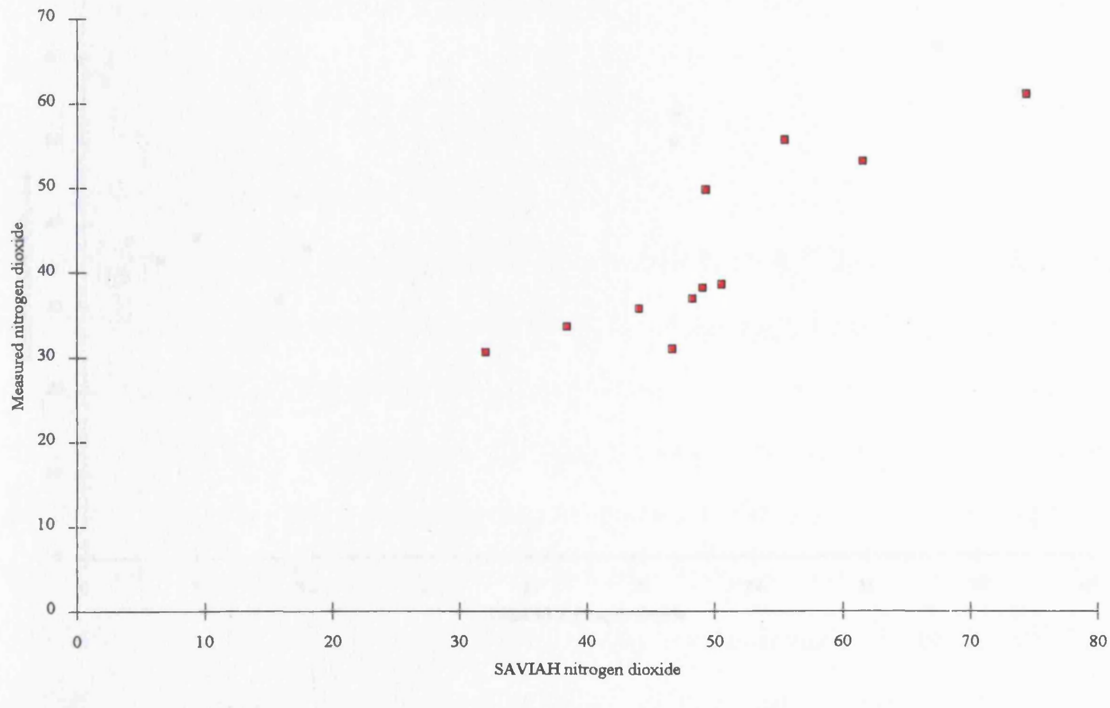


Figure 5.18: Modelled mean NO_2 (CALINE-3) against measured NO_2 (μg/m^3)

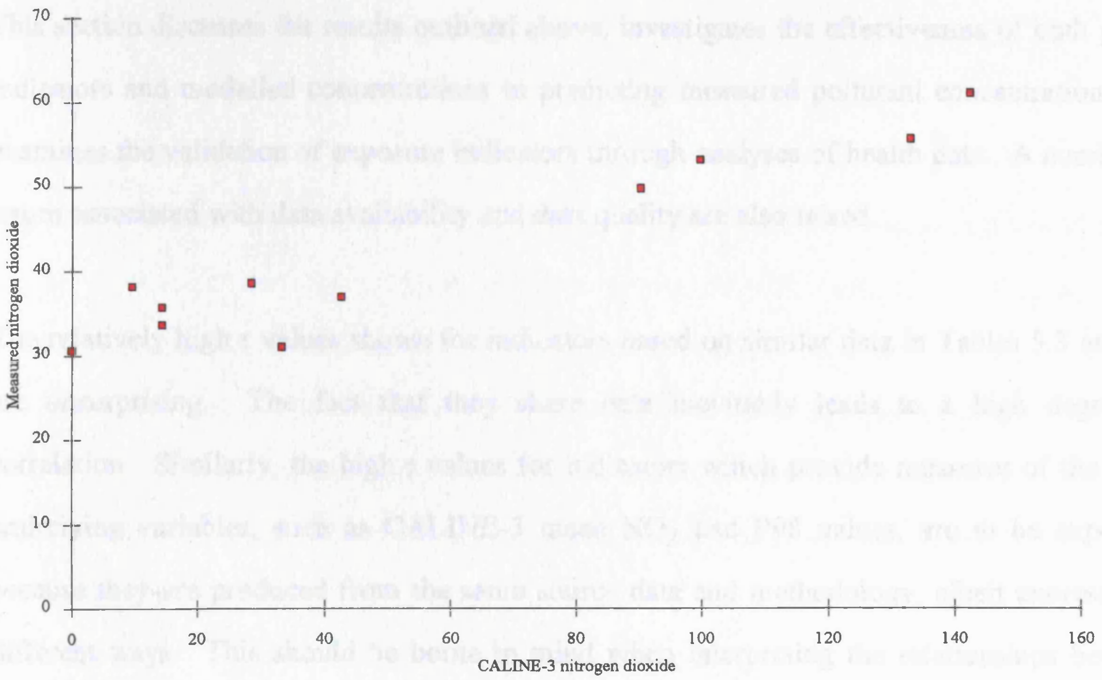
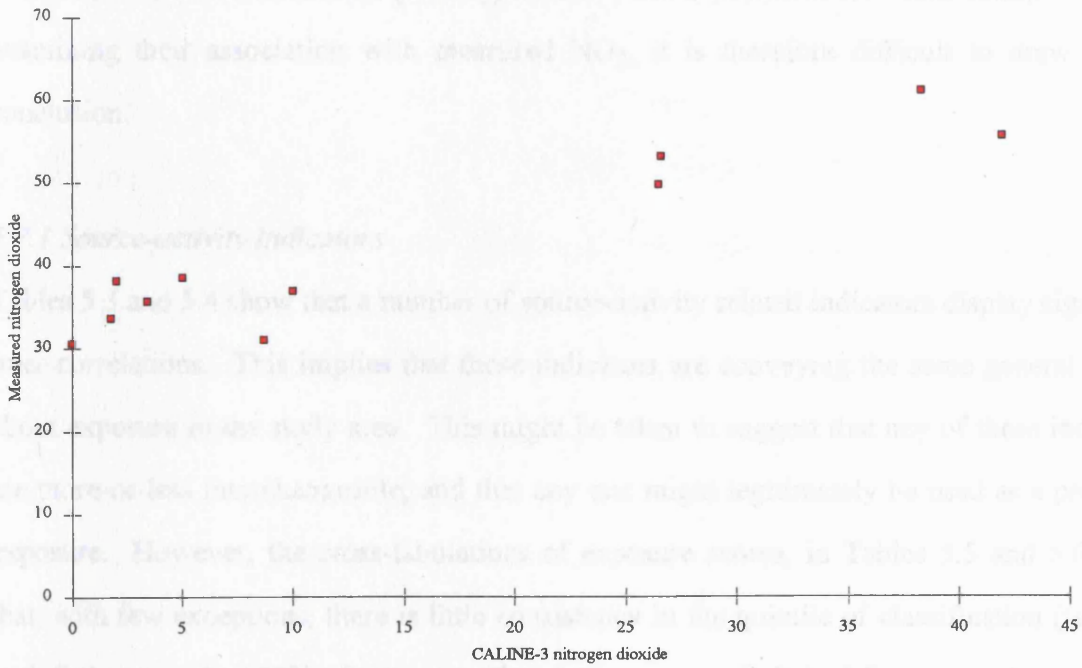


Figure 5.19: Modelled 98th percentile of daily NO_2 (CALINE-3) against measured NO_2 (μg/m^3)



5.7 Discussion

This section discusses the results outlined above, investigates the effectiveness of both proxy indicators and modelled concentrations in predicting measured pollutant concentrations and examines the validation of exposure indicators through analyses of health data. A number of issues associated with data availability and data quality are also raised.

The relatively high r values shown for indicators based on similar data in Tables 5.3 and 5.4 are unsurprising. The fact that they share data inevitably leads to a high degree of correlation. Similarly, the high r values for indicators which provide measures of the same underlying variables, such as CALINE-3 mean NO_2 and P98 values, are to be expected, because they are produced from the same source data and methodology, albeit expressed in different ways. This should be borne in mind when interpreting the relationships between indicators. For example, the high level of correlation between SAVIAH and CALINE derived mean annual NO_2 in both case/control and NO_2 sites could be used to argue that they both provide good estimates of pollution. However, this relationship may be due to the fact that they rely on similar data (namely, traffic volume and distance from road). Without examining their association with measured NO_2, it is therefore difficult to draw such a conclusion.

5.7.1 Source-activity indicators

Tables 5.3 and 5.4 show that a number of source-activity related indicators display significant inter-correlations. This implies that these indicators are conveying the same general picture about exposure in the study area. This might be taken to suggest that any of these indicators are more-or-less interchangeable, and that any one might legitimately be used as a proxy for exposure. However, the cross-tabulations of exposure scores, in Tables 5.5 and 5.6, show that, with few exceptions, there is little consistency in the quintile of classification (typically with little more than 20% of sites classified in the same quintile). Moreover, whether or not any of these indicators are truly representative of exposure depends upon how well they correlate with ambient pollution levels. This can be examined to some extent here by comparing the source-activity indicators with both the modelled NO_2 concentrations (from CALINE-3 and SAVIAH), and the 11 monitoring sites with measured NO_2 data.

Population density

Population density was the simplest indicator used: it was selected because it is considered to be a general-purpose indicator of socio-economic activity, and possibly road traffic. Although it showed a moderate correlation with road density, however, it is not significantly correlated with most of the other source-activity indicators, at the case/control sites. It has only very weak or non significant relationships with modelled concentrations at these sites, and is not significantly correlated with measured NO_2 at the monitoring sites. Its value as an exposure indicator is therefore open to doubt.

All road density

All road density appears to be a relatively poor indicator, which is weakly correlated with all other variables for the case/control sites (Table 5.3), and rarely exceeds 20% in terms of the consistency of classification by quintile (Table 5.5). It does, however, show some correlation with modelled and measured NO_2 concentrations at the monitoring sites (Table 5.4).

Main road density

Main road density seems to provide a better indicator in many ways. It displays a number of significant correlations with other source-activity indicators, and has relatively high correlations with modelled NO_2 concentrations at the case/control sites ($r = 0.37$ for SAVIAH and 0.47 - 0.52 for CALINE-3). It similarly shows significant correlations with modelled NO_2 at the monitoring sites ($r = 0.72$), but is not correlated significantly with measured NO_2. It should also be noted that fewer than a third of sites tend to be classified in the same quintile by other indicators.

Distance to nearest road

Distance to nearest road is another weak indicator, with few significant correlations with other source-activity measures, and showing no significant correlation with modelled NO_2 at the case/control sites. Nor is it correlated with modelled or measured NO_2 at the monitoring sites.

Distance to nearest main road

Distance to nearest main road is quite strongly correlated with several other source-activity indicators, especially main road density (r = -0.61) and traffic volume divided by distance to nearest main road (r = 0.89). It is also strongly correlated with modelled NO_2 concentration at the case/control sites, with r values between -0.65 and -0.81. These relationships remain strongly significant for the monitoring sites, and the indicators are also highly correlated with measured NO_2. The cross-tabulation of quintile scores (Table 5.5) shows that between a third and a half of sites tend to be classified in the same quintile by other source-activity indicators.

All road traffic volume

Amongst other source-activity indicators, traffic volume on the nearest road has strong correlations only with traffic volume divided by distance (all roads), with which it inevitably shares source data. It does, however, correlate relatively strongly with modelled NO_2 concentration using the SAVIAH method (r = 0.50), and rather more weakly with modelled concentrations from CALINE-3 (r = 0.31 - 0.38) at the case/control sites. At the monitoring sites, these relationships are maintained, and the indicator is also correlated with measured NO_2. On the other hand, normally no more than one-third of sites are classified in the same quintile by other indicators.

Main road traffic volume

Traffic volume on the nearest main road is, in contrast, only weakly correlated both with other source-activity indicators, and with modelled NO_2 at both the case/control and monitoring sites. As is to be expected, a low proportion of sites tend to be classified in the same quintile by other indicators.

Traffic volume of nearest road divided by distance to nearest road

Traffic volume divided by distance was significant, but rarely strongly correlated with other source-activity indicators. and with modelled concentration at the case/control sites. At the monitoring sites, these relationships tend to be stronger, and it is significantly correlated with both modelled and measured NO_2 concentration (r = 0.74 - 0.82). In most cases, however, fewer than one third of sites are classified in the same quintile by other indicators.

Traffic volume of nearest main road divided by distance to nearest main road

Traffic volume divided by distance to nearest main road is moderately well correlated with several other source-activity indicators, and with modelled NO_2 concentration at the case/control sites. Especially strong correlations are seen with modelled concentrations at the monitoring sites, and a significant, yet weak correlation, is found with measured NO_2 at these sites. In general, only a third or fewer sites are classified in the same quintile by other source-activity indicators, but this increases to around 50% for modelled concentration.

5.7.2 Emission-based indicators

The two emission-based indicators, unsurprisingly, show similar patterns. Weakly but consistently correlated with source-activity indicators, they show moderate levels of correlation with modelled NO_2 at the case/control sites (r = 0.36 - 0.48). At the monitoring sites, only weak and marginally significant correlations are seen with modelled NO_2 levels, and neither indicator is significantly correlated with measured NO_2.

5.7.3 Concentration-based indicators

The three modelled indicators of NO_2 concentration are relatively strongly inter-correlated (r = 0.62 - 0.79) at the case/control sites. At the monitoring sites, levels of inter-correlation remain strong, with r values of between 0.89 and 0.98. These three indicators also show the strongest correlation with measured NO_2 (r = 0.82 - 0.95). Notably, the SAVIAH model seems to give the best prediction of measured NO_2 at these sites. Even so, only about 30-40% of sites are normally classified in the same quintile by other indicators.

5.7.4 Indicator comparability

As the preceding discussion has shown, the various indicators analysed here tend to perform differently within the study area. The nine source-activity indicators examined tend to be only weakly inter-correlated and have low percentages of sites classified in the same quintile. These indicators cannot therefore be seen as direct proxies for each other. In contrast, the emission-based indicators are strongly correlated, as are the three indicators of modelled concentration. In each of these cases, choice of indicator makes little difference. Even in these cases, however, the consistency of exposure classification by quintile, is low, often with no more than 35% of sites being classified in the same quintile by different indicators. Overall, therefore, it is evident that the choice of indicator can greatly affect the exposure quintile within which any site is classified. Consequently, different indicators are likely to give a different measure of health risk. This, in turn, makes it difficult to translate different exposure indicators into a common measure of health risk (e.g. to convert measures of distance to road or traffic volume to measures of ambient pollution concentration). This also makes it difficult to compare results from previous studies, which have used different exposure indicators, or to conduct a meta-analysis aimed at deriving dose-response relationships. In addition, these differences raise some doubts about the underlying meaning of the relationship found between traffic-related air pollution and health in previous studies.

5.7.5 Estimating exposure

In the absence of independent data on exposure, it is difficult to evaluate the extent to which the proxy indictors used here provide reliable estimates of exposure. This would require detailed studies of personal exposure for a large sample of individuals. In practice, however, few studies use personal exposure measures, most inferring exposure from estimates of ambient concentrations or other indicators. Within the constraints of this study, it is possible to estimate the relative ability of the indicators to predict ambient concentrations of NO_2. However, there are clearly limitations to this approach.

The availability of information on measured concentrations is still relatively poor and levels of air pollution are highly variable over relatively short distances. At the same time, people are inherently mobile and individual exposure can be greatly affected by movement through differently polluted micro-environments. Moreover, reliance on a single measures of exposure to traffic-related pollution ignores the synergistic effects of different pollutant combinations on health outcome and the individual effects of specific pollutants. Despite the epidemiological evidence presented in Chapter Four, the extent to which measured concentrations of NO_2 and associated proxy indicators provide reliable estimates of exposure to traffic-related pollution is therefore uncertain. This issue is explored in more detail in section 5.7.6.

Based on the results presented above, it is nevertheless evident that the indicators based on modelling of NO_2 concentration proffer the best estimates of ambient pollution levels. Of the two models tested, the SAVIAH method performed marginally better in this respect. The problem with both of these indicators, however, is that considerable data and resources are required for their construction. For many purposes, therefore, simpler and less data-demanding indicators are required. As Tables 5.5 and 5.6 show, of the remaining indicators, the most satisfactory proxies for measured concentration appear to be:

- traffic volume of nearest road divided by distance to nearest road (r = 0.82, 64% of sites classified in the same quintile);
- traffic volume of nearest road (r = 0.76, 45% of sites classified in the same quintile);
- distance to nearest main road (r = -0.76, 45% of sites classified in the same quintile).

These results further suggest that the position of the indicator in the environment-health chain has some significance. In general - and perhaps not surprisingly - indicators from nearer the bottom of the environment-health chain provide better measures of ambient pollution concentration. Those from further upstream perform less well, although in some cases this may be mitigated, to some extent, by their ease of construction. Any choice of exposure indicator must therefore be made with care. Whilst account undoubtedly needs to be taken of resource and data constraints, there is clearly little to be gained by using poor proxy indicators, however easy they are to create.

5.7.6 Relationships with health

The previous section identifies a number of potential proxy indicators for measured concentrations of NO_2. It also highlights the fact that despite evidence from previous epidemiological studies, it is difficult to validate these indicators in the absence of data on measured exposure. Another way to assess the utility of proxy indicators, however, is to examine their association with measures of health outcome.

In order to explore the relationships between the indicators used in this study and respiratory health, the complete list of indicators for the 500 case/control sites along with residential unit postcodes was analysed by The Department of Epidemiology and Public Health at St. Mary's Hospital Medical School, Imperial College. Odds ratios were calculated for admission to hospital for respiratory illness and asthma during the study period, based on unit postcode admission rates. The full results of this analysis are presented in Appendix 2. These include calculations for both raw variables and variables divided into exposure quintiles. Quintile 1 refers to the least exposed group, while quintile 5 refers to the most exposed group. For example, "data$saviah.factorq2 36-39" means the second quintile of the SAVIAH variable and represents an NO_2 concentration of between 36 and 39 μg/m^3. The first quintile represents the baseline group and is not shown in the results. The odds ratios for NOx and VOCs are per 10000, while all other odds ratios are per unit increase. Below the list of variables there is also a test of deviance for the inclusion of the traffic-related variables in the model.

In order to control for the effect of socio-economic confounding, odds ratios were also calculated with adjustment for deprivation by Carstairs quintile, based on the ED of residence. The Carstairs score is calculated from a number of variables, including measures of employment, housing and mobility. Quintile 1 refers to the most affluent group, whilst Quintile 5 refers to the most deprived group.

The results for respiratory illness are summarised in Table 5.7.

Table 5.7: Summary of odds ratios

Exposure indicator	*Respiratory illness*			
	Without adjustment for deprivation		With adjustment for Carstairs quintiles	
	Odds ratio	Confidence interval (95%)	Odds ratio	Confidence interval (95%)
Population density	0.993	(0.968 - 1.018)	1.002	(0.979 - 1.026)
Road density (all roads)	1.006	(0.977 - 1.035)	1.007	(0.979 - 1.036)
Road density (main roads)	1.027	(0.972 - 1.085)	1.035	(0.980 - 1.092)
Distance to nearest road	1.009	(0.992 - 1.026)	1.010	(0.993 - 1.027)
Distance to nearest main road	1.000	(0.999 - 1.001)	1.000	(0.999 - 1.001)
Traffic volume divided by distance to nearest road	1.000	(0.998 - 1.001)	1.000	(0.998 - 1.001)
Traffic volume divided by distance to nearest main road	1.000	(0.999 - 1.001)	1.000	(0.999 - 1.001)
NO_X emissions	1.003	(0.984 - 1.023)	1.006	(0.987 - 1.026)
VOC emissions	0.988	(0.955 - 1.022)	0.988	(0.956 - 1.021)
Saviah mean	0.979	(0.955 - 1.004)	0.984	(0.960 - 1.008)
Caline mean	0.979	(0.954 - 1.005)	0.981	(0.956 - 1.007)

As the results show, after adjusting for age, sex, hospital of admission and Carstairs quintile, no positive or significant associations were found. None of the p-values from the deviance tests are less than 0.05, so none of the traffic exposure variables show a significant effect. Even when the varibles are classified by quintile, there is no apparent increase in risk with increased exposure. The coefficients for age and sex also show a high level of consistency.

These results may be interpreted in a variety of ways. One conclusion might be that, despite evidence from previous epidemiological studies, none of the indicators used here provided an adequate measure of exposure. Whilst some of the indicators used have been shown to act as effective proxies for NO_2, the extent to which NO_2 is a reliable marker of exposure to traffic-related air pollution is uncertain. The proxies used may not, therefore be representative indicators of exposure to traffic-related air pollution, and their use may have diluted any relationship with respiratory health. If this is the case, there is clearly a need to develop better alternative exposure indicators.

A seond possibility is that some or all of the indicators might provide good proxies for exsposure, but their relationship to health could be masked by the effect of other factors, including the synergistic effects of other pollutants and the effect of exposure to other pollutants (for example, PM_{10}). At the same time, variations in individual susceptibility, age, sex and lifestyle may have an effect on the observed relationship between environmental factors and health outcome. This would imply that adjustments for confounding were inadequate, or perhaps that the confounding effect is so strong that the independent contribution of exposure to traffic related pollution on respiratory health cannot be detected. This is an acknowledged problem in many ecological studies (English 1992).

Thirdly, it is possible that, at the levels of exposure found in this study, there may be no effect on health. If the baseline health of the population is high, the effects of exposure are also likely to be reduced. Although this would appear to contradict results of previous studies, it is important to recognise that many of the studies previously reported have focused on acute health effects, at exposures beyond the range examined here. Results from chronic studies have been far more equivocal. Considerable reporting bias may also exist in published epidemiological studies. The question of whether detectable effects of chronic exposure to traffic related pollution, at the levels studied here, actually exist thus remains unresolved.

Which of these interpretations is appropriate in this case cannot be determined with certainty. Given these findings, however, and the uncertainty surrounding both the use of NO_2 as a marker for exposure and the relationship between traffic-related air pollution and health, all of the indicators examined here need to be used with caution.

5.8 Conclusions

This chapter has assessed the ability of different indicators to predict measured NO_2 concentrations at the small area level, and examined the association between traffic-related air pollution and respiratory health. The results imply that it may be possible to use certain source-activity indicators and indicators of modelled pollutant concentration as proxies for measured NO_2, although their utility as proxies for exposure is dificult to assess without access to independent data on exposure.

The previous chapter identified four potential proxy indicators of exposure to traffic-related pollution: distance to nearest road, traffic volume of nearest road, modelled pollutant concentrations and measured pollutant concentrations. Distance to nearest main road and traffic volume of nearest road (all roads) are both seen to give reasonably reliable estimates of monitored pollution levels in the study area. Combining these two indicators into the indicator traffic volume divided by distance to nearest road provides a somewhat better indication of pollution levels. On the basis of this study, however, the strongest prediction is provided by modelled pollutant concentration.

Whilst some of these indicators therefore appear to be effective proxies for measured concentrations of NO_2, it is uncertain whether they are suitable for predicting exposure and health risk. None of the indicators used appear to correlate with health outcome (in the form of hospital admissions for respiratory illness), both before and after control for socio-economic confounding. The evidence of this study therefore appears to cast doubt both on the use of these indicators as predictors of health risk, and on the relationship between traffic-related air pollution and health.

Chapter Six further examines the utility of proxy indicators for exposure at the broader scale, focusing on ward level data in selected areas of England and Wales. The extent to which selected proxy indicators provide reliable estimates of pollutant concentrations will be evaluated.

Chapter 6: National-Level Environmental Health Indicators

The wise man is not the man who gives the right answers; he is the one who asks the right questions.

Claude Levi-Strauss

6.1 Introduction

The previous chapter assessed the utility of different proxy indicators of exposure and explored the use of environmental health indicators to examine relationships between traffic-related air pollution and health at the small-area level. The purpose of this chapter is to assess the utility of EHIs at the broader, policy-related scale. Specifically, its aim is to investigate the relationships between proxy indicators and measured pollutant concentrations, and to compare the performance of different indicators in terms of their ability to estimate population risk.

Whilst small-area studies evaluating the relationships between environmental and health factors are clearly required, there is also a need for exposure and risk assessment at the regional or national level, to identify populations at risk from traffic-related pollution, support policy-making, identify areas which may require more detailed analysis and monitor the effectiveness of policy. As the previous chapter demonstrates, constructing indicators at the local level is time, resource and data intensive. Performing such detailed analyses at the broader scale is neither practicable, nor likely to meet the requirement of providing information to support policy. Broad scale methods of estimating exposure and health risk are therefore required. However, as the previous chapter also demonstrates, the construction of proxy indicators of exposure is constrained by data availability, resource limitations and the spatial variability of both air pollution and exposure. The extent to which valid proxies for exposure can be developed at the regional or national level is unknown. This chapter examines the feasibility of constructing proxy indicators at the broad scale and assesses their utility for estimating exposure and health risk.

The development of indicators at the broad scale is, however, hampered by a number of constraints and limitations. Many of the proxy exposure indicators which can be used at the local level are difficult to construct and require a wide range and large volume of data. For example, the CALINE-3 line dispersion model requires information on traffic volume, meteorological factors, road width and surface roughness for the area under assessment. Meeting all of these data needs in one area involves considerable resources and time. Using the model to calculate pollution concentration levels at the broader scale, for one region, or for the whole country would be impracticable. The data used to construct proxy indicators is frequently costly to produce, and may only be available in certain areas, for example, in a city where purpose designed monitoring has been undertaken as part of a pollution study. When the necessary data is available, however, responsibility for collection, processing and dissemination may be split between a large number of different agencies and organisations, making access to the data difficult. The construction of indicators at the broad scale is also hampered by the need to ensure that data requirements are met in all the areas being studied. If the information needed to compile an indicator is unavailable in say 10% of the areas being studied, comparisons between areas using that indicator may not be valid. Finally, it should be noted that the use of proxies for exposure at the broad scale limits the choice of indicators available. Distance to nearest main road, traffic volume over distance to nearest road (for all roads and main roads), for example, can only be calculated for point locations and not for geographic areas. The use of these indicators in this study is therefore precluded. Based on the discussion above, it is clear that the range of proxy indicators which can be developed at the broad scale is limited both by the availability of data and resources, and by methodological constraints.

As the previous chapter demonstrates, the relationship between proxy measures of exposure and measured pollutant concentrations can be examined at point locations where data from pollution monitoring networks is available. In such cases, both proxy indicators and pollutant values are calculated for the same geographic location. When compiling exposure indicators at the broad scale, however, it is necessary to use a single value to describe conditions within a geographic area. Although the indicators relate to the same area, this approach clearly masks the variation which is likely to exist in the underlying conditions within that area. In developing proxy indicators for geographic areas, it is therefore necessary to ensure that the single value used is as representative as possible of conditions in the area. Whilst this problem can, to some extent, be mitigated by constructing indicators for relatively small geographic areas, air pollution is spatially highly variable. Considerable variations in air quality are likely to exist within a few tens of metres (Hewitt 1991). At the same time, people are inherently mobile and may be exposed at home, during commuting and at work. Unravelling these complex patterns of pollution dispersion and population movement is very difficult. Whilst exposure at residential locations can be calculated relatively accurately, exposure at the home may not be representative of total personal exposure. Raaschou-Nielsen *et al.* (1996), for example, found only a weak correlation between personal NO_2 exposure in children and pollutant levels outside the home (r^2 = .05). At the same time, several epidemiological studies have demonstrated positive associations between single pollution values at the city level and health outcome: see, for example, Pope *et al.* (1995c) (the 151 US cities study) and Dockery *et al.* (1993) (the 6 US cities study). Consequently, estimating the long-term minimum level of pollution to which the population is exposed, using data from background monitoring stations, may provide the best estimate of exposure at the broad scale. The World Health Organisation's Health and Environment Geographical Information System (HEGIS) programme for Europe, for example, has chosen to use city background sites as a means of assessing urban residential population exposure. Whilst it is acknowledged that such sites do not describe conditions in pollution 'hot-spots', or account for the variation found within urban areas, in the absence of more detailed data on population distribution and traffic density, it can be argued that they provide realistic estimates of urban background exposure.

In the previous chapter, three issues relating to the use of exposure proxies were identified:

1. Does the choice of exposure proxy matter? In other words, do they all tell the same story, or do some appear to be more accurate or reliable predictors of exposure?
2. Which, if any, are the 'best' proxies and are they consistent?
3. Does the position of the exposure proxy in the environment-health chain have any effect? In other words, are proxies better as one goes up, or down the chain?

On the basis of the preceding discussion, two further questions can be added:

4. Can valid proxies for exposure be developed for geographic areas?
5. Is the relationship between exposure proxies affected by the spatial scale at which they are constructed?

6.2 Study aims

Based on the above, the specific aims of this study are:

- to develop and construct selected national-level proxy exposure indicators based on the potential indicators identified in Chapter Four and an assessment of the available data;
- to examine the relationship between these proxy indicators and measured pollutant concentrations;
- to assess the utility of national-level proxy exposure indicators for exposure and risk assessment.

6.3 Selected proxy exposure indicators

Based on the literature review detailed in Chapter 4, the conclusions of the previous chapter and the data available, the following indicators have been selected for inclusion in this study. Their methodologies are explained in section 6.6.

1. Population density (people/km^2);
2. Car ownership (people with no car, with 2 cars and 3 or more cars - percentage of socio-economic sub-group);
3. Car usage (people who drive to work - percentage of socio-economic sub-group);
4. Road density (motorways/motorways, primary roads and A-roads/A-roads, primary roads and B-roads/all roads) (km/km^2);
5. NO_x emissions in 1990 (tonnes/year);
6. VOC emissions in 1990 (tonnes/year);
7. Measured maximum monthly NO_2 concentrations;
8. Measured mean annual NO_2 concentrations.

6.4 Study design

In this study, electoral wards have been selected as the geographical units for indicator construction. Urban wards, for example, are relatively small, being approximately 4.5 km^2 in size and containing 5000 people on average. As such, they are likely to be reasonably environmentally homogenous. Indeed, several environment and health studies have used indicators developed at ward level as the basis of their analysis. Waldron, Pottle and Dod (1995), for example, use motorway density by ward in a study of asthma prevalence, whilst Landon (1996) uses ward level indicators in a study of intra-urban health differentials in London. A number of socio-economic indicators have also been developed at ward level, for example, the Carstairs and Townsend deprivation indices. In addition, the availability of census-derived data at this level of spatial aggregation is good. Wards are therefore a convenient level at which to carry out national scale health risk assessment.

The measured NO_2 data used in this study has been taken from the national diffusion tube survey. This is a co-operative network, which aims to monitor spatial and temporal trends in NO_2 concentrations throughout the UK. It is managed by the Department of the Environment and Local Authorities (LAs), and is co-ordinated by AEA Technology's National Environmental Technology Centre (NETCEN). In each Local Authority area, monitoring is performed using diffusion tubes exposed for consecutive one month periods at three types of urban location:

Kerbside (K): 1-5m from a busy road (one per LA);

Intermediate (I): 20-30m from the same or an equivalent road (one per LA);

Background (B): more than 50m from any busy road (2 sites per LA).

The location of the network sites is shown in Figure 6.1. In the light of the earlier discussion about assessing background exposure in geographic areas, only background sites have been used in this study. If the relationship between background, intermediate and kerbside concentrations within each area is shown to be consistent, however, background values can also reflect peak exposure. The relationship between different sites within each Local Authority area is shown in Figures 6.2 and 6.3. For 1993 and 1994 data, the relationship is approximately linear. Figure 6.4 shows the relationship between 1993 and 1994 mean concentration. Note that sites with missing values for one of the years have been removed. Table 6.1 demonstrates that the different sites are also strongly correlated. Correlations were run in SPSS for 1-tailed significance. The r values shown were all significant at the 0.005 level in the predicted direction and missing values have been excluded listwise.

Table 6.1: Background, intermediate and kerbside monitoring sites - Spearman's rank correlation

	1993 (n=189)		**1994** (n=230)	
Sites	Background	Intermediate	Background	Intermediate
Intermediate	.81		.86	
Kerbside	.72	.79	.76	.79

Figure 6.1: Nitrogen dioxide survey monitoring sites (1993 & 1994)

Figure 6.2: 1993 NO_2 survey - background, intermediate and kerbside concentrations (ppb)

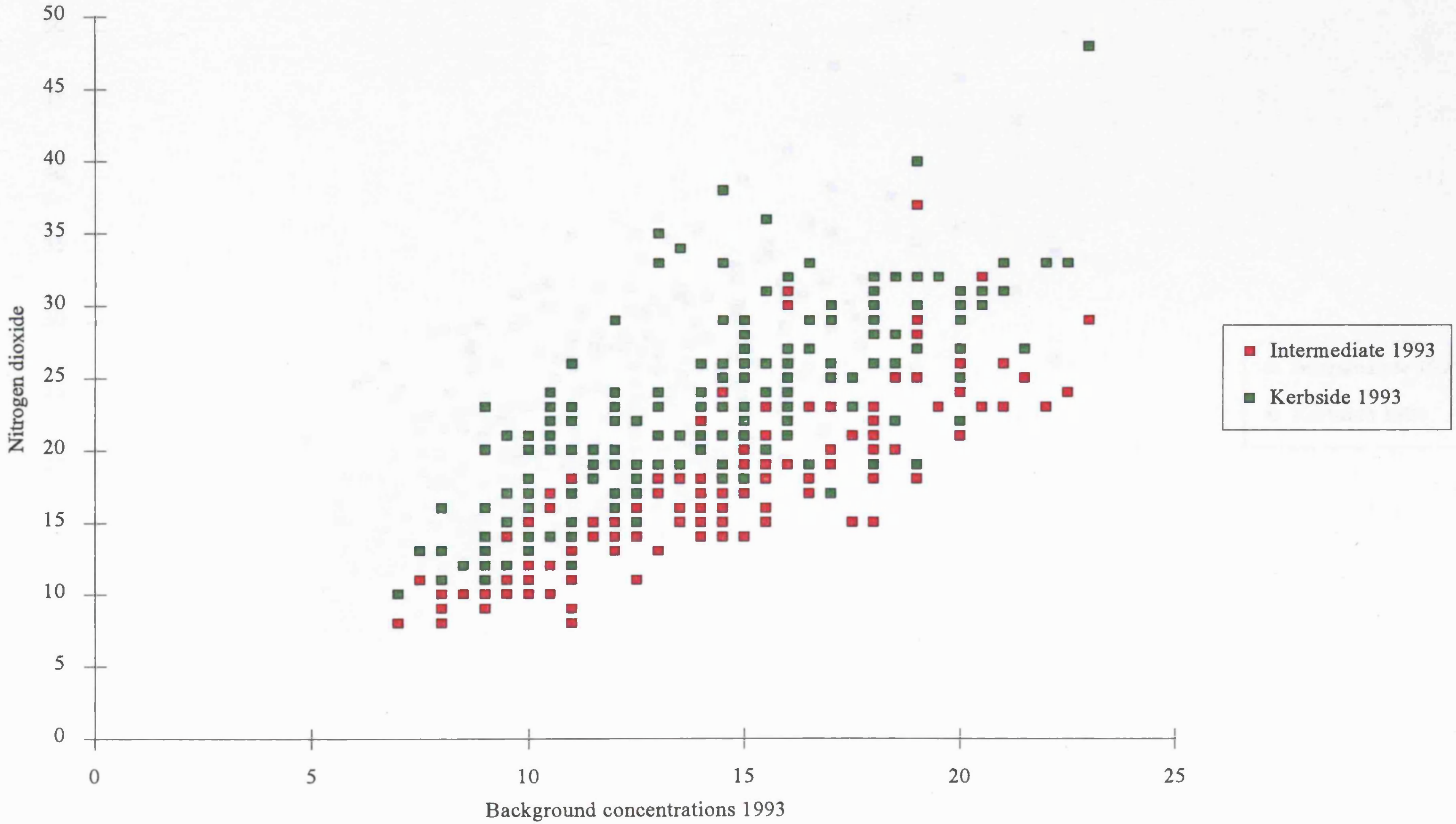


Figure 6.3: 1994 NO_2 survey - background, intermediate and kerbside concentrations (ppb)

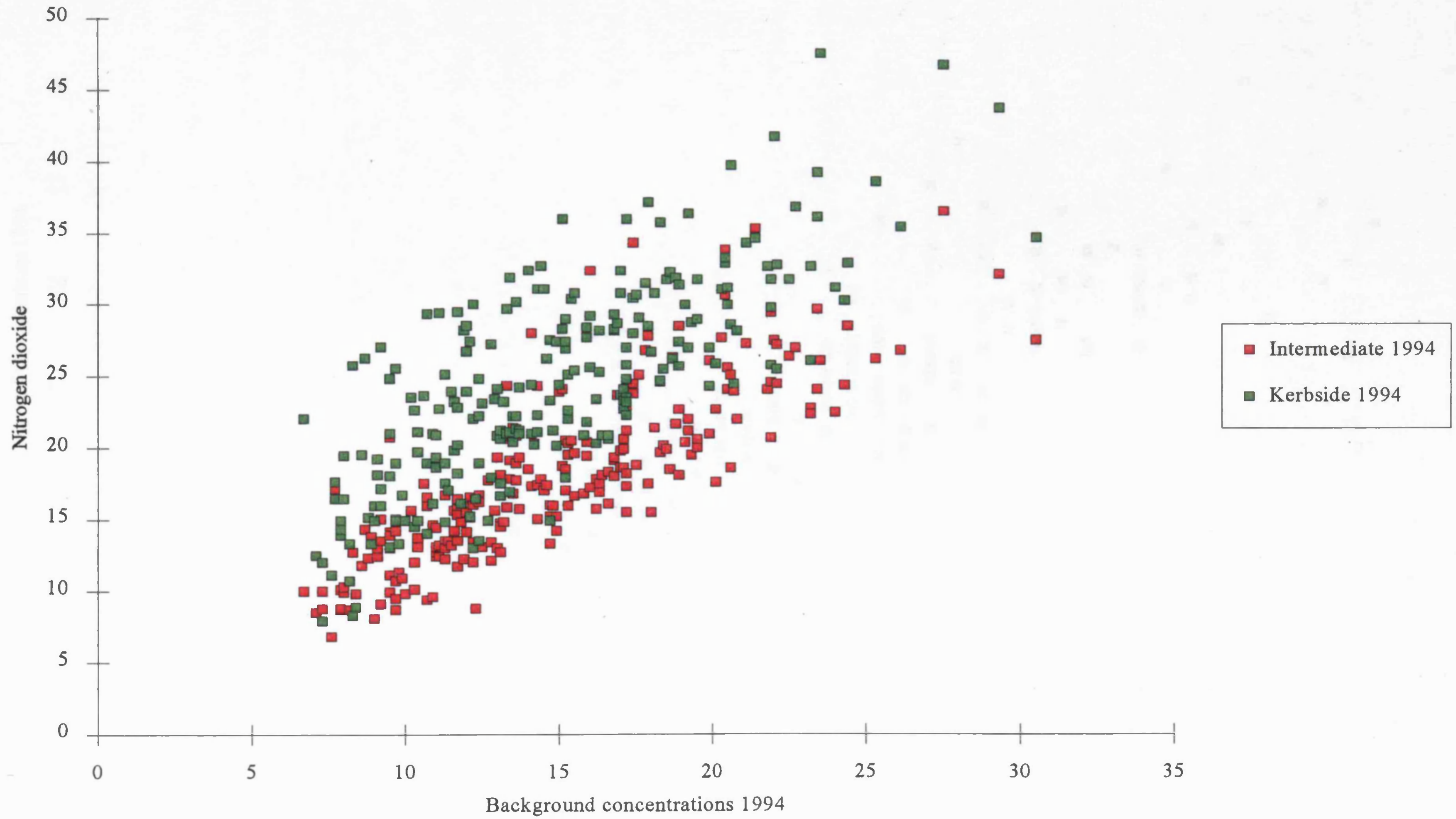
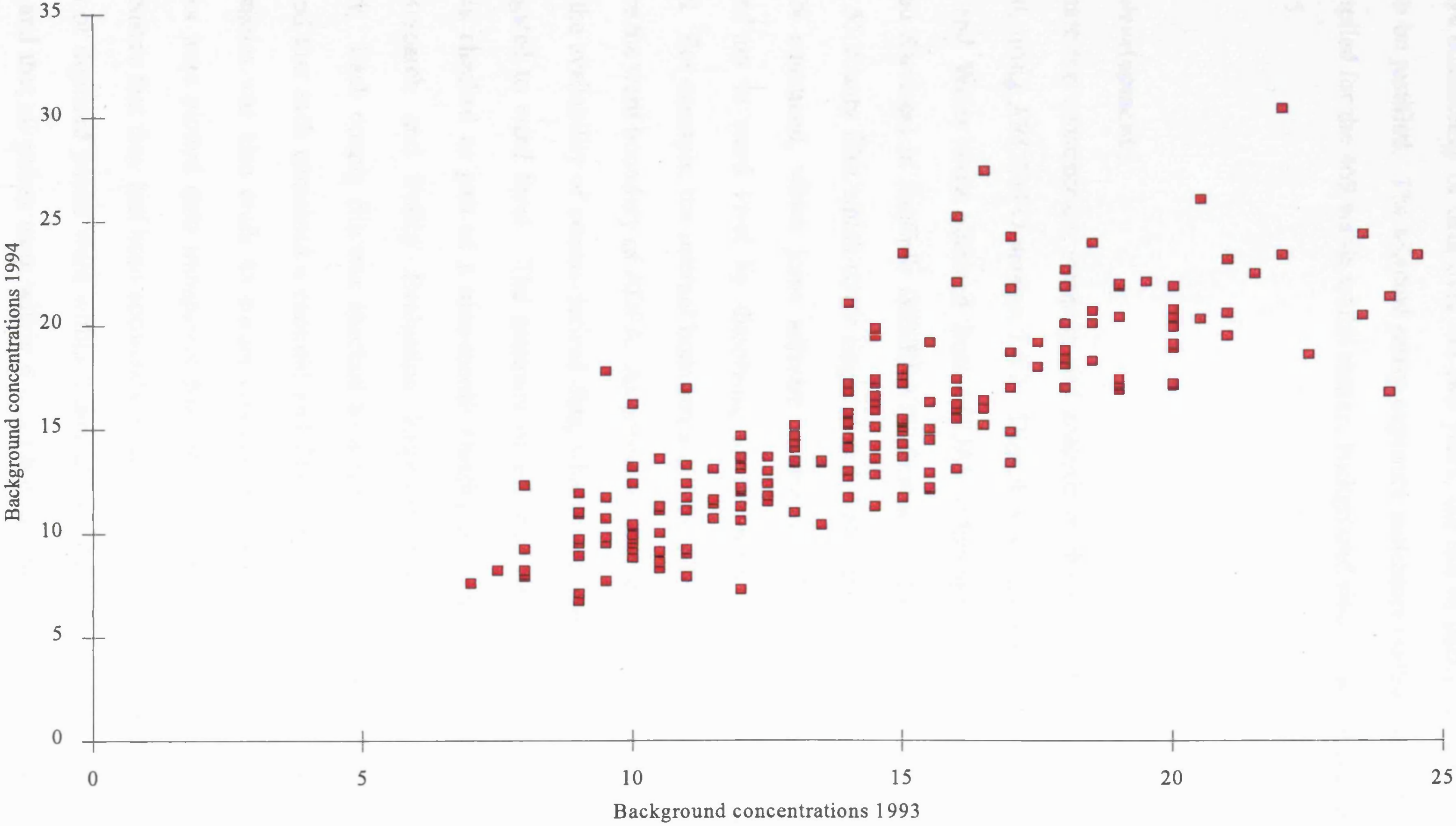


Figure 6.4: 1993 and 94 NO_2 survey - background concentrations (ppb)



Given the strong relationship between background, intermediate and kerbside locations, and the relative consistency of data over the two years, the use of background monitoring sites appears to be justified. The selected proxy exposure indicators outlined in section 6.3 have been compiled for the 469 wards which contain background sites. These wards are shown in Figure 6.5.

6.5 GIS development

To facilitate the construction, mapping and analysis of the selected indicators, a GIS was developed, using ARC/INFO version 7.0.2. Digital boundary data for the 113,196 EDs in England and Wales were obtained from MIDAS (Manchester Information Datasets and Associated Services) in Arc/Info GENERATE format. Individual coverages were created from the 55 county files which cover England and Wales and these were merged using the MAPJOIN command, which joins adjacent coverages. The ED boundaries were then generalised up to ward level by dissolving on the ward codes, using the DISSOLVE command. For example, the internal boundaries of EDs ADFA01 to ADFA21 were merged to produce the ward boundary of ADFA. As previously stated, one of the advantages of using wards is the availability of census-derived data, which is collated at ED level and can easily be aggregated to ward level. The accuracy of ED and ward boundaries have also been thoroughly checked as part of a nine-month Quality Assurance project conducted by the Urban Research and Policy Evaluation Regional Research Laboratory, Manchester University. Each county file was checked to ensure that the correct number of polygons existed and that each contained a centroid and ED label. A cross check against the Small Area Statistics was also made to ensure consistency with census data. A sample of ED boundaries were plotted onto transparent film and overlayed with the original OPCS base maps to ensure that they had been accurately digitised. The adopted specification demanded that 95% of digitised points were within 2 mm of their base map equivalents (20m on the ground), and that all points were within 4 mm (40m on the ground). Although the project exposed some errors, these were found to be within acceptable limits and are not thought to

Figure 6.5: Wards which contain one or more NO_2 monitoring sites

affect the majority of users. Census variables for these wards were also obtained from MIDAS. These are described in section 6.6.

Access to the census digital boundary data is free for academic users in the UK, but the cost of purchasing the spatial data needed to construct some proxy indicators can be prohibitive. Although this study concerns the development of broad-scale, policy-related indicators, the issues of data accuracy and reliability are no less important than at the local level. Selected indicators should therefore be compiled using the most accurate and detailed data available. In the case of the road density indicators, this would be the OSCAR Asset Manager dataset, which includes all motorways, A-roads, B-roads and unclassified roads and is spatially accurate to approximately one metre. However, the cost of obtaining this data for the whole country would run into tens of thousands of pounds. It has therefore been necessary to use a cheaper, less detailed or accurate alternative: the AA Automaps 1:200,000 roads database. Similarly, traffic volume data is available for the whole country from the Department of the Environment, Transport and the Regions, but the cost for accessing this data is approximately £5000. In addition, the data is only updated on a rolling three year cycle and does not cover all roads in the country. Whilst traffic levels are also monitored by Local Authorities, collecting the necessary data for the whole country would be very time consuming and many authorities would be likely to charge for using the data.

6.6 Indicator construction

6.6.1. Population density

Ward level population data, from the 1991 Census, was extracted from the national datasets archive at MIDAS using the SASPAC programme. Total population for all persons at ward level (approximately 10,000) was extracted from Table S02 (field 1) in the small-area statistics and written to a text file. The surface area (m^2) of each ward was calculated from the ward attribute table using the STATISTICS command in TABLES and exported to a text file. Both files were then opened in EXCEL and joined to calculate population density (persons per square kilometre) by dividing population by surface area.

6.6.2. Car ownership and usage

As previously mentioned, some proxy indicators which can be used to assess exposure at individual points could not be used in this study. Distance to nearest road, traffic volume of nearest road and traffic volume over distance to nearest road, for example, can be calculated for points, but not for areas. In the absence of more detailed indicators, a number of source-activity, census-related variables have been used in this study, in the belief that these measures convey information about factors further down the environment-health chain.

All of the variables described below were extracted from the Small Area Statistics held at MIDAS, using the SASPAC data extraction package developed by the London Research Centre. The Small Area Statistics consist of a series of tables which cover all the topics for which information was obtained in the Census. SASPAC accesses the desired table and field, then extracts the data at the specified level of aggregation (ED, ward, district, county or country). Output can be saved as a comma separated file (.csv) containing the ward code (or other unit of aggregation, as desired) and the values for the selected variables.

The majority of variables recorded in the Census were straightforward to code and have been therefore coded for the whole population. These include age, sex, country of birth, employment status and ethnic origin and are known as the '100% tables'. Other, more complex factors, which include breakdowns of occupation, employment status and education level have only been coded for a 10% sample of households. These are known as the '10% tables'. Several of the 10% tables describe variables for the socio-economic sub-group (SEG), which includes residents aged 16 and over (employees and self-employed). The SEG is defined by the Office of Population, Census and Surveys (OPCS 1991) (now the Office for National Statistics) as follows:

> "SEG categories are derived for persons who are economically active employees or self-employed by reference to their present occupation and employment status. For persons who are unemployed, on a Government scheme, or economically inactive, SEG is derived from their previous occupation and employment status if they have been in employment in the 10 years preceding the Census. Otherwise, no SEG category is allocated. In the LBA and SAS the unemployed and persons on a Government scheme are excluded from the analysis of Socio-economic group, except in Table 86" (OPCS 1991, p19).

Table S82 is a 10% table which describes car ownership and usage levels for the SEG. Field 5 represents people who drive to work, fields 196 and 209 represent people with 2 cars and 3 or more cars respectively. The rationale behind using measures of car ownership and usage is that car ownership levels are likely to be related to car usage. Both variables are likely to be related to ambient pollutant levels.

Field 1 was extracted along with fields 5, 6, 196 and 209 because this describes the number of persons in the SEG (10% sample) - i.e. 10% of the economically active population (employed and self-employed) aged 16 and over resident in households in each ward. These fields were imported into EXCEL and the percentage of the SEG population with 2 cars, 3 or more cars and people driving to work were calculated by dividing the values for relevant fields by the SEG population and multiplying by 100. It should be noted that these indicators are expressed as a percentage of the socio-economic sub-group, rather than the total ward population, because the SEG does not form exactly 10% of the total ward population.

Using the same method, the proportion of people in each ward without cars was calculated from Table S20 (a 100% table), which covers tenure and amenities. The rationale behind this indicator was the belief that car ownership levels are related to car usage and ambient pollution levels. Field 150 was saved in a comma separated variable file, imported into

EXCEL and combined with the file containing total ward population. The number of people without cars is expressed as the percentage of population in the ward without cars.

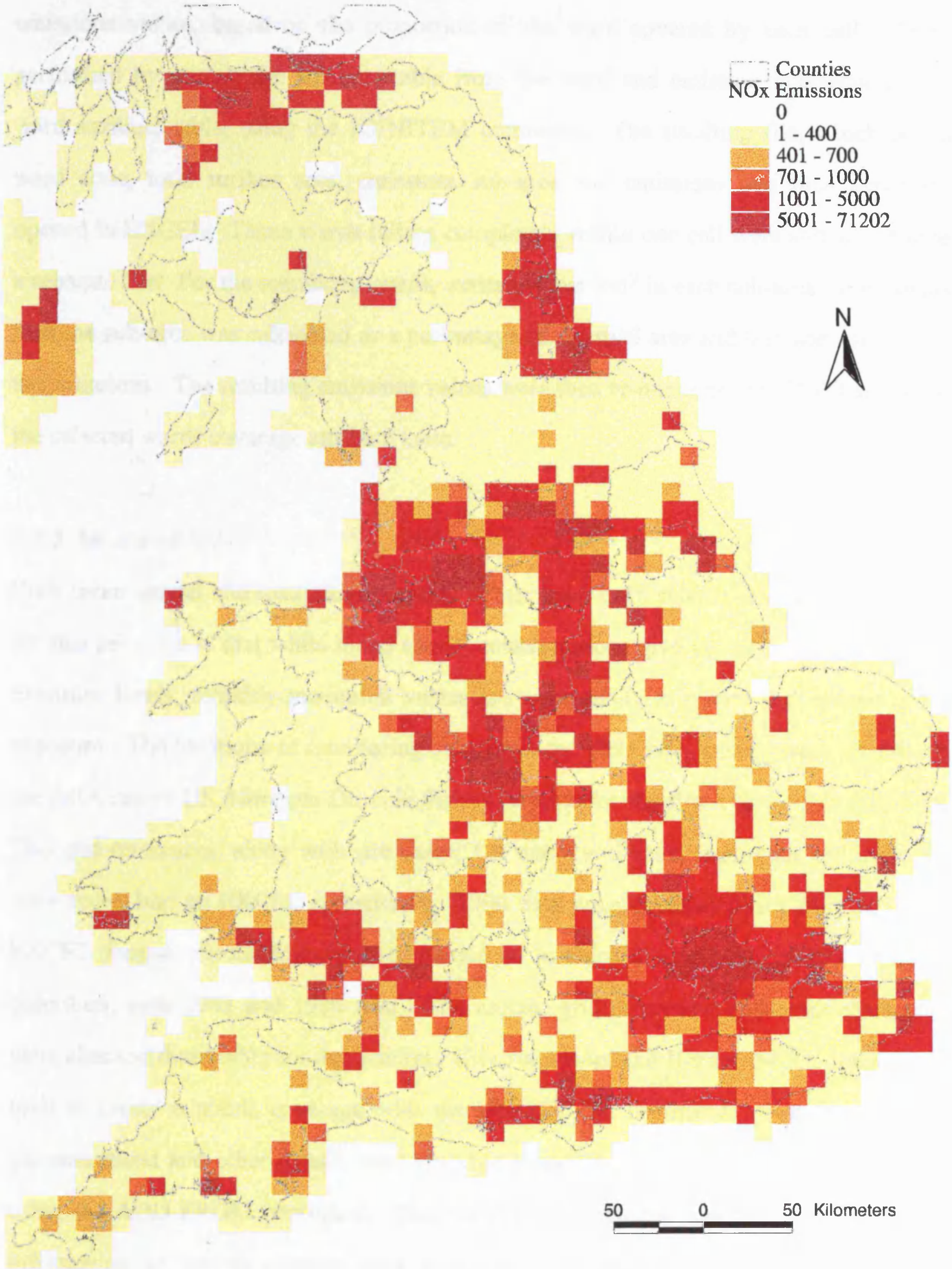
6.6.3. Road density

As previously mentioned, roads data was used from the AA Automaps vector database. Derived from 1:100,000 satellite imagery and mapped at 1:200,000 scale, the dataset includes 3,212 km of motorways, 25,768 km of primary roads, 41,408 km of A-roads, 35,851 km of B-roads and 168,436 km of unclassified roads. The road and ward coverages were joined using the INTERSECT command to identify the roads which fell within selected wards. The STATISTICS command in TABLES was then used to calculate the length of roads in each ward and the results were exported to a text file. This process was repeated for each road class in turn; motorways, Primary roads, A-roads, B-roads and unclassified roads. The license for this dataset is held by The Department of Epidemiology and Public Health at St. Mary's Hospital Medical School, Imperial College. The roads-based indicators were therefore constructed at Imperial College and the recorded values exported to prevent breach of copyright. The text files containing road length calculations were combined in EXCEL and the surface area/ward label file added. The length of road per square kilometre for each ward was then calculated.

6.6.4. Emissions data

Emissions data from the 1990 National Atmospheric Emissions Inventory (NAEI) were obtained for oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Text files containing emissions in tonnes per year for each 10 km^2 grid were then used to create point coverages for NO_x and VOCs with the GENERATE command. Emissions values were added as labels. Using the POINTGRID command, these coverages were rasterised to create two separate grids. It was then necessary to convert the values from floating-point values back to integers using the INT command. Emissions of nitrogen oxides are shown in Figure 6.6. The emission grids were converted into polygon coverages with the GRIDPOLY command and overlayed with the selected wards, using the INTERSECT command. Whilst the majority of

Figure 6.6: Emissions of nitrogen oxides (NO_x) per 10km^2 (Tonnes/year)



wards fell completely within individual cells, a considerable number were found to fall under the boundary of two or more cells. It was therefore necessary to calculate area-weighted emissions values, based on the proportion of the ward covered by each cell. This was performed by joining the attribute table from the ward and emission intersection with the ward attribute table, using the JOINITEM command. The resulting file, which contained ward code, total surface area, emissions sub-area and emissions was then exported and opened in EXCEL. Those wards falling completely within one cell were sorted and saved in a separate file. For the remaining wards, emissions per km^2 in each sub-area were calculated, then the sub-area was calculated as a percentage of the total area and this was used to weight the emissions. The resulting emissions values were then re-imported into INFO and joined to the selected wards coverage attribute table.

6.6.5. Measured NO_2

Both mean annual and maximum monthly values have been selected for use. The rationale for this selection is that while mean annual concentrations give an indication of background exposure levels, monthly maximum values are more likely to reflect shorter-term peaks in exposure. The locations of monitoring sites from the 1993 NO_2 survey were obtained from the AEA report UK Nitrogen Dioxide Survey Results for the first year - 1993 (AEA 1993). The grid references, along with site name, LA name and code, maximum and mean values were typed into an EXCEL spreadsheet. 1994 data were obtained direct from NETCEN in EXCEL format. Both files were combined to produce a single list of 993 unique sites describing both 1993 and 1994 data. Site names, grid references and other characteristics were checked thoroughly for duplication. Grid references and IDs for the 993 sites were then used to create a points coverage with the GENERATE command. Site names, pollutant concentrations and other details were saved in a text file and imported into an INFO table using the ADD FROM command. The JOINITEM command was then used to attach this information to the monitoring sites coverage attribute table. Using the INTERSECT command, the ward and monitoring site coverages were overlayed to determine which wards contained monitoring sites. 469 wards were found to contain background monitoring sites. It was discovered that 23 wards contained more than one monitoring site (1 with 3 sites, 22 with 2 sites). In these wards, the site with the highest maximum monthly value was used, whilst mean annual concentrations were calculated by averaging duplicate sites.

6.7 Results

The final list of indicators was combined in EXCEL and converted into Dbase 4 format. The relationship between indicators was assessed using one-tailed Spearman's rank correlation in SPSS, whilst the consistency of exposure classification by quintile was examined through cross-tabulation. These results are summarised in Tables 6.2, 6.3, 6.4 and 6.5.

Table 6.2 shows r values for the 324 wards which contained a complete dataset of maximum and mean measured NO_2 values for 1993. Table 6.3 shows r values for the 458 wards which contained maximum and mean NO_2 values for 1994. Whilst the r values in the two tables are very similar, a small degree of variation can be observed. Several of the indicators appear to be strongly correlated, although the highest r values appear between variables which share source data and reflect the same underlying factors. For example, between NO_x and VOC emissions (0.90 for both datasets), 1993 mean and maximum NO_2 concentration (0.85) and the percentage of the SEG population with two cars and who drive to work (0.78 for 1994 data). Conversely, the relationships between unconnected indicators appear to be weak, weakly negative or not significant. For example, there is a strong negative relationship between the percentage of people driving to work and the percentage of people without access to a car (r = -0.78 in table 6.2), but the relationship between the percentage of people driving to work and measured concentrations of NO_2 is weakly negative (r = -.20 in Table 6.2). Similarly, in Table 6.3, the relationship between main-road density and all-road density is moderately strong (r = 0.62), yet the relationship with NO_x emissions is poor (r = 0.14). It therefore appears that the relationships between indicators constructed at different stages in the environment-health chain are weak, and that it is difficult to construct valid proxy measures for exposure at ward level. However, there are two exceptions to this trend.

TABLE 6.2: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

1993 data

	Source Activity									*Emissions*		*Conc.*
	POP'N DENS.	2 CARS	>3 CARS	DRIVE	NO CAR	MWAY DEN	MJRD DEN	MRD DEN	ALLRD DEN	NO_x EMIS.	VOC EMIS.	93 MAX
Source Activity												
POP'N DENSITY												
2 CARS	**-.37**											
3 OR MORE CARS	**-.31**	**.66**										
PASS. TO WORK	*-.11*	**-.23**	**-.21**	(.02)								
NO CAR	**.35**	**-.83**	**-.70**	**-.78**								
MWAY DENSITY	**-.27**	**.20**	*.12*	**.21**	**-.17**							
MAJ'R RD DENSITY	**.25**	**-.18**	**-.18**	**-.21**	**.24**	(.01)						
MAIN RD DENSITY	**.30**	**-.18**	**-.16**	**-.21**	**.23**	**-.18**	**.77**					
ALL RD DENSITY	**.23**	(-.07)	(-.05)	(-.02)	*.10*	(.08)	**.45**	**.56**				
Emissions												
NO_x EMISSIONS	**.46**	**-.24**	**-.18**	**-.27**	**.29**	(.06)	**.22**	*.13*	(-.09)			
VOC EMISSIONS	**.48**	**-.18**	*-.12*	**-.23**	**.24**	(.06)	**.25**	**.16**	(.06)	**.90**		
Concentration												
1993 MAX NO_2	*.11*	(-.03)	(-.03)	(-.07)	(.08)	**.14**	*.11*	(.04)	(.04)	**.32**	**.32**	
1993 MEAN NO_2	**.16**	(-.08)	(-.07)	**-.13**	**.15**	**.18**	*.12*	(.04)	(-.01)	**.43**	**.44**	**.85**

Note: all correlations based on n = 324; figures in italics significant at 0.025 level in predicted direction; figures in bold significant at 0.005 level in predicted direction; figures in brackets not significant

TABLE 6.3: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

1994 data

	Source Activity									*Emissions*		*Conc.*
	POP'N DENS.	2 CARS	>3 CARS	DRIVE	NO CAR	MWAY DEN	MJRD DEN	MRD DEN	ALLRD DEN	NO_x EMIS.	VOC EMIS.	94 MAX
Source Activity												
POP'N DENSITY												
2 CARS	**-.38**											
3 OR MORE CARS	**-.29**	**.64**										
DRIVE TO WORK	**-.33**	**.78**	**.61**									
NO CAR	**.37**	**-.83**	**-.69**	**-.77**								
MWAY DENSITY	**-.23**	**.17**	**.11**	**.16**	**-.13**							
MAJ'R RD DENSITY	**.24**	**-.19**	**-.17**	**-.22**	**.24**	(.01)						
MAIN RD DENSITY	**.29**	**-.18**	**-.15**	**-.20**	**.23**	**-.17**	**.79**					
ALL RD DENSITY	**.17**	*-.08*	(-.03)	(-.04)	*.09*	(.07)	**.50**	**.62**				
Emissions												
NO_x EMISSIONS	**.47**	**-.24**	**-.15**	**-.25**	**.28**	*.10*	**.21**	**.14**	(-.06)			
VOC EMISSIONS	**.51**	**-.20**	*-.10*	**-.22**	**.25**	(.07)	**.25**	**.18**	(-.02)	**.90**		
Concentration												
1994 MAX NO_2	**.24**	*-.09*	(-.06)	*-.10*	**.14**	(.08)	*.09*	(.03)	(-.05)	**.40**	**.40**	
1994 MEAN NO_2	**.23**	**-.11**	(-.05)	**-.17**	**.16**	**.11**	**.13**	(.07)	(-.02)	**.48**	**.48**	**.88**

Note: all correlations based on n = 458; figures in italics significant at 0.025 level in predicted direction; figures in bold significant at 0.005 level in predicted direction; figures in brackets not significant

TABLE 6.4: CROSS-TABULATION OF INDICATORS: PERCENTAGE OF WARDS CLASSIFIED IN THE SAME QUINTILE

1993 data

	Source Activity									*Emissions*		*Conc.*
	POP'N DENS.	2 CARS	>3 CARS	DRIVE	NO CAR	MWAY DEN	MJRD DEN	MRD DEN	ALLRD DEN	NO_x EMIS.	VOC EMIS.	93 MAX
Source Activity												
POP'N DENSITY												
2 CARS	16											
3 OR MORE CARS	17	40										
DRIVE TO WORK	17	49	37									
NO CAR	27	10	10	11								
MWAY DENSITY	12	27	22	24	17							
MAJ'R RD DENSITY	25	14	16	15	26	23						
MAIN RD DENSITY	29	16	15	15	23	16	49					
ALL RD DENSITY	23	19	18	19	19	22	28	29				
Emissions												
NO_x EMISSIONS	34	13	18	16	24	19	24	22	20			
VOC EMISSIONS	35	15	19	17	24	19	25	20	22	73		
Concentration												
1993 MAX NO_2	21	20	15	18	18	19	21	24	18	20	24	
1993 MEAN NO_2	21	18	17	16	20	18	20	22	21	26	31	63

Note: all cross-tabs based on n = 324

TABLE 6.5: CROSS-TABULATION OF INDICATORS: PERCENTAGE OF WARDS CLASSIFIED IN THE SAME QUINTILE

1994 data

	Source Activity									*Emissions*		*Conc.*
	POP'N DENS.	2 CARS	>3 CARS	DRIVE	NO CAR	MWAY DEN	MJRD DEN	MRD DEN	ALLRD DEN	NO_x EMIS.	VOC EMIS.	94 MAX
Source Activity												
POP'N DENSITY												
2 CARS	17											
3 OR MORE CARS	15	42										
DRIVE TO WORK	17	49	36									
NO CAR	15	50	38	47								
MWAY DENSITY	15	26	21	23	24							
MAJ'R RD DENSITY	23	15	16	16	16	23						
MAIN RD DENSITY	29	17	16	16	16	19	48					
ALL RD DENSITY	21	20	19	16	16	24	33	32				
Emissions												
NO_x EMISSIONS	34	13	18	17	14	19	25	24	21			
VOC EMISSIONS	37	17	22	16	14	18	25	24	21	75		
Concentration												
1994 MAX NO_2	23	17	22	17	17	19	22	24	20	24	25	
1994 MEAN NO_2	23	20	24	18	18	18	19	24	20	30	29	57

Note: all cross-tabs based on n = 458

Firstly, population density appears to be moderately well correlated with both NO_X and VOC emissions. The r values for the 1993 analysis are 0.46 and 0.48 respectively, whilst they are slightly stronger for 1994 data, at 0.47 and 0.51 respectively. The relationships between these indicators can be seen more clearly in Figures 6.7 to 6.10 and clearly reflect, at least in part, the inclusion of population data in the models used to estimate emissions. Secondly, and more importantly, NO_X and VOC emissions correlate moderately well with mean annual measured NO_2 concentrations in both 1993 and 1994. The r values for both indicators are 0.46 for the 1993 analysis and 0.48 for 1994. These relationships can be seen in more detail in Figures 6.11 to 6.14.

The results from the cross-tabulations show the percentage of sites classified in the same quintile by different indicators and are illustrated in Tables 6.4 and 6.5. These results appear to support the findings of the Spearman's rank correlations. The percentage of sites classified in the same quintile is considerably higher between closely connected indicators, than between indicators constructed at different stages in the environment-health chain. For example, for the 1993 analysis, 49% of sites are classified in the same quintile by major-road density and main road density and 73% by NO_X and VOC emissions. Conversely, only 18% of sites are classified in the same quintile by the percentage of people driving to work and mean annual NO_2 concentrations for 1993. With few exceptions, most indicators only classify around 20% of sites in the same quintile. The two exceptions to this trend are population density with NO_X and VOC emissions (34% and 35% in 1993, 34% and 37% in 1994; along with VOC emissions and mean NO_2 (31% in 1993 and 30% in 1994).

Figure 6.7: Population density against NO_x emissions (1993 data)

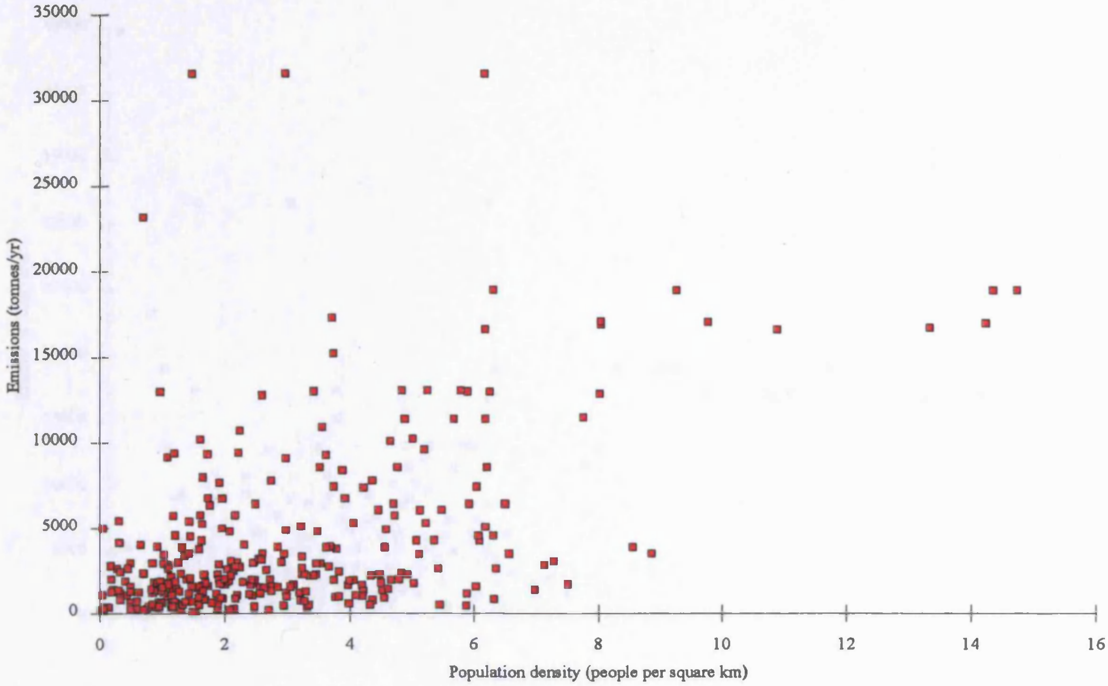


Figure 6.8: Population density against VOC emissions (1993 data)

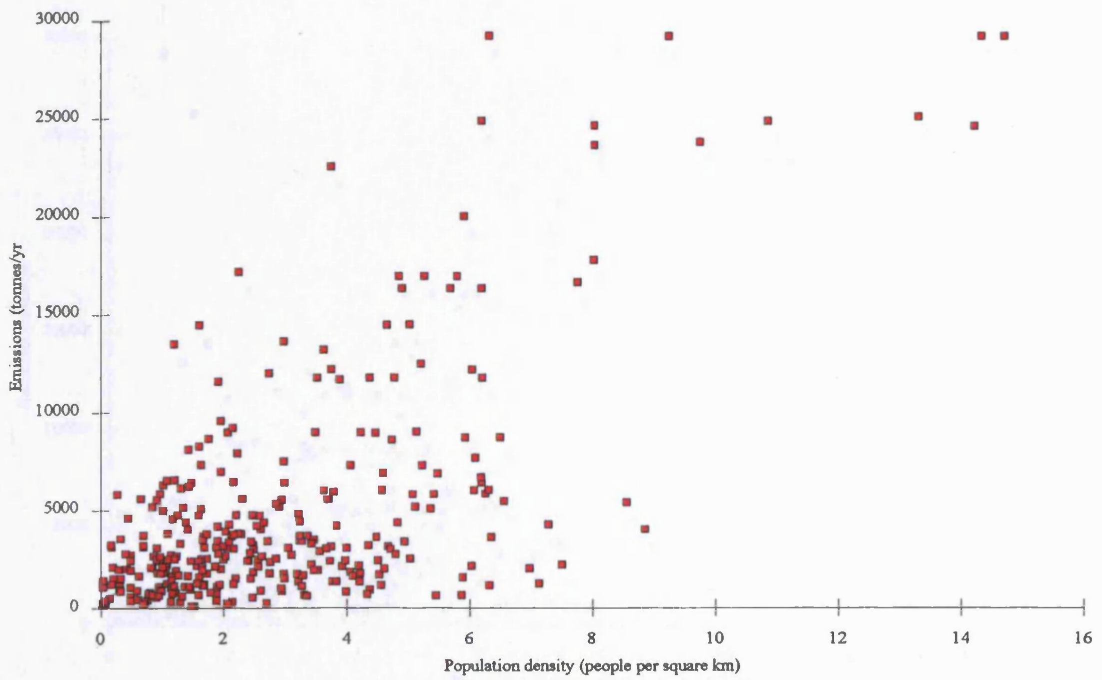


Figure 6.9: Population density against NO_x emissions (1994 data)

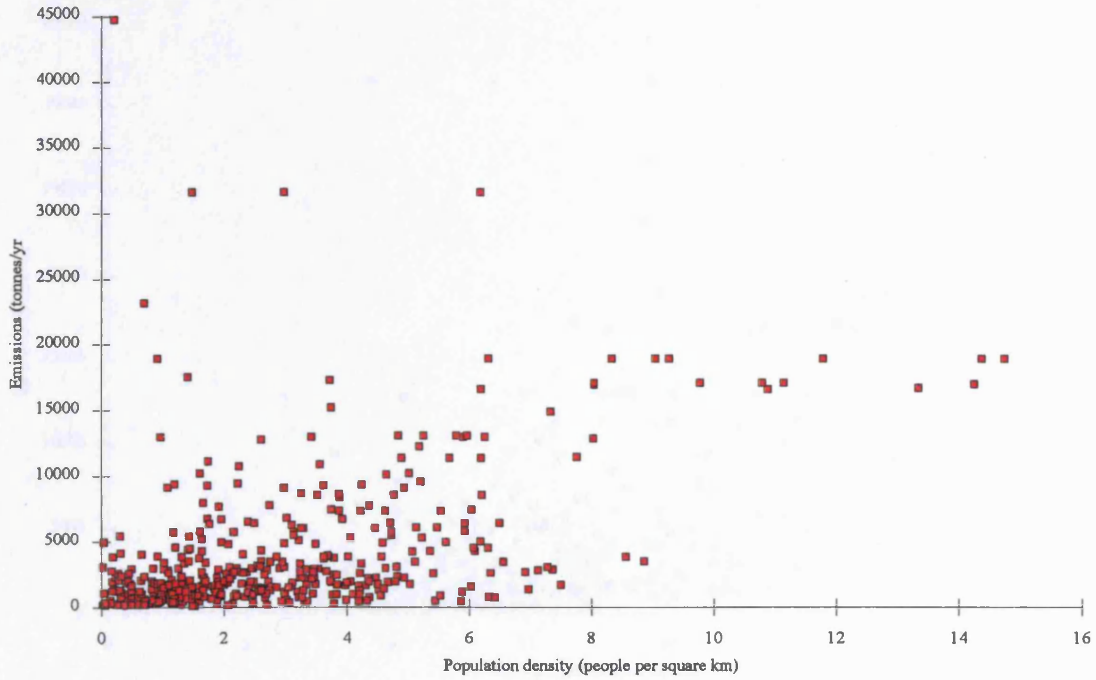


Figure 6.10: Population density against VOC emissions (1994 data)

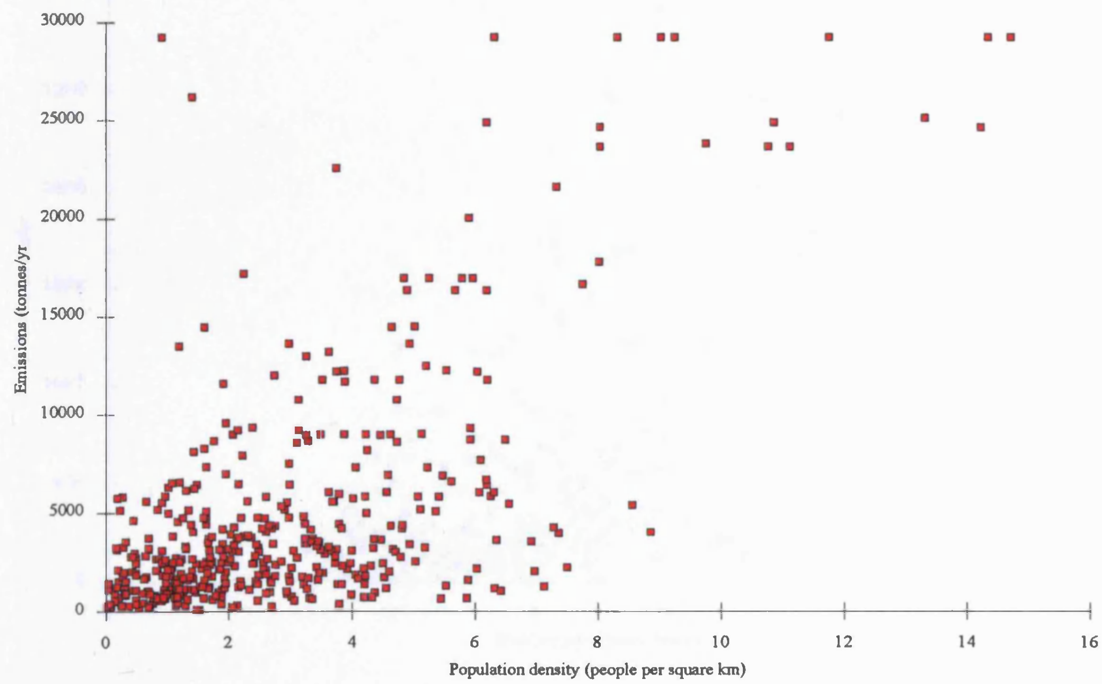


Figure 6.11: Mean annual NO_2 concentrations (ppb) against NO_x emissions (1993 data)

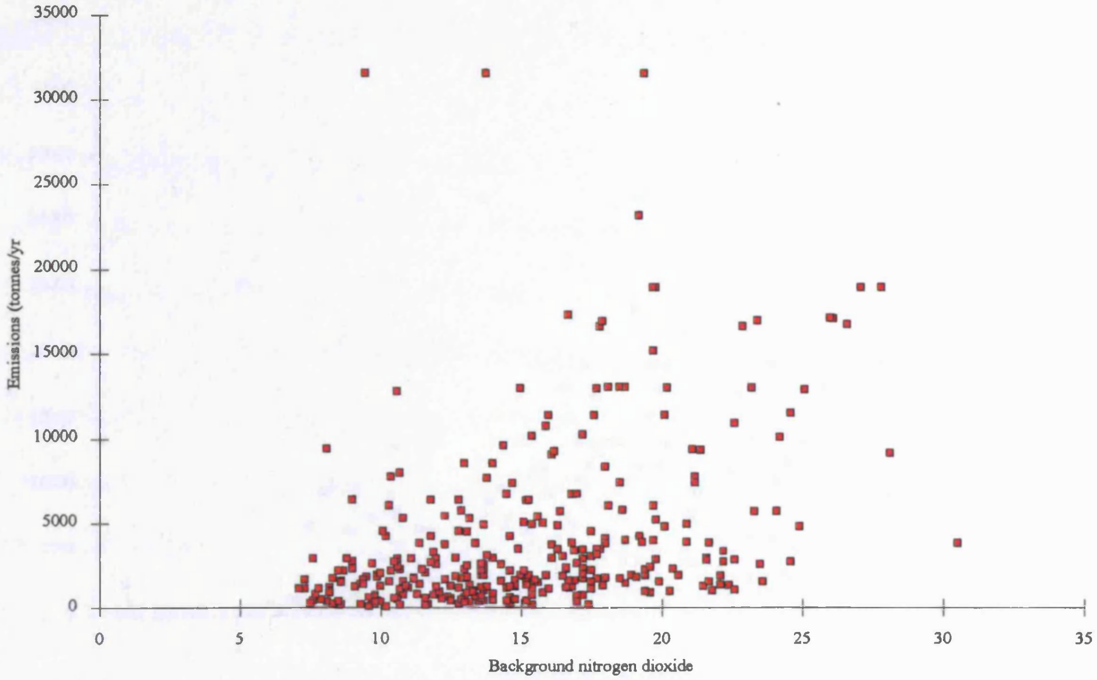


Figure 6.12: Mean annual NO_2 concentrations (ppb) against VOC emissions (1993 data)

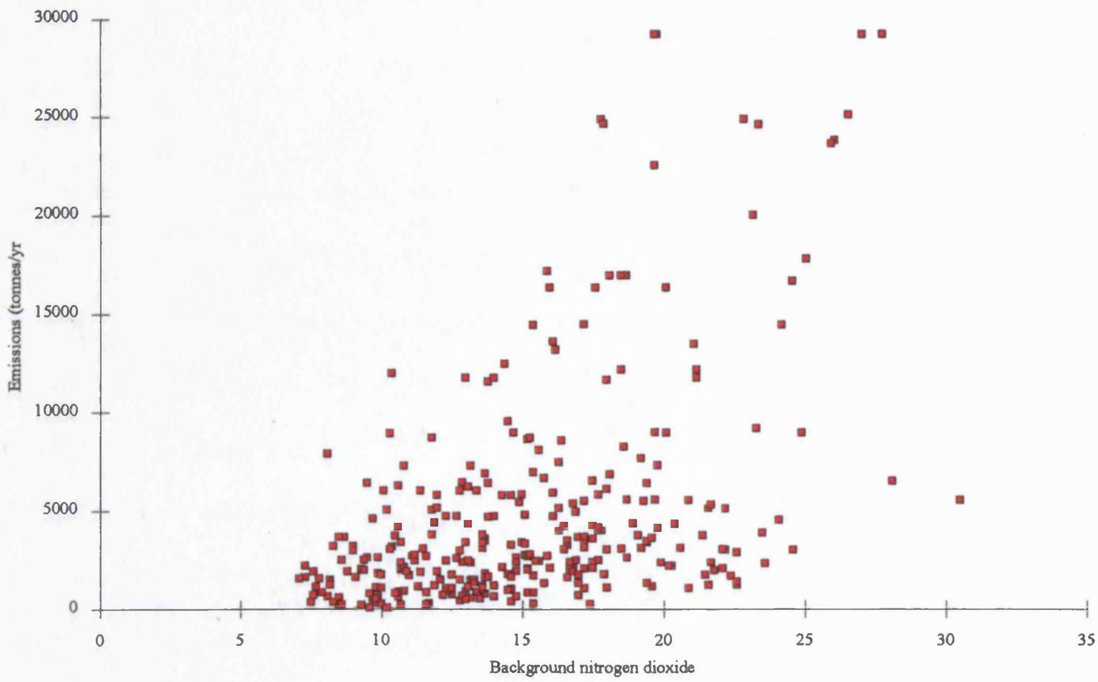


Figure 6.13: Mean annual NO_2 concentrations (ppb) against NO_x emissions (1994 data)

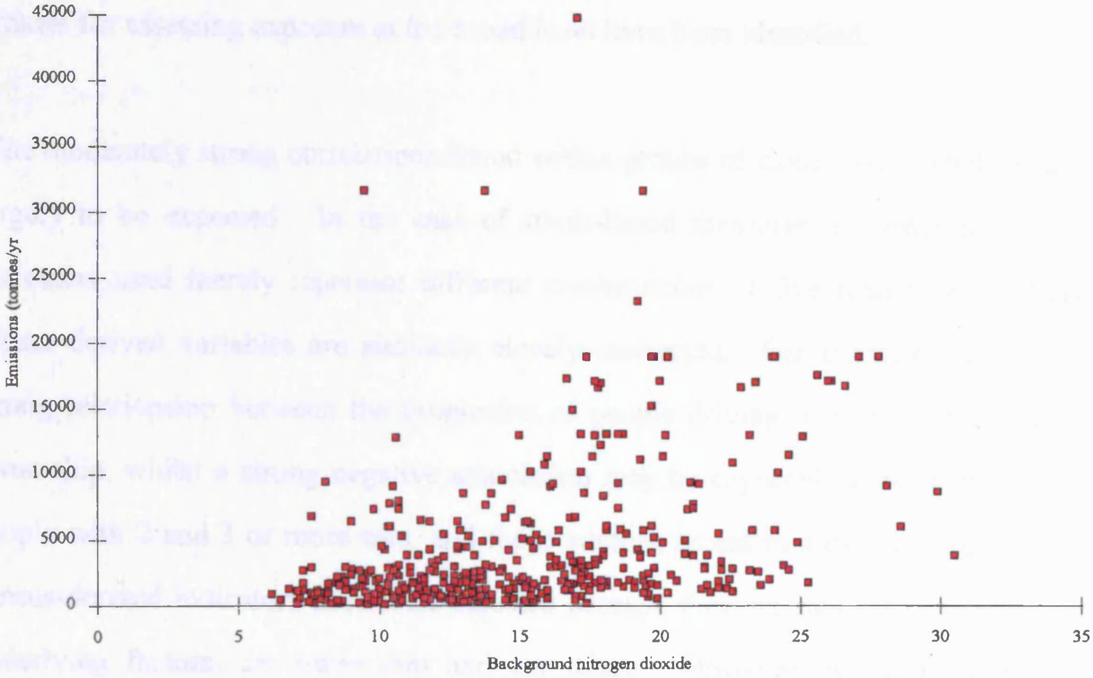
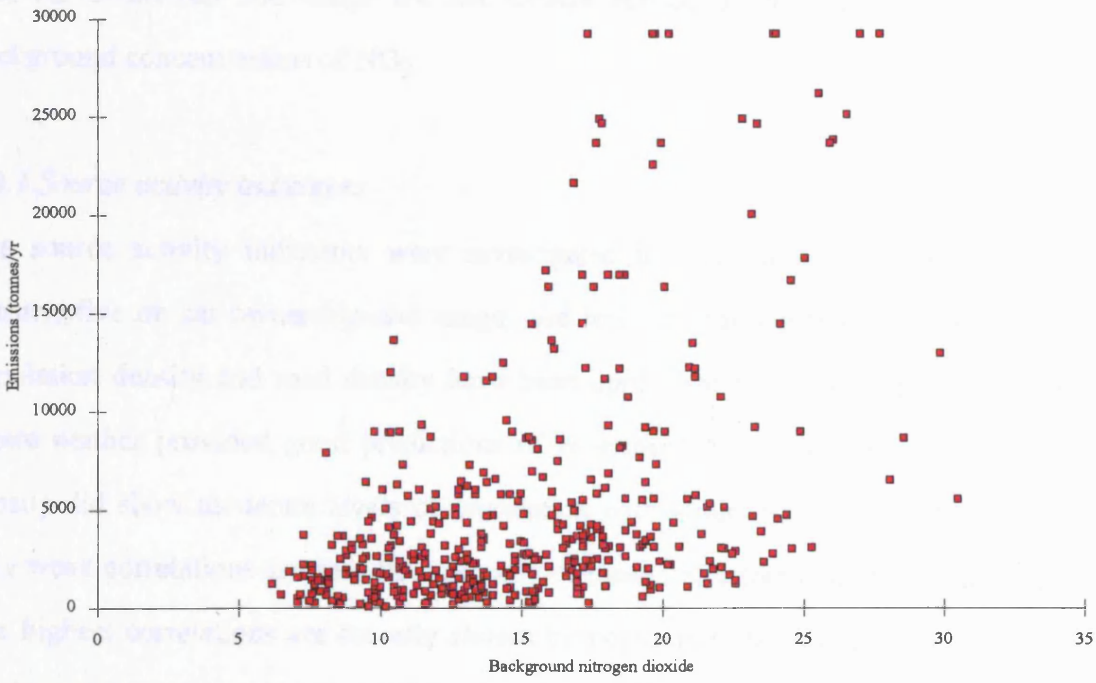


Figure 6.14: Mean annual NO_2 concentrations (ppb) against VOC emissions (1994 data)



6.8 Discussion

The following discussion evaluates the results above and examines the extent to which valid proxies for assessing exposure at the broad level have been identified.

The moderately strong correlations found within groups of closely connected variables were largely to be expected. In the case of roads-based measures, for example, the different indicators used merely represent different combinations of five road types. Many of the census-derived variables are similarly closely connected. For example, there is clearly a strong relationship between the proportion of people driving to work and the level of car ownership, whilst a strong negative association may be expected between the proportion of people with 2 and 3 or more cars, and those without access to a car. Indeed, several of the census-derived indicators used were selected because they are thought to measure the same underlying factors: car ownership and car usage. However, whilst it appears that car ownership and car usage are relatively closely associated, these variables do not correlate well with pollutant emissions and NO_2 concentrations. It can therefore be concluded that either the indicators used do not accurately reflect car ownership and usage levels, or, more likely, that car ownership and usage are not closely related to NO_x and VOC emissions and background concentrations of NO_2.

6.8.1 Source activity indicators

Ten source activity indicators were investigated in this study, one based on population density, five on car ownership and usage, and four on road density. As noted earlier, only population density and road density have been applied at the local scale (in Chapter Five), where neither provided good predictions of monitored NO_2 concentrations (although road density did show moderate levels of correlation with modelled NO_2. At the national level, only weak correlations are seen between any of these indicators and measured concentration. The highest correlations are actually shown by population density ($r = 0.11 - 0.24$). These results suggest that none of these indicators are reliable proxies for ambient concentration.

6.8.2 Emission indicators

The two emission indicators used perform considerably more effectively, with r values of 0.32 to 0.48 for relationships with measured NO_2. Even this, however, represents a relatively poor level of prediction, although between one third and one half of wards are classified in the same quintile by other indicators.

6.8.3 Interpretation

The relatively poor performance of proxies for measured concentration is therefore uncertain and they should be used with considerable caution.

Firstly, one can ask whether it is appropriate to use data from a single site to represent air pollution in a geographic area. As previously mentioned, using a single value of pollution is likely to mask the spatial variation which exists within an area. As Hewitt (1991) indicates, pollutant levels may vary considerably over only a few tens of metres. Within the 4-5 km^2 covered by an average ward, there is likely to be considerable spatial variation in air quality. It may therefore appear more logical to use multiple sites within each area, although the issue then becomes one of how best to combine these measures to obtain a single concentration-based exposure indicator. It may also be the case that, whilst there is a large degree of variation between kerbside and background levels within each area, the difference in background levels is small. Comparisons between background concentrations and both intermediate and kerbside concentrations (Figures 6.2 and 6.3) suggest that the background sites used do provide a valid and reliable measure of NO_2 pollution in the wards studied. To investigate this hypothesis further, however, the coefficient of variation was calculated for the 23 wards which contained more than one monitoring site. In the 14 wards which contained more than one site with 1993 mean annual NO_2 data, the average internal variation was 11.95% (range 0 - 40%), whilst the average variation for the 19 wards containing more than one site with 1994 data was 11.44% (range 2.4 - 27.7%). It therefore appears that, in these wards, background levels of NO_2 are relatively stable between different sites. In the absence of more detailed information, it is consequently possible to justify the use of single measures of pollution concentrations to represent areas such as wards.

The second issue which requires consideration is the use of wards as the geographical units for constructing and analysing indicators. As previously mentioned, wards are relatively small spatial units, yet the availability of data at this level is good. To investigate the spatial distribution of NO_2 sites within wards, a closer examination was made of the intersection between NO_2 monitoring site and ward coverages. This revealed that many sites were located at the very edges of wards. Whilst the neighbouring ward may contain important sources of NO_2, the methods used to compile the selected indicators will not allow for their inclusion in calculations of exposure. A more appropriate method of constructing indicators may be to buffer around each monitoring site, and to use this geographical area as the basis of indicator construction and analysis. This would limit the problem of extrapolating from a point-based measure of concentration to an area-based measure and the size of buffering could be controlled by the researcher. It would, however, increase the difficulties of obtaining other, relevant, census-based data (e.g. on population) in a comparable spatial form.

6.8.4 Exposure and risk assessment

As the opening paragraph of this chapter states, one of the main aims of constructing and applying indicators at the broader scale is to estimate the population at risk from exposure to traffic-related pollution. This discussion has demonstrated the difficulties in developing ward-based proxies for exposure. Nevertheless, it is instructive to compare the effects of using the various indicators examined here as a basis for health risk assessment.

Reliable dose-response relationships are not available for the links between long-term levels of traffic-related air pollution and health, and as noted in pervious chapters, it is possible that any such association is weak. It is therefore not possible to quantify this risk in terms of health outcomes. It is, however, possible to derive a measure of the number of people at risk, by calculating the number of people living in wards within the highest quintile class for each indicator. Such an analysis is, of course, far from wholly accurate, since it ignores spatial variation in pollution levels within wards, and assumes that all people in the ward are at equal risk. However, it does provide a simple means for comparison, which can show the possible implications of using different indicators as a basis for policy.

Table 6.6 shows the number and percentage of people in the top exposure quintile by each indicator for the 458 wards which contain monitored NO_2 data for 1994. As this illustrates, the size of the most exposed population varies considerably, according to which indicator is used. The lowest estimate is produced by using the percentage of people with three or more cars (505355 people - 16.8%), whilst VOC emissions provides the highest estimate (869634 people - 28.9%). Excluding these extreme indicators, along with all road density and NO_x emissions, reduces the range of estimates to between 17% and 25%. Considerable variations in the estimated number of people 'at risk' still occur, however, even between relatively closely connected indicators (e.g. between NO_x and VOC emissions - 818175 and 869634 respectively).

Table 6.6: The proportion of people classified in the top exposure quintile by each different indicator

Indicator name	*Population in the most exposed quintile*	*Percentage of the study population*
Population density	757094	25.1
People with 2 cars	522653	17.4
People with 3 or more cars	505355	16.8
People driving to work	600243	19.9
People without cars	525108	17.4
Road density - motorways	609006	20.2
Road density - motorways, primary roads and A-roads	544704	18.1
Road density - A-roads, primary roads and B-roads	551374	18.3
Road density - all roads	508728	16.9
NO_x emissions	818175	27.2
VOC emissions	869634	28.9
1993 Maximum NO_2	698965	23.2
1993 Mean NO_2	680025	22.6
Total	3011769	

In addition, using the data on monitored NO_2 concentrations it is possible to assess the proportion of the population living in wards with mean annual NO_2 concentrations above the new UK guideline value of 21 parts per billion (ppb). Of the 324 wards which contain monitored concentration data for 1993, 25 have mean annual levels of NO_2 above 21 ppb. The population of these 25 wards is 204609, which equates to 9.4% of the total population of the 324 wards (2.17 million people). Of the 458 wards with monitored NO_2 data for 1994, 50 have mean annual levels of over 21 ppb. The population of these wards is 396319, which is 13.2% of the total population in the 458 wards (approximately 3 million). Whilst this approach clearly assumes that all people within wards with annual mean concentrations above the WHO guideline are equally exposed, it offers a rapid means of estimating population risk.

6.9 Conclusions

The results presented in this chapter show that it is extremely difficult to develop reliable proxies for exposure to traffic-related pollution on the basis of readily available data. Unfortunately, indicators such as road density or car usage do not appear to provide good predictions of measured pollutant concentrations. Of the indicators used here, the only ones to show even moderate corrrelations with NO_2 levels were the two emission-based measures (NO_x and VOC emissions). As was shown in Chapter Five, however, neither of these correlate strongly with monitored concentrations at the small-area level. Their use as exposure indicators at the ward scale thus needs to be treated with care.

On the other hand, this study has demonstrated that monitored background concentrations do provide a reasonably consistent indicator of pollution levels within wards. Notwithstanding the local variations in air pollution which obviously occurs, ambient concentration at different background sites varied only slightly (by between 10-12%) and close correlations were found between background, intermediate and kerbside sites. The use of data from single background monitoring sites therefore appears to be the best available indicator of ambient concentrations at this scale.

These data currently exist for approximately 450 wards in England and Wales, covering a population of just over two million people. Where these data do not exist, the problem of finding suitable exposure indictors persists. For many epidemiological studies, the solution lies in purpose-designed monitoring, using diffusion tubes. The recent SAVIAH study, for example, has shown that three or four two-week surveys within one year can provide reasonably accurate measures of mean annual concentrations (Briggs *et al.* 1997). For broader scale, or policy applications, it may be possible to model concentrations using regression-based, or other methods. Campbell *et al.* (1994), for example, developed a regression-based model of urban NO_2 concentrations, based on monitored concentrations at over 300 urban sites between July and December 1991, and population density at the 5 km by 5 km grid square level (see also Stedman 1995). The equation produced was:

$$\text{Urban } NO_2 = \text{rural } NO_2 + 0.317 \text{ x (population per 5 km}^2)^{0.35} + 0.56$$

In this study, a similar attempt was made to model NO_2 concentrations using the ward data presented here. Stepwise regression analysis was used to compute relationships between monitored concentration and the available ward-level indicators for the 324 wards with 1993 data, and the 458 wards with 1994 data. The best regression models for mean annual concentration in 1993 was:

$$\text{Mean } NO_2 = 12.97 + 3.97 \text{ x (motorway density)} + (\text{VOC emissions})^{0.00025}$$

for which $r^2 = 0.14$ and the standard error of the estimate was 3.75.

For 1994, the best-fit model was:

$$\text{Mean } NO_2 = 4.73 + 0.00023 \text{ x (VOC emissions)} + (\log NO_x \text{ emissions})^{1.16}$$

for which $r^2 = 0.27$ and the standard error of the estimate was 4.13.

Neither of these equations may be considered adequate as models of ward level NO_2. A more effective approach might be to model monitored concentration from environmental data for a smaller area around each site, for example, by using a 1 km buffer around each monitoring station. The problem of developing reliable estimates of exposure at this scale therefore remains.

Chapter 7: Mapping Pan-European Environmental Health Risk

The truth is rarely pure, and never simple.

Oscar Wilde

7.1 Introduction

An important focus of much recent effort, and of this thesis, has been the development of environmental health indicators which can be used to inform and support policy. The need for these indicators is especially acute at the European level, where a number of contemporary policy developments have implied the use of EHIs.

The Health For All programme, for example, was launched at the 30th World Health Assembly in May 1977 and aims to promote the attainment of good health for all citizens by the year 2000 (WHO 1990b). Three key areas of the programme have been identified:

- life-styles which are conducive to health;
- the prevention of preventable conditions;
- health rehabilitation and health services.

Progress in these areas within Europe is measured against 38 regional targets. Targets 18 to 25 relate to producing healthy environments (WHO 1985). Systematic monitoring and reporting are undertaken every three years, with a thorough evaluation every six years. Currently, 280 statistical indicators (with 19 relating specifically to the environment) are used as part of this monitoring (WHO 1994d). The availability of validated EHIs would clearly aid this process and the WHO have been actively involved in indicator development for a number of years.

The European Charter on Environment and Health was launched at the *First European Conference on Environment and Health,* held in 1989 (WHO 1994e). In recognising the paucity of existing information on environmental health, the charter states:

> "Information that allows new problems to be identified and the success of policies and control measures to be monitored, is essential to effective management of environmental health programmes. .....Information is grossly inadequate on the extent to which environmental conditions in Europe are causing ill health. Important public health problems may not be detected. On the other hand, some conditions may be less harmful than is popularly supposed, and costly control measures may be unnecessarily stringent" (WHO 1989 pp. 64-65).

At the second conference, held in Helsinki, June 1994, the *Environmental Health Action Plan for Europe* (EHAPE) was endorsed. The aims of this plan include the development of national environmental health action plans and the improvement of policy tools. The important role of information is recognised in the following Action Plan objectives:

- To improve the relevance, quality and availability of data on various aspects of the environment related to health (e.g. pollutant levels in air, water, soil, food, body fluids and tissues) for purposes of situation, trend and impact analysis, as required for national policy development and evaluation, as well as for research purposes.
- To ensure that effective mechanisms exist for the identification and assessment of environmentally determined health hazards.

(WHO 1994f paragraphs 79 & 68)

In the light of these and other policy developments reviewed in Chapter Two, the main requirements of EHIs at this level are:

- to allow comparisons of problems between regions and countries;
- to provide a basis for policy assessment;
- to identify 'hot-spots' and areas for more detailed analysis;
- to identify trends in environmental health;
- to evaluate health risk;
- to inform stakeholders;
- to direct sparse resources;
- to evaluate the effectiveness of policy actions.

7.2 EHIs for traffic-related air pollution and health

Environmental health indicators of exposure to traffic-related pollution are particularly important at the European level, in view of the important role of European Union policies in influencing transport development, the trans-national nature of traffic-related pollution and health issues, and the European-wide growth in road traffic.

In Chapter Three, the criteria which need to be met by EHIs were examined. In particular, the requirement for consistent, significant relationships between the indicator and the condition of interest was emphasised (in the context of this thesis, exposure to traffic-related air pollution). Chapters Five and Six examined potential proxy indicators for exposure to traffic-related air pollution at the site and small-area level. The results of this work show that few indicators satisfy this requirement. Many of the indicators examined show only weak relationships with monitored pollution concentrations of NO_2 (as a marker for traffic-related air pollution). The strongest relationships were seen to be provided by modelled pollution concentrations (where modelling was possible), distance to the nearest main road, traffic volume of the nearest road or traffic volume of the nearest road divided by distance to the nearest road. At the national level, the use of these indicators is restricted by the lack of available data. However, single measures of background concentrations were seen to provide reasonable estimates of pollutant levels for small areas (namely wards) across England and

Wales. Where these data are not available, emissions of NO_X and VOCs appear to provide weak proxies (and may form the basis for modelling pollutant concentrations). Nevertheless, it should be stressed that these analyses are limited. In the absence of independent data on exposure, it was only possible to examine their relationship with monitored concentration.

7.2.1 Data availability

At the European level, the problems of data availability and comparability are even more acute (Briggs 1992 & 1995). This problem is further compounded by the need to rely on published data and statistics. The level of spatial aggregation at which data are available is also considerably greater. The majority of Eurostat (the European Statistical Office) data, for example, are only available for the NUTS 2 and NUTS 3 levels. (NUTS stands for Nomenclature of Territorial Units for Statistics. The establishment of NUTS boundaries is an attempt to define a common spatial framework for the collation and dissemination of data across the European region. All Eurostat data is supplied by NUTS region. NUTS level 0 represents the boundary of the European Union, NUTS 1 comprises national borders, NUTS 2, regions and NUTS 3, counties (in the UK). The NUTS 2 and NUTS 3 boundaries can be seen in Figures 7.1 and 7.2). NUTS 2 and NUTS 3 regions clearly represent large, heterogeneous units. Consequently, any indicators compiled at this scale are likely to be highly generalised. In the case of environmental health indicators, this problem is particularly acute, since exposure (which provides the link between environment and health) typically occurs at the local scale. Whilst the NUTS 5 level (wards in the UK or communes in France) is being developed as the base unit for statistical data in the European Union, as yet, little data is available at this scale.

7.2.2 Data review

In order to assess the possibility of constructing EHIs for exposure to traffic-related air pollution, a review of relevant datasets was undertaken. Several major data sources were examined, including Eurostat (REGIO and GISCO data) and the European Environment Agency (EEA). The results, which are presented in Table 7.1, suggest that whilst the availability of data on socio-economic factors is relatively good, the availability of environmental data is extremely limited. Information on measured pollutant concentrations, is particularly sparse. APIS, the European Air Pollution Information System, which was until recently used for recording and disseminating air quality information in the European Union, only contains data on measured NO_2 concentrations, for example, in approximately 70 cities within the European Union. As Figure 7.3 shows, the majority of these monitoring sites are also located in northern Europe. Data on emissions are more widely available; as part of the CORINE programme, an emissions inventory was compiled for European countries (EU12 countries) in 1985. The inventory includes total and transport-related emissions of NO_x, VOCs and SO_2 down to NUTS 3 level. The methodology used has since been revised and emissions for 1990 have also been calculated (although they were not available at the time this review was undertaken). Data on transport infrastructure are also widely available. Details of transport networks (road, rail and canal lengths) and transport stock (i.e. vehicle numbers) are available from the late 1970s to the early 1990s, though only down to NUTS 2 level.

7.2.3 Study design

Using these data, a GIS was constructed in Arc/Info (version 7.0.2) to explore the potential utility of the available proxy indicators. The following indicators were compiled at NUTS 2 and NUTS 3 level:

1. Population density (people/km^2);
2. Road density (motorways, non-motorway roads and all roads - from GIS and Eurostat data) (km/km^2);
3. Emissions of NO_x and VOCs - total and transport-related (tonnes/km^2);
4. Mortality - pneumonia, bronchitis and asthma, and road traffic accidents (cases/1000 people).

Figure 7.1: NUTS 2 boundaries

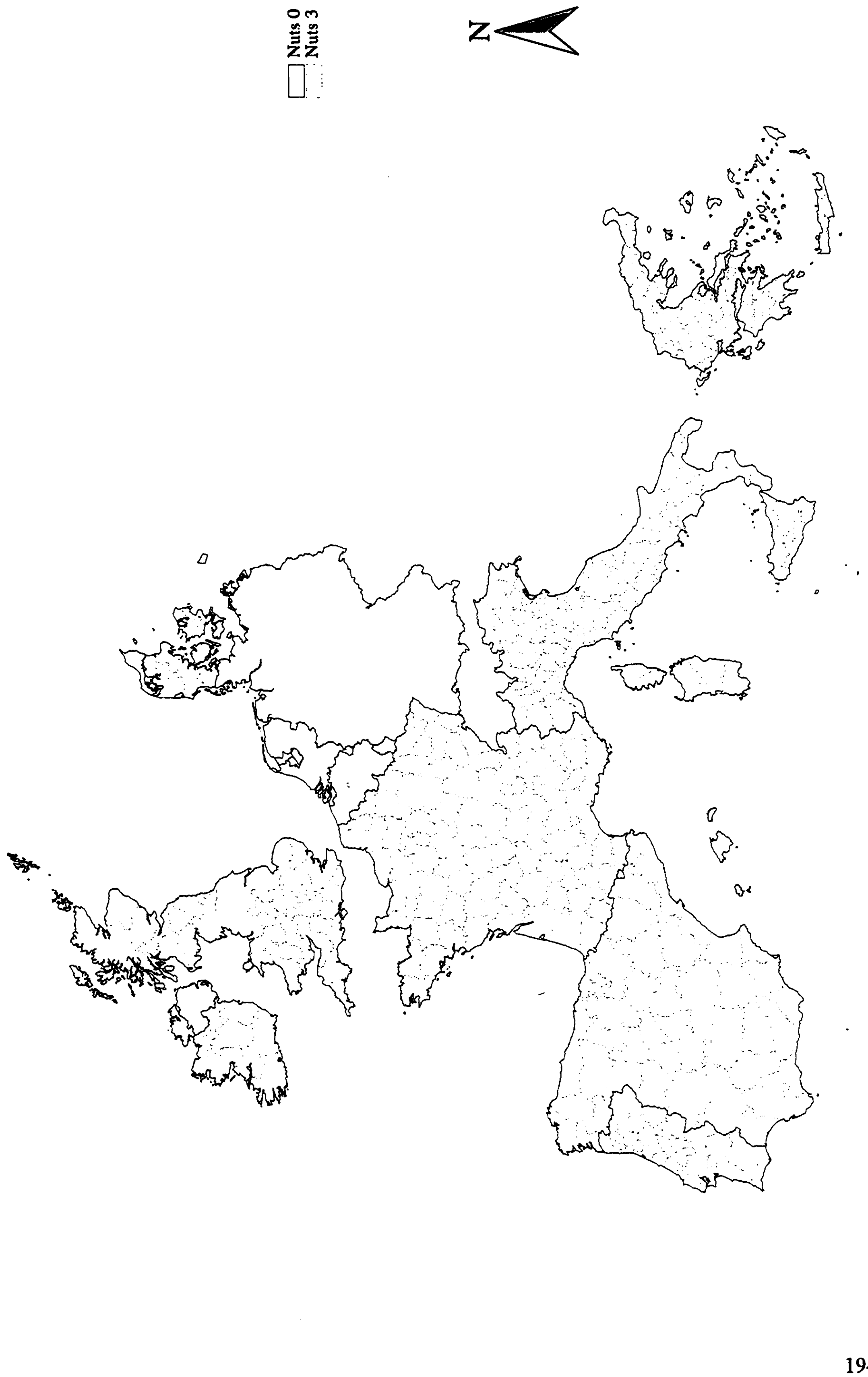


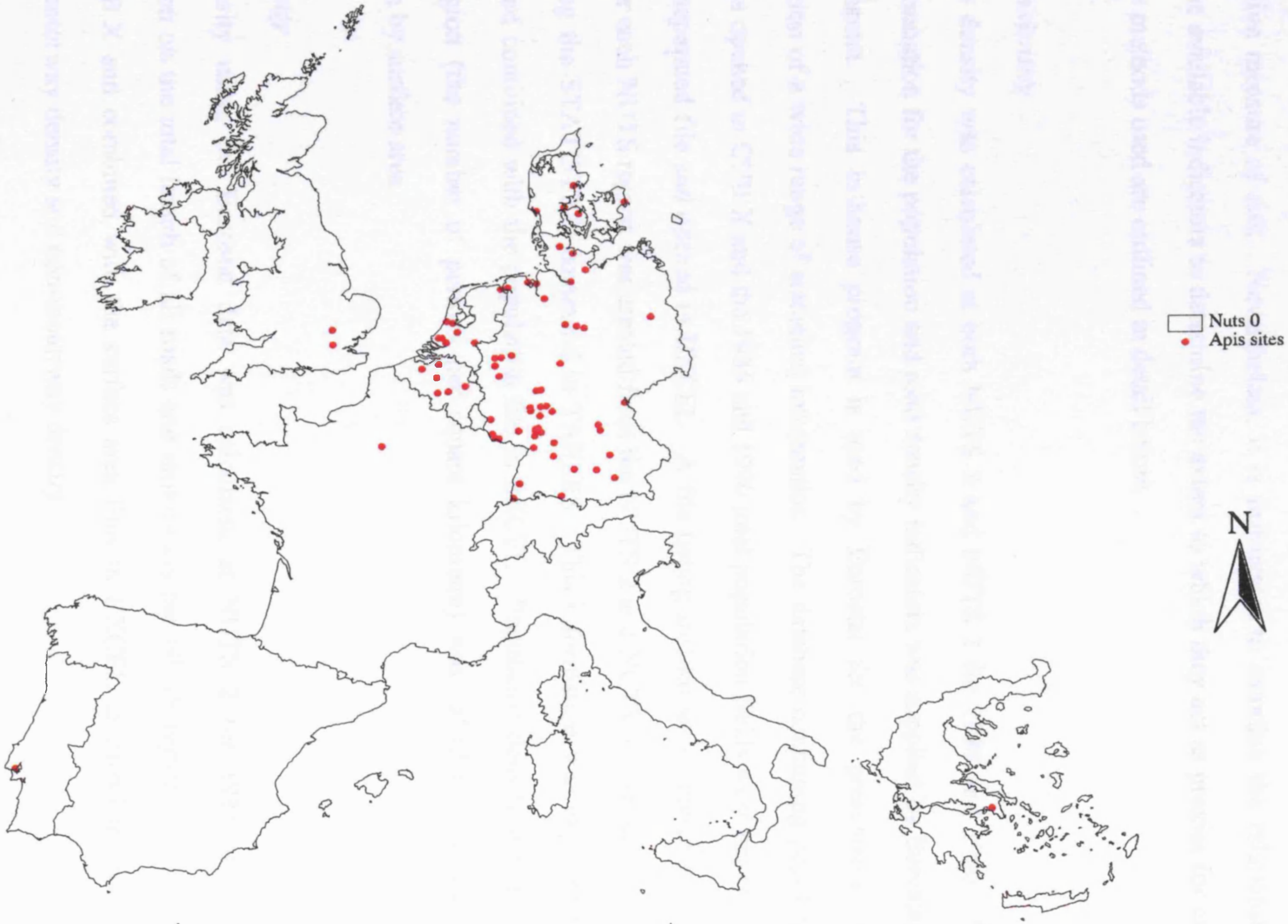
Figure 7.2: NUTS 3 boundaries

Table 7.1: Data availability at the European level

Data	Description
GIS coverages	
Road network	*source* - EUROSTAT (GISCO) *coverage* - pan-European *scale* - 1:1,000,000 projection-Lambert Azimuthal *details* - road types for ferry connections, motorway, motorway (European), national road, national road (double lane), national road (European), national road (European double lane), principal road, principal road (European).
Settlements	*source* - EUROSTAT (GISCO) *coverage* - pan-European *scale* - 1:1,000,000 projection-Lambert Azimuthal *details* - settlements with population over 50,000 including total population, settlement size (km^2) and settlement location
Administrative regions	*source* - EUROSTAT (GISCO) *coverage* - pan-European *scale* - 1:10,000,000 projection-Lambert Azimuthal *details* - administrative boundaries: NUTS0-3 (Nomenclature of territorial units for statistics)
Administrative regions	*source* - EUROSTAT (GISCO) *coverage* - EU12 countries *scale* - 10,000,000 projection-Lambert Azimuthal *details* - administrative boundaries: NUTS0-3 (Nomenclature of territorial units for statistics)
Datasets	
Population	*source* - EUROSTAT *coverage* - EU12 countries at NUTS0-3 *period* - 1970 to 1993 *details* - NUTS regional code, year and population (male, female & total)
Transport network	*source* - EUROSTAT *coverage* - EU12 countries at NUTS0-2 *period* - 1978 to 1993 *details* - NUTS regional code, year, length of motorway, other road, rail, double rail, electrified rail, navigable canals & navigable rivers (km)
Transport stock	*source* - EUROSTAT *coverage* - EU12 countries at NUTS0-2 *period* - 1978 to 1992 *details* - NUTS regional code, year, number of cars, buses, goods vehicles, tractors. special goods vehicles, road tractors, special vehicles, trailers, semi-trailers & motorcycles over $50cm^3$
Environment	
Atmospheric emissions	*source* - CORINE *coverage* - EU12 countries at NUTS0-3 *period* - 1985 only *details* - NUTS regional code, transport-related SO_2, NO_x and VOCs, total SO_2, NO_x and VOCs

Atmospheric concentrations	*source* - APIS/GIRAF *coverage* - pan-European *period* - 1985 to 1990 *details* - Latitude and Longitude, annual average, P50 & P98 for SO_2, strong acidity, black smoke, SPM, lead, cadmium, nitric oxide, nitrogen dioxide, oxides of nitrogen, ozone and carbon monoxide
Health	
Health	*source* - EUROSTAT *coverage* - EU12 countries at NUTS0-2 *period* - 1985 to 1992 *details* - NUTS regional code, number of deaths from all causes, diseases of the circulatory system, malignant neoplasms, malignant neoplasms of trachea, bronchus and lung, pneumonia, bronchitis & asthma, heart disease, road traffic accidents
Mortality	*source* - Atlas of Mortality in Europe *coverage* - WHO European member countries (minus part of the Russian Federation) *period* - 1980/81 and 1990/91 details - NUTS level 2 or equivalent data for all cause mortality, infecious and parasitic diseases, malignant neoplasms, malignant neoplasm of colon, rectum, rectosigmoid junction and anus, malignant neoplasm of trachea, bronchus and lung, malignant neoplasm of female breast, leukaemia, diseases of the circulatory system, ischaemic heart disease, diseases of pulmonary circulation and other forms of heart disease, cerebrovascular disease, ischaemic heart disease, cerebrovascular disease and atherosclerosis, diseases of the respiratory system, chronic obstructive pulmonary disease and allied conditions, diseases of the digestive system, diseases of the urinary system, accidents, injury and poisoning, motor vehicle traffic accidents, suicide and self-inflicted injury

Figure 7.3: APIS monitoring stations for NO_2



Given the lack of usable data on exposure or atmospheric concentrations, it is clearly impossible to evaluate the performance of these indicators in the same way as for the small area level, in Chapters Five and Six. The available health data is also admittedly coarse, both in terms of geographic aggregation and its specificity. It therefore cannot be used to provide a quantitative measure of risk. Nevertheless, it is instructive to examine the relationship between the available indicators to determine the extent to which they act as proxies for each other. The methods used are outlined in detail below.

Population density

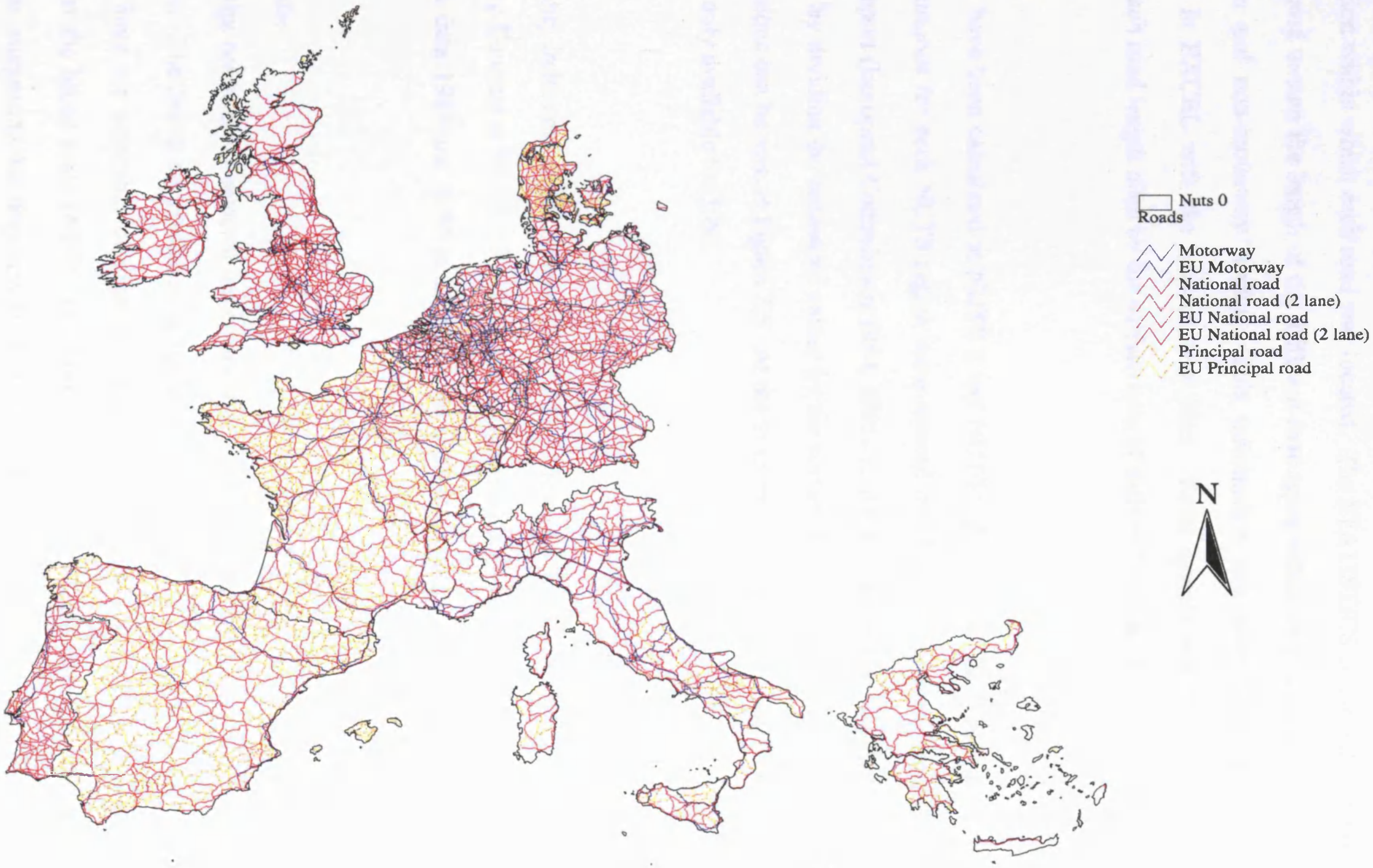
Population density was calculated at both NUTS 2 and NUTS 3 for 1985 and 1990. The source information for the population and road density indicators was supplied by Eurostat in CUB.X format. This in-house program is used by Eurostat for the presentation and dissemination of a wide range of statistical information. The database containing population figures was opened in CUB.X and the 1985 and 1990 total population fields were exported to a comma separated file and opened in EXCEL. A file listing surface area values (in square metres) for each NUTS region was created from the NUTS 2 and NUTS 3 coverage attribute tables using the STATISTICS command in TABLES. This information was exported to a text file and combined with the population file in EXCEL. Population density within each NUTS region (the number of persons per square kilometre) was calculated by dividing population by surface area.

Road density

Road density using the Eurostat data was calculated at NUTS 2 for 1985 and 1990. Information on the total length of all roads and motorways per NUTS region was extracted from CUB.X and combined with the surface area files in EXCEL to calculate total road density, motorway density and non-motorway density.

The road density indicators were also constructed at NUTS 2 and NUTS 3 for 1990, using GISCO data. This dataset is shown in Figure 7.4. The roads coverage was overlayed with

Figure 7.4: Road type



the NUTS 2 and NUTS 3 coverages using the INTERSECT command. This identified the NUTS region within which each road was located. The STATISTICS command in TABLES was then used to sum the length of the different road types within each region (i.e. all roads, motorways and non-motorway roads). This information was saved as a text file and combined in EXCEL with the surface area files. Road density was then calculated by dividing each road length class by the surface area of each NUTS region.

Emissions

Emissions have been calculated at NUTS 2 and NUTS 3 for 1985. The total and transport-related emissions for each NUTS region were entered into EXCEL manually from the 1985 Corinair report (European Commission 1994, 1995a & 1995b). Emissions per km^2 were then calculated by dividing the emissions values by the surface area of each NUTS region. Total NO_x emissions can be seen in Figure 7.5. At the time the research was undertaken, emissions data were only available for 1985.

Mortality

The mortality indicators were constructed at NUTS 2 level for 1985 and 1990. The data was supplied by Eurostat at NUTS 2 level in comma separated format. This was combined with population data 1985 and 1990 in EXCEL and used to calculate mortality rates per 1000 people.

7.2.4 Results

Relationships between the selected indicators were analysed using one-tailed Spearman's rank correlations. The results are presented in Tables 7.2 to 7.5. As can be seen from the different n values, there are a number of gaps in the data coverage and many indicators are only available at the broad scale (NUTS 2). Several indicators nevertheless show strong inter-correlations, suggesting that they may act as effective proxies for each other.

Figure 7.5: Total NO_x emissions (Tonnes/km^2)

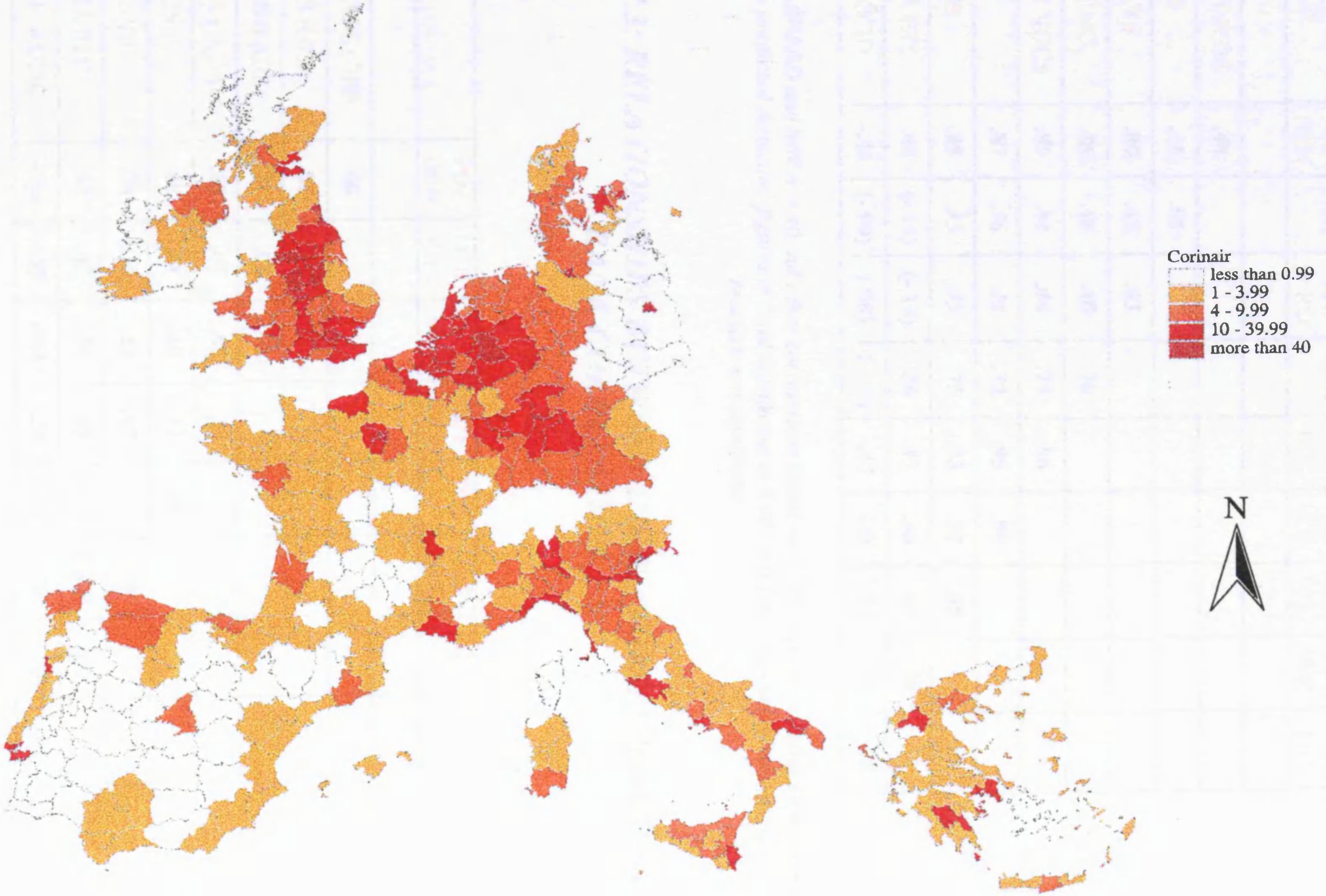


TABLE 7.2: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

NUTS2 1985

	POP DEN	*RD	*MW & RD	*MW	TR NO_x	TR VOC	TOT NO_x	TOT VOC	PNEU MO
POP DEN									
*NON MWAY R'DS	**.40**								
*ALL ROADS	**.41**	**.99**							
*MOTORWAYS	**.80**	**.42**	**.43**						
TRANSPORT NO_x	**.86**	**.48**	**.48**	**.76**					
TRANSPORT VOCS	**.89**	**.44**	**.44**	**.71**	**.96**				
TOTAL NO_x	**.87**	*.36*	*.36*	**.72**	**.95**	**.95**			
TOTAL VOCS	**.85**	*.35*	*.35*	**.75**	**.93**	**.92**	**.95**		
PNEUMONIA ETC.	**.40**	(-.14)	(-.13)	**.38**	**.47**	**.36**	**.43**	**.45**	
RD TRAF. ACCID.	**-.46**	(-.09)	(.08)	(-.09)	**-.47**	**-.48**	**-.50**	**-.57**	*-.18*

*Note: *RD, MW&RD and MW n = 40; all other correlations based on n=90; figures in italics significant at 0.025 level in predicted direction; figures in bold significant at 0.005 level in predicted direction; figures in brackets not significant*

TABLE 7.3: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

NUTS2 1990

	POP DEN	OTH RDS	ALL RDS	MOT WAY	*RD	*MW & RD	*MW	PNEU MO.
POP DEN								
OTHER ROADS (GIS)	**.66**							
ALL ROADS (GIS)	**.81**	**.94**						
MOTORWAYS (GIS)	**.81**	**.55**	**.78**					
*NON M'WAY ROADS	**.38**	**.62**	**.65**	*.29*				
*ALL ROADS	**.40**	**.61**	**.65**	*.31*	**.99**			
*MOTORWAYS	**.78**	(.10)	**.42**	**.95**	**.37**	**.39**		
PNEUMONIA ETC.	**.62**	**.45**	**.50**	**.48**	(-.23)	(-.22)	*.33*	
ROAD TRAF. ACCID.	-.76	-.50	-.61	-.59	-.27	-.28	-.50	-.61

*Note: *RD, MR & MW n = 40; all other correlations based on n=110; figures in italics significant at 0.025 level in predicted direction; figures in bold significant at 0.005 level in predicted direction; figures in brackets not significant.*

TABLE 7.4: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

NUTS3 1985

	POP. DEN	TR. NO_x	TR VOC	TOT. NO_x
POP DEN				
TRANSPORT NO_x	.92			
TRANSPORT VOC'S	.91	.98		
TOTAL NO_x	.89	.93	.91	
TOTAL VOC'S	.85	.88	.88	.89

Note: all correlations based on n = 334; all figures significant at 0.005 level in predicted direction.

TABLE 7.5: RELATIONSHIPS BETWEEN INDICATORS: SPEARMAN'S RANK CORRELATION

NUTS3 1990

	POP. DEN	OTH. RDS	ALL RDS
POP DEN			
OTHER ROADS (GIS)	.55		
ALL ROADS (GIS)	.66	.94	
MOTORWAYS (GIS)	.65	.44	.64

Note: all correlations based on n = 248; all figures significant at 0.005 level in predicted direction.

Table 7.2 shows r values for indicators at NUTS 2 in 1985. As can be seen, the majority of correlations between proxy indicators are significant at the 0.005 level in the predicted direction and many are strongly related. Although the strongest associations are found between closely connected indicators from the same datasets (for example, between different road types or emissions), population density, motorway density and emissions appear to be strongly related. For example, the r value between motorway density and transport-related NO_x emissions is 0.76.

Table 7.3 lists r values for NUTS 2 level indicators in 1990. Again, the majority of correlations between proxy indicators are significant at the 0.005 level in the predicted direction. Population density appears to be strongly related to all road density (GISCO) and motorway density (Eurostat and GISCO). However, the relatively weak correlations between all road density and non-motorway density calculated by the two different methods appears to shed doubt on the consistency of these indicators.

Table 7.4 shows r values for indicators at NUTS 3 in 1985. As can be seen, whilst the number and range of indicators is limited, all correlations are strongly significant at the 0.005 level. Population appears to be strongly correlated with all classes of emissions, whilst the emissions are strongly inter-correlated.

Table 7.5 shows r values for NUTS 3 in 1985. Population density appears to be moderately strongly associated with all road density (r = 0.6) and motorway density (r = 0.65), whilst the road density indicators are relatively strongly inter-correlated.

The relationships between proxy indicators and measured of health outcome indicators were generally weak, although there are some exceptions. For example, at NUTS 2 in 1985, the r value between transport-related NO_X emissions and pneumonia, bronchitis and asthma is 0.47. At NUTS 2 in 1990, the r value between population density and pneumonia, bronchitis and asthma is 0.62. However, at the same time, there are relatively strong negative correlations between total VOC emissions and road traffic accidents in 1985 (r = -0.57), and between population density and road traffic accidents in 1990 (r = -0.76). How well these indicators act as measures of health risk is thus extremely uncertain. No account has been taken of potential confounders and the indicators are highly aggregated. In the absence of independent data, it is impossible to assess their relationship with ambient pollution concentrations or exposure. On the basis of the small-area studies in Chapters Five and Six, the best proxy indicators available may be NO_X and VOC emissions, or road density. These proxies, however, clearly need to be applied with utmost caution.

Given the lack of relevant data and validated EHIs at this scale, the question can be posed of whether better indicators, capable of showing health risk from exposure to traffic-related pollution, can be developed. One possibility would be to increase the availability of information on monitored pollutant concentrations, for example, by incorporating data from national networks. Most countries have extensive monitoring networks, especially for NO_x, SO_2 and particulates in urban areas. Table 7.6 presents an overview of national monitoring networks in Europe.

Table 7.6: Number of stations in national air quality monitoring networks for SO_2

Country	*Number of stations*	*Land area per station (km^2)*
Belgium	272	112
Denmark	30	1436
France	1420	388
Germany (West)	350	1000
Ireland	40	1757
Italy	425	709
Luxembourg	5	520
Netherlands	85	480
Spain	465	1085
U.K.	261	938

However, the problem with these networks is that they have been constructed to fulfil a wide range of different functions. There is consequently a lack of consistency and comparability between the networks. Major, but unseen differences often exist in site distribution, measurement methods, and the specific pollutants being measured (see, for example Briggs 1992). The compilation of comparable data from these diverse networks will clearly require considerable effort, and would benefit from the development or adoption of improved data standards.

7.3 Risk mapping

An alternative approach would be to model pollution levels or exposure to traffic-related air pollution. The potential of this approach has already been shown at the site level (in Chapter Five) and was seen to have some potential at the small-area scale (in Chapter Six). To date, two major risk mapping studies have been conducted at the European level, one by the Bilthoven division of the WHO European Centre for Environment and Health (Krzyzanowski 1997), and a joint study by the National Institute of Public Health and the Environment (RIVM) in the Netherlands, and the Norwegian Institute for Air Research (NILU) (Sluyter 1995). These studies are outlined below.

7.3.1 WHO-ECEH

The WHO study covered the whole WHO/EURO region and drew on data from three sources:

- the European Commission Exchange of Information (EoI) programme (pollutant data from monitoring networks in EU countries);
- the WHO/EURO Concern for Europe's Tomorrow (CET) project (mean annual air pollution data for towns with over 50,000 inhabitants);
- the EEA Dobris Assessment (pollutant data for cities with more than 200,000 inhabitants).

Data were available for 263 towns with a population of more than 50,000 in 32 countries, covering a total population of 158 million; 50% of the population in these 32 countries and 43% of the urban population in the WHO/EURO region. NO_2 data were available for 202 settlements, covering some 130 million people. In the absence of data from more than one monitoring site, or detailed information on population distribution, it was assumed that the entire population in each settlement experienced the same exposure level. Based on this assumption, it was calculated that 53% (43 million) of the population covered were exposed to ambient levels of NO_2 above the 50μg/m^3 WHO long-term guideline value. This percentage was then extrapolated to estimate the number of people exposed in the whole WHO/EURO region: 195 million (i.e. 53% of the 368 million people in the WHO/EURO region).

This study takes no account of the variation in air quality within each city and assumes that all people will experience the same level of exposure. As Hewitt (1991) points out, air pollution is highly spatially variable, particularly in urban areas, and single measures of pollution concentrations will not necessarily provide good indicators of ambient levels within settlements. In the absence of additional information on monitoring station locations, it is not possible to determine whether particular sites relate to background, industrial or residential areas. In addition, individual exposure depends to a large degree on individual time activity patterns and lifestyle. Urban exposure is characterised by complex movement patterns over a highly variable air pollution surface. Calculating exposure is therefore difficult. However, it can be argued that the WHO attempt serves a useful purpose in highlighting the possible magnitude of urban air pollution problems within European, in attempting to quantify potential health risks.

7.3.2 RIVM/NILU

This study covered the European Union and utilised data from the following sources:

- APIS (the European Air Pollution Information System);
- GEMS-AIR (the Global Environmental Monitoring System);
- Municipal authorities (this dataset was collected through two purpose-designed surveys).

Wherever possible, data on population, topography, meteorology and emissions were also collected. Data were available for 105 cities with more than 500,000 inhabitants in 35 countries; 22% of the European population of 148 million. At the time the study was undertaken, no long-term guideline value for NO_2. The short-term guideline of 150 $\mu g/m^3$

(highest 1 hour concentration), however, was exceeded at background monitoring stations in 6 cities, including Katowice, Manchester, Prague and Warsaw.

A re-analysis of the data on annual averages for city background stations reveals that WHO long-term guidelines were exceeded in 22 cities. Using the same assumption about exposure distribution as the WHO study, this equates to 19% of the population - 28.4 million people. Whilst the analysis of NO_2 exposure in this study differs little from that conducted by WHO, the overall analysis is more detailed. The importance of temporal and spatial variations in air pollution, population distribution, activity patterns, topography and meteorology in calculating exposure, however, are recognised:

> "In this project, special interest is paid to city background concentrations. Humans are exposed to these levels whenever they are outdoors. In busy streets and near industrial estates, concentrations of a number of components can be far higher and thus the total human exposure. .....The actual outdoor exposure of the urban population to air pollutants is difficult to estimate. Next to estimating the spatial distribution and time variation of the pollutant concentration, the location and physical activity level of the population should be known" (Sluyter 1995 p4).

The indicators below were defined for each city in the study and were shown to correlate well with measured exceedences of WHO Air Quality Guidelines for winter smog at background monitoring stations, implying that it may be possible to predict air quality and hence exposure, based on other data:

- average dispersion - based on city topography and wind speed;
- meteorological smog potential - based on summer and winter meteorological conditions;
- environmental pressure - based on population size and density;
- emissions - for summer and winter smog based on emissions data.

Population exposure to SO_2 and suspended particulates was then estimated in 88 cities, using the following assumptions:

- city background monitoring stations are located in the part of the city with the poorest air quality for the compound in question;
- the higher the maximum concentration, the higher the proportion of the population above the guideline;
- the larger the number of measurement sites, the better the classification of exposure.

The proportion of the population exposed at levels above WHO Air Quality Guidelines (AQG) was calculated based on maximum 24 hour concentrations at individual sites and city averages. For example, in a city with two monitoring stations, if the city mean is equal to the AQG, it is estimated that 60% of the population are exposed to an excedence. Similarly, if the concentration at one monitoring station is equal to the AQG, it is estimated that 25% of the population are exposed to an excedence. Unfortunately, due to the lack of available data, this exercise was not repeated for NO_2.

7.3.3 Discussion

Neither of these approaches are ideal. They are both clearly limited to cities where monitoring data already exist; at best, this relates to 43% of the urban WHO/EURO population and 22% of the EU population respectively. The studies also demonstrate the limited availability of information on measured pollutant concentrations, both in terms of the number of cities covered and the number of sites within each city. Whilst similar exceedences to those illustrated by these studies may occur in smaller cities for which monitored data is not available, it is not possible to confirm or deny this without further information on pollutant levels or exposure. The question, therefore, is whether these methods can be improved upon. As previously mentioned, the lack of data is a significant constraint and precludes the use of formal dispersion models. Similarly, broad-scale, long-distance pollution transport models are inappropriate, due to their low resolution. One possible approach is the use of regression-based techniques, as applied by Campbell *et al.* (1994) in the UK and Briggs *et al.* (1997) at the urban scale.

An attempt was therefore made to develop this approach, based on the APIS data outlined earlier. Whilst these data are clearly limited and show a marked bias towards sites Germany (see Figure 7.1), APIS does include information on site and traffic characteristics, which provide the opportunity for modelling.

7.3.4 An exploratory study

The following method was used to develop a regression model for NO_2.

84 monitoring stations in urban and suburban locations within 73 cities were selected from APIS and mean annual NO_2 data for 1989 extracted into EXCEL. A coverage was made of these sites using the GENERATE command. Information on latitude, longitude, landuse zone and traffic levels (very light, light, moderate and heavy) for each site was added from APIS. This coverage was subsequently overlayed with the NUTS region coverage, using the INTERSECT command, to determine the NUTS code for the region within which each monitoring station is situated. The NUTS codes were automatically joined onto the APIS sites attribute table. Values for the following proxy indicators at NUTS 3 level (or NUTS 2 level where necessary) were then attached, using the JOINITEM command:

- population density;
- road density;
- motorway density;
- total NO_x emissions;
- transport-related emissions;

The resulting coverage was exported as a text file using the EXPORT command in INFO and opened in SPSS. A stepwise multiple regression equation was then developed to construct a predictive model of measured concentration. It was found that the following combination of population, road density, motorway density and longitude produced the best estimates:

Mean annual NO_2 = 28.041 + (4.136 x traffic volume) - (0.0000111 x Y coordinate) + 0.00000473 x (traffic level x population density) x (traffic level x motorway density) - 0.000000439 x (population density x road density)

$r^2 = 0.56$ and the standard error of the estimate = 10.48

The relationship between measured and modelled concentration at the 84 sites can be seen in Figure 7.6.

This equation was then applied to calculate mean annual NO_2 concentrations for the 2039 towns with more than 50,000 inhabitants in the GISCO European settlements dataset. The location of these settlements can be seen in Figure 7.7. Population density, road and motorway density and longitude variables were calculated for these towns and cities using the methods outlined above. The resulting coverage was exported as a text file and opened in EXCEL. The formula builder was then used to calculate NO_2 concentrations at four sites within each settlement, reflecting very light, light, moderate and heavy traffic densities.

The percentage of the population and the total number of people exposed to pollutant exceedences was estimated, based on assumptions about the proportion of people exposed to different pollutant levels. For this purpose, it was assumed that 90% of the population were exposed to very light traffic levels and above, 75% to light traffic volume and above, 25% to moderate and above, 10% to heavy and above. The number of people in each settlement exposed to modelled concentrations above the WHO-AQG of 50 $\mu g/m^3$ was then calculated by combining the settlement population data from the attribute table and the modelled concentration values. Out of an urban population of 189 million people (i.e. the total population of the 2039 settlements), 25% (or 48 million people) were estimated to be exposed

Figure 7.6: Mean against modelled NO_2 at APIS monitoring sites ($\mu g/m^3$)

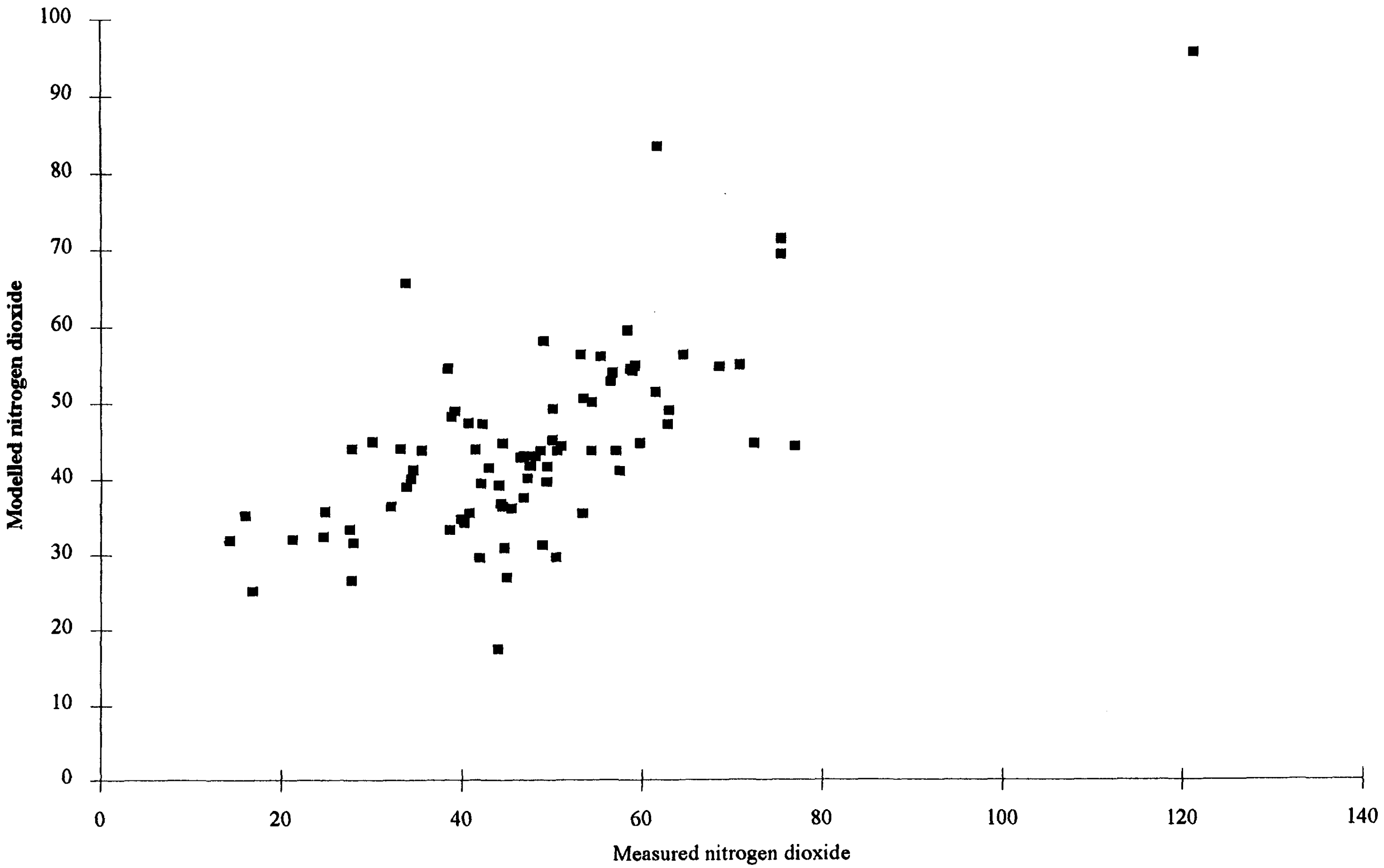
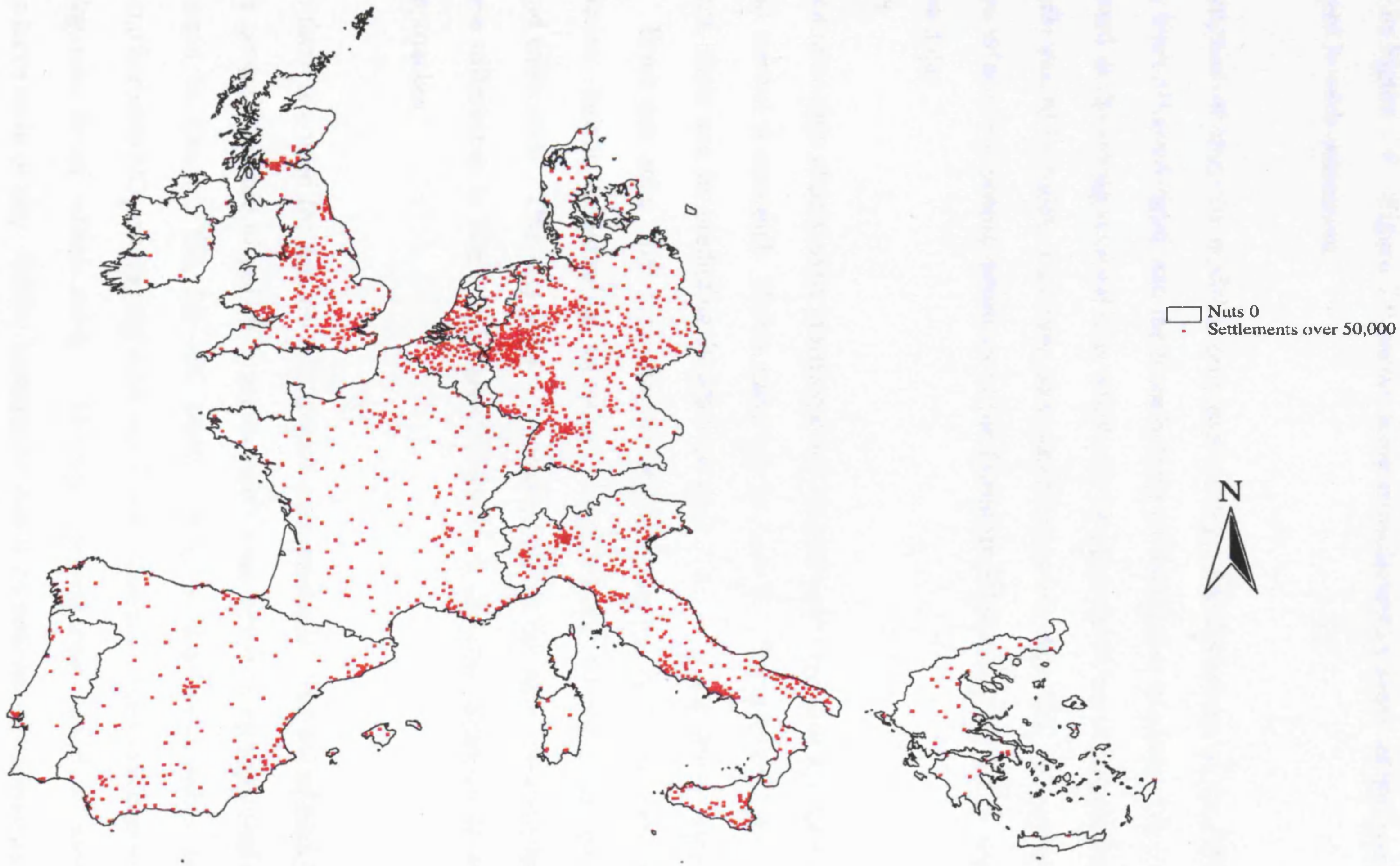


Figure 7.7: Settlements with more than 50,000 people



to NO_2 concentrations above 50 μg/m^3. This compares to 53% of people in the WHO study and 19% of people in the RIVM study. The percentage of people exposed in each settlement can be seen in Figure 7.8. Figure 7.9 shows these exceedences in terms of the number of people exposed in each settlement.

It must be emphasised that this model is only exploratory. The limitations of the APIS data have already been acknowledged, and the three heavily polluted cities in southern Europe are clearly reflected in the strong regional bias which can be observed in the exposure maps (i.e. the strong influence of latitude). However, this general approach may offer the possibility to develop more effective exposure estimates at the European level, using enhanced and more representative data.

More representative data clearly exist in national and international networks, but data quality assurance and control is essential. Unless users can be confident that data are both reliable and consistent, their use in predicting health risk may lead to inaccurate or misleading conclusions. Error can arise from a number of different sources, including variations in sampling station height, monitoring technique, measurement method, normalisation conditions and calibration. This may lead to inconsistencies in the data. Nevertheless, the effect of these differences is likely to be small, relative to the poor accuracy of existing modelling approaches.

In particular, there is a need for data on background concentrations. The use of background site data as a general measure of pollution across small areas seems to be supported by the results presented in Chapter Six for UK wards, where a close relationship between background and kerbside NO_2 monitoring sites was found. Relatively little variation was also seen in background levels within wards.. However, several sites would be needed to characterise a large town or city. Whilst background data from national monitoring networks may be available to meet this need, collecting and collating the data would be a major task. With its existing resources and contacts, the EEA Topic Centre on Air Quality would be in an

Figure 7.8: The estimated percentage of people exposed to WHO-AQG exceedences by settlement

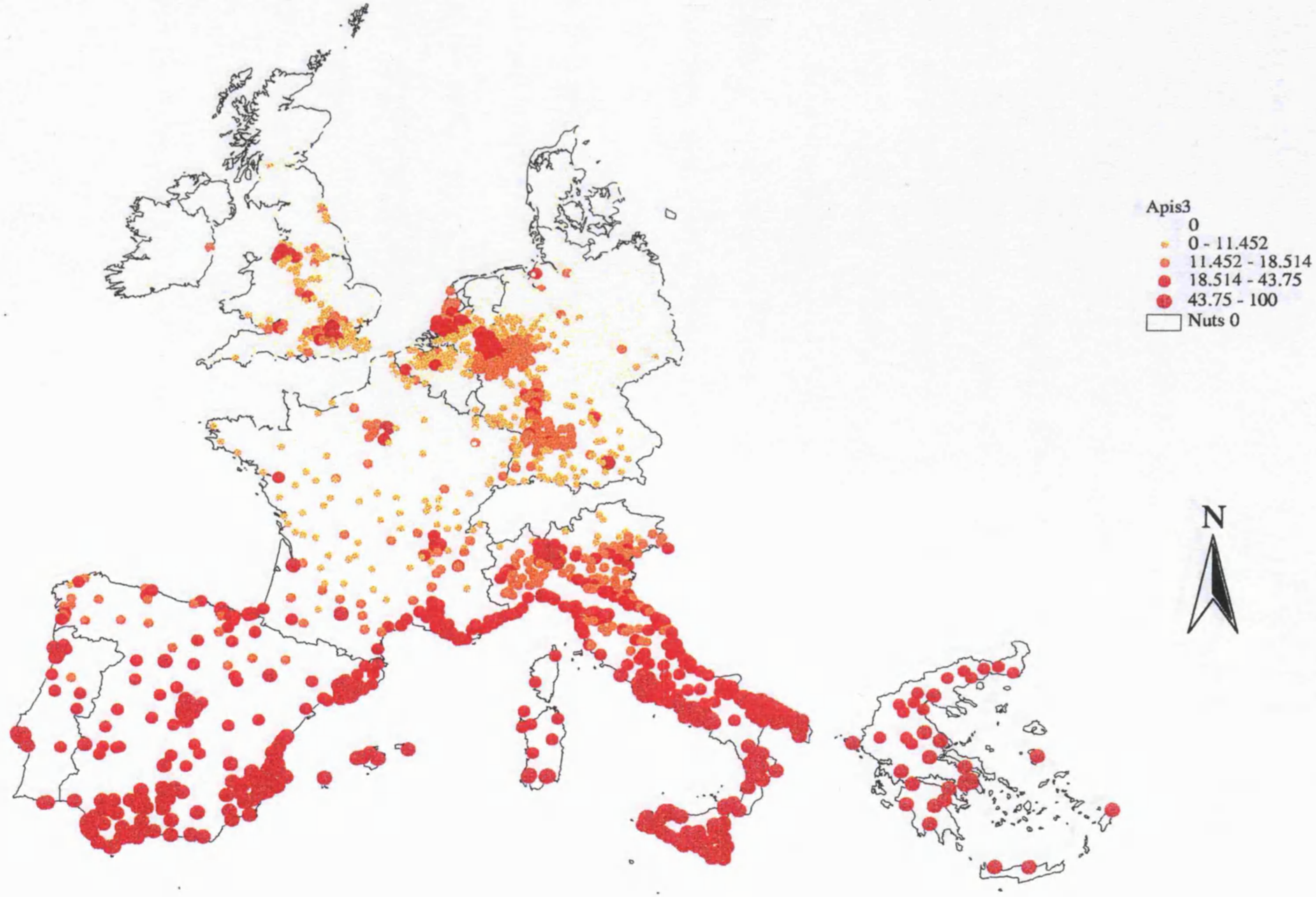
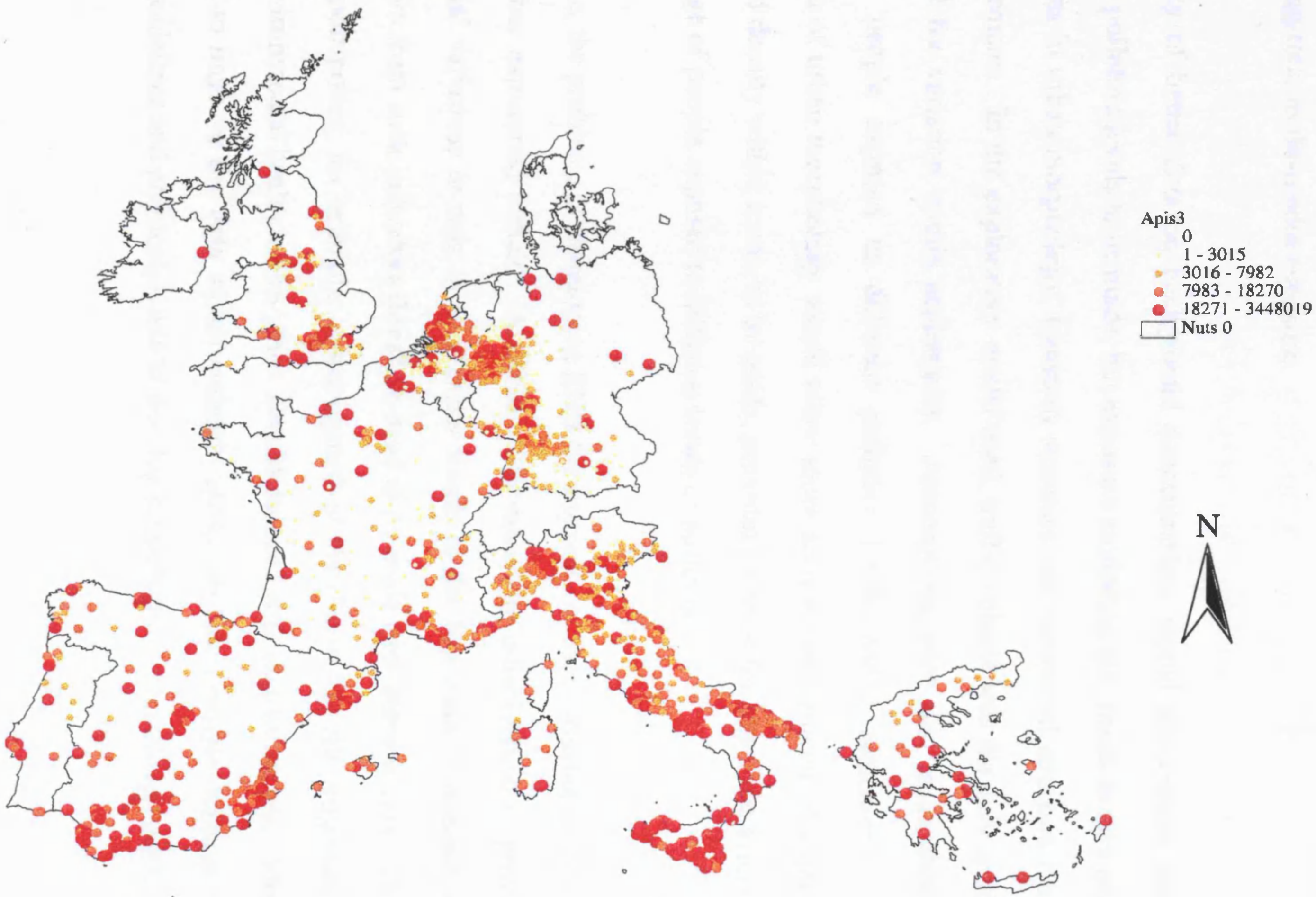


Figure 7.9: The estimated number of people exposed to WHO-AQG exceedences by settlement



advantageous position to undertake this work. As previously mentioned, the characterisation of exposure by using background sites has been adopted by the HEGIS programme for Europe, where data from background monitoring sites is being used to predict exposure to winter and summer-type smog, long-term urban exposure (in particular to SO_2, NO_2, and TSPM) and long-term multi-media exposure.

The availability of better data on background concentrations would allow more accurate assessments of pollution levels to be made, but exposure modelling also needs to take account of the variations in urban morphology, transport structure and residential structure between European settlements. In the exploratory model used, traffic volume was the only condition which allowed for variation within settlements. Assumptions were also made about the percentage of people exposed to different pollution levels within settlements. The characterisation of urban morphology would allow more accurate assessments of population distribution and density within towns to be made, providing a basis for improved assessment of the percentage of people exposed to different levels of pollution..

In the meantime, the problems of developing EHIs for exposure to traffic-related air pollution (and indeed other exposures) remain. Available data cannot be reliably used to provide a picture of spatial variations in risk, or to monitor trends at the European or national level. Inferences drawn from such indicators therefore need to be made with extreme care. The use of EHIs to support policy, for example, in the context of the Health For All programme, or aid national environmental health action plans, should proceed with utmost caution. There is an urgent need to improve the data which underpin indicators (for example, through more stringent data guidelines and protocols), and to develop procedures for modelling health risk.

7.4 Conclusions

This Chapter has demonstrated the need for policy-related information on environmental health, in particular, to identify trends in environmental health, allow comparisons of problems between regions and countries, to provide a basis for policy assessment and to evaluate the effectiveness of policy actions. However, the lack of suitable data, both to construct and evaluate proxy indicators means that alternative methods of estimating exposure need to be developed. While there appears to be some potential for modelling pollutant concentrations, using existing data, the effectiveness of this approach is limited by the paucity of relevant data. More effective modelling requires the improved availability of pollution concentration data (especially for towns and cities in southern Europe), and the development of methodologies for characterising the distribution of population and exposure within settlements.

Chapter 8: Conclusions

Like all young men I set out to be a genius, but mercifully laughter intervened.

Lawrence Durrell

8.1 Re-statement of general research objectives

This thesis examines the development and use of environmental health indicators for epidemiology and policy applications. Specifically, it aims to develop concepts for EHIs and examine the utility and validity of exposure-based indicators, using the example of traffic-related air pollution.

In Chapter One, the use of GIS techniques in studies of environment and health was reviewed. The general context and aims of the thesis were also outlined. Chapter Two examined the early development of environmental indicators and contemporary developments in environmental, health-related and 'quality of life' indicators. In Chapter Three, the essential characteristics and requirements for environmental health indicators (EHIs) were discussed and attention was drawn to the way in which EHIs can be used:

- to support and direct national and international policy on environmental health;
- to promote local awareness and action in relation to environmental health;
- as part of health risk assessments
- as tools for environmental epidemiology

Chapter Four explored some of the issues associated with the use of EHIs in a specific policy area - traffic-related air pollution and health. The use of indicators of exposure in previous small scale epidemiological studies was reviewed. A list of potential indicators was then compiled, using those indicators which demonstrated an association with health outcome in one or more of the studies reviewed. In Chapters Five, Six and Seven these indicators, and a number of additional measures, were applied at different spatial scales. Chapter Five focuses on the small-area scale, using site level data in the Boroughs of Hammersmith and Ealing, London, UK. Chapter Six is a national level study using small area data for selected areas of England and Wales. Chapter Seven is an international level study, using regional data for the European Union. This chapter reviews the main conclusions and then considers their implications for the application of EHIs and for further research.

8.2 Review of conclusions

8.2.1 The small-area scale

Based on an analysis at the small-area scale, using site level data for the London boroughs of Hammersmith and Ealing, it is evident that some proxy indicators are relatively strongly inter-correlated. Whilst this may suggest that these indicators can be used as proxies for each other, many of the indicators are seen to be only weakly related with measured pollution levels. Only three of the indicators used appear to be effective in predicting measured concentration. These are:

- modelled NO_2 using the CALINE-3 line dispersion model
- modelled NO_2 using the SAVIAH regression model
- traffic volume of nearest road divided by distance to nearest road;

Two other widely used indicators - traffic volume of nearest road and distance to nearest main road - had weaker relationships with measured concentrations, but do appear to have some validity as exposure indicators.

Even with these, however, the relationship with exposure is unknown. These results nevertheless demonstrate that the choice of indicator is important; not all proxy indicators are effective in predicting measured concentration. Moreover, the results of the health analysis do not appear to support the use of these indicators to assess chronic health risk from exposure to traffic-related pollution.

8.2.2 The national level

The national level study, using small area data, showed that relatively few indicators could be compiled given the available data. Of those indicators which could be used, none were strongly correlated with measured concentration. Emissions appear to be the best proxies available, although these show only moderate correlations with measured NO_2.

Attempts were made to use a regression model to predict concentration at monitored sites on the basis of existing ward level data, but with limited success. It therefore appears that the estimation of exposure and the evaluation of health risk at the national level are currently hampered by the lack of available data. On the other hand, this study demonstrated that monitored background concentrations appear to provide a reasonably consistent indicator of pollution levels within wards. Variations between monitored background concentrations within a ward were relatively small, while good correlations were found between background and both kerbside and intermediate sites within the ward. As a first approximation, therefore, monitored background concentrations may provide an acceptable measure of exposure at the small area level.

One implication of this is that surveys, such as the national passive sampler network for NO_2 in the UK, provide valuable data on exposure, which can inform epidemiological research and policy. This said, it is clear that the area over which point measurements are representative is relatively small. Within a city, for example, significant variation in background concentrations may be expected. A high density of sampling points is therefore needed to characterise pollution levels - and hence exposure - at this scale.

8.2.3 The international level

The real challenge in developing EHIs is at the international level for broad scale health risk assessment. The importance of this challenge is emphasised by the work of the WHO and the Environmental Health Action Plan for Europe. Nevertheless, the review of available data at this level shows the lack of complete and comparable datasets. This clearly acts as a major limitation to the development of EHIs. Whilst those indicators which can be developed are closely correlated, they cannot be relied upon to give an accurate or representative measure of health risk at this scale as their relationship to exposure and health outcome are unknown.

Several attempts have been made to model exposure and health risk at the international level, and a regression approach was developed in this study. Although these approaches offer the potential for future development, data limitations are still a major constraint. The problems of developing EHIs at the international level therefore remain and the available data cannot be relied upon to give an accurate picture of spatial variations in risk, or trends in health risk. Indicators therefore need to be interpreted with extreme care and their use to support policy, for example, in the Health For All programme, or in national environmental health action plans, should proceed with utmost caution. There is an urgent need to improve the data on which indicators are based, and to develop procedures for modelling health risk.

8.3 Discussion: what makes a good environmental health indicator?

The first part of this thesis clearly addresses the conceptual development of EHIs. The second part focuses on the development and use of exposure-based indicators for traffic-related air pollution, but the development and use of indicators in this specific application can inform the wider discussion about what makes a good environmental health indicator. This research has helped to reveal a number of issues which are of significance both to the specific areas of environmental epidemiology, risk assessment and environmental health policy, and to other areas of indicator development and application. The results of this thesis are also novel in that there have been relatively few attempts to validate indicators.

8.3.1 Environmental Health Indicators

EHIs have the ability to summarise and communicate complex information about the relationships between environmental hazards and human health. They may be used for such diverse tasks as highlighting the potential health implications of poor housing, and evaluating the effect of contaminated water supplies on levels of bacterial infection. In many cases, EHIs may be used to measure the relationships between environment and health, in quantitative or qualitative terms. They may also be used as proxies for factors which cannot be measured directly, or which are difficult and costly to measure.

However, EHIs are not panaceas. They must be well founded intellectually and should be targeted for specific purposes. Indicators consist of raw data plus a relationship with their target issue. Their utility therefore depends on that relationship. In view of the widespread and increasing use of EHIs, it is essential that consideration is given to the concepts and criteria which relate to their use. There are also definite benefits in establishing and sharing good practice between the different agencies and individuals involved.

8.3.2 Concepts and frameworks for EHIs

One of the most important principles pursued within this thesis is that the development and use of environmental health indicators needs to be based upon a clear conceptual framework. EHIs have been used for many years, particularly in policy-related applications, yet prior to this study, a clear framework had not been established. This research has directly contributed to the development of one such framework - the DPSEEA model - and its subsequent adoption by the World Health Organisation.

EHIs embody a relationship between environment and health (whether it be qualitative or quantitative). The development of an overall concept and framework for EHIs helps to clarify the ways in which environmental factors affect health. This can be a crucial factor in the development of indicators. An indicator developed for estimating the health risks of emissions from municipal incinerators, for example, is unlikely to be effective without a clear understanding of the chemicals or agent involved, their routes of exposure and the likely health effects. The conceptual framework therefore assists in unravelling and highlighting the relationships between environment and health.

EHIs may be used to fulfil a wide range of functions in many different applications. It therefore follows that indicators will need to be developed and applied at different stages in the conceptual framework, in response to different needs and requirements. The conceptual framework helps us to understand these different uses and applications in relation to one another within a broader context. The results of this thesis also demonstrate that indicators constructed at different points in the conceptual framework have different strengths and weaknesses. It is very important to be aware of these when constructing EHIs, in order to ensure that they are well-founded and appropriate for their intended use. For example, in Chapter Five, the utility of proxy measures of NO_2 concentration (as a marker for exposure to traffic-related air pollution) was examined. It was demonstrated that while data for the construction of proxy indicators towards the top of the framework (related to source activity and emissions) was readily available, the indicators were relatively poor predictors of NO_2 concentrations. In contrast, indicators from lower in the framework tended to be more effective predictors of concentration, but were typically more difficult to construct and more data intensive. In any application one clearly needs to be aware of the potential advantages and disadvantages of developing different EHIs and have an understanding of how the indicators relate to one another. The conceptual framework can help to place the issues associated with indicator use in context and can assist in the selection of appropriate indicators. It can also be particularly useful in analyses and comparisons of different indicators.

The position of indicators in the framework and the importance of other criteria are discussed in the following sections, prior to an examination of the issue of scale.

8.3.3 Relation to exposure, health outcome and policy

Indicators developed towards the top of the conceptual framework tend to be closely related to policy and relatively easy to construct. Many of the actions taken to protect health and reduce environmental hazards are also targeted towards the top of this chain - for example, by controlling source activities, banning or limiting the use of hazardous substances or processes, managing and planning the location of hazardous activities, or reducing emissions into the environment. Indicators from higher up the environment health chain will tend to provide a better measure of the effectiveness of such interventions, and thus may be more policy relevant. Because of the time-lag between source activity and health effect, these indicators can also provide an early warning of potential risks. This is especially important because, once released into the environment, any pollutant is essentially uncontrollable. It also helps to focus attention on preventative measures, rather than ameliorative responses, and helps to shift responsibility for reducing risks from the victim to the polluter. As such, indicators from higher up the environment-health chain are more in keeping with the polluter-pays-principle which now underpins environmental policy in Europe.

The results of Chapters Five, Six and Seven demonstrate the fact that information is indeed more readily available for the construction of indicators higher in the framework. At the European level for example, the review of existing data shows that data on monitored pollutant concentrations is almost totally lacking, whilst data on emissions are only collated every five years. In contrast, information on transport infrastructure and socio-economic factors is far more widely available.

On the other hand, indicators from lower down the framework are likely to reflect more closely the link between environment and health (mediated through the process of exposure), and as such are more likely to provide valid indicators of health risk. However, as has already been illustrated, data on such indicators are often difficult to acquire, thus limiting their utility. Evaluating the relationship between exposure and health outcome is also very difficult, in part, due to variations in individual susceptibility and time-lags between exposure and health effect, but also because of the complex time-activity and behaviour patterns which determine individual exposure within a pollution field. Moreover, single health effects may be influenced by a wide range of environmental hazards, whilst individual hazards may affect many different health outcomes. Environment-health relationships are also typically affected by socio-economic confounding, whereby observed relationships result from deprivation, class and lifestyle factors rather than from environmental hazards.

The results from Chapter Five demonstrate the difficulty of using exposure-based indicators to predict health risk. Potential indicators of exposure to traffic-related air pollution were selected on the basis of previous epidemiological studies and these measures were applied in the boroughs of Hammersmith and Ealing, West London. Odds ratios for admission to hospital for respiratory illness and asthma were calculated, but no statistically significant association between exposure (as measured by the proxy indicators) and health outcome was found.

Because of the lack of monitored personal exposure data, it cannot be demonstrated unequivocally that ambient pollution concentrations generally, and NO_2 concentrations in particular, are themselves good proxies for exposure. Such pollutant-specific measures may be over-specific as indicators of the risk of exposure from complex sources, such as road traffic. Although NO_2 has been widely used as a marker for exposure to traffic-related pollution it may provide far too limited a measure of exposure. Measurements of NO_2 clearly do not account for the health effects of other traffic-related pollutants, whilst not all of the variation observed in NO_2 levels results from traffic-related pollution. Whether it provides a valid marker for exposure is therefore far from certain. The results from this research suggest that using exposure-based EHIs to quantify the health risk from exposure to traffic-related pollution is very difficult if not impossible. Moreover, any measure of exposure to traffic-related pollution provides insight into only one small area of the wider effects of road traffic on health. It ignores, for example, many of the other issues of concern, such as road accidents, noise and disruption. Yet these issues are often of considerable concern both to those directly affected and to policy makers. For many purposes, therefore, there is value in using the apparently 'blunter', less specific indicators such as traffic volume on the nearest road or distance to the nearest main road. Whilst these are less directly related to exposure to any particular pollutant or any specific health outcome, they may better capture the mix of issues and effects which are most relevant to the user.

This discussion highlights an important dilemma in the development and use of environmental health indicators. On the one hand, there is a need for indicators which are capable of providing reliable measures of exposure or health risk. On the other hand, indicators need to be based on readily available information and to be relevant to the issue of concern. The balance between these depends upon the purpose for which EHIs are being developed. This point can be illustrated by the hypothetical example of urban transport viewed from the perspective of a policy maker, a local resident and a public health official.

The policy maker is likely to require information which relates to existing policies, or to factors which can be influenced through the policy process. For example, in efforts to support sustainable transport use, reduce accidents and promote a generally 'greener' urban environment, a policy maker may use 'the percentage of trips made by public transport'. This indicator is a measure of health risk, albeit an indirect one, in that it will reflect changes in the levels of traffic-related emissions and therefore exposure. However, it does not relate to a single, measurable health outcome, and the relationships with health are both remote and likely to be highly confounded. Changes in emissions will not necessarily reflect changes in health risk. On the other hand, as a policy indicator, it has the benefit of being easy to compile and directly relevant to policy and whilst encompassing many different aspects of the issue of concern.

In contrast, a local resident may be concerned about the 'quality of life' aspects associated with traffic in their local area. As such, they may not be overly concerned about the policy relevance or absolute scientific credibility of indicators. Rather, they are likely to require information which can be gathered quickly and easily, but which is clear and understandable. For example, many local communities are concerned about the effect of traffic-related air pollution on children's health, and the dangers from traffic-related accidents. Appropriate indicators in this instance may be the percentage of streets where traffic-calming measures have been introduced, or the percentage of children receiving medication for asthma. Whilst these indicators are more specific in their identification of particular issues or health problems, the relationship between the indicators used, exposure and health outcome is less explicit.

A public health official, however, may wish to investigate very specific aspects of the relationship between traffic-related air pollution and health. For example, there may be concern that high volumes of traffic and serious congestion problems are associated with local hospital admission rates for asthma, which are well above the national average. Very specific information on the factors which affect respiratory health will therefore be required. The indicators used are likely to be based on existing epidemiological evidence and their policy relevance is unlikely to be an important issue. In this respect, a key indicator may be the level of exposure to fine particulates (Pope 1989, Pope 1991, Pope & Dockery 1992, Roemer *et al.* 1993, Pope *et al.* 1995b). Collecting the information needed, however, may be difficult and it might be necessary to use proxy measures of exposure. Moreover, in order to explain the relationship to health, additional information may be needed on confounding factors, such as measures of deprivation and domestic exposures.

As the previous example has illustrated, issues of consistency and comparability depend on the purpose of the indicator and the needs of the user. For any particular issue, there are clearly a number of potential indictors available. However, no single indicator will be interpreted in the same way by two different users. Where there are many stakeholders involved, it is likely to be difficult to get an indicator which is acceptable to all parties and which will convey the same message. The implications of this are that a range of different indicators may be needed, and that indicators fail to achieve a common language of communication.

8.3.4 Geographical and temporal consistency

The same issues of consistency and comparability also apply to the temporal and spatial application of EHIs. The underlying relationships between environment and health affect how transferable indicators are between areas and how consistent they are over time. In fact, these relationships vary over both space and time in response to a number of factors. Considerable differences in age structure and genetic make-up may be observed between populations in different geographic areas and over different time periods. There may be similar differences in both the process of exposure and in exposure profiles between areas and over time. For example, particulates are generally less significant in profiles of exposure to traffic-related air pollution in the United States compared to the UK, due to the reduced numbers of diesel fuelled cars. This relative importance could also change over time, for example, in response to different policy measures.

There may also be significant differences in medical diagnosis, health service provision and health treatment over and between areas. This is likely to affect the temporal consistency of health data and impede comparisons of different areas. In addition, there may also be marked variations in the quality and consistency of data on both environment and health between different areas. It is therefore very difficult to examine geographical or temporal trends, especially over large areas or over long periods of time. It is also difficult to combine studies from different areas or time periods for meta-analysis.

8.3.5 Comparability of indicators

A further problem is that a potentially large range of indicators are available. If these indicators convey the same message, then the choice of indicator is relatively unimportant. If, however, they tell different stories, the choice is crucial. This thesis has applied a number of different indicators at the same time, at a range of different spatial scales. The results of the analyses suggest that estimates of exposure are greatly affected by the choice of indicator and that there is little consistency in exposure classification between indicators. Chapter Five, for example, demonstrates that different indicators are generally only weakly inter-correlated, whilst typically no more than a third of sites were classified in the same quintile by different indicators. The choice of indicator is therefore crucial will have a major effect on the outcome of any study.

8.3.6 Testing and validation

All indicators clearly depend on a relationship with their issue of concern. In the case of proxies for exposure , this is a two-stage relationship. The proxy must provide a good measure of exposure, which in turn, must be closely related to health outcome. A weakness in either of these links will weaken the effectiveness of the indicators. However, the links do not always need to be quantitative, but may also, in some cases, be qualitative. even then, however, the direction of influence should be known. For example, if the percentage of trips taken by public transport is increasing, we need to know whether this implies an increase in the levels of exposure, and therefore, the health risk.

In reality, these relationships are often highly complex and not immediately clear. In developing indicators, therefore, it is vital that these relationships are clearly established. Nevertheless, testing and evaluating the relationships implied by indicators is often difficult. The analysis of EHIs at the national level, for example, was hampered by the lack of direct data on exposure and health outcome. Validation can be undertaken to check the ability of indicators to predict exposure and health outcome, but both are difficult. In the case of exposure, it is very difficult to obtain reference data, particularly on exposure. In many cases it is also far from clear which indicator provides the best measure of exposure. For example, in the case of exposure to water pollution, whether carcinogenic agents are more significant than bacteria. Neither is it clear how that measure should be expressed (e.g. as annual averages, daily means or peak concentrations).

In relation to health, validation is complicated by the problem of socio-economic confounding. Confounding factors clearly need to be accounted for in any testing of indicators, yet not all of the necessary data may be available. There may also be a time large between exposure and health effect. Accounting for this in any validation exercise is very difficult. In addition, it should also be noted that environment-health relationships are far from linear. As has already been mentioned, individual environmental factors may affect a number of health outcomes, whilst single health outcomes are likely to be influenced by a wide range of environmental hazards. All of these issues complicate the process of validating EHIs. Finally, it should also be noted that many health risks involve a low relative risk. Any change in exposure therefore only leads to a small change in risk. The implication of this is that a large population study is needed to pick up these small changes, yet data for such a study may not be available, due to time and cost restraints. This problem is illustrated in Chapter Five, where none of the odds ratios show a clear directional effect for any of the indicators studied.

8.3.7 The issue of scale

The problems with developing reliable exposure indicators are seen to become even more severe when they are used at broader scales, either in the attempt to determine the numbers of people at risk or as broad policy indicators (e.g. to inform national resource allocations or to set targets for environmental health plans). The difficulties at this level derive from a number of factors. One is that the relationships between environmental exposure and health are, for the most part, highly localised and specific: they occur through individuals being exposed to specific pollutants or groups of pollutants, at specific locations and times. Aggregated, broad-scale environmental information is thus likely to provide only poor indications of the exposures or patterns of risk which actually occur. A second problem is the paucity of environmental data at these scales. Relatively few of the measures needed to construct the more effective exposure indicators are available at a sufficient density of sites to allow reliable indicators to be developed. As the level of spatial aggregation increases, therefore, the range of potential indicators becomes more limited. As this study has shown, the relationships between these indicators also become weaker, implying that they cannot be used as effective proxies for each other. Again, therefore, choice of indicator at this level is extremely important.

In the light of these considerations, it is clear that the use of exposure-side EHIs, either for broad-scale risk assessment or for policy applications, needs to be conducted with care. The extent to which any of the available indicators can actually provide meaningful measures of spatial variations in risk is extremely uncertain. Testing the validity of indicators at this level is also difficult, due to the lack of exposure information (or even, in many cases, reliable measures of ambient pollution levels) and the high levels of confounding likely to occur in relationships with health outcome. Indicators used at these levels thus need to be locally validated. It is also apparent that, due to inconsistencies in the data and the shortage of appropriate data at the broad scale, national and international indicators need to be based on aggregated small-scale data, rather than macro-level data.

The implications of these findings are that the use of EHIs for both epidemiology and policy applications is problematic. Whilst proxies for measured pollutant concentration have been found at the local level, these relationships break down at broader spatial scales and, crucially, the extent to which these measures provide reliable indications of exposure is unknown. In the absence of additional information on time activity patterns, lifestyle and personal risk factors, the validity of using proxy measures of site-specific pollutant concentration in predicting exposure is limited. Similarly, at the broad scale, EHIs cannot be relied upon to provide reliable estimates of exposure. Their use as predictors of health risk in policy applications may consequently lead to the production of inaccurate or misleading conclusions.

8.4 Further Research

Further testing and evaluation of EHIs at the local and broad scale is clearly required to investigate the relationships between indicators and the extent to which proxy indicators for measured pollutant concentration can be found. In particular, it is evident that one of the major weaknesses in this study is the lack of measured exposure data to test any of the indicators investigated. For this purpose, an intensive programme of personal exposure monitoring is required, alongside data collection for the development of proxy indicators. This must be a prime research requirement for the future if more definitive conclusions are to be drawn about the extent to which reliable proxy measures for exposure can in fact be found.

Improvements in the availability of data to construct indicators are also required. At the same time, improvements are also needed in levels of data comparability, particularly at the national and international level, to ensure that effective indicators can be developed, and that these are comparable. More extensive data on environmental pollution is clearly vital in this context. Providing this data does not necessarily imply the need for the construction of extensive new monitoring networks. Rather, it requires effort to collate and cross-calibrate the existing regional and national networks more effectively, and to make the data more accessible to users. Equally important, however, is improved data on proxies from higher up the environment-health chain - for example, data on road traffic volumes and composition, emission factors and road networks which could help feed into pollution models. Again, many of the requisite data are available at the local level, but at present are not collated either nationally or internationally at an appropriate level of aggregation. As this implies, there is also the need for further research into methods for modelling pollution concentrations and exposure, especially at the regional and broader scale.

8.5 Implications

The environmental health indicators examined in this thesis represent an attempt to reduce the complexity of environmental health relationships to a few relatively simple measures.

Because of the intricate web of relationships involved, the effects of confounding, and uncertainties in the data, this is inherently difficult. Many of the assumptions made in using EHIs - for example, that they provide a direct indication of the condition of interest - are not necessarily valid. It is therefore crucial to test EHIs before using them. Different EHIs, which may be expected to act as proxies for each other, often fail to do so. Whether intended for use in environmental epidemiology or policy applications, therefore, EHIs need to be developed and used with caution. This is certainly true in the case of exposure indicators used in epidemiological studies, where the choice of an inappropriate or ineffective indicator is likely to distort or dilute the relationship of interest. It is even more important at the policy level, where EHIs are likely to be used as the basis for decisions which may have wide-ranging and costly effects. EHIs at this level need to be based on, and derived from, well-tested relationships at the local scale. Sadly, the available data often make this impossible, with the result that much policy relies on imperfect information.

These lessons are equally true outside the environmental health arena. Recent years have seen what might be described as an explosion of effort to develop indicators in a wide range of fields. The extent to which any of these indicators are effective depends on how well they indicate their condition of interest. All too often, this is only poorly known. There is therefore a need to test the validity of indicators prior to their use. Many indicators are based on knowledge developed at the local level. Whether relationships persist at the broader scale of application is often uncertain. The effect of aggregation and generalisation on indicator performance also needs testing. The extent to which various indicators can be used as proxies for each other - to enable comparisons to be made across different studies, or to provide substitutes where data are scarce - is also largely unknown and needs to be evaluated.

It is therefore clear that EHIs are a useful tool, but that they are not panaceas for inadequate data or knowledge. Good EHIs (or other types of indicator) are not easy to develop. They must be crafted out of good science and a strong understanding of the realities involved.

Appendix 1

Environmental, Socio-Economic and Health Indicators - a review of proposed and existing indicators

Table A.1: List of Sources for the indicator datasets

1	Lancaster County Council
2	Organisation for Economic Cooperation and Development (OECD 1991)
3	World Health Organisation - Health and Environment GIS (HEGIS) Programme
4	Environment Ministry, Canada
5	Environment Ministry, Norway
6	United Nations Statistical Office (UNSTAT)
7	World Health Organisation - Health For All
8	Hope & Parker Pilot Environmental Index
9	Local Government Management Board (LGMB) Indicators Project
10	Organisation for Economic Cooperation and Development (OECD 1993)
11	World Health Organisation - Second Health For All Evaluation
12	Leeds Quantifiable City Project
13	P. Townsend: Deprivation Index
14	United Nations Association (UNA): Measuring Sustainability
15	Sustainable Seattle
16	Odemerho & Chokor: Benin City, Nigeria
17	J. Catford: Wessex Regional Health Authority;
18	V. Anderson: Alternative Economic Indicators
19	A. Adriaanse: Netherlands Environmental Policy Performance Indicators
20	World Health Organisation - Health For All Multi City Action Plan
21	Commission of the European Communities (CEC): Programme and Project Indicators
22	World-Wide Fund for Nature (WWF) - New Economics Foundation (NEF) Indicators Initiative
23	E.F. Guitierrez-Espeleta: Costa Rica Approximated Sustinability Index
24	World Resources Institute (WRI): Environmental Indicators
25	European Statistical Office (EUROSTAT): Pressure Index Project
26	Dirgha Tiwari, Food & Agriculture Organisation (FAO): Country Case Study Comparisons/Project Monitoring & Evaluation
27	Jacksonville Chamber of Commerce: Life in Jacksonville, Quality of Life Project

Table A.2: Categories used in the indicator datasets

1	Access to facilities, goods & services
2	Access to good food, water, shelter & fuel
3	Access to skills, knowledge & information
4	Accessibility
5	Acidification
6	Acidification/biological production
7	Aesthetic space
8	Air quality
9	Atmosphere
10	Atmosphere, oceans and all kinds of seas
11	Biodiversity
12	Biological resources
13	Biological & ecosystem diversity
14	Biota
15	Climate
16	Climate change
17	Community
18	Community empowerment in decision-making
19	Contamination of the natural environment
20	Critical elements of sustainability
21	Culture and society
22	Culture, leisure & recreation opportunities
23	Decision-making structures
24	Economic policy
25	Economy
26	Education, science, technology etc. transfers
27	Efficient resource use & waste minimisation
28	Energy
29	Environment
30	Environmental
31	Environmental quality
32	Eutrophication
33	Financial resources and mechanisms
34	Fish resources
35	Food & nutrition
36	Forest resources
37	Freedom from fear of violence/persecution
38	General health
39	General indicators
40	Health
41	Health balance
42	Health of ecosystems
43	Health status
44	Health-protection, prevention & care
45	Health, human settlements & freshwater
46	Housing
47	Human settlements
48	Industry & labour
49	Input indicators
50	International co-operation
51	Land
52	Landscape quality
53	Land, desertification, forests & biodiversity

54	Land/soil use & quality
55	Lifestyle
56	Material deprivation
57	Meeting local needs locally
58	Mineral resources
59	Morbidity
60	Mortality
61	Multi-media & others
62	Natural disasters
63	Natural diversity
64	Natural economic resources
65	Natural environment
66	Natural & cultural landscape diversity
67	Noise
68	Output Indicators
69	Pollution limitation & reduction
70	Population & resources
71	Population & living
72	Population, health & welfare
73	Process indicators
74	Radiation
75	Resource consumption
76	Roles of major groups
77	Secondary environmental
78	Shelter
79	Social
80	Social deprivation
81	Social environment
82	Socio-economic status
83	Socio-economic
84	Soil degradation-erosion & desertification
85	Stratospheric ozone depletion
86	Support
87	Target group indicators
88	The ozone layer
89	Theme indicators
90	Toxic chemicals & hazardous wastes
91	Toxic contamination
92	Transport
93	Transport & mobility
94	Urban environmental quality
95	Urban local environment
96	Value/protection of local distinctiveness
97	Waste
98	Waste & recycling
99	Water
100	Water quality
101	Water resources
102	Water supply
103	Work-satisfaction/fair pay/value etc.

CATEGORY	INDICATOR	ID No.	USE	AVAIL ABLTY	SOURCE	LOC AL	REGI ONAL	NATI ONAL	INTE RNAT
AIR QUALITY	SO2 EMISSIONS	1	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	NO2 EMISSIONS	2	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	TOTAL SUSPENDED PARTICULATES (TSPs)	3	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	CO	4	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	NH3	5	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	VOLATILE ORGANIC CARBON EMISSIONS (VOCs)	6	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	Pb	7	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	Cd	8	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	CO2	9	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	CFCs	10	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	CH3	11	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	NO	12	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	PROPORTION OF HOMES IN WHICH RADON LEVELS EXCEED A SPECIFIED LEVEL	13	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AIR QUALITY	COMPLAINTS OF ODOURS AS A PROPORTION OF ALL COMPLAINTS MADE TO ENVIRONMENTAL HEALTH DEPARTMENTS	14	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF THE POPULATION WHO ARE HOMELESS	15	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF THE POPULATION WHO ARE IN TEMPORARY ACCOMMODATION	16	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF HOUSEHOLDS WITH MORE THAN 1 PERSON PER ROOM	17	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF DWELLINGS FOR WHICH THE NUMBER OF PERSONS PER ROOM FALLS BELOW THE NATIONAL STANDARD	18	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF THE POPULATION IN MULTI-OCCUPANCY DWELLINGS	19	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF HOMES WHICH ARE UNFIT FOR HUMAN HABITATION	20	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HOUSING	PROPORTION OF HOMES WHICH ARE DAMP AND/OR MOULDY	21	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			

HOUSING	PROPORTION OF HOMES WHICH ARE INFESTED WITH VERMIN	22	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOMES WITH ADEQUATE HEATING AND INSULATION	23	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOMES LACKING BASIC AMENITIES (INSIDE WC, CENTRAL HEATING, BATH OR SHOWER)	24	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOMES IN NEED OF RENOVATION	25	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	NUMBER OF HOUSEHOLDS IN RECEIPT OF A HOME IMPROVEMENT GRANT	26	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOUSEHOLDS ON A HOUSING LIST, IE WITH A HOUSING NEED UNMET	27	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	AVERAGE COST OF HOME HEATING, PROPORTIONAL TO WEEKLY HOUSEHOLD INCOME	28	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOMES WITH ADEQUATE PROTECTION AGAINST FALLS, FIRES, BURNS AND SCOLDS	29	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	AVERAGE HOUSEHOLD ENERGY RATING	30	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOMES WITH HEATING BILL ARREARS	0	SHORT-LIST	PROPOSED	LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOUSEHOLD INCOME SPENT ON HEATING	0	SHORT-LIST	PROPOSED	LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF MORTGAGE ARREARS	31	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF HOME REPOSSESSIONS	32	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF RENT ARREARS	33	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	PROPORTION OF SHELTERED HOUSING UNITS PER POPULATION AGED 65 OR OLDER	34	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HOUSING	NUMBER OF HIGH RISE TENEMENT BLOCKS	35	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
NOISE	COMPLAINTS OF NOISE AS A PROPORTION OF ALL COMPLAINTS MADE TO ENVIRONMENTAL HEALTH DEPARTMENTS	36	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
NOISE	NOISE LEVELS IN URBAN AND RURAL AREAS (dB)	37	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
NOISE	AVERAGE TRAFFIC DENSITY AT 0830 HOURS AND 1730 HOURS	38	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
RADIATION	AVERAGE RADIATION LEVELS IN MILK	39	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
RADIATION	NUMBER OF CONTAMINATED LAND SITES PER 1000 POPULATION	40	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
RADIATION	HUMAN EXPOSURE	41	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				

RADIATION	RADON LEVELS IN PRIVATE HOMES	42	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	WASTE WATER DISCHARGES (m3)	43	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	TOTAL VOLUME OF SLUDGE FROM WASTE WATER TREATMENT PLANTS AS USED IN AGRICULTURE, INCINERATION, SEA AND LAND DUMPING	44	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	PROPORTION OF THE POPULATION SERVED BY WASTE WATER TREATMENT PLANTS	45	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	TREATMENT AND DISPOSAL OF DOMESTIC WASTE	46	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	PROPORTION OF INDUSTRIAL DISCHARGE CONSENTS GRANTED OR RENEWED FOR POTENTIALLY HAZARDOUS WASTES	47	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	RECYCLING AND RE-USE OF MATERIALS	48	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	PROPORTION OF RECYCLABLE WASTE COLLECTED FROM DOMESTIC PREMISES	49	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	PROXIMITY TO RECYCLING POINTS AND WASTE DISPOSAL SITES	50	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	PROPORTION OF BATTERIES SOLD WHICH ARE RECYCLABLE	51	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	VOLUME OF LITTER FOUND IN PUBLIC AREAS	52	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WASTE & RECYCLING	NUMBER OF GREEN REFRIGERATORS PURCHASED AS A PROPORTION OF ALL REFRIGERATORS SOLD	53	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	TOTAL NUMBER OF DRINKING WATER DISCONNECTIONS, OR HOUSEHOLDS WITH MINIMUM DRINKING WATER SUPPLIES	54	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	COMPLIANCE, EXCLUDING UNDERTAKINGS AND RELAXATIONS, WITH THE DRINKING WATER STANDARDS FOR LEAD (Pb)	55	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	COMPIANCE WITH THE DRINKING WATER STANDARDS FOR GIVEN PESTICIDES	56	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	PROPORTION OF DESIGNATED RECREATIONAL WATERS WHICH COMPLY WITH THE RECREATIONAL WATER QUALITY MICROBIOLOGICAL STANDARDS	57	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	PROPORTION OF WASTE WATER TREATMENT PLANTS WHICH SUPPLY MECHANICAL, BIOLOGICAL &/OR ADVANCED TREATMENT	58	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
WATER QUALITY	WASTE WATER DISCHARGES (m3)	59	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	PEDESTRIAN SPACE	60	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	PUBLIC TRANSPORT FARES	61	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	AVERAGE PROXIMITY TO THE NEAREST PUBLIC TRANSPORTATION STOP	62	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			

ACCESSIBILITY	PROPORTION OF PUBLIC TRANSPORT ABLE TO ACCOMMODATE DISABLED PEOPLE	63	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	AVAILABILITY OF PUBLIC TRANSPORT OUTSIDE OF COMMUTER HOURS	64	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	PROPORTION OF TOTAL HEALTH RESOURCES GOING TO PRIMARY HEALTH CARE	65	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	RATIO OF HOSPITAL BEDS, DOCTORS AND OTHER HEALTH CARE WORKERS TO POPULATION	66	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	RATIO OF HEALTH FACILITIES TO LOCAL POPULATION, ADJUSTED BY AGE	67	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	DISTANCE OR TIME TRAVELLED TO PRIMARY HEALTH CARE FACILITIES	68	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	QUALITY OF PAVEMENTS	69	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	STREET CROSSINGS FOR DISABLED PEOPLE (%)	70	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ACCESSIBILITY	WHEELCHAIR ACCESS (% OF PREMISES)	71	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	PROPORTION OF STREETLIGHTS NOT FUNCTIONING	72	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	AVAILABILITY OF PEDESTRIAN SPACE	73	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	NUMBER OF CONTAMINATED LAND SITES	74	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	ACCESS TO URBAN PARKS, OR UNDEVELOPED LAND	75	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	PROPORTION OF SAFE RESIDENTIAL STREETS (EG. TRAFFIC CALMED, SUITABLY ASSESSED OR SIGN-POSTED FOR PLAY)	76	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	DISTANCE TO THE NEAREST SAFE PLAY AREA	77	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	PROPORTION OF PUBLIC SPACES FREE OF DOG EXCREMENT	78	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	RATIO OF THE LENGTH OF PUBLIC FOOTPATHS TO ROADS	79	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	TOTAL PROPORTION OF BUILT UP LAND	80	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	HECTARES OF DERELICT LAND AS A PROPORTION OF HECTARES IN THE DISTRICT	81	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	PROPORTION OF AGRICULTURAL LAND DEVELOPED	82	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
AESTHETIC SPACE	AMOUNT OF OPEN SPACE NEWLY DEVELOPED AS A PROPORTION OF ALL LAND DEVELOPED	83	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	PERCENTAGE OF LONE PARENT HOUSEHOLD	84	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			

COMMUNITY	MEMBERS BELONGING TO RESIDENT ASSOCIATIONS, SUCH AS GOOD NEIGHBOUR SCHEMES	85	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	AVERAGE NUMBER OF DAILY TRIPS MADE OUTSIDE THE HOME	86	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	HOURS OF HOME HELP PER HEAD OF POPULATION AGED 75 OR OLDER	87	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	PROPORTION OF THE POPULATION AGED 65 OR OLDER LIVING OUTSIDE OF INSTITUTIONS	88	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	MEASURE OF THE PROVISION OF SUPPORT SERVICES FOR PEOPLE PREVIOUSLY IN CARE	89	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	PERCEPTIONS OF COMMUNITY SAFETY, BY PARENTS OR CHILDREN	90	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	ADULT ILLITERACY RATE PER 1000 POPULATION	91	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	TOTAL YEARS OF EDUCATION PER 1000 POPULATION AGED 5-18	92	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	PROPORTION OF 17-21 YEAR OLDS IN EDUCATION	93	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF PRE-SCHOOL PLACES PER 1000 POPULATION AGED LESS THAN 5 YEARS	94	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	PROPORTION OF CHILDREN WITH SPECIAL EDUCATIONAL NEEDS PER 1000 POPULATION LESS THAN 16 YEARS	95	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	DELINQUENCY (%)	96	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF CHILDREN REFERRED FOR PSYCHIATRIC CONSULTATION PER 1000 POPULATION AGED LESS THAN 16 YEARS	97	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	TOTAL NUMBER OF SOCIAL SERVICE REFERRALS (LEVEL 1)	98	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF CHILDREN UNDER SUPERVISION ORDERS PER 1000 POPULATION AGED LESS THAN 18 YEARS	99	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF CHILDREN ON THE CHILD PROTECTION REGISTER PER 1000 POPULATION AGED LESS THAN 18 YEARS	100	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF INFORMAL HOSPITAL ADMISSIONS UNDER THE MENTAL HEALTH ACT (1983) PER 1000 POPULATION OVER 18 YEARS	101	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	MENTAL ILLNESS OCCUPIED BED DAYS, INCLUDING SHORT STAY & CHILD/ADOLECENT PSYCHIATRY	102	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF SUICIDE	103	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF HOMICIDE	104	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF ACTS OF VIOLENCE	105	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	NUMBER OF CRIMES AGAINST THE PERSON PER 1000 POPULATION	106	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			

COMMUNITY	NUMBER OF CRIMES AGAINST PROPERTY PER 1000 HOUSEHOLDS	107	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	READING LEVEL AT 16 YEARS OF AGE	0	SHORT-LIST	PROPOSED	LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF ALCOHOL-RELATED CRIMES	108	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF SMOKING	109	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF TRANQUILLISER PRESCRIPTIONS	110	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	SUBSTANCE ABUSE IN CHILDREN (DRUGS, ALCOHOL ETC)	111	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
COMMUNITY	RATE OF OBESITY	112	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	PROPORTION OF REPORTED ACCIDENTS WHICH ARE TRANSPORT RELATED	113	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	NUMBER OF SERIOUS INJURIES PER CYCLE JOURNEY AS A PROPORTION OF THE NUMBER OF CYCLE JOURNEYS	114	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	YEARS OF LIFE LOST BY MOTOR VEHICLE TRAFFIC ACCIDENTS	115	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	ROAD TRAFFIC ACCIDENTS PER 1000 POPULATION	116	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	NUMBER OF TRAFFIC CALMING AREAS	117	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	INVESTMENT IN PUBLIC TRANSPORT	118	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	AVERAGE TRAFFIC DENSITY AT 0830 HOURS AND 1730 HOURS	119	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	PERCEPTION OF PEDESTRIAN SAFETY	120	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	NUMBER OF JOURNEYS MADE BY PEDAL CYCLE	121	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	PROPORTIION OF SCHOOL CHILDREN WHO TRAVEL TO SCHOOL VIA SAFE CYCLE OR PEDESTRIAN ROUTES	122	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	ROAD DENSITY	123	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	VEHICULAR KILOMETRES (EXCLUDING TAXIS) IE LENGTH OF ROAD TRAVELLD BY ALL PASSENGERS	124	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	NUMBER OF PASSENGER CARS PER 1000 POPULATION	125	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	LENGTH OF ALL ROADS (KMS)	126	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
TRANSPORT & MOBILITY	LENGTH OF ALL MOTORWAYS (KMS)	127	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			

TRANSPORT & MOBILITY	LENGTH OF ALL CYCLE TRACKS	128	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
TRANSPORT & MOBILITY	ANNUAL NUMBER OF CAR MILES	129	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
TRANSPORT & MOBILITY	PERCENTAGE OF JOURNEYS TO WORK MADE BY, EG. PEDAL CYCLE, WALKING, PUBLIC TRANSPORT	130	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	NUMBER OF REPORTED FOOD POISONING CASES	131	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	NUMBER OF PREMISES PER 1000 POPULATION CONSIDERED TO BE A HIGH SAFETY RISK	132	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	COST OF A FOOD BASKET	133	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	AVAILABILITY OF LOCALLY GROWN FRESH PRODUCE	134	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	PROPORTION OF CHILDREN BREAST FED AT 3 AND 6 MONTHS OF AGE	135	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	HOUSEHOLD EXPENDITURE ON FOOD AS A PROPORTION OF WEEKLY HOUSEHOLD INCOME	136	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	PROPORTION OF CHILDREN HAVING A WEIGHT ABOVE 120% OR BELOW 80% OF THE REFERENCE VALUE, ADJUSTED FOR AGE	137	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
FOOD & NUTRITION	CHILD'S HEIGHT FOR AGE	138	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	JARMAN INDEX OF DEPRIVATION	139	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	TOWNSEND INDEX OF DEPRIVATION	140	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	CARSTAIRS INDEX OF DEPRIVATION	141	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	UNEMPLOYMENT RATE	142	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	PROPORTION OF THE POPULATION INRECEIPT OF DISABILITY BENEFITS	143	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	PROPORTION OF THE POPULATION IN RECEIPT OF ANY TYPE OF BENEFIT	144	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	PROPORTION OF HOUSEHOLDS IN RECEIPT OF INCOME SUPPORT	145	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	PROPORTION OF THE POPULATION DEEMED TO BE LONG TERM UNEMPLOYED	146	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	OCCUPATIONAL CLASS DISTRIBUTION	147	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	AVERAGE HOUSEHOLD INCOME	148	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
SOCIO-ECONOMIC STATUS	EDUCATIONAL ATTAINMENT IN WOMEN	149	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				

SOCIO-ECONOMIC STATUS	PERCENTAGE OF WOMEN IN THE WORK FORCE	150	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
SOCIO-ECONOMIC STATUS	PROPORTION OF WORKING AGED DISABLED PEOPLE ENGAGED IN REGULAR OCCUPATIONAL ACTIVITIES	151	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
SOCIO-ECONOMIC STATUS	DEPENDENCY RATIO, IE THE NUMBER OF PEOPLE AGED <15 AND >65 YEARS PER 1000 POPULATION	152	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	LIFE EXPECTANCY AT BIRTH BY SEX	153	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	LIFE EXPECTANCY AT 45 YEARS OF AGE	154	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	YEARS OF LIFE LOST PER 1000 POPULATION, FOR PARTICULAR CAUSES OF DEATH, EG ACCIDENTAL FALLS, TB	155	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	RATE OF THE SIX MOST PREVALENT CHRONIC DISEASES IN LANCASHIRE	156	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	PERCENTAGE OF INFANTS WITH LOW BIRTH WEIGHT	157	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	STANDARDISED INFANT MORTALITY	158	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	STANDARDISED PERINATAL MORTALITY	159	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	STANDARDISED NEONATAL MORTALITY	160	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	STANDARDISED POST NEONATAL MORTALITY	161	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	NUMBER OF STILLBIRTHS AS A PROPORTION OF ALL BIRTHS	162	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	CHILDHOOD MORTALITY, CHILDREN AGED 1-4 YEARS	163	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	STANDARDISED MATERNAL MORTALITY	164	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	PROPORTION OF PREGNANCIES IN WOMEN LESS THAN 16 YEARS	165	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	ABORTIONS IN WOMEN AGED LESS THAN 16 YEARS	166	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	WAITING LISTS, BY SPECIALITY, FOR ADMISSION AND DAY CASES	167	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	PROPORTION OF PER CAPITA EXPENDITURE ON HEALTH SERVICES, BY AREA ADJUSTED FOR AGE OF THE POPULATION	168	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	NUMBER OF PEOPLE USING A GIVEN HEALTH SERVICE AS A FUNCTION OF THE PROPORTION OF THE POPULATION REQUIRING THE SERVICE	169	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	RATION OF POPULATION SIZE ON HEALTH PERSONNEL	170	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	NUMBER OF HEALTH PERSONNEL OF A SPECIFIED TYPE PER 1000 POPULATION	171	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			

HEALTH STATUS	PROPORTION OF PUBLIC AGENCIES AND DEPARTMENTS WHICH FORMALLY CONSIDER HEALTH CONSEQUENCES WHEN REVIEWING PUBLIC POLICY DECISIONS	172	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	NUMBER OF FIRST ANTENATAL CONTACTS AS APROPORTION OF THE NUMBER OF EXPECTED BIRTHS	173	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	RATIO OF GP CONSULTATIONS PER GP PANEL SIZE	174	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	UPTAKE BY AGE OF IMMUNISATION PER 1000 POPULATION	175	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	NUMBER OF DAYS OF TEMPORARY DISABILITY PER PERSON PER YEAR	176	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PERCEIVED HEALTH STATUS	177	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF CHILDREN WHO UNDERTAKE A SPECIFIC TYPE OF PHYSICAL ACTIVITY	178	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	RATE OF SEXUALLY TRANSMITTED DISEASE	179	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	TB CASES PER 1000 POPULATION	180	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF THE POPULATION REPORTED TO BE HIV/AIDS POSITIVE	181	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	CARBOXI-HAEMOGLOBIN IN BLOOD	182	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	UPTAKE OF SCREENING PROGRAMMES	183	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	LIMITING LONG TERM ILLNESS PER 1000 POPULATION	184	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	LIMITING LONG-TERM ILLNESS BY ETHNICITY	185	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF THE POPULATION SUFFERING FROM LONG TERM DISABILITY	186	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF THE POPULATION SUFFERING FROM LONG TERM ILLNESS	187	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	NUMBER OF DECAYED MISSING OR FILLED TEETH (DMF)IN THE 12 YEAR OLD POPULATION	188	SHORT-LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	NUMBER OF YEARS OF LIFE LOST DUE TO DEATHS OCCURRING BEFORE AGE 65	189	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF HOSPITAL ADMISSIONS FOR INJURIES AND POISONINGS	190	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	PROPORTION OF HOSPITAL ADMISSIONS FROM FALLS AS A FUNCTION OF ALL ACCIDENTS	191	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	REPORTED CHILDREN'S ACCIDENTS IN THE HOME PER 1000 POPULATION	192	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				
HEALTH STATUS	REPORTED CHILDREN'S ACCIDENTS OUTSIDE THE HOME PER 1000 POPULATION	193	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y				

HEALTH STATUS	REPORTED ACCIDENTS IN THE HOME PER 1000 POPULATION AGED 65 OR OVER	194	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
HEALTH STATUS	REPORTED ACCIDENTS OUTSIDE THE HOME PER 1000 POPULATION AGED 65 OR OLDER	195	REFERENCE LIST		LANCASTER COUNTY COUNCIL	Y			
ENVIRONMENTAL	CO2 EMISSIONS FROM ENERGY USE (MILLION TONNES OF CARBON, CHANGE FROM 1971, /UNIT GDP, /CAPITA)	1	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	GREENHOUSE GAS EMISSIONS (CO2, MH4, CFCs, TOTAL, /UNIT GDP, /CAPITA)	1	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	SOx EMISSIONS (1000 TONNES, CHANGE FROM 1980, /UNIT GDP, /CAPITA)	3	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	NOx EMISSIONS (1000 TONNES, CHANGE FROM 1970, /UNIT GDP, /CAPITA)	4	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	USE OF WATER RESOURCES (WATER WITHDRAWAL, AS % OF GROSS ANNUAL AVAILABILITY, M3/CAPITA)	5	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	RIVER QUALITY (DISSOLVED OXYGEN mg/l, NITRATE CONCENTRATION mgN/l)	6	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	WASTEWATER TREATMENT (% OF POPULATION SERVED, % WITH PRIMARY TREATMENT ONLY, POPULATION NOT SERVED-MILLIONS)	7	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	LAND USE CHANGES (AREA, % OF LAND & CHANGE SINCE 1970 IN BOTH - ARABLE AND CROP LAND, AND WOODED AREAS	8	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	PROTECTED AREAS (1000 km2, % OF LAND AREA)	9	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	USE OF NITROGENOUS FERTILISERS (TONNES/km2 APPLIED ON ARABLE LAND, % CHANGE FROM 1970)	10	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	USE OF FOREST RESOURCES (GROWING STOCK m3/ha, ANNUAL INCREMENT m3/ha, ANNUAL HARVEST m m3, INTENSITY-TOTAL HARVEST/ANNUAL GROWTH	11	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	TRADE IN TROPICAL WOOD (IMPORTS OF CORK AND WOOD FROM AFRICA, LATIN AMERICA, FAR EAST, OCEANA, TOTAL - 1000US$)	12	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	THREATENED SPECIES (IN LATE 1980'S AS A % OF MAMMAL, BIRD, FISH, REPTILE, AMPHIBIAN AND VASCULAR PLANT SPECIES KNOWN)	13	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	FISH CATCHES (IN MARINE WATERS,1000 TONNES 1970,75,80,85,88, AS A % OF WORLD CATCHES, /UNITS GDP, /CAPITA, AQUACULTURE AS A % OF FISHERIES)	14	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	WASTE GENERATION (MUNICIPAL-1000 TONNES, /CAPITA. INDUSTRIAL-1000 TONNES, /UNIT GDP, 1000 TONNES HAZARDOUS. NUCLEAR-TONNES HMa, /UNIT ENERGY	15	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	MUNICIPAL WASTE (KG/CAPITA-75,80,85,LATE 80's, % CHANGE FROM 75. /UNIT GDP. PRIVATE FUEL CONSUMPTION EXPENDITURE-% CHANGE FROM 75)	16	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	INDUSTRIAL ACCIDENTS (ACCIDENTS AND DEATHS - TOTAL NUMBER 70-74, 75-79, 80-84, 85-89, /UNIT GDP)	17	PRELIMINARY SET		OECD			Y	Y
ENVIRONMENTAL	PUBLIC OPINION (ENVIRONMENTAL PROTECTION VS. GROWTH TRADEOFF)	18	PRELIMINARY SET		OECD			Y	Y

SECONDARY ENVIRONMENTAL	GROWTH OF ECONOMIC ACTIVITY (GDP INDEX AT 1985 PRICES-70,75,80,85,89. 1989-BILLION US$, 1000 US$/CAPITA)	19	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	ENERGY INTENSITY (INTENSITY-TOE /1000 US$, % CHANGE FROM 1970. ENERGY REQUIREMENTS-TOE/CAPITA, MTOE TOTAL)	20	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	ENERGY SUPPLY (ENERGY REQUIREMENTS BY SOURCE-SOLID FUELS, NATURAL GAS, NUCLEAR, HYDRO ETC - % OF TOTAL FOR YEARS 1970 & 88)	21	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	INDUSTRIAL PRODUCTION (INDEX OF CHANGE-PULP,PAPER&PAPERBOARD, CHEMICAL PRODUCTS, PETROLEUM REFINERIES, IRON & STEEL, ELECT. MACH., VEHICLES	22	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	TRANSPORT TRENDS (ROAD TRAFFIC, MOTORWAYS & PASSENGER CARS IN USE - 1970 & 89 FIGURES + CHANGE FROM 1970)	23	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	PRIVATE FINAL CONSUMPTION (EXPENDITURE 1970,75,80,85,89, BILLION US$IN 1989, 1000 US$/CAPITA IN 1989)	24	PRELIMINARY SET		OECD			Y	Y
SECONDARY ENVIRONMENTAL	POPULATION (1000 INHABITANTS 1970,75,80,85,90, CHANGE FROM 1970, POPULATION DENSITY inh./km2 1990)	25	PRELIMINARY SET		OECD			Y	Y
AIR QUALITY	SO2 CONCENTRATION IN AIR (OR EXCEEDING WHO OR NATIONAL GUIDELINES/EMISSIONS/USE OF COAL FOR DOMESTIC HEATING/COOKING)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
AIR QUALITY	NO2 CONCENTRATION IN AIR (OR EXCEEDING WHO OR NATIONAL GUIDELINES/EMISSIONS/USE OF GEAS FOR DOMESTIC HEATING/COOKING/TRAFFIC DENSITY)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
AIR QUALITY	PARTICULATES TSP/PM10 CONCENTRATION IN AIR (EXCEEDING WHO OR NATIONAL GUIDELINES/BLACK SMOKE/EMISSIONS OF TSP/USE OF COAL	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
AIR QUALITY	OZONE CONCENTRATION IN AIR	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
AIR QUALITY	CO CONCENTRATION IN AIR (OR EMISSIONS/TRAFFIC DENSITY/CITY GAS USAGE)	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-HARDNESS (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-WATER COLOUR (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-TASTE (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-pH (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-CONDUCTIVITY/TSS (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-BOD,VOC,TOC (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-NITRATES, NITRITES (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
WATER QUALITY	DRINKING WATER QUALITY-PHOSPHATES (OR WATER TREATMENT)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y

MULTI-MEDIA & OTHERS	VOCs-CONCENTRATION OF SPECIFIC VOCs IN AIR AND WATER (OR EMISSIONS/PETROL USAGE)	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PAHs-CONCENTRATION OF BENZO(A)PYRENE IN AIR AND FOOD (OR SMALL-SCALE WOOD AND COAL BURNING/TRAFFIC DENSITY)	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	METALS AND TRACE ELEMENTS-CONC. OF Cd, Pb, As, Hg IN HUMAN TISSUE + Al IN DRINKING WATER (OR CONC. IN AIR, WATER, SOIL, FOOD / EMISSIONS	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PERSISTENT ORGANIC CHEMICALS-CONCENTRATION OF PCBs, DIOXIN, ETC. IN HUMAN TISSUE (OR CONC. IN AIR,FOOD,WATER /EMISSIONS/PROD.\CONSUMPTION)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI MEDIA & OTHERS	PESTICIDES-CONCENTRATION IN FOOD (OR PESTICIDES USE/SALES/LAND USE)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PESTICIDES-CONCENTRATION IN SOIL (OR PESTICIDES USE/SALES/LAND USE)	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PESTICIDES-CONCENTRATION IN HUMAN TISSUE (OR PESTICIDES USE/SALES/LAND USE)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	NITRATES, ETC.-CONCENTRATION OF NITRATE, NITRITE, PHOSPHATE, ETC. IN SURFACE WATER (OR FERTILISER USAGE/ADDITIVE USAGE)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	NITRATES, ETC.-CONCENTRATION IN GROUNDWATER, FOOD (OR FERTILISER USAGE/ADDITIVE USE)	0	PROPOSED	CLASS 2	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PATHOGENS & ALLERGENS-FOODBOURNE PATHOGENS (OR CONC./LAND USE\VEG'N/HUMIDITY/HOUSING QUAL/WATER TREATMENT/WASTEWATER TREATMENT/FOOD HYGEINE)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PATHOGENS & ALLERGENS-WATERBOURNE PATHOGENS (OR CONC./LAND USE\VEG./HUMIDITY/HOUSING QUAL/WATER TREATMENT/WASTEWATER TREATMENT/FOOD HYGEINE)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PATHOGENS & ALLERGENS-AIRBOURNE ALLERGENS (OR CONC./LAND USE\VEG./HUMIDITY/HOUSING QUAL./WATER TREATMENT/WASTEWATER TREATMENT/FOOD HYGEINE)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	PATHOGENS & ALLERGENS-INDOOR ALLERGENS (OR CONC./LAND USE\VEG./HUMIDITY/HOUSING QUALITY/WATER TREATMENT/WASTEWATER TREATMENT/FOOD HYGEINE)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	RADIATION-ACTIVITY OF RADON IN HOUSEHOLD AIR (OR GEOLOGY)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	RADIATION-SOLAR RADIATION (OR SUNSHINE/CLOUDINESS)	0	PROPOSED	CLASS 1	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	EXPOSURE TO TOBACCO SMOKE-COTININE IN URINE (OR PARTICLE CONC. IN INDOOR AIR/MUTAGENICITY OF AIR/TOBACCO CONS'N/SMOKING CONTROLS IN PUBLIC BUILDINGS)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	NUISANCES-NUISANCE CAUSED BY ODOURS (OR COMPLAINTS/WASTE TREATMENT)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
MULTI-MEDIA & OTHERS	NUISANCES-NOISE LEVELS IN HOME (OR COMPLAINTS)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y

MULTI-MEDIA & OTHERS	NUISANCES-TRAFFIC NOISE (OR NOISE EMISSIONS/TRAFFIC DENSITY)	0	PROPOSED	CLASS 3	HEALTH & ENVIRONMENT GIS		Y	Y	Y
POPULATION & LIVING	POPULATION DENSITY	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
POPULATION & LIVING	POPULATION STRUCTURE (BY GENDER) -TOTAL POPULATION/%<15 YEARS/%>65 YEARS)	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
POPULATION & LIVING	URBAN/RURAL	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
POPULATION & LIVING	HOUSEHOLD SIZE	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
POPULATION & LIVING	HOUSING QUALITY-HEATING TYPE/WATER SUPPLY/SANITATION/WASTE COLLECTION	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
INDUSTRY & LABOUR	PRODUCTION BY SECTOR-AGRICULTURE/MINING & ENERGY/CHEMICALS/OTHER INDUSTRY/CONSTRUCTION/TRADE/BANKING & FINANCE/ADMINISTRATION & SERVICES/OTHER	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
SOCIOECONOMIC STATUS	INCOME	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
SOCIOECONOMIC STATUS	EDUCATION	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
SOCIOECONOMIC STATUS	OCCUPATION	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
LIFESTYLE	PERSONAL FACTORS-TOBACCO SMOKING/ALCOHOL CONSUMPTION/NUTRITION/PHYSICAL EXERCISE/SOCIAL CONTACTS/NARCOTICS & DRUGS USE	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
LIFESTYLE	MOBILITY-TRAFFIC DENSITY/MIGRATION	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
GENERAL HEALTH	PERCEIVED HEALTH	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
GENERAL HEALTH	BODY MASS INDEX	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
GENERAL HEALTH	HEALTHY LIFE EXPECTANCY	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
GENERAL HEALTH	BIRTH WEIGHT	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORTALITY	LIFE EXPECTANCY AT BIRTH	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORTALITY	ALL CAUSES OF DEATH (AGE AND GENDER STANDARDIZED)	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORTALITY	PREMATURE DEATH (0-64)	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORTALITY	INFANT MORTALITY	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORTALITY	PRIMARY CAUSES OF DEATH-INFECTIOUS AND PARASITIC DISEASES/CANCERS	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y

MORBIDITY	RESPIRATORY-ASTHMA/CHRONIC OBSTRUCTIVE DISEASES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	CANCER-LUNG CANCER/LEUKAEMIA/STOMACH CANCER/MESOTHELIOMA/SKIN CANCER	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	ALLERGIES/HYPERSENSITIVITY	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	CARDIOVASCULAR DISEASES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	INFECTIOUS DISEASES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	CONGENITAL ABNORMALITIES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	DIGESTIVE DISEASES-CHRONIC LIVER DISEASES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	OCCUPATIONAL DISEASES	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	SPONTANEOUS ABORTIONS	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
MORBIDITY	ACUTE POISONINGS	0	PROPOSED		HEALTH & ENVIRONMENT GIS		Y	Y	Y
ATMOSPHERE	CLIMATE CHANGE-CANADIAN ENERGY RELATED EMISSIONS OF CARBON DIOXIDE (M TONNES EMISSIONS 1920-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	CLIMATE CHANGE-ATMOSPHERIC CONCENTRATIONS OF CARBON DIOXIDE (ppm CO2 1959-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	CLIMATE CHANGE-GLOBAL AIR TEMPERATURE (AVERAGE 'C TEMPERATURE VARIATION 1861-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	STRATOSPHERIC OZONE DEPLETION-CANADIAN PRODUCTION AND IMPORTATION OF OZONE-DEPLETING CHEMICALS (THOUSAND TONNES OZONE DEPLETING POTENTIAL 1975-1990)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	STRATOSPHERIC OZONE DEPLETION-STRATOSPHERIC OZONE LEVELS (DOBSON UNITS 1960-1990)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	RADIATION-LEVELS OF RADIOACTIVITY IN THE AIR (MILLIBEQUERELS PER CUBIC METRE 1959-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	ACID RAIN-SULPHUR DIOXIDE (SO2) AND NITROGEN OXIDES (NOx) EMISSIONS (M TONNES 1970-1985)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	OUTDOOR URBAN AIR QUALITY-NITROGEN DIOXIDE AND CARBON MONOXIDE:LEVELS IN URBAN AIR AND EMISSIONS (EMISSIONS INDEX + M TONNES 1970-90/% OF MAX ACCEPTABLE LEVEL 1970-89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	OUTDOOR URBAN AIR QUALITY-SULPHUR DIOXIDE AND TOTAL SUSPENDED PARTICULATES:LEVELS IN URBAN AIR AND EMISSIONS (EMISSIONS INDEX + M TONNES 1970-90/% OF MAX ACCEPT. LEVEL)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
ATMOSPHERE	OUTDOOR URBAN AIR QUALITY-GROUND-LEVEL OZONE CONCENTRATIONS (AV. NO. OF DAYS PER YEAR EXCEEDING THE 1HR OZONE AIR QUALITY OBJECTIVE/% OF MAX ACCEPTABLE LEVEL 1979-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	

ATMOSPHERE	OUTDOOR URBAN AIR QUALITY-LEAD CONCENTRATIONS IN URBAN AIR (MICROGRAMS PER CUBIC METRE 1974 & 1978-89/KILOTONNES EMISSIONS 1973-1988)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-POPULATION SERVED BY TREATED WATER SUPPLY (INDEX OF POPULATION SERVED 1975-1989)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-MUNICIPAL DISCHARGES TO FRESH WATER:BOD, TSS AND PHOSPHORUS (% DISCHARGES INDEX 1983-89/% MUNICIPAL POPULATION SERVED BY TREATMENT 1983, 86 & 89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-PULP AND PAPER MILL DISCHARGES TO FRESH WATER:TSS AND BOD (1000 KILOGRAMS PER DAY 1970, 78, 82, 85, 87 & 89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-DISCHARGES OF REGULATED SUBSTANCES BY PETROLEUM REFINERIES TO WATER (1000 KILOS PER DAY TSS, OIL&GREASE, AMMONIA NITROGEN, PHENOLS, SULPHIDE 1972-87)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-CONCENTRATIONS OF PHOSPHORUS & NITROGEN IN WATER (mg PER LITRE IN LAKE ONTARIO & THE BOW, QU'APPELLE THAMES & DUNK RIVERS 1978-89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	FRESHWATER QUALITY-MAXIMUM OBSERVED CONCENTRATIONS OF PESTICIDES IN WATER:2,4-D, ATRAZINE & LINDANE (% OF GUIDELINE IN THE BOW, QU'APPELLE, THAMES & GRAND RIVERS 1978-88)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	TOXIC CONTAMINANTS IN THE FRESHWATER ECOSYSTEM-CONTAMINANTS LEVEL IN HERRING GULL EGGS IN THE GREAT BASIN:PCBs & DDE (ppm 1974 & 78-90 SNAKE ISLAND, LAKE ONTARIO)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	TOXIC CONTAMINANTS IN THE FRESHWATER ECOSYSTEM-CONTAMINANT LEVELS IN LAKE TROUT, A SPORT FISH FROM THE GREAT LAKES:PCBs & DDT (ppm 1977-86 LAKE ONTARIO LAKE TROUT AGE>4)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	MARINE ENVIRONMENTAL QUALITY-MUNICIPAL DISCHARGES TO COASTAL WATERS:TSS & BOD (1000KILOS/DAY TO PACIFIC & ATLANTIC + % OF COASTAL POP'N WITH SEWAGE TREATMENT 1983,86&89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	MARINE ENVIRONMENTAL QUALITY- PULP & PAPER MILL DISCHARGES TO COASTAL WATERS:TSS AND BOD (1000 KILOS PER DAY 1970, 78, 82, 85 & 87 TO ATLANTIC & PACIFIC WATERS)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	MARINE ENVIRONMENTAL QUALITY-VOLUME OF SIGNIFICANT MARINE SPILLS (1000 TONNES PER YEAR + SIGNIFICANCE BY SOURCE - PACIFIC & ATLANTIC COASTS 1976-87)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	MARINE ENVIRONMENTAL QUALITY-AREA CLOSED TO SHELLFISH HARVESTING (1000 HECTARES 1970-1990 FOR ATLANTIC & PACIFIC REGIONS)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	

WATER	MARINE ENVIRONMENTAL QUALITY-CONTAMINANT LEVELS IN SEABIRD EGGS:PCBs (ppm 1970-89 IN DOUBLE-CRESTED CORMORANT EGGS-STRAIT OF GEORGIA, BAY OF FUNDY & ST. LAWRENCE ESTUARY)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
WATER	MARINE ENVIRONMENTAL QUALITY-CONTAMINANT LEVELS IN SEABIRD EGGS: DIOXINS AND FURANS (ppt 1973-89 IN DOUBLE CRESTED CORMORANT EGGS STRAIT OF GEORGIA & BAY OF FUNDY)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
BIOTA	BIOLOGICAL DIVERSITY AT RISK-WILDLIFE SPECIES AT RISK (% OF MARINE MAMMAL, BIRD, TERRESTRIAL MAMMAL, REPTILE & AMPHIBIAN, FISH & NATIVE PLANT SPECIES AT RISK IN 1990)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
BIOTA	STATE OF WILDLIFE-LEVELS OF MIGRATORY GAME BIRD POPULATIONS (AMERICAN BLACK DUCK-1000s 1955-89/CAUSES OF WETLAND HABITAT DECLINE/PRAIRIEMALLARD & N. PINTAIL-Ms 1955-89)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
LAND	PROTECTED AREAS-LAND UNDER PROTECTED STATUS (CUMULATIVE AREA-1000KM2 1880-1990/PROTECTED SPACE BY ECOZONE-% OF TOTAL)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
LAND	URBANISATION-RURAL TO URBAN LAND CONVERSION (TOTAL RURAL LAND URBANISED & PRIME CAPABILITY AGRICULTURAL LAND URBANISED-1000 HA 1966-86)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
LAND	SOLID WASTE MANAGEMENT-MUNICIPAL SOLID WASTE DISPOSAL TRENDS (DISPOSAL INDEX 1981-89/WASTE MANAGEMENT METHODS USED BY MUNICIPALITIES/PER CAPITA WASTE GENERATION-KG/DAY)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	FORESTRY-REGENERATION SUCCESS VERSUS TOTAL FOREST AREA HARVESTED (TOTAL REGENERATION, AREA HARVESTED & SUCCESSFUL REGENERATION AS A % OF AREA HARVESTED-1000 HA 1976-88)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	AGRICULTURE-CHANGES IN AGRICULTURAL LAND USE (M HA 1961-86 TOTAL FARMLAND, TOTAL CULTIVATED LAND, CROPLAND, SUMMERFALLOW & IMPROVED PASTURE)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	AGRICULTURE-AMOUNT OF CHEMICAL FERTILISER USED AND ITS ASSOCIATED NUTRIENT CONTENT (1000 TONNES 1966-89 TOTAL FERTILISER MATERIAL & NUTRIENT OF FERTILISER MATERIAL)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	AGRICULTURE-AGRICULTURAL PESTICIDE APPLICATION ON CULTIVATED LAND (M HA 1971-86 TOTAL CULTIVATED LAND & AREA SPRAYED WITH HERBICIDES, INSECTICIDES & FUNGICIDES)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	FISHERIES-TOTAL COMMERCIAL FISH CATCHES IN CANADIAN WATERS OFF THE ATLANTIC COAST (TONNES 1960-87 GROUNDFISH, PELAGIC FISH & INVERTEBRATES/TONNES TOTAL COD CATCHES)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	FISHERIES-COMMERCIAL FISH HARVEST IN THE GREAT LAKES (M lb 1978-87 SMELT, WALLEYE, YELLOW PERCH & LAKE WHITEFISH)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	WATER USE-TOTAL WATER WITHDRAWAL COMPARED WITH GROWTH IN GDP (WATER WITHDRAWAL INDEX 1972-86)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	

NATURAL ECONOMIC RESOURCES	WATER USE-RATES OF WATER WITHDRAWAL AND CONSUMPTION BY KEY ECONOMIC SECTORS (MUNICIPAL, AGRICULTURE, MANUFACTURING, THERMAL POWER & MINING-% CONSUMPTION + M CUBIC METRES)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	WATER USE-RATES OF WATER RECIRCULATION BY KEY INDUSTRIAL SECTORS (% RECIRCULATION IN MINING, MANUFACTURING, THERMAL POWER & CANADIAN TOTAL)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	WATER USE-DAILY HOUSEHOLD WATER USE PER CAPITA (LITRES PER DAY 1983, 86 & 89/INTERNATIONAL PRICE PER 1000 LITRES COMPARISON)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	ENERGY-TOTAL PER CAPITA PRIMARY ENERGY USE (INDEX 1960-89/PRIMARY ENERGY PER $GDP INDEX 1960-89/MTOE 1960-89 BY SECTOR-INDUSTRY, RESIDENTIAL\COMMERCIAL & TRANSPORTATION)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	ENERGY-EMISSIONS OF CO2 PER UNIT OF ENERGY CONSUMED (TONNES PER TOE 1960-89/KG PER $GDP 1960-90/TONNES PER PERSON 1960-90)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
NATURAL ECONOMIC RESOURCES	ENERGY-FOSSIL FUEL INTENSITY OF PRIMARY ENERGY DEMAND (% OF PRIMARY ENERGY 1960-89/% SHARE OF ENERGY MARKET OIL, COAL, GAS, HYDRO & BIOMASS)	0	PRELIMINARY SET		ENVIRONMENT MINISTRY, CANADA			Y	
CLIMATE	EMISSIONS OF CO2 AND OTHER CLIMATE GASES GLOBALLY AND IN NORWAY	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	Y
CLIMATE	CHANGES IN THE FOREST LIMIT FOR BIRCH	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CLIMATE	EXTENT OF ICE IN THE BARENTS SEA	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
THE OZONE LAYER	TOTAL EMISSIONS OF OZONE-DEPLETING SUBSTANCES GLOBALLY AND IN NORWAY	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	Y
THE OZONE LAYER	THICKNESS OF THE OZONE LAYER	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	Y
THE OZONE LAYER	DOSE OF UV RADIATION	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
HEALTH	NOISE (EG <55dB AND/OR <65dB)	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
HEALTH	EMISSIONS OF ONE OR MORE (POSSIBLE INDEX) OF: NOx, SO2, Pb, VOC (VALUES EXCEEDING A SELECTION OF THRESHOLD VALUES EG PERSON/DAY WITH EXCESS VALUES)	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
HEALTH	RADIOACTIVE LOAD	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
EUTROPHICATION	EMISSIONS OF NITROGEN AND PHOSPHORUS TO A PRIMARY RECIPIENT	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
EUTROPHICATION	WATER QUALITY CLASSES	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
NATURAL & CULTURAL LANDSCAPE DIVERSITY	VEGETATION BELTS IN THE CULTURAL LANDSCAPE	0	PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	

NATURAL & CULTURAL LANDSCAPE DIVERSITY	AREA OF "WILDERNESS" >5KM FROM RAILWAY, ROAD OR POWER TRANSMISSION LINE		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
NATURAL & CULTURAL LANDSCAPE DIVERSITY	KM RIVER WITHOUT REGULATED WATER FLOW - POSSIBLY WITHOUT EMBANKMENTS		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
URBANE LOCAL ENVIRONMENT	EXISTENCE OF "GREEN BELTS" IN URBAN AREAS (OR NUMBER OF PERSONS RESIDENT CLOSE TO THESE)		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
URBANE LOCAL ENVIRONMENT	LENGTH OF ACCESSIBLE BEACHES-INLAND AND MARINE WATERS		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
BIODIVERSITY	INTRODUCTION OF FOREIGN GENETIC MATERIAL		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
BIODIVERSITY	NUMBER OF SALMON STRAINS		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
BIODIVERSITY	GENETIC INFLUENCE ON WILD SALMON		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
BIODIVERSITY	ENDANGERED SPECIES-SELECTED BIOTOPES (EG ANCIENT WOODLAND , "INDIGENOUS" FOREST/WETLANDS/RIVER DELTA/RIPARIAN FOREST)		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CONTAMINATION OF THE NATURAL ENVIRONMENT	EMISSIONS OF 3 SELECTED MICROPOLLUTANTS (CADMIUM, MERCURY, DIOXINS)		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CONTAMINATION OF THE NATURAL ENVIRONMENT	MERCURY IN COD, TROUT AND FLOUNDER		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CONTAMINATION OF THE NATURAL ENVIRONMENT	EGGSHELL THICKNESS IN MERLIN AND GOSHAWK		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CONTAMINATION OF THE NATURAL ENVIRONMENT	RADIOACTIVITY IN REINDEER		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
CONTAMINATION OF THE NATURAL ENVIRONMENT	HEAVY METALS IN SEDIMENTS AND/OR HYLOCOMIUM SP (GLITTERING FEATHER MOSS)		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
ACIDIFICATION/BIOLOGICAL PRODUCTION	DEPOSITIONS OF SO2 AND NOx		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
ACIDIFICATION/BIOLOGICAL PRODUCTION	INDEX:CROWN DENSITY (DEFOLIATION)/EPIPHYTIC LICHENS		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
ACIDIFICATION/BIOLOGICAL PRODUCTION	INDEX:"DEAD" LAKES IN RESPECT OF FISH/INVERTEBRATES		PROPOSED 1992		ENVIRONMENT MINISTRY, NORWAY			Y	
ATMOSPHERE	OUTDOOR AIR QUALITY-NOx,CO & SO2 EMISSIONS IN URBAN AREAS (TONS/YEAR)		PROPOSED		UNSTAT			Y	Y
ATMOSPHERE	OUTDOOR AIR QUALITY-GREENHOUSE GAS EMISSIONS (TONS/YEAR)		PROPOSED		UNSTAT			Y	Y
ATMOSPHERE	OUTDOOR AIR QUALITY-CONSUMPTION OF (EQUIVALENTS OF) OZONE DESTROYING SUBSTANCES (TONS/YEAR)		PROPOSED		UNSTAT			Y	Y
ATMOSPHERE	OUTDOOR AIR QUALITY-AIR QUALITY INDEX FOR URBAN AREAS		PROPOSED		UNSTAT			Y	Y

WATER	FRESHWATER QUALITY-DISSOLVED OXYGEN IN MAJOR RIVERS (mg/l)		PROPOSED		UNSTAT			Y	Y
WATER	FRESHWATER QUALITY-INDUSTRIAL/MUNICIPAL DISCHARGES INTO FRESH WATER BODIES (TONS/m3)		PROPOSED		UNSTAT			Y	Y
WATER	FRESHWATER QUALITY-BIOCHEMICAL OXYGEN DEMAND (BOD,COD)		PROPOSED		UNSTAT			Y	Y
WATER	FRESHWATER QUALITY-ANNUAL AVERAGE CONCENTRATIONS OF PHOSPHORUS AND NITROGEN IN MAJOR RIVERS (ug/l)		PROPOSED		UNSTAT			Y	Y
WATER	MARINE WATER POLLUTION-INDUSTRIAL/MUNICIPAL DISCHARGES TO COASTAL WATERS (TONS/m3)		PROPOSED		UNSTAT			Y	Y
WATER	WATER TREATMENT/SANITATION-WASTE WATER TREATMENT (%)		PROPOSED		UNSTAT			Y	Y
WATER	WATER TREATMENT/SANITATION-ACCESS TO SAFE DRINKING WATER AND SANITATION SERVICES (%)		PROPOSED		UNSTAT			Y	Y
WATER	WATER TREATMENT/SANITATION-WATER QUALITY INDEX BY FRESH WATER BODY		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	LAND USE CHANGES (KM2)		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	USE OF FERTILISERS (TONS/KM2)		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	USE OF AGRICULTURAL PESTICIDES (TONS/KM2)		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	AREAS OF SOIL EROSION (KM2)		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	DESERTIFIED AREAS (KM2)		PROPOSED		UNSTAT			Y	Y
LAND/SOIL USE & QUALITY	PROTECTED AREAS (KM2)		PROPOSED		UNSTAT			Y	Y
BIOLOGICAL RESOURCES	THREATENED SPECIES (%)		PROPOSED		UNSTAT			Y	Y
BIOLOGICAL RESOURCES	DEFORESTATION RATE (KM2)		PROPOSED		UNSTAT			Y	Y
BIOLOGICAL RESOURCES	FOREST AREA REGENERATED AND HARVESTED (KM2)		PROPOSED		UNSTAT			Y	Y
MINERAL RESOURCES	ENERGY-TOTAL PER CAPITA PRIMARY ENERGY USE (JOULES, OIL EQUIVALENTS ETC)		PROPOSED		UNSTAT			Y	Y
MINERAL RESOURCES	ENERGY-LIFETIME OF ENERGY RESERVES (YEARS)		PROPOSED		UNSTAT			Y	Y
MINERAL RESOURCES	OTHER MINERAL RESOURCES-DEPLETION/DEPRECIATION OF ENERGY AND OTHER MINERAL RESOURCES (%, $)		PROPOSED		UNSTAT			Y	Y
HUMAN SETTLEMENTS	MUNICIPAL WASTE DISPOSAL (TONS)		PROPOSED		UNSTAT			Y	Y
HUMAN SETTLEMENTS	RECYCLING (TONS)		PROPOSED		UNSTAT			Y	Y
HUMAN SETTLEMENTS	NOISE IN DWELLING AREA (NO.)		PROPOSED		UNSTAT			Y	Y
HUMAN SETTLEMENTS	AREA AND POPULATION IN MARGINAL SETTLEMENTS (KM2, NO.)		PROPOSED		UNSTAT			Y	Y
POPULATION, HEALTH & WELFARE	POPULATION DENSITY AND DISTRIBUTION (NO.)		PROPOSED		UNSTAT			Y	Y

POPULATION, HEALTH & WELFARE	INCIDENCE OF ENVIRONMENTALLY-RELATED DISEASES SUCH AS BILHARZIA, RESPIRATORY DISEASES, ETC (NO.)		PROPOSED		UNSTAT			Y	Y
POPULATION, HEALTH & WELFARE	ECOLOGICAL REFUGEES (NO.)		PROPOSED		UNSTAT			Y	Y
POPULATION, HEALTH & WELFARE	INFANT MORTALITY RATE (NO. PER 1000 LIVE BIRTHS)		PROPOSED		UNSTAT			Y	Y
POPULATION, HEALTH & WELFARE	PEOPLE IN ABSOLUTE POVERTY (NO., %)		PROPOSED		UNSTAT			Y	Y
POPULATION, HEALTH & WELFARE	ADULT LITERACY (%)		PROPOSED		UNSTAT			Y	Y
HEALTH OF ECOSYSTEMS	ECOLOGICAL INDICATORS (%, km2, ETC.)		PROPOSED		UNSTAT			Y	Y
HEALTH OF ECOSYSTEMS	ECOLOGICAL VULNERABILITY INDEX		PROPOSED		UNSTAT			Y	Y
NATURAL DISASTERS	FREQUENCY AND EFFECTS OF NATURAL DISASTERS (NO., $)		PROPOSED		UNSTAT			Y	Y
ECONOMIC POLICY	EVA, EDP, CAPITAL ACCUMULATION, ENVIRONMENTAL (PROTECTION) EXPENDITURE		PROPOSED		UNSTAT			Y	Y
ECONOMIC POLICY	ECONOMIC VULNERABILITY INDEX		PROPOSED		UNSTAT			Y	Y
INTERNATIONAL COOPERATION	DISTRIBUTION/ALLOCATION OF FINANCIAL MECHANISM ($)		PROPOSED		UNSTAT			Y	Y
INTERNATIONAL COOPERATION	PARTICIPATION IN INTERNATIONAL INSTRUMENTS AND AGREEMENTS		PROPOSED		UNSTAT			Y	Y
SUPPORT	NATIONAL STATE OF THE ENVIRONMENT REPORT		PROPOSED		UNSTAT			Y	Y
SUPPORT	ENVIRONMENT STATISTICS COMPENDIUM (YEAR)		PROPOSED		UNSTAT			Y	Y
SUPPORT	NATIONAL SUSTAINABLE DEVELOPMENT STRATEGY (YEAR)		PROPOSED		UNSTAT			Y	Y
SUPPORT	ENVIRONMENT AND SUSTAINABLE DEVELOPMENT NGOs (NO.)		PROPOSED		UNSTAT			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH SELF-ASSESSMENT OF HEALTH AS GOOD	20201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF UNEMPLOYED PERSONS	20501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ASSESSMENT OF SOCIAL HEALTH INDEX	20601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ASSESSMENT OF SOCIAL SUPPORT INDEX	20602	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF DISABLED OF WORKING AGE WITH A REGULAR OCCUPATION	30201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	TEMPORARY DISABILITY DAYS PER PERSON PER YEAR	40101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH LONG-TERM DISABILITY	40201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF TUBERCULOSIS (PER 100000)	40301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	NEW CASES OF AIDS	40309	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF HEPATITIS-TOTAL (PER 100000)	40310	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF HEPATITIS-A (PER 100000)	40311	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF HEPATITIS-B (PER 100000)	40312	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF HEPATITIS-OTHER (PER 100000)	40313	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF AIDS (PER 100000)	40314	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF ALL VENEREAL DISEASES (PER 100000)	40320	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	INCIDENCE OF SYPHILIS (PER 100000)	40321	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF GONOCOCCAL INFECTIONS (PER 100000)	40322	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF OTHER VENEREAL DISEASES (PER 100000)	40323	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF PERTUSSIS (PER 100000)	40331	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY FREE FROM DISABILITY (YEARS)	40501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH MALIGNANT NEOPLASMS	40601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH SELECTED CHRONIC MENTAL DISORDERS	40602	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF THE POPULATION WITH DISEASES OF THE CIRCULATORY SYSTEM	40603	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF THE POPULATION WITH SELECTED CHRONIC DISEASES OF THE MUSCULOSKELETAL SYSTEM	40604	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASES	40605	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH DIABETES MELLITUS	40606	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DECAYED, MISSING OR FILLED TEETH AT AGE 12 (VALUE)	40701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF MISSING TEETH FOR AGE-GROUP 35-44 YEARS	40702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF TOTALLY TOOTHLESS PERSONS IN AGE-GROUP 65-74 YEARS	40703	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF GENETIC DISORDERS-TOTAL (PER 100000 LIVE BIRTHS)	40800	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF THALASSAEMIA (PER 100000 LIVE BIRTHS)	40801	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF DOWN SYNDROME (PER 100000 LIVE BIRTHS)	40803	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF PHENYLKETONURIA (PER 100000 LIVE BIRTHS)	40805	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF SPINA BIFIDA (PER 100000 LIVE BIRTHS)	40806	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF ANENCEPHALY (PER 100000 LIVE BIRTHS)	40807	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF C6PD DEFICIENCY (PER 100000 LIVE BIRTHS)	40809	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF SYSTIC FIBROSIS (PER 100000 LIVE BIRTHS)	40810	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF SICKLE CELL DISEASES (PER 100000 LIVE BIRTHS)	40811	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH LONG-TERM WORK INCAPACITY	40901	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF MEASLES	50101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF MALARIA	50102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF DIPTHERIA	50103	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF TETANUS	50104	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF ACUTE POLIOMYELITIS	50105	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF CONGENITAL SYPHILIS	50106	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF CONGENITAL RUBELLA	50107	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF NEONATAL TETANUS	50108	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF MEASLES (CASES PER 100000)	50111	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF MALARIA (CASES PER 100000)	50112	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF DIPTHERIA (CASES PER 100000)	50113	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF TETANUS (CASES PER 100000)	50114	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	INCIDENCE OF ACUTE POLIOMYELITIS (CASES PER 100000)	50115	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF CONGENITAL SYPHILIS (CASES PER 100000)	50116	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF CONGENITAL RUBELLA (CASES PER 100000)	50117	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF NEONATAL TETANUS (CASES PER 100000)	50118	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF RUBELLA	50120	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CASES OF MUMPS	50121	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF CONGENITAL SYPHILIS (CASES PER 100000 LIVE BIRTHS)	50126	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF CONGENITAL RUBELLA (CASES PER 100000 LIVE BIRTHS)	50127	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF NEONATAL TETANUS (CASES PER 100000 LIVE BIRTHS)	50128	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF RUBELLA (CASES PER 100000)	50130	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF MUMPS (CASES PER 100000)	50131	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY AT BIRTH (YEARS)	60101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY AT AGE 1 (YEARS)	60201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY AT AGE 15 (YEARS)	60202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY AT AGE 45 (YEARS)	60203	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIFE EXPECTANCY AT AGE 65 (YEARS)	60204	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	REDUCTION OF LIFE EXPECTANCY THROUGH DEATH BEFORE 65 (IN YEARS)	60301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PROBABILITY OF DYING BEFORE 5 YEARS OF AGE	60401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INFANT MORTALITY RATE (PER 1000 LIVE BIRTHS)	70100	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	NEONATAL RATE (PER 1000 LIVE BIRTHS)	70101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	EARLY NEONATAL MORTALITY RATE (PER 1000 LIVE BIRTHS)	70102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LATE NEONATAL MORTALITY RATE (PER 1000 LIVE BIRTHS)	70103	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	POSTNEONATAL MORTALITY RATE (PER 1000 LIVE BIRTHS)	70104	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERINATAL MORTALITY RATE (PER 1000 BIRTHS)	70401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MORTINATALITY RATE (PER 1000 BIRTHS)	70402	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-ALL CAUSES (PER 100000 LIVE BIRTHS)	80100	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-ABORTION (PER 100000 LIVE BIRTHS)	80101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-HAEMORRHAGE (PER 100000 LIVE BIRTHS)	80102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-TOXAEMIA OF PREGNANCY (PER 100000 LIVE BIRTHS)	80103	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-PUERPERIUM (PER 100000 LIVE BIRTHS)	80104	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-OTHER DIRECT ODSTETRIC CAUSES (PER 100000 LIVE BIRTHS)	80105	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MATERNAL DEATHS-OTHER INDIRECT ODSTETRIC CAUSES (PER 100000 LIVE BIRTHS)	80106	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE CIRCULATORY SYSTEM (AGES 0-64 PER 100000)	90101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE CIRCULATORY SYSTEM (ALL AGES PER 100000)	90102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	SDR ISCHAEMIC HEART DISEASE (AGES 0-64 PER 100000)	90201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ISCHAEMIC HEART DISEASE (ALL AGES PER 100000)	90202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CEREBROVASCULAR DISEASES (AGES 0-64 PER 100000)	90301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CEREBROVASCULAR DISEASES (ALL AGES PER 100000)	90302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL INCIDENCE OF ISCHAEMIC HEART DISEASE (PER 100000)	90401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL INCIDENCE OF CEREBROVASCULAR DISEASES (PER 100000)	90501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MALIGNANT NEOPLASMS (AGES 0-64 PER 100000)	100101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MALIGNANT NEOPLASMS (ALL AGES PER 100000)	100102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR TRACHEA/BRONCHUS/LUNGCANCER (AGES 0-64 PER 100000)	100201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR TRACHEA/BRONCHUS/LUNGCANCER (ALL AGES PER 100000)	100202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CANCER OF THE CERVIX (AGES 0-64 PER 100000)	100301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CANCER OF THE CERVIX (ALL AGES PER 100000)	100302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL INCIDENCE OF CANCER OF THE CERVIX (PER 100000)	100401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MALIGNANT NEOPLASM FEMALE BREAST (AGES 0-64 PER 100000)	100501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MALIGNANT NEOPLASM FEMALE BREAST (ALL AGES PER 100000)	100502	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL INCIDENCE OF CANCER OF THE FEMALE BREAST (PER 100000)	100601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR EXTERNAL CAUSES OF INJURY AND POISONING (PER 100000)	110101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MOTOR VEHICLE TRAFFIC ACCIDENTS (PER 100000)	110201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	OCCURENCE OF ROAD TRAFFIC ACCIDENTS WITH INJURY (PER 100000)	110301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERSONS INJURED IN ROAD TRAFFIC ACCIDENTS (PER 100000)	110302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERSONS INJURED IN HOME ACCIDENTS-TOTAL (PER 100000)	110403	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERSONS INJURED IN WORK-RELATED ACCIDENTS (PER 100000)	110502	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	FATALITIES OF WORK RELATED ACCIDENTS (PER 100000)	110503	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR SUICIDE AND SELF INFLICTED INJURY (PER 100000)	120101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ADULT LITERACY RATE IN PERCENTAGE OF POPULATION AGED 15+	150201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION AGED 25+ WITH PRIMARY EDUCATION ONLY	150504	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION AGED 25+ WITH SECONDARY EDUCATION	150505	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION AGED 25+ WITH POSTSECONDARY EDUCATION	150506	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL TOBACCO CONSUMPTION PER PERSON (KG)	160101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL CIGARETTE CONSUMPTION PER PERSON (UNITS)	160102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF NON-SMOKERS IN POPULATION	160201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION SMOKING 20+ CIGARETTES PER DAY	160202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WHO HAVE NEVER SMOKED	160203	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WHO HAVE STOPPED SMOKING FOR THE PAST 2 YEARS	160204	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	PERCENTAGE OF POPULATION WHO HAVE REDUCED SMOKING FOR THE PAST 2 YEARS	160205	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF TOTAL ENERGY AVAILABLE FROM FAT	160306	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF TOTAL ENERGY AVAILABLE FROM PROTEIN	160307	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF TOTAL ENERGY AVAILABLE FROM ALCOHOLIC BEVERAGES	160308	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF NEONATES WEIGHING 2500g OR MORE	160401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN WITH WEIGHT 80-120% OF REFERENCE	160500	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF INFANTS BREASTFED AT THREE MONTHS	160601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF INFANTS BREASTFED AT SIX MONTHS	160602	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF INFANTS BREASTFED AT SIX WEEKS	160603	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DAILY ENERGY EXPENDITURE IN KJ FOR LEISURE PHYSICAL ACTIVITIES	160702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DAILY ENERGY EXPENDITURE IN KJ FOR INTENSE PHYSICAL ACTIVITIES	160703	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH BODY MASS INDEX GREATER THAN 30KG/M2	161001	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL PURE ALCOHOL CONSUMPTION (LITRES PER PERSON)	170101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF NON-DRINKERS IN THE POPULATION	170203	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION CONSUMING 50+ GRAMS ETHANOL PER DAY	170204	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	CONSUMPTION OF PRINCIPLE NARCOTIC DRUGS (GRAMS)	170301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR HOMICIDE AND PURPOSEFUL INJURY	170401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION CONSUMING PHARMACEUTIC PSYCHOTROPIC SUBSTANCES	170601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ROAD TRAFFIC ACCIDENTS INVOLVING ALCOHOL (PER 100000)	170701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION 15 YEARS OLD WHO HAVE TAKEN ILLICIT DRUGS	170803	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION 15 YEARS OLD WHO HAVE TAKEN ILLICIT DRUGS WITHIN THE LAST 30 DAYS	170804	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL NUMBER OF DEATHS FROM OVERDOSE OF ILLICIT DRUGS	170805	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL FIRST ADMISSIONS TO ILLICIT DRUG TREATMENT CENTRES	170806	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH ACCESS TO HYGEINIC SEWAGE DISPOSAL (TOTAL)	200107	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH ACCESS TO HYGEINIC SEWAGE DISPOSAL (URBAN)	200108	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH ACCESS TO HYGEINIC SEWAGE DISPOSAL (RURAL)	200109	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION CONNECTED AT HOME TO WATER SUPPLY SYSTEM (TOTAL)	200701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION CONNECTED AT HOME TO WATER SUPPLY SYSTEM (URBAN)	200702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	PERCENTAGE OF POPULATION CONNECTED AT HOME TO WATER SUPPLY SYSTEM (RURAL)	200703	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH NO ACCESS TO WATER WITHIN REASONABLE WALKING DISTANCE	200801	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF INLAND SURFACE WATER MEETING NATIONAL DRINKING PREPARATION STANDARDS	201001	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF RECREATIONAL WATER SURFACES MEETING NATIONAL STANDARDS	201101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	FOOD POISIONING -TOTAL NUMBER OF OUTBREAKS	220200	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	FOOD POISIONING -TOTAL NUMBER OF VICTIMS (PER 100000)	220203	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH SUBSTANDARD ACCOMMODATION	240301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION HOMELESS	240302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	AVERAGE NUMBER OF PERSONS PER ROOM IN OCCUPIED HOUSING UNITS	240501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	INCIDENCE OF CERTIFIED OCCUPATIONAL DISEASES (AGED 15-64 PER 100000)	250201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MORTALITY FROM CERTIFIED OCCUPATIONAL DISEASES (AGED 15-64 PER 100000)	250202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL LOST WORK DAYS PER PERSON DUE TO CERTIFIED OCCUPATIONAL DISEASE	250401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF HEALTH EXPENDITURE ON HOSPITAL INPATIENT OPERATIONAL EXPENDITURE	270102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PHYSICIANS PER 100000	270201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	QUALIFIED NURSES PER 100000	270202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DENTISTS PER 100000	270203	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PHARMACISTS PER 100000	270204	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	HOSPITAL BEDS PER 100000	270205	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PRIMARY HEALTH CARE UNITS PER 100000	270206	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	AUXILIARY NURSING STAFF PER 100000	270208	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MIDWIVES PER 100000	270209	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	NUMBER OF HOSPITALS PER 100000	270210	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF PHYSICIANS WORKING IN HOSPITALS	270321	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF NURSES WORKING IN HOSPITALS	270322	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST DIPTHERIA	280101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST TETANUS	280102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST PERTUSSIS	280103	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST MEASLES	280104	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST POLIOMYELITIS	280105	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF CHILDREN IMMUNIZED AGAINST TUBERCULOSIS	280106	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF ABORTIONS TO 1000 LIVE BIRTHS (ALL AGES)	280500	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF ABORTIONS TO 1000 LIVE BIRTHS (UNDER 20)	280501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF ABORTIONS TO 1000 LIVE BIRTHS (AGED 35+)	280502	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	RATIO OF ABORTIONS TO 1000 LIVE BIRTHS (AGED 20-34)	280503	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF ALL LIVE BIRTHS TO MOTHERS UNDER 20	280601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF ALL LIVE BIRTHS TO MOTHERS AGED 35+	280602	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF ALL LIVE BIRTHS TO MOTHERS AGED 20-34	280603	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR APPENDICITIS (AGES 0-64)	310301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR HERNIA AND INTESTINAL OBSTRUCTION (AGES 0-64)	310302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ADVERSE EFFECTS OF THERAPEUTIC AGENTS (AGES 0-64)	310303	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR APPENDICITIS (ALL AGES)	310304	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR HERNIA AND INTESTINAL OBSTRUCTION (ALL AGES)	310305	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ADVERSE EFFECTS OF THERAPEUTIC AGENTS (ALL AGES)	310306	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SURGICAL WOUND INFECTION RATES-TOTAL	310701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	HOSPITAL READMISSION RATES	310702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	AUTOPSY RATES FOR HOSPITAL DEATHS	310703	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	AUTOPSY RATES FOR ALL DEATHS	310704	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DIABETIC COMPLICATION RATES	310705	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	HAEMOGLOBIN ALCOHOL LEVELS	310706	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF RADIODIAGNOSTIC INVESTIGATIONS PER 1000 POPULATION	310802	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF UNITS OF BLOOD TRANSFUSED PER 1000 POPULATION	310803	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	RATIO OF LABORATORY TESTS PERFORMED PER 1000 POPULATION	310804	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF GNP SPENT ON HEALTH	340101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PHYSICIANS GRADUATING PER 100000	360301	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	NURSES GRADUATING PER 100000	360302	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	DENTISTS GRADUATING PER 100000	360303	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PHARMACISTS GRADUATING PER 100000	360304	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	MIDWIVES GRADUATING PER 100000	360305	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	AUXILIARY NURSING PERSONNEL GRADUATING PER 100000	360306	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	GROSS NATIONAL PRODUCT PER CAPITA IN US$	990000	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ALL CAUSES (AGES 0-64)	990100	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ALL CAUSES (ALL AGES)	990102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR BRONCHITIS/EMPHYSEMA/ASTMA (ALL AGES)	990201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR BRONCHITIS/EMPHYSEMA/ASTMA (AGES 0-64)	990202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL CONSUMPTION OF SPIRITS PER PERSON (LITRES)	991701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL CONSUMPTION OF WINE PER PERSON (LITRES)	991702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL CONSUMPTION OF BEER PER PERSON (LITRES)	991703	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	ANNUAL PURE ALCOHOL CONSUMPTION (LITRES PER PERSON AGED 15+)	991704	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CHRONIC LIVER DISEASE AND CIRRHOSIS (ALL AGES)	991705	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CHRONIC LIVER DISEASE AND CIRRHOSIS (AGES 0-64)	991706	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH WATER SUPPLY IN THE HOME-TOTAL	992001	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y

HEALTH	PERCENTAGE OF POPULATION WITH WATER SUPPLY IN THE HOME-URBAN	992002	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	PERCENTAGE OF POPULATION WITH WATER SUPPLY IN THE HOME-RURAL	992003	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR INFECTIOUS AND PARASITIC DISEASES (AGES 0-64)	993001	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR INFECTIOUS AND PARASITIC DISEASES (ALL AGES)	993002	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CANCER OF DIGESTIVE ORGANS AND PERITONEUM (AGES 0-64)	993101	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR CANCER OF DIGESTIVE ORGANS AND PERITONEUM (ALL AGES)	993102	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE RESPIRATORY SYSTEM (AGES 0-64)	993201	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE RESPIRATORY SYSTEM (ALL AGES)	993202	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE DIGESTIVE SYSTEM (AGES 0-64)	993401	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE DIGESTIVE SYSTEM (ALL AGES)	993402	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ENDOCHRINE, NUTRITIONAL/METABOLIC DISEASE, IMMUNITY DISORDER (AGES 0-64)	993501	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR ENDOCHRINE, NUTRITIONAL/METABOLIC DISEASE, IMMUNITY DISORDER (ALL AGES)	993502	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF BLOOD AND BLOOD FORMING ORGANS (AGES 0-64)	993601	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF BLOOD AND BLOOD FORMING ORGANS (ALL AGES)	993602	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MENTAL DISORDER AND DISEASES OF THE NERVOUS SYSTEM & SENSE ORGANS (AGES 0-64)	993701	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR MENTAL DISORDER AND DISEASES OF THE NERVOUS SYSTEM & SENSE ORGANS (ALL AGES)	993702	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE GENITOURINARY SYSTEM (AGES 0-64)	993801	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR DISEASES OF THE GENITOURINARY SYSTEM (ALL AGES)	993802	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR SIGNS, SYMPTOMS AND ILL-DEFINED CONDITIONS (AGES 0-64)	993901	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	SDR SIGNS, SYMPTOMS AND ILL-DEFINED CONDITIONS (ALL AGES)	993902	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	LIVE BIRTHS BY SEX	999998	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
HEALTH	POPULATION BY SEX	999999	HFA SOFTWARE		WHO-HEALTH FOR ALL			Y	Y
AIR QUALITY	NOx CONCENTRATION (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	1	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
AIR QUALITY	SO2 CONCENTRATION (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	2	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
AIR QUALITY	LOW LEVEL OZONE CONCENTRATION (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	3	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
AIR QUALITY	CO2 EMISSIONS (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	4	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
WATER QUALITY	OIL SPILLS (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	5	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
WATER QUALITY	RIVER QUALITY (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	6	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
LANDSCAPE QUALITY	POPULATION INCREASE (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	7	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	

LANDSCAPE QUALITY	FERTILISER USE (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	8	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
LANDSCAPE QUALITY	PERMANENT DWELLINGS (PART OF 1980-88 COMPOSITE ENVIRONMENTAL INDEX)	9	IN PILOT INDEX	Y	HOPE/PARKER PILOT ENVIRONMENTAL INDEX			Y	
EFFICIENT RESOURCE USE & WASTE MINIMISATION	NUMBER OF HOUSEHOLDS PRACTISING COMPOSTING OF KITCHEN AND GARDEN WASTE	1.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	DOMESTIC WASTE PRODUCTION (PER CAPITA/ PER ANNUM)	1.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	AMOUNT OF MATERIAL COLLECTED FOR RECYCLING (AS A PERCENTAGE OF TOTAL DOMESTIC SOLID WASTE)	1.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	AMOUNT OF INDUSTRIAL/COMMERCIAL WASTE WHICH GOES THROUGH TRANSFER STATIONS (PER ANNUM)	1.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	NUMBER/PERCENTAGE OF COMPANIES PARTICIPATING IN RECYCLING SCHEMES	1.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	WATER ABSTRACTION RATE (PER CAPITA/PER CAPITA CONSUMPTION)	1.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	PER CAPITA ENERGY CONSUMPTION IN THE HOME-E.G. GAS, ELECTRICITY, COAL, OIL (AVEARGE & INDIVIDUAL FIGURES)	1.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	INSTALLED RENEWABLE ENERGY CAPACITY-WINDMILLS, BIOGAS, SOLAR PANELS	1.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	PERCENTAGE OF HOUSING STOCK WITH AN ENERGY RATING OF 8 OR GREATER	1.9	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
EFFICIENT RESOURCE USE & WASTE MINIMISATION	AREA OF OPEN LAND LOST TO DEVELOPMENTS	1.10	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	CO2 EMISSIONS PER HOUSEHOLD (AVERAGE/PER CAPITA)	2.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	AIR QUALITY INDICATORS-SO2, NOx, CO, VOCs, PARTICULATES, OZONE, PAHs, PCBs, DIOXIN ETC. - SUBSTANCES AS APPROPRIATE LOCALLY (CONCENTRATIONS)	2.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	NUMBER OF CARS FAILING MOT EMISSIONS TEST AS A PERCENTAGE OF TOTAL	2.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

POLLUTION LIMITATION & REDUCTION	QUANTITY OF CFCs COLLECTED FOR RECYCLING	2.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	TONNES OF SEWAGE DISCHARGED UNTREATED OR INCINERATED	2.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	NUMBER OF PROSECUTIONS AND ENFORCEMENT NOTICES FOR BREACHES OF POLLUTION REGULATIONS	2.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	NUMBER OF REPORTED POLLUTION INCIDENTS (TOTAL AND "SERIOUS")	2.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	AREA OF CONTAMINATED LAND	2.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	EXPENDITURE ON POLLUTION CONTROL/PREVENTION TECHNOLOGY	2.9	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	PERCENTAGE OF RIVER MILEAGE IN CLASS 1	2.10	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	NUMBERS OF BEACHES FAILING EU BLUE FLAG STANDARD	2.11	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
POLLUTION LIMITATION & REDUCTION	NUMBERS OF BATHING WATERS FAILING EU DIRECTIVE STANDARDS	2.12	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	PERCENTAGE OF THE POPULATION WITH GARDENS GARDENING ORGANICALLY	3.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	NUMBER OF DOMESTIC PONDS WITH FROGS	3.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	MAINTENANCE OR PERCENTAGE INCREASE OF POPULATIONS OF CHARACTERISTIC SPECIES/INDICATORS OF SPECIES ASSEMBLAGES	3.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	CHANGES IN AREAS OF NATURAL/SEMI-NATURAL HABITATS AS A PERCENTAGE OF TOTAL AREA	3.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	AREA OF PROTECTED NATURAL OR SEMI-NATURAL HABITATS (SSSIs, ESAs, LOCAL NATURE RESERVES)	3.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	CHANGE IN POPULATION OF RED DATA BOOK SPECIES	3.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	PERCENTAGE OF FARMLAND COVERED BY FARM CONSERVATION PLANS	3.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	PERCENTAGE OF LAND FARMED ORGANICALLY	3.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
NATURAL DIVERSITY	PERCENTAGE OF LAND FARMED ORGANICALLY	3.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

MEETING LOCAL NEEDS LOCALLY	PERCENTAGE OF ALLOTMENTS IN USE/WAITING TIME FOR ALLOTMENTS	4.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
MEETING LOCAL NEEDS LOCALLY	PERCENTAGE OF INCOME SPENT LOCALLY	4.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
MEETING LOCAL NEEDS LOCALLY	PERCENTAGE OF LOCAL DEMAND FOR WATER MET FROM LOCAL RESOURCES	4.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
MEETING LOCAL NEEDS LOCALLY	PERCENTAGE OF LOCAL DEMAND FOR BUILDING MATERIALS MET LOCALLLY	4.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	NUMBER OF HOMELESS HOUSEHOLDS IN TEMPORARY ACCOMODATION	5.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	PERCENTAGE OF HOUSING STOCK NEEDING MAJOR RENOVATION IN PUBLIC /PRIVATE SECTOR	5.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	PERCENTAGE OF LOCAL AUTHORITY DWELLINGS EMPTY	5.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	PERCENTAGE OF POPULATION WITH DRINKING WATER BELOW EU STANDARDS	5.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	PERCENTAGE OF HOMES HEATED TO AGREED STANDARD FOR LESS THAN 10% OF HOUSEHOLD DISPOSABLE INCOME	5.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	PERCENTAGE OF DWELLINGS DISCONNECTED FROM WATER/ELECTRICITY/GAS SUPPLIES	5.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO GOOD FOOD, WATER, SHELTER & FUEL	INCOME NEEDED TO PURCHASE/MEET BASKET OF BASIC HOUSEHOLD NEEDS	5.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	PERCENTAGE OF POPULATION LIVING BELOW THE POVERTY LINE	6.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	RATE OF LONG-TERM UNEMPLOYMENT	6.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	JOBS CREATED/LOST	6.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	PERCENTAGE OF BUSINESSES FAILING WITHIN 3 YEARS	6.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	PERCENTAGE OF WORKFORCE WORKING IN THE TOP 5 LARGEST COMPANIES	6.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

WORK-SATISFACTION/FAIR PAY/VALUE	NUMBER OF BUSINESSES WITH ENVIRONMENTAL STRATEGY	6.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	NUMBERS PARTICIPATING IN LOCAL ECONOMIC TRADING SYSTEMS (LETS),COMMUNITY BUSINESSES ETC.	6.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
WORK-SATISFACTION/FAIR PAY/VALUE	TOTAL NUMBER OF CHILD DAY CARE SPACES AVAILABLE	6.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	PERCENTAGE OF SMOKERS	7.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	PERCENTAGE OF OVERWEIGHT CHILDREN	7.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	INFANT MORTALITY/1000	7.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	LOW BIRTH WEIGHT/1000	7.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	CHILD ASTHMA/1000	7.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	HEART DISEASE/1000	7.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	PERCENTAGE OF POPULATION COVERED BY CERVICAL CANCER/BREAST CANCER SCREENING PROGRAMMES AND TAKE-UP RATE	7.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	AMBIENT NOISE LEVELS BREACHING EC STANDARDS	7.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
HEALTH-PROTECTION, PREVENTION & CARE	ROAD TRAFFIC ACCIDENTS/1000	7.9	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	PERCENTAGE OF POPULATION WITHIN 400m OF PUBLIC TRANSPORT	8.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	AVERAGE TRAVEL TO WORK DISTANCE	8.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	PERCENTAGE OF POPULATION WITHIN X METRES OF BASIC SERVICES (E.G. HEALTH CENTRE, FOOD SHOP, PO/BANK, SCHOOL)	8.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	PERCENTAGE OF TOWN CENTRE OR LENGTH OF STREETS PEDESTRIANISED	8.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	KILOMETRES OF DEDICATED CYCLES ROUTES	8.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	INVESTMENT IN PUBLIC TRANSPORT AS A PERCENTAGE OF EXPENDITURE ON ROADS	8.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	NON-ROAD FREIGHT AS A PERCENTAGE OF TOTAL FREIGHT (TONNES/KM)	8.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	NUMBER OF COMPANIES OFFERING SUBSIDIES/LOAN FOR USE OF BIKES, PUBLIC TRANSPORT	8.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

ACCESS TO FACILITIES, GOODS & SERVICES	PASSENGER MILES BY MODE PER CAPITA	8.9	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO FACILITIES, GOODS & SERVICES	PERCENTAGE OF POPULATION LIVING WITHIN 1KM OF RECYCLING FACILITY (OR SERVED BY KERBSIDE COLLECTION)	8.10	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	PERCENTAGE OF POPULATION FEELING SAFE TO GO OUT AT NIGHT	9.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	VIOLENT CRIMES/1000	9.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	BURGLARIES/1000	9.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	ANNUAL INCREASE IN COST OF PROPERTY INSURANCE (HOUSEHOLD, BUSINESS)	9.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	NUMBER OF REPORTED RACIALLY MOTIVATED ATTACKS	9.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	NUMBERS OF REPORTED RAPES/INDECENT ASSAULTS	9.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	NUMBERS OF TRIBUNAL CASES FOR DISCRIMINATION/HARASSMENT	9.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
FREEDOM FROM FEAR OF VIOLENCE/PERSECUTIO N	NUMBERS KNOWING COMMUNITY POLICEMAN BY NAME	9.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	CHILDREN UNDER 5 IN NURSERY/PRE-SCHOOL AS A PERCENTAGE OF TOTAL	10.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	PUPIL/TEACHER RATIO	10.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	PERCENTAGE OF ADULT POPULATION IN FULL/PART TIME EDUCATION OR TRAINING (INCLUDING EVENING CLASSES)	10.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	PERCENTAGE OF 18-21 YEAR OLDS IN FURTHER/HIGHER EDUCATION OR TRAINING	10.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	PERCENTAGE OF SCHOOLS WHICH HAVE UNDERTAKEN ENVIRONMENTAL EDUCATION PROGRAMMES, OR IN SERVICE TRAINING (INSET) IN THE LAST TWO ACADEMIC YEARS	10.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
ACCESS TO SKILLS, KNOWLEDGE & INFORMATION	PUBLICATION OF LOCAL ENVIRONMENTAL STRATEGY, STATE OF THE ENVIRONMENT REPORT, ETC.	10.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	PERCENTAGE OF A POPULATION ATTENDING COMMUNITY FORA	11.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	MEMBERSHIP OF SPECIFIC VOLUNTARY GROUPS	11.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	NUMBER OF VOLUNTARY GROUPS	11.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	ETHNIC MINORITIES AS A PERCENTAGE OF TOTAL SCHOOL GOVERNORS RELATED TO MIX OF PUPILS	11.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	NUMBER OF NEIGHBOURS KNOWN BY NAME	11.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	PERCENTAGE OF ELECTORATE VOTING IN LOCAL ELECTIONS	11.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
COMMUNITY EMPOWERMENT IN DECISION-MAKING	NUMBER OF RESPONSES TO LOCAL PLAN OR SIMILAR PUBLIC CONSULTATION DOCUMENT	11.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
CULTURE, LEISURE & RECREATION OPPORTUNITIES	AREA OF SEMI-NATURAL GREENSPACE AVAILABLE FOR COMMUNITY USE/1000	12.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
CULTURE, LEISURE & RECREATION OPPORTUNITIES	PERCENTAGE OF POPULATION LIVING >1KM FROM ACCESSIBLE GREEN SPACE OF RECOGNISED ECOLOGICAL VALUE	12.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
CULTURE, LEISURE & RECREATION OPPORTUNITIES	PERCENTAGE OF PUBLIC BUILDINGS WITH DISABLED ACCESS OR FACILITIES FOR PHYSICALLY IMPAIRED	12.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
CULTURE, LEISURE & RECREATION OPPORTUNITIES	LIBRARY USE PER CAPITA	12.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	NUMBERS PARTICIPATING IN COMMUNITY ENVIRONMENTAL IMPROVEMENT SCHEMES (E.G. ENVIRONMENT WEEK)	13.1	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			

VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	MEMBERSHIP OF LOCAL AMENITY/RESIDENTS GROUPS	13.2	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	PERCENTAGE OF LAND DESIGNATED FOR LANDSCAPE QUALITY OR AMENITY VALUE	13.3	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	AREA OF SEMI-NATURAL GREENSPACE VERSUS AREA DEVOTED TO CARS	13.4	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	PERCENTAGE OF HISTORIC BUILDINGS ON 'AT RISK' REGISTER	13.5	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	NUMBER OF DEVELOPMENTS BREACHING LOCAL PLAN	13.6	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	NEW TREES PLANTED PER CAPITA	13.7	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	NUMBER OF TREE PRESERVATION ORDERS (TPOs) AND NUMBERS BREACHED	13.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
VALUE/PROTECTION OF LOCAL DISTINCTIVENESS	NUMBER OF TREE PRESERVATION ORDERS (TPOs) AND NUMBERS BREACHED	13.8	INDICATORS MENU 6/94		LGMB INDICATORS PROJECT	Y			
CLIMATE CHANGE	PRESSURES-INDEX OF GREEN HOUSE GAS EMISSIONS		PROPOSED 8/93	M	OECD			Y	Y
CLIMATE CHANGE	PRESSURES-EMISSIONS OF CO2		PROPOSED 8/93	S	OECD			Y	Y
CLIMATE CHANGE	PRESSURES-EMISSIONS OF CH4		PROPOSED 8/93	S/M	OECD			Y	Y
CLIMATE CHANGE	PRESSURES-APPARENT CONSUMPTION OF CFC 11 & 12; HALONS		PROPOSED 8/93	S/M	OECD			Y	Y
CLIMATE CHANGE	PRESSURES-EMISSIONS OF N2O		PROPOSED 8/93	M	OECD			Y	Y
CLIMATE CHANGE	CONDITIONS-ATMOSPHERIC CONCENTRATION OF GREENHOUSE GASES		PROPOSED 8/93	S	OECD			Y	Y
CLIMATE CHANGE	RESPONSES-ENERGY EFFICIENCY		PROPOSED 8/93	M/L	OECD			Y	Y
CLIMATE CHANGE	RESPONSES-ENERGY INTENSITY		PROPOSED 8/93	S	OECD			Y	Y
CLIMATE CHANGE	RESPONSES-IMPLICIT AND EXPLICIT TAX ON ENERGY/CO2		PROPOSED 8/93	M/L	OECD			Y	Y
CLIMATE CHANGE	RESPONSES-EXPENDITURES ON CLEAN TECHNOLOGY AND PRODUCTS , R&D EXPENDITURES ON ENERGY EFFICIENCY, ALTERNATIVE ENERGIES, CLIMATE CHANGE RESEARCH		PROPOSED 8/93	M	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	PRESSURES-INDEX OF OZONE DEPLETING SUBSTANCES		PROPOSED 8/93	M	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	PRESSURES-APPARENT CONCENTRATION OF CFCs		PROPOSED 8/93	S	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	PRESSURES-APPARENT CONCENTRATION OF HALONS		PROPOSED 8/93	M	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	CONDITIONS-ATMOSPHERIC CONCENTRATION OF OZONE-DEPLETING SUBSTANCES		PROPOSED 8/93	M	OECD			Y	Y

STRATOSPHERIC OZONE DEPLETION	CONDITIONS-ATMOSPHERIC CONCENTRATION OF CFCs		PROPOSED 8/93	S	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	CONDITIONS-STRATOSPHERIC OZONE LEVELS OVER SELECTED CITIES		PROPOSED 8/93	S/M	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	RESPONSES-CFC RECOVERY RATES		PROPOSED 8/93	M	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	RESPONSES-EXPENDITURE FOR CFC RECOVERY AND REPLACEMENT TECHNOLOGIES		PROPOSED 8/93	L	OECD			Y	Y
STRATOSPHERIC OZONE DEPLETION	RESPONSES-COUNTRIES' CONTRIBUTIONS TO THE INTERIM FUND ASSOCIATED WITH THE MONTREAL PROTOCOL		PROPOSED 8/93	S/M	OECD			Y	Y
EUTROPHICATION	PRESSURES-EMISSIONS OF NITROGEN & PHOSPHORUS INTO WATER AND SOIL		PROPOSED 8/93	L	OECD			Y	Y
EUTROPHICATION	PRESSURES-APPARENT CONSUMPTION OF FERTILISERS		PROPOSED 8/93	S	OECD			Y	Y
EUTROPHICATION	PRESSURES-WASTE WATER DISCHARGES		PROPOSED 8/93	M	OECD			Y	Y
EUTROPHICATION	CONDITIONS-BOD/DO/CONCENTRATION OF NITROGEN & PHOSPHORUS IN SURFACE WATERS		PROPOSED 8/93	S/M	OECD			Y	Y
EUTROPHICATION	RESPONSES-PERCENTAGE OF POPULATION CONNECTED TO CHEMICAL WASTE WATER TREATMENT PLANTS		PROPOSED 8/93	M/L	OECD			Y	Y
EUTROPHICATION	RESPONSES-PERCENTAGE OF POPULATION CONNECTED TO CHEMICAL WASTE WATER TREATMENT		PROPOSED 8/93	S	OECD			Y	Y
EUTROPHICATION	RESPONSES-LEVIES ON WASTE WATER DISCHARGES		PROPOSED 8/93	M	OECD			Y	Y
EUTROPHICATION	RESPONSES-MARKET SHARE OF PHOSPHATE-FREE DETERGENTS		PROPOSED 8/93	M/L	OECD			Y	Y
EUTROPHICATION	RESPONSES-BEST FARMING PRACTICES		PROPOSED 8/93	L	OECD			Y	Y
ACIDIFICATION	PRESSURES-INDEX OF ACIDIFYING SUBSTANCES		PROPOSED 8/93	M/L	OECD			Y	Y
ACIDIFICATION	PRESSURES-EMISSIONS OF SOx AND NOx		PROPOSED 8/93	S	OECD			Y	Y
ACIDIFICATION	PRESSURES-EMISSIONS OF AMMONIAC		PROPOSED 8/93	M	OECD			Y	Y
ACIDIFICATION	CONDITIONS-pH LEVEL IN WATER AND SOIL RELATIVE TO CRITICAL LEVELS		PROPOSED 8/93	M	OECD			Y	Y
ACIDIFICATION	CONDITIONS-CONCENTRATIONS IN ACID PRECIPITATIONS (pH, SO4, NO3)		PROPOSED 8/93	S	OECD			Y	Y
ACIDIFICATION	CONDITIONS-DEPOSITIONS OF NO2, SO2, NH3		PROPOSED 8/93	M	OECD			Y	Y
ACIDIFICATION	RESPONSES-PERCENTAGE OF CAR FLEET EQUIPPED WITH CATALYTIC CONVERTERS		PROPOSED 8/93	S/M	OECD			Y	Y
ACIDIFICATION	RESPONSES-STATIONARY SOURCES WITH SOx AND NOx ABATEMENT EQUIPMENT		PROPOSED 8/93	M/L	OECD			Y	Y
ACIDIFICATION	RESPONSES-EXPENDITURE FOR AIR POLLUTION ABATEMENT		PROPOSED 8/93	S	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-EMISSIONS OF HEAVY METALS		PROPOSED 8/93	M/L	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-EMISSIONS OF ORGANIC COMPOUNDS		PROPOSED 8/93	L	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-USE OF LEAD		PROPOSED 8/93	M/S	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-USE OF CADMIUM		PROPOSED 8/93	M/L	OECD			Y	Y

TOXIC CONTAMINATION	PRESSURES-USE OF MERCURY		PROPOSED 8/93	M/L	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-USE OF PESTICIDES		PROPOSED 8/93	M/S	OECD			Y	Y
TOXIC CONTAMINATION	PRESSURES-GENERATION OF HAZARDOUS WASTE		PROPOSED 8/93	S	OECD			Y	Y
TOXIC CONTAMINATION	CONDITIONS-CONCENTRATION OF HEAVY METALS AND ORGANIC COMPUNDS IN ENVIRONMENTAL MEDIA		PROPOSED 8/93	L	OECD			Y	Y
TOXIC CONTAMINATION	CONDITIONS-CONCENTRATION OF LEAD, CADMIUM, CHROMIUM & COPPER IN RIVERS		PROPOSED 8/93	S/M	OECD			Y	Y
TOXIC CONTAMINATION	RESPONSES-RECOVERY RATIO OF HAZARDOUS WASTE		PROPOSED 8/93	M/L	OECD			Y	Y
TOXIC CONTAMINATION	RESPONSES-REHABILITATED AREAS AS A PERCENTAGE OF TOTAL AREAS IDENTIFIED AS CONTAMINATED		PROPOSED 8/93	L/M	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	PRESSURES-URBAN AIR EMISSIONS SOx, NOx, VOC		PROPOSED 8/93	M	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	PRESSURES-DEGREE OF URBANISATION		PROPOSED 8/93	S/M	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	CONDITIONS-URBAN CONCENTRATION OF SO2 AND NOx PARTICULATES		PROPOSED 8/93	S	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	CONDITIONS-GROUND LEVEL OZONE		PROPOSED 8/93	M	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	CONDITIONS-NOISE		PROPOSED 8/93	M	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	RESPONSES-GREEN SPACE AS A PERCENTAGE OF TOTAL URBAN AREA/TOTAL URBAN POPULATION		PROPOSED 8/93	M/L	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	RESPONSES-EXPENDITURE ON URBAN MASS TRANSIT RELATIVE TO TOTAL URBAN TRANSPORT INFRASTRUCTURE EXPENDITURE		PROPOSED 8/93	M/L	OECD			Y	Y
URBAN ENVIRONMENTAL QUALITY	RESPONSES-EXPENDITURE ON NOISE ABATEMENT		PROPOSED 8/93	S/M	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	PRESSURES-HABITAT ALTERATION AND CONVERSION OF LAND FROM ITS NATURAL STATE		PROPOSED 8/93	L	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	PRESSURES-LAND USE CHANGES		PROPOSED 8/93	S	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	PRESSURES-INTRODUCTION OF NEW GENETIC MATERIAL AND SPECIES		PROPOSED 8/93	L	OECD			Y	Y

BIOLOGICAL & ECOSYSTEM DIVERSITY	PRESSURES-TRADE IN ENDANGERED SPECIES		PROPOSED 8/93	M	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	CONDITIONS-THREATENED OR EXTINCT SPECIES AS A SHARE OF KNOWN SPECIES		PROPOSED 8/93	S	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	RESPONSES-PROTECTED AREAS AS A PERCENTAGE OF TOTAL AREA		PROPOSED 8/93	S	OECD			Y	Y
BIOLOGICAL & ECOSYSTEM DIVERSITY	RESPONSES-PROTECTED SPECIES AS A PERCENTAGE OF THREATENED SPECIES		PROPOSED 8/93	M/L	OECD			Y	Y
WASTE	PRESSURES-WASTE GENERATION:MUNICIPAL WASTE		PROPOSED 8/93	S	OECD			Y	Y
WASTE	PRESSURES-WASTE GENERATION:INDUSTRIAL WASTE		PROPOSED 8/93	S	OECD			Y	Y
WASTE	PRESSURES-WASTE GENERATION:NUCLEAR WASTE		PROPOSED 8/93	S	OECD			Y	Y
WASTE	RESPONSES-WASTE RECYCLING AND RECOVERY RATES		PROPOSED 8/93	M/S	OECD			Y	Y
WASTE	RESPONSES-CHARGES FOR WASTE DISPOSAL		PROPOSED 8/93	M	OECD			Y	Y
WATER RESOURCES	PRESSURES-INTENSITY OF USE OF WATER RESOURCES		PROPOSED 8/93	S	OECD			Y	Y
WATER RESOURCES	PRESSURES-SHARE OF DISCHARGED WASTE WATER IN RIVERS		PROPOSED 8/93	M/L	OECD			Y	Y
WATER RESOURCES	CONDITIONS-REGULARITY OF NATURAL WATER SUPPLY		PROPOSED 8/93	M	OECD			Y	Y
WATER RESOURCES	RESPONSES-WATER PRICES AND USER CHARGES FOR WASTE WATER TREATMENT		PROPOSED 8/93	M	OECD			Y	Y
WATER RESOURCES	RESPONSES-EXPENDITURE FOR SUPPLY OF DRINKING WATER		PROPOSED 8/93	M	OECD			Y	Y
FOREST RESOURCES	PRESSURES-INTENSITY OF USE OF FOREST RESOURCES CORRECTED FOR AGE STRUCTURE		PROPOSED 8/93	M/L	OECD			Y	Y
FOREST RESOURCES	PRESSURES-INTENSITY OF USE OF FOREST RESOURCES		PROPOSED 8/93	S	OECD			Y	Y
FOREST RESOURCES	CONDITIONS-AREA AND VOLUME OF FORESTS		PROPOSED 8/93	S	OECD			Y	Y
FOREST RESOURCES	CONDITIONS-SHARE OF DETERIORATED FOREST IN TOTAL FOREST AREA		PROPOSED 8/93	M/L	OECD			Y	Y
FOREST RESOURCES	RESPONSES-PERCENTAGE OF PROTECTED FOREST AREA OVER TOTAL FOREST AREA		PROPOSED 8/93	S/M	OECD			Y	Y
FOREST RESOURCES	RESPONSES-REFORESTATION RATIO		PROPOSED 8/93	M	OECD			Y	Y
FISH RESOURCES	PRESSURES-FISH CATCHES PER UNIT EFFORT		PROPOSED 8/93	S/M	OECD			Y	Y
FISH RESOURCES	PRESSURES-FISH CATCHES		PROPOSED 8/93	S	OECD			Y	Y
FISH RESOURCES	CONDITIONS-SUSTAINABLE SPAWNING STOCKS		PROPOSED 8/93	M/L	OECD			Y	Y
FISH RESOURCES	CONDITIONS-OVERFISHED AREAS		PROPOSED 8/93	M/L	OECD			Y	Y
FISH RESOURCES	RESPONSES-NUMBER OF STOCKS REGULATED BY QUOTAS		PROPOSED 8/93	M	OECD			Y	Y
FISH RESOURCES	RESPONSES-EXPENDITURE FOR FISH STOCK MONITORING		PROPOSED 8/93	L/M	OECD			Y	Y
SOIL DEGRADATION-EROSION & DESERTIFICATION	PRESSURE-POTENTIAL AND ACTUAL USE OF SOIL FOR AGRICULTURE		PROPOSED 8/93	L	OECD			Y	Y
SOIL DEGRADATION-EROSION & DESERTIFICATION	PRESSURE-LAND USE CHANGES		PROPOSED 8/93	S	OECD			Y	Y
SOIL DEGRADATION-EROSION & DESERTIFICATION	CONDITIONS-DEGREE OF TOP SOIL LOSSES		PROPOSED 8/93	M	OECD			Y	Y

SOIL DEGRADATION-EROSION & DESERTIFICATION	RESPONSES-REHABILITATED AREAS		PROPOSED 8/93	M/L	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-POPULATION GROWTH AND DENSITY		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-GDP GROWTH		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-INDUSTRIAL PRODUCTION		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-ENERGY INTENSITY		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-STRUCTURE OF ENERGY SUPPLY		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-ROAD TRAFFIC VOLUMES		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	PRESSURES-ROAD VEHICLE STOCK		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	RESPONSES-ENVIRONMENTAL EXPENDITURE		PROPOSED 8/93	M	OECD			Y	Y
GENERAL INDICATORS	RESPONSES-PUBLIC OPINION		PROPOSED 8/93	S	OECD			Y	Y
GENERAL INDICATORS	RESPONSES-POLLUTION ABATEMENT AND CONTROL EXPENDITURE		PROPOSED 8/93	S	OECD			Y	Y
HEALTH	NUMBER OF COUNTRIES IN WHICH HEALTH FOR ALL IS CONTINUING TO RECEIVE ENDORSEMENT AS POLICY AT THE HIGHEST LEVEL	1	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	NUMBER OF COUNTRIES IN WHICH MECHANISMS FOR INVOLVING PEOPLE IN THE IMPLEMENTATION OF STRATEGIES ARE FULLY FUNCTIONING OR ARE BEING FURTHER DEVELOPED	2	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	PERCENTAGE OF GROSS NATIONAL PRODUCT SPENT ON HEALTH	3	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	PERCENTAGE OF THE NATIONAL HEALTH EXPENDITURE DEVOTED TO LOCAL HEALTH SERVICES	4	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	NUMBER OF COUNTRIES IN WHICH RESOURCES FOR PRIMARY HEALTH CARE ARE BECOMING MORE EQUITABLY DISTRIBUTED	5	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	AMOUNT OF INTERNATIONAL AID RECEIVED OR GIVEN FOR HEALTH	6	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	PERCENTAGE OF THE POP'N COVERED BY PRIMARY HEALTH CARE, WITH AT LEAST: SAFE WATER IN THE HOME, IMMUNISATION AGAINST....., LOCAL HEALTH SERVICES & % USING FAMILY PLANNING	7	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	PERCENTAGE OF NEWBORNS WEIGHING AT LEAST 2500 GRAMS AT BIRTH, AND THE PERCENTAGE OF CHILDREN WHOSE WEIGHT-FOR-AGE AND/OR WEIGHT-FOR-HEIGHT ARE ACCEPTABLE	8	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	INFANT MORTALITY RATE (IMR), MATERNAL MORTALITY RATE (MMR) AND PROBABILITY OF DYING BEFORE THE AGE OF 5 YEARS IN ALL IDENTIFIABLE SUBGROUPS	9	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	LIFE EXPECTANCY AT BIRTH, BY SEX, IN ALL IDENTIFIABLE SUBGROUPS	10	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	ADULT LITERACY RATE, BY SEX, IN ALL IDENTIFIABLE SUBGROUPS	11	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y
HEALTH	PER CAPITA GROSS NATIONAL PRODUCT	12	2ND GLOBAL HFA EVALUATION		WHO-2ND HEALTH FOR ALL EVALUATION			Y	Y

INPUT INDICATORS	DEMOGRAPHY-POPULATION TOTAL AND DENSITY BY POSTAL DISTRICT	D1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
INPUT INDICATORS	DEMOGRAPHY-MEAN HOUSEHOLD SIZE (OCCUPANTS PER DWELLING) BY POSTAL DISTRICT	D2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
INPUT INDICATORS	DEMOGRAPHY-LIFE EXPECTANCY IN YEARS BY WARD	D3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
PROCESS INDICATORS	TRANSPORT-EASE OF ACCESS TO DEMAND DESTINATION	T1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
PROCESS INDICATORS	TRANSPORT-DISTANCE TRAVELLED PER CAPITA BY MODE OF TRANSPORT	T2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
PROCESS INDICATORS	TRANSPORT-CAR OWNERSHIP PER 1000 HEAD OF POPULATION	T3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
PROCESS INDICATORS	TRANSPORT-DISTANCE TRAVELLED BY CAR PER CAPITA BY JOURNEY TYPE	T4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & CLIMATE CHANGE-SO2 EMISSIONS (TONNES)	AC1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & CLIMATE CHANGE-NOx EMISSIONS (TONNES)	AC2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & CLIMATE CHANGE-ANTHROPOGENIC (ie ENERGY RELATED CO2 EMISSIONS (TONNES CARBON)	AC3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & CLIMATE CHANGE-PRODUCTION OF OZONE DEPLETING CHEMICALS (LOCAL PRODUCTION+VOLUME IMPORTED-EXPORTED)	AC4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS CO CONCENTRATION IN URBAN AIR (ppb) EXCEEDS PERMITTED LEVEL	AH1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS NO2 CONCENTRATION IN URBAN AIR (ppb) EXCEEDS PERMITTED LEVEL	AH2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS GROUND LEVEL OZONE (O3) CONCENTRATION IN URBAN AIR (ppb) EXCEEDS PERMITTED LEVEL	AH3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS PAH IN URBAN AIR (ppb) EXCEEDS PERMITTED LEVEL	AH4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS SO2 CONCENTRATION IN URBAN AIR (ppb) EXCEEDS PERMITTED LEVEL	AH5	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS FINE PARTICULATE CONCENTRATION (pm 10; SMOKE) IN URBAN AIR (mg/m3) EXCEEDS PERMITTED LEVEL	AH6	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AIR QUALITY & HUMAN HEALTH-NUMBER OF DAYS GAMMA RADIATION IN URBAN AIR (BEQ/m3) EXCEEDS PERMITTED LEVEL	AH7	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AGGREGATES & MINERALS-PRIMARY AGGREGATE CONSUMPTION, TOTAL (TONNES PER ANNUM) AND TONNES PER UNIT OF CONSTRUCTION (MEASURED AS COST IN £)	AM1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	AGGREGATES & MINERALS-PRIMARY NON ENERGY MINERAL CONSUMPTION TOTAL (TONNES PER ANNUM) AND TONNES PER UNIT OUTPUT (PRODUCT PRODUCTION COST)	AM2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				

OUTPUT INDICATORS	ENERGY-TOTAL ENERGY CONSUMPTION RELATED TO UNIT PRODUCTIVITY (GIGA JOULES PER £K VALUE OF OUTPUT) BY ECONOMIC SECTOR	E1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	ENERGY-ENERGY EFFICIENCY: CO2 EMISSIONS PER GIGA JOULE	E2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	ENERGY-PER CAPITA PRIMARY ENERGY CONSUMPTION (MJ PER CAPITA)	E3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	ENERGY-PERCENTAGE PRIMARY ENERGY DEMAND MET BY RENEWABLE FUEL (NOT INCLUDING NUCLEAR)	E4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-LAND USE IN LMD (PERCENTAGE IN EACH CATEGORY PER YEAR)	LU1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-CHANGE (% AREA) IN "GREEN" LAND USE (GREEN=AGRICULTURE, OPEN SPACE, PARKS ETC.)	LU2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-CHANGE (% AREA) OF LAND CLASSED AS CONTAMINATED, DEGRADED OR DERELICT	LU3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-AREA IN EACH AGRICULTURAL LAND CAPABILITY CLASS	LU4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-NUMBER OF LISTED BUILDINGS IN EACH "AT RISK" CLASS	LU5	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-PERCENTAGE OF GREEN SPACE COVERED BY PROTECTED STATUS	LU6	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	LAND USE-URBAN FORESTRY INDEX (AREA UNDER FORESTRY X FOREST QUALITY)	LU7	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	SOCIOLOGICAL-AVERAGE HOUSEHOLD INCOME (£K/YR) RELATED TO NATIONAL AVERAGE	S1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	SOCIOLOGICAL-EDUCATION PROVISION; STAFF TO PUPIL RATIOS IN SECONDARY SCHOOLS	S2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	SOCIOLOGICAL-LEVELS OF CRIME: STANDARDISED HOUSEHOLD CONTENTS INSURANCE	S3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-INDUSTRIAL SOLID WASTE PRODUCTION: TOTAL (TONNES) AND TOTAL PER UNIT PRODUCTION	R1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-TOTAL HAZARDOUS SOLID WASTE PRODUCTION (TONNES)	R2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-MUNICIPAL WASTE PRODUCTION (KG PER CAPITA)	R3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-PERCENTAGE (BY WEIGHT) MUNICIPAL WASTE STREAM RECYCLED OR COMPOSTED	R4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-PERCENTAGE NON RECYCLED MUNICIPAL WASTE STREAM SUBJECT TO ENERGY RECOVERY	R5	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WASTE-PERCENTAGE MUNICIPAL WASTE STREAM LANDFILLED, DUMPED AT SEA OR INCINERATED WITHOUT ENERGY RECOVERY	R6	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-NUMBER OF DAYS PER YEAR SUB-STANDARD POTABLE WATER SUPPLIED BY WQZ	W1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-HOUSEHOLD CONSUMPTION (LITRES/DAY/PER CAPITA)	W2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				

OUTPUT INDICATORS	WATER-TOTAL CITY CONSUMPTION BY KEY ECONOMIC SECTORS AS A PERCENTAGE OF EFFECTIVE (50YR) DROUGHT RAINFALL	W3	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-ANNUAL DEEP GROUND WATER ABSTRATION TO RECHARGE RATIO	W4	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-MEAN CONCENTRATION OF SELECTED CONTAMINANTS IN GROUND WATER	W5	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-RIVER LENGTH IN EACH WATER CLASS INDEX (PERCENTAGE OF TOTAL RIVER LENGTH IN LMD)	W6	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-SEWAGE DISCHARGE TO FRESH WATER (BOD, TSS, DO)	W7	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-TOTAL INDUSTRIAL DISCHARGE LOAD (KG/DAY X IMPACT WEIGHTING) BY RIVER REACH	W8	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	WATER-TOTAL LOAD OF TOXIC MATERIALS IN RIVER SEDIMENTS (ppm X IMPACT WEIGHTING) BY RIVER REACH	W9	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	BIOTA & ECOLOGY-ABUNDANCE OF VIABLE KEY, THREATENED OR NATIONALLY IMPORTANT SPECIES	B1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	BIOTA & ECOLOGY-URBAN AMOEBA BASED ON PRE-DETERMINED ECOLOGICAL OBJECTIVE	B2	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
OUTPUT INDICATORS	QUALITY OF LIFE-SPECIFICALLY CONSTRUCTED URBAN QUALITY OF LIFE INDEX BASED ON EARLIER INDICATORS (AC THRO W)	Q1	INDICATOR SUITE 6/94		LEEDS QUANTIFIABLE CITY PROJECT	Y				
MATERIAL DEPRIVATION	DIETARY DEPRIVATION-AT LEAST ONE DAY IN LAST FORTNIGHT WITH INSUFFICIENT TO EAT	1.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DIETARY DEPRIVATION-NO FRESH MEAT OR FISH MOST DAYS OF WEEK (ALTERNATIVE FORMULATION FOR VEGETARIANS)	1.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DIETARY DEPRIVATION-NO SPECIAL MEAL OR ROAST MOST WEEKS	1.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DIETARY DEPRIVATION-NO FRESH FRUIT MOST DAYS	1.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DIETARY DEPRIVATION-SHORT OF FOOD ON AT LEAST ONE OCCASION IN LAST 12 MONTHS TO MEET NEEDS OF SOMEONE IN FAMILY	1.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-INADEQUATE FOOTWEAR FOR ALL WEATHERS	2.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-INADEQUATE PROTECTION AGAINST HEAVY RAIN	2.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-INADEQUATE PROTECTION AGAINST SEVERE COLD	2.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-NO DRESSING GOWN	2.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-FEWER THAN THREE PAIRS SOCKS/STOCKINGS IN GOOD REPAIR	2.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	CLOTHING DEPRIVATION-BOUGHT SECONDHAND CLOTHING IN LAST 12 MONTHS	2.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-NO EXCLUSIVE USE OF INDOOR WC AND BATH OR SHOWER	3.i	DEPRIVATION INDEX		P. TOWNSEND	Y				

MATERIAL DEPRIVATION	HOUSING DEPRIVATION-EXTERNAL STRUCTURAL DEFECTS	3.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-INTERNAL STRUCTURAL DEFECTS	3.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-NO ELECTRICITY	3.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-ALL ROOMS NOT HEATED WINTER EVENINGS	3.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-HOUSING NOT FREE OF DAMP	3.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-HOUSING NOT FREE OF INFESTATION	3.vii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-POOR STATE OF INTERNAL AND/OR EXTERNAL PAINTWORK AND DECORATION	3.viii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-POOR ACCESS TO ACCOMODATION	3.ix	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-OVERCROWDED (FEWER ROOMS-EXCLUDING KITCHEN AND BATHROOM-THAN PERSONS)	3.x	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	HOUSING DEPRIVATION-NO SPARE ROOM FOR VISITOR TO SLEEP	3.xi	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO CAR	4.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO TELEVISION	4.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO RADIO	4.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO WASHING MACHINE	4.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO REFRIGERATOR	4.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO FREEZER	4.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO ELECTRIC IRON	4.vii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO GAS OR ELECTRIC COOKER	4.viii	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO VACUUM CLEANER	4.ix	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO CENTRAL HEATING	4.x	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-NO TELEPHONE	4.xi	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	DEPRIVATION OF HOME FACILITIES-LACK OF CARPETING IN MAIN ROOMS	4.xii	DEPRIVATION INDEX		P. TOWNSEND	Y				

MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-NO GARDEN	5.i	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-NOWHERE FOR CHILDREN UNDER FIVE TO PLAY SAFELY OUTSIDE	5.ii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-NOWHERE FOR CHILDREN AGED FIVE TO TEN TO PLAY SAFELY NEARBY	5.iii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-INDUSTRIAL AIR POLLUTION	5.iv	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-OTHER FORMS OF AIR POLLUTION	5.v	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-RISK OF ROAD ACCIDENTS AROUND HOME	5.vi	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF ENVIRONMENT-PROBLEM OF NOISE FROM TRAFFIC, AIRCRAFT, BUILDING WORKS	5.vii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF LOCATION-NO OPEN SPACE (LIKE PARK OR HEATH) WITHIN EASY WALKING DISTANCE	6.i	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF LOCATION-NO RECREATIONAL FACILITIES FOR YOUNG PEOPLE OR OLDER ADULTS NEARBY	6.ii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF LOCATION-NO SHOPS FOR ORDINARY HOUSEHOLD GOODS WITHIN 10 MINUTES JOURNEY	6.iii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF LOCATION-PROBLEM OF LITTER AND DEBRIS IN LOCAL STREETS	6.iv	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION OF LOCATION-DOCTOR'S SURGERY OR HOSPITAL OUTPATIENTS' DEPARTMENT NOT WITHIN 10 MINUTES JOURNEY	6.v	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION AT WORK-POOR WORKING ENVIRONMENT (POLLUTED AIR, DUST, NOISE, VIBRATION AND HIGH OR LOW WORKING TEMPERATURE-MAXIMUM SCORE OF 9)	7.i	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION AT WORK-STANDS OR WALKS ABOUT MORE THAN THREE-QUARTERS OF THE WORKING DAY	7.ii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION AT WORK-WORKS 'UNSOCIAL HOURS'	7.iii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	DEPRIVATION AT WORK-EITHER POOR OUTDOOR AMENITIES OF WORK; OR POOR INDOOR AMENITIES AT WORK (MAXIMUM SCORE OF 10)	7.iv	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	ALTERNATIVE SERIES ON DEPRIVATION AT WORK (THOSE DOING >=20 HOURS UNPAID WORK PER WEEK)-REPEAT OF TOTAL SCORE FOR HOUSING DEPRIVATION	7a.i	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	ALTERNATIVE SERIES ON DEPRIVATION AT WORK (THOSE DOING >=20 HOURS UNPAID WORK PER WEEK)-NO CENTRAL HEATING	7a.ii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	ALTERNATIVE SERIES ON DEPRIVATION AT WORK (THOSE DOING >=20 HOURS UNPAID WORK PER WEEK)-NO TELEPHONE	7a.iii	DEPRIVATION INDEX		P. TOWNSEND	Y			
MATERIAL DEPRIVATION	ALTERNATIVE SERIES ON DEPRIVATION AT WORK (THOSE DOING >=20 HOURS UNPAID WORK PER WEEK)-WORKED 50 OR MORE HOURS IN LAST WEEK (UNPAID WORK BUT ALSO ANY PAID WORK)	7a.iv	DEPRIVATION INDEX		P. TOWNSEND	Y			

MATERIAL DEPRIVATION	INDUSTRIAL AIR POLLUTION AND OTHER FORMS OF AIR POLLUTION	7a.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
MATERIAL DEPRIVATION	ALTERNATIVE SERIES ON DEPRIVATION AT WORK (THOSE DOING >=20 HOURS UNPAID WORK PER WEEK)-REPEAT THE TOTAL SCORE FOR LOCATIONAL DEPRIVATION	7a.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-UNEMPLOYED FOR TWO WEEKS OR MORE DURING PREVIOUS 12 MONTHS	8.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-SUBJECT TO ONE WEEK'S TERMINATION OF EMPLOYMENT OR LESS	8.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-NO PAID HOLIDAY	8.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-NO MEALS PAID OR SUBSIDISED BY EMPLOYER	8.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-NO ENTITLEMENT TO OCCUPATIONAL PENSION	8.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-NOT ENTITLD TO FULL PAY IN FIRST SIX MONTHS OF SICKNESS	8.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF RIGHTS IN EMPLOYMENT-WORKED 50 OR MORE HOURS IN PREVIOUS WEEK	8.vii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-DIFFICULTIES INDOORS FOR CHILD TO PLAY	9.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-IF HAS CHILDREN, CHILD HAS NOT HAD HOLIDAY AWAY FROM HOME IN THE LAST 12 MONTHS	9.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-IF HAS CHILDREN, CHILD HAS NOT HAD OUTING DURING THE LAST 12 MONTHS	9.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-NO DAYS STAYING WITH FAMILY OR FRIENDS IN PREVIOUS 12 MONTHS	9.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-PROBLEM OF THE HEALTH OF SOMEONE IN FAMILY	9.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	DEPRIVATION OF FAMILY ACTIVITY-HAS CARE OF DISABLED OR ELDERLY RELATIVE	9.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-BEING ALONE AND ISOLATED FROM PEOPLE	10.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-RELATIVELY UNSAFE IN SURROUNDING STREETS	10.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-RACIAL HARASSMENT	10.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-EXPERIENCES DISCRIMINATION ON GROUNDS OF RACE, SEX, AGE, DISABILITY OR SEXUAL ORIENTATION	10.iv	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-IN ILLNESS NO EXPECTED SOURCE OF HELP	10.v	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-NOT A SOURCE OF CARE OR HELP TO OTHERS INSIDE OR OUTSIDE THE HOME	10.vi	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF INTEGRATION INTO COMMUNITY-MOVED HOUSE THREE OR MORE TIMES IN LAST FIVE YEARS	10.vii	DEPRIVATION INDEX		P. TOWNSEND	Y				

SOCIAL DEPRIVATION	LACK OF FORMAL PARTICIPATION IN SOCIAL INSTITUTIONS-DID NOT VOTE AT LAST ELECTION	11.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF FORMAL PARTICIPATION IN SOCIAL INSTITUTIONS-NO PARTICIPATION IN TRADE UNION OR STAFF ASSOCIATION, EDUCATIONAL COURSES, SPORT CLUBS/ASSOCIATIONS OR POLIT. PARTIES)	11.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	LACK OF FORMAL PARTICIPATION IN SOCIAL INSTITUTIONS-NO PARTICIPATION IN VOLUNTARY SERVICE ACTIVITIES	11.iii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	RECREATIONAL DEPRIVATION-NO HOLIDAY AWAY FROM HOME IN LAST 12 MONTHS	12.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	RECREATIONAL DEPRIVATION-FEWER THAN FIVE HOURS A WEEK OF SPECIFIED RANGE OF LEISURE ACTIVITIES	12.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	EDUCATIONAL DEPRIVATION-FEWER THAN 10 YEARS' EDUCATION	13.i	DEPRIVATION INDEX		P. TOWNSEND	Y				
SOCIAL DEPRIVATION	EDUCATIONAL DEPRIVATION-NO FORMAL QUALIFICATIONS FROM SCHOOL OR SUBSEQUENT EDUCATIONAL COURSES OR APPRENTICESHIPS	13.ii	DEPRIVATION INDEX		P. TOWNSEND	Y				
RESOURCE CONSUMPTION	ENERGY USE (IN BTUs?/KwH EQUIVALENT?/CO2 EQUIVALENT?/) PER CAPITA	1	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
RESOURCE CONSUMPTION	ENERGY USE PER UNIT OF ECONOMIC PRODUCTIVITY	2	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
RESOURCE CONSUMPTION	WATER USE PER CAPITA	3	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
RESOURCE CONSUMPTION	SOLID WASTE GENERATION PER CAPITA	4	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
RESOURCE CONSUMPTION	WEIGHT OF MATERIAL RECYCLED PER CAPITA	5	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
NATURAL ENVIRONMENT	SO2 LEVELS (NUMBER OF DAYS SAFE LEVEL (EC GUIDELINE) EXCEEDED)	6	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
NATURAL ENVIRONMENT	OZONE LEVELS (NUMBER OF DAYS SAFE LEVEL (EC GUIDELINE) EXCEEDED)	7	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				

NATURAL ENVIRONMENT	PERCENTAGE OF MILES OF RIVERS IN DISTRICT THAT ARE CLASS 1 (OR CLASS 4)	8	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
NATURAL ENVIRONMENT	NUMBER OF REPORTED WATER POLLUTION INCIDENTS PER YEAR (NRA FIGURES)	9	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
NATURAL ENVIRONMENT	ACRES OF IMPORTANT NATURAL HABITAT	10	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	PERCENTAGE OF CITIZENRY HOMELESS OR IN SHORT-TERM ACCOMMODATION	11	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	PERCENTAGE OF PEOPLE WHO REPORT BEING A VICTIM OF A CRIME	12	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	ABUSE AND NEGLECT CASES PER 1000 CITIZENS	13	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	POPULATION DENSITY	14	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	PERCENTAGE OF POPULATION THAT GARDENS/OR HAS ACCESS TO GARDENS	15	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	PERCENTAGE OF POPULATION THAT GIVE TIME OR MONEY TO COMMUNITY/VOLUNTARY GROUPS	16	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	LITERACY RATE	17	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
SOCIAL ENVIRONMENT	PERCENTAGE OF TEENAGERS IN HIGHER EDUCATION	18	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			

ECONOMY	UNEMPLOYMENT	19	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
ECONOMY	LENGTH OF TIME UNEMPLOYED	20	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
ECONOMY	PERCENTAGE OF PEOPLE LIVING BELOW POVERTY LEVEL	21	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
ECONOMY	NUMBER OF PEOPLE EMPLOYED IN 'TRADITIONAL' INDUSTRIES	22	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
ECONOMY	RATIO OF BUSINESS START-UPS TO BUSINESS FAILURES	23	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
TRANSPORT	PERCENTAGE OF POPULATION WITH ACCESS TO CAR	24	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
TRANSPORT	AVERAGE TRAVEL TIME BY MODE AND DISTANCE FOR SELECTED STARTING POINTS AND DESTINATIONS	25	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
TRANSPORT	VEHICLE MILES TRAVELLED PER CAPITA IN SINGLE/MULTIPLE OCCUPANCY VEHICLES	26	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
TRANSPORT	PERCENTAGE OF POPULATION LIVING WITHIN 400m OF BUS STOP	27	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
TRANSPORT	NUMBER OF BUSES IN SERVICE PER CAPITA	28	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			
HEALTH	PERCENTAGE OF INFANTS BORN WITH LOW BIRTH-WEIGHT	29	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y			

HEALTH	NUMBER OF GPs PER CAPITA	30	POTENTIAL INDICATORS LIST		UNITED NATIONS ASSOCIATION-MEASURING SUSTAINABILITY	Y				
ENVIRONMENT	WILD SALMON RUNS THROUGH LOCAL STREAMS	1	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENT	BIODIVERSITY IN THE REGION (SPECIFIC INDICATORS SPECIES TO BE IDENTIFIED AND INDICATOR TO BE DEVELOPED)	2	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENT	NUMBER OF DAYS PER YEAR AIR QUALITY FAILS TO MEET AIR QUALITY STANDARDS	3	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENT	AMOUNT OF TOPSOIL LOST IN KING COUNTY	4	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENT	ACRES OF WETLANDS REMAINING IN KING COUNTY	5	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENT	PERCENTAGE OF SEATTLE STREETS MEETING "PEDESTRIAN-FRIENDLY" CRITERIA	6	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	TOTAL POPULATION OF KING COUNTY (WITH ANNUAL GROWTH RATE)	7	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	GALLONS OF WATER CONSUMED PER CAPITA	8	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	TONS OF SOLID WASTE GENERATED AND RECYCLED PER CAPITA PER YEAR	9	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	VEHICLE MILES TRAVELED PER CAPITA AND GASOLINE CONSUMPTION PER CAPITA	10	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	RENEWABLE AND NONRENEWABLE ENERGY (IN BTUs) CONSUMED PER CAPITA	11	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	ACRES OF LAND PER CAPITA FOR A RANGE OF LAND USES (RESIDENTIAL, COMMERCIAL, OPEN SPACE, TRANSPORTATION, WILDERNESS)	12	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	AMOUNT OF FOOD GROWN IN WASHINGTON, FOOD EXPORTS, AND FOOD IMPORTS	13	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
POPULATION AND RESOURCES	EMERGENCY ROOM USE FOR NON-EMERGENCY PURPOSES	14	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	PERCENTAGE OF EMPLOYMENT CONCENTRATED IN THE TOP TEN EMPLOYERS	15	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	HOURS OF PAID EMPLOYMENT AT THE AVERAGE WAGE THAT WOULD BE REQUIRED TO SUPPORT BASIC NEEDS	16	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	REAL UNEMPLOYMENT, INCLUDING DISCOURAGED WORKERS, WITH DIFFERENTIATION BY ETHNICITY AND GENDER	17	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	DISTRIBUTION OF PERSONAL INCOME, WITH DIFFERENTIATION BY ETHNICITY AND GENDER	18	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	AVERAGE SAVINGS RATE PER HOUSEHOLD	19	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	RELIANCE ON RENEWABLE OR LOCAL RESOURCS IN THE ECONOMY (SPECIFIC INDICATOR TO BE DEVELOPED)	20	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				

ECONOMY	PERCENTAGE OF CHILDREN LIVING IN POVERTY	21	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	PERCENTAGE OF CITIZENRY THAT CAN AFFORD ADEQUATE HOUSING	22	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ECONOMY	PER CAPITA HEALTH EXPENDITURES	23	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENTAGE OF INFANTS BORN WITH LOW BIRTHWEIGHT (INCLUDING DISAGGREGATION BY ETHNICITY)	24	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	ETHNIC DIVERSITY OF TEACHING STAFF IN ELEMENTARY AND SECONDARY SCHOOLS	25	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	NUMBER OF HOURS PER WEEK DEVOTED TO INSTRUCTION IN THE ARTS FOR ELEMENTARY AND SECONDARY SCHOOLS	26	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENT OF PARENT/GUARDIAN POPULATION THAT IS INVOLVED IN SCHOOL ACTIVITIES	27	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	JUVENILE CRIME RATE	28	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENT OF YOUTH PARTICIPATING IN SOME FORM OF COMMUNITY SERVICE	29	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENT OF ENROLLED 9TH GRADERS WHO GRADUATE FROM HIGH SCHOOL (BY ETHNICITY, GENDER, AND INCOME LEVEL)	30	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENTAGE OF POPULATION VOTING IN ODD-YEAR (LOCAL) PRIMARY ELECTIONS	31	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	ADULT LITERACY RATE	32	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	AVERAGE NUMBER OF NEIGHBOURS THE AVERAGE CITIZEN REPORTS KNOWING BY NAME	33	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	EQUITABLE TREATMENT IN THE JUSTICE SYSTEM (SPECIFIC INDICATOR TO BE DEVELOPED)	34	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	RATIO OF MONEY SPENT ON DRUG AND ALCOHOL PREVENTION AND TREATMENT TO MONEY SPENT ON INCARCERATION FOR DRUG AND ALCOHOL RELATED CRIMES	35	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENTAGE OF POPULATION THAT GARDENS	36	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	USAGE RATES FOR LIBRARIES AND COMMUNITY CENTRES	37	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PARTICIPATION IN THE ARTS	38	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	PERCENT OF ADULT POPULATION DONATING TIME TO COMMUNITY SERVICE	39	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
CULTURE AND SOCIETY	INDIVIDUAL SENSE OF WELL BEING	40	DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
HEALTH BALANCE	HUMAN GROWTH-BIRTHWEIGHT		DRAFT INDICATOR LIST 6/93		SUSTAINABLE SEATTLE	Y				
ENVIRONMENTAL QUALITY	STEEPNESS OF SLOPE (% SLOPE)	1	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y				

ENVIRONMENTAL QUALITY	RUGGEDNESS OF TOPOGRAPHY	2	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	MONOTOMY OF LANDSCAPE	3	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	NATURAL DRAINAGE (NO. OF SWAMPS)	4	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	EROSION OF RIVER BANKS	5	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	RIVER SCENERY	6	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PROVISION OF DRAINAGE FACILITIES	7	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	SEVERITY OF STREET EROSION (AVERAGE CROSS-SECTIONAL AREA OF GULLIES IN m2)	8	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	RIVER WATER POLLUTION	9	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	FREQUENCY OF STREET FLOODING (NO. OF POINTS WITH >6 HOUR FLOOD PONDAGE)	10	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	SEDIMENTATION ON STREETS (NO. OF POINTS)	11	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	VISTAS	12	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	APPEARANCE OF NEIGHBOURHOOD SOILS	13	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	SURFACE SOIL TEXTURAL CLASS (% SURFACE STONINESS)	14	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	OVERALL CLIMATE (ROOM TEMPERATURE IN `C)	15	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	AIR QUALITY	16	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	RODENT INFESTATION (% HOUSES INFESTED)	17	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ANT/COCKROACH INFESTATION (% HOUSES INFESTED)	18	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	MOSQUITO NUISANCE	19	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ARCHITECTURAL DESIGNS (RATIO OF COMMON TO UNIQUE DESIGNS)	20	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	SCENIC BEAUTY	21	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ATTRACTIVENESS OF BUILDING COLOURS (RATIO OF DULL TO BRIGHTLY COLOURED BUILDINGS)	22	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	COMPATIBILITY OF BUILDING COLOURS	23	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			

ENVIRONMENTAL QUALITY	AGE OF BUILDINGS (IN YEARS)	24	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDINGS OF HISTORIC IMPORTANCE (NO. OF SUCH BUILDINGS)	25	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING DECORATIONS (% BUILDINGS WITH FANCIFUL DECORATIONS)	26	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PRESENCE OF RECREATIONAL PARKS/GARDENS	27	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PRESENCE OF ORNAMENTAL PLANTS/TREES (% COMPOUNDS WITH)	28	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	COMBINATION OF LANDSCAPE FEATURES	29	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	TIDINESS OF NEIGHBOURHOODS/STREETS (NO. OF OVERGROWN PLOTS)	30	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	OVERALL HEALTHINESS OF NEIGHBOURHOOD	31	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	EFFECTIVENESS OF WASTE DISPOSAL (% BINS OVERFLOWING WITH RUBBISH)	32	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING CONSTRUCTION MATERIAL (DOMINANT WALL MATERIAL TYPE)	33	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING STRENGTH/FOUNDATION (DOMINANT FOUNDATION MATERIAL TYPE)	34	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	LEVEL OF MAINTENANCE OF HOUSING SHELL (RATIO OF FAULTS TO REPAIRS IN LAST 2 YEARS)	35	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	HOUSE VENTILATION (AVERAGE NO. OF WINDOWS PER ROOM)	36	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PLANNING STANDARDS	37	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING TYPES (% DETACHED SINGLE FAMILY DWELLINGS)	38	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	EXCLUSIVENESS OF BUILDINGS (WALL-TO-WALL DISTANCE BETWEEN BUILDINGS)	39	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ADEQUACY OF KITCHEN FACILITIES (% BUILDINGS WITH PRIVATE KITCHEN)	40	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ADEQUACY OF TOILET FACILITIES (% BUILDINGS WITH PIT TOILET)	41	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ADEQUACY OF COMMUNICATION FACILITIES (% BUILDINGS WITH TELEPHONES)	42	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING PLOTS (% OF DEVELOPED PLOTS)	43	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	MONOTONY OF BUILDING TYPES	44	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	AMOUNT GREENERY (AVERAGE % GREEN COVER WITHIN COMPOUNDS)	45	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			

ENVIRONMENTAL QUALITY	EVIDENCE OF LANDSCAPING	46	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PRESENCE OF OPEN SPACES	47	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	LEVEL OF ROAD MAINTENANCE (NO. OF POTHOLES PER KILOMETRE OF ROAD)	48	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	DOMINANT ROAD CONDITIONS	49	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	BUILDING DENSITY/CLUSTERING (NO. OF BUILDINGS PER KILOMETRE OF STREET)	50	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	NEIGHBOURHOOD NOISE LEVEL	51	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	POPULATION DENSITY/CROWDING (AVERAGE NO. OF PERSONS PER ROOM)	52	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	VEHICLE TRAFFIC FLOW (PEAK COUNT PER HOUR)	53	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	LAND-USE COMPATIBILITY	54	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	LAND-USE TYPE	55	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	FRIENDLINESS OF NEIGHBOURS	56	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	NEIGHBOURHOOD FEELINGS	57	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	CRIME (REPORTED CASES IN 1988)	58	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	RESIDENTS' SOCIAL STATUS (AVERAGE ANNUAL INCOME IN THOUSANDS OF NAIRA)	59	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	COMPATIBILITY OF NEIGHBOURS	60	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	NEIGHBOURHOOD SYMBOLS	61	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	MIGRANT STATUS (% MIGRANTS)	62	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	HOUSEHOLD SIZE (AVERAGE NUMBER OF PERSONS)	63	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ACCESSIBILITY TO PRIMARY SCHOOL (AVERAGE DISTANCE IN KM)	64	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ACCESSIBILITY TO HEALTH FACILITIES (AVERAGE DISTANCE IN KM)	65	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	ACCESSIBILITY TO MARKETS (AVERAGE DISTANCE IN KM)	66	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			
ENVIRONMENTAL QUALITY	PRESENCE OF COMMUNITY HALL	67	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR- BENIN CITY, NIGERIA	Y			

ENVIRONMENTAL QUALITY	PRESENCE OF SACRED PLACES	68	AGGREGATE ENV'TAL INDEX		ODEMERHO & CHOKOR-BENIN CITY, NIGERIA	Y			
HEALTH	NUTRITION-% OBESE/MALNOURISHED		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	NUTRITION-% DAILY INTAKE OF FAT,FIBRE,VITAMINS,SALT,SUGAR		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	NUTRITION-% BLOOD TOTAL CHOLESTEROL <200mg/dl		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	PHYSICAL ACTIVITY-% UNDERGOING VIGOROUS EXERCISE THREE TIMES PER WEEK		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	PHYSICAL ACTIVITY-% WHO CAN SWIM 100m/RUN 400m IN THREE MINUTES		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	DRUGS-% SMOKERS/NON-SMOKERS/EX-SMOKERS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	DRUGS-% CONSUME MORE THAN 5 ALCOHOLIC DRINKS PER DAY		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	DRUGS-% ABUSE MEDICINES/GLUE SNIFFING		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	TRANSPORT-% MOTORCYCLE USERS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	TRANSPORT-% CRASH HELMET AND SEATBELT USE		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	TRANSPORT-% DRINK AND DRIVE/EXCEED SPEED LIMITS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	DENTAL HEALTH-% VISITING DENTIST ONCE A YEAR		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	DENTAL HEALTH-% OWN TOOTHBRUSH/CLEAN TEETH DAILY		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% BREAST FEEDING AT ONE MONTH		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	

HEALTH	REPRODUCTION-% BIRTH WEIGHT >2500g		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% RECEIVING ANTENATAL CARE BY 16 WEEKS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% CONTRACEPTIVE USE OF SEXUALLY ACTIVE WISHING TO AVOID PREGNANCY		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% TEENAGERS PREGNANT		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% PREGNANCIES SCREENED FOR NEURAL TUBE DEFECTS/DOWN'S SYNDROME		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% NEONATES SCREENED FOR PHENYLKETONURIA,CONGENITAL HYPOTHYROIDISM,PHYSICAL ABNORMALITIES		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	REPRODUCTION-% BIRTHS TO SINGLE PARENT FAMILIES		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	INFECTIOUS DISEASE-% IMMUNISATION UPTAKE		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	INFECTIOUS DISEASE-% SEXUALLY TRANSMITTED DISEASE AND TUBERCULOSIS CASES WITH CONTACT TRACING		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% AGED OVER 35 SCREENED FOR HYPERTENSION IN LAST FIVE YEARS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% BLOOD PRESSURE >95mm Hg DIASTOLIC		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% WOMEN AGED 35-60 WITH CERVICAL SMEAR IN LAST FIVE YEARS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% WOMEN PRACTISING REGULAR BREAST SELF EXAMINATION		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% AGED OVER 75 WHO HAVE HAD 'HEALTH VISIT' IN THE LAST YEAR		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	SCREENING-% FIVE YEAR OLDS SCREENED FOR SENSORY/DEVELOPMENTAL DEFECTS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	

HEALTH	ACTIVITIES OF HEALTH\EDUCATION AUTHORITIES-% POPULATION AT RISK OFFERED FAMILY PLANNING/CERVICAL SMEARS/ANTENATAL CARE/CHILDHOOD SCREENING/BLOOD PRESSURE MEASUREMENT.....		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	ACTIVITIES OF HEALTH\EDUCATION AUTHORITIES-PREVENTIVE SERVICES TO POPULATION RATIOS:EG. HEALTH VISITING/GENERAL PRACTITIONERS/FACTORY INSPECTORS/EHOs/ROAD SAFETY OFFICERS		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% CONSIDER HEALTH AS A VALUABLE ASSET		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% UNDERSTAND BASIC HEALTH ISSUES (SMOKING, DIET, SXERCISE, ETC.)		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% KNOW BASIC FIRST AID, LIFE SAVING,ROAD SAFETY, ACCIDENT PREVENTION		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% CONSIDER THEMSELVES TO BE IN GOOD HEALTH, FIT, SLEEPING WELL		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% SEEKING TO CHANGE THEIR LIFE-STYLE (SMOKING, DIET, EXERCISE, ETC.)		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
HEALTH	HEALTH KNOWLEDGE/BELIEFS-% SATISFIED WITH HEALTH PROMOTION SERVICES		1983 INDICATOR LIST		J. CATFORD-WESSEX REGIONAL HEALTH AUTHORITY	Y	Y	Y	
SOCIAL	EDUCATION AND LITERACY-NET PRIMARY SCHOOL ENROLMENT RATIO FOR GIRLS	1	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	EDUCATION AND LITERACY-NET PRIMARY SCHOOL ENROLMENT RATIO FOR BOYS	2	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	EDUCATION AND LITERACY-FEMALE ILLITERACY RATE	3	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	EDUCATION AND LITERACY-MALE ILLITERACY RATE	4	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	WORK AND UNEMPLOYMENT-RATE OF UNEMPLOYMENT	5	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	CONSUMPTION-AVERAGE CALORIE SUPPLY AS A PERCENTAGE OF REQUIREMENTS	6	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	

SOCIAL	CONSUMPTION-PERCENTAGE OF THE POPULATION WITH ACCESS TO SAFE DRINKING WATER	7	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	CONSUMPTION-TELEPHONES IN USE PER THOUSAND PEOPLE	8	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	DISTRIBUTION OF INCOME AND WEALTH-HOUSEHOLD INCOME RECEIVED BY THE TOP 20 PER CENT DIVIDED BY THE INCOME RECEIVED BY THE BOTTOM 20 PER CENT	9	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	HEALTH-INFANT MORTALITY RATE	10	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
SOCIAL	HEALTH-UNDER-FIVE MORTALITY RATE	11	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
ENVIRONMENTAL	TROPICAL DEFORESTATION-DEFORESTATION IN SQUARE KILOMETRES PER YEAR	12	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
ENVIRONMENTAL	GREENHOUSE EFFECT-CARBON DIOXIDE EMISSIONS FROM FOSSIL FUEL USE, IN MILLIONS OF METRIC TONS PER YEAR	13	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
ENVIRONMENTAL	POPULATION-AVERAGE ANNUAL PERCENTAGE RATE OF INCREASE IN POPULATION	14	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
ENVIRONMENTAL	LONG-TERM RISK-NUMBER OF OPERABLE NUCLEAR REACTORS	15	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
ENVIRONMENTAL	ENERGY INTENSITY-ENERGY CONSUMPTION (IN TONS OF OIL EQUIVALENT) PER MILLION DOLLARS OF GDP	16	PROPOSED 1991		V.ANDERSON-ALTERNATIVE ECONOMIC INDICATORS	Y	Y	Y	
THEME INDICATORS	CHANGE OF CLIMATE-EMISSIONS OF CO2, CH4, N2O, PRODUCTION OF CFCs (11, 12, 113, 114, 115) AND HALONS (1211, 1301)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
THEME INDICATORS	DEPLETION OF THE OZONE LAYER-PRODUCTION OF CFCs (11, 12, 13, 113, 114, 115) AND HALONS (1211, 1301)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
THEME INDICATORS	ACIDIFICATION OF THE ENVIRONMENT-DEPOSITION OF SO2, NOx & NH3		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
THEME INDICATORS	EUTROPHICATION OF THE ENVIRONMENT-PHOSPHORUS & NITROGEN IN THE WASTE STREAM (MANURE/FERTILISER APPLICATION, DUMPING-DREDGE SPOIL/SOLID WASTE/SEWAGE SLUDGE, WASTEWATER DISCHARGE		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
THEME INDICATORS	DISPERSION OF TOXIC SUBSTANCES-AGRICULTURAL & OTHER PESTICIEDS, PRIORITY SUBSTANCES, RADIOACTIVE SUBSTANCES		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	

THEME INDICATORS	DISPOSAL OF SOLID WASTE-EQUIVALENTS BY CATEGORY (BUILDING, INDUSTRIAL, DOMESTIC, REST, RETAIL, AGRICULTURAL		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
THEME INDICATORS	DISTURBANCE OF LOCAL ENVIRONMENTS-THOSE AFFECTED BY NOISE AND/OR ODOUR		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	AGRICULTURE-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO ACIDIFICATION (NH3), EUTROPHICATION (N & P) AND DISPERSION		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	TRAFFIC AND TRANSPORT-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CO2), ACIDIFICATION (NOx) AND DISTURBANCE (NOISE & ODOUR NUISANCE)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	INDUSTRY-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CO2), ACIDIFICATION (NOx & SO2) AND DISPOSAL (INDUSTRIAL & CHEMICAL WASTE)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	ENERGY SECTOR-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CO2), ACIDIFICATION (NOx & SO2) AND DISPOSAL (STORED FLY ASH AND RADIOACTIVE WASTE)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	REFINERIES-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CO2) AND ACIDIFICATION (SO2)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	BUILDING TRADE-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CFCs-11 & 113) AND DISPOSAL (DUMPED BUILDING AND DEMOLITION WASTE)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
TARGET GROUP INDICATORS	CONSUMERS-ENVIRONMENTAL PRESSURE:CONTRIBUTION TO CHANGE OF CLIMATE (CO2), ACIDIFICATION (NOx) AND DISPOSAL (DUMPED MUNICIPAL AND BULKY MUNICIPAL WASTE)		1993-INDICATORS		A.ADRIAANSE-ENV'TAL POLICY PERFORMANCE INDICATORS			Y	
HEALTH	MORTALITY:ALL CAUSES (ANNUAL MORTALITY RATE:ALL CAUSES, ACCORDING TO AGE GROUP - RATE PER 100000)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
HEALTH	CAUSE OF DEATH (ANNUAL MORTALITY RATEPER CAUSE OF DEATH STUDIED - RATE PER 100000)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
HEALTH	LOW BIRTH RATE (PERCENTAGE OF CHILDREN WEIGHING 2.5KG OR LESS THAN 2.5KG AT BIRTH - RATE PER 100000)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	ATMOSPHERIC POLLUTION (NO2, CO, O3-NUMBER OF HOURS PER YEAR; SO2, DUST, LEAD-NUMBER OF DAYS PER YEAR-ABOVE THE LIMIT DIVIDED BY THE TOTAL NUMBER OF HOURS/DAYS PER YEAR VALIDLY MEASURED)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	MICROBIOLOGICAL QUALITY OF THE WATER SUPPLY (PERCENTAGE OF MEASUREMENTS EXCEEDING THE RECOMMENDED WHO GUIDELINES)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	CHEMICAL QUALITY OF THE WATER SUPPLY (CHEMICAL QUALITY OF THE WATER DISTRIBUTED BY THE CITY-NITRATES, FLUORINE, BENZENE, CHLORDANE)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y

ENVIRONMENT	PERCENTAGE OF WATER POLLUTANTS REMOVED FROM TOTAL SEWAGE PRODUCED (LEVEL OF LINK-UP TO NETWORK/PURIFICATION STATION EFFICIENCY LEVEL/UNIT, NETWORK OR WASTE WATER OVERFLOW LEVEL)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	HOUSEHOLD WASTE COLLECTION QUALITY INDEX (QUALITY IN RELATION TO TYPE OF COLLECTING SYSTEM-LOOSE/IN SEALED CONTAINER/HOME SELECTION/IN PLASTIC BAGS/VOLUNTARY SELECTION-% PER CATEGORY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	HOUSEHOLD WASTE TREATMENT QUALITY INDEX (TYPE OF TREATMENT USED-ROUGH LANDFILL/SANITARY LANDFILL/INCINERATION WITH/WITHOUT HEAT RECOVERY/COMPOSTING/SORTING CENTRE, RECYCLING-% PER CAT.)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	POLLUTION LEVEL INDICATOR AS PERCEIVED BY THE POPULATION (NATURE AND DEGREE OF POLLUTION PERCEIVED BY THE POPULATION)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	QUANTITY OF DRINKING-WATER USED PER INHABITANT PER DAY		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	RELATIVE SURFACE AREA OF GREEN SPACES IN THE CITY (PERCENTAGE OF THE SURFACE AREA OF GREEN SPACES RELATIVE TO THE SURFACE AREA OF THE CITY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	PUBLIC ACCESS TO GREEN SPACES (SURFACE AREA OF GREEN SPACES PER INHABITANT TO BE OPENED TO THE PUBLIC)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	DERELICTED INDUSTRIAL SITES (PERCENTAGE OF DERELICTED INDUSTRIAL SITES COMPARED TO THE TOTAL SURFACE AREA OF THE CITY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	SPORT AND LEISURE (NUMBER OF SPORTS FACILITIES PER 1000 INHABITANTS)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	PEDESTRIAN STREETS (TOTAL LENGTH OF PEDESTRIAN STREETS DIVIDED BY SURFACE AREA OF THE CITY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	PUBLIC TRANSPORT (NUMBER OF SEATS ON PUBLIC TRANSPORT PER 1000 INHABITANTS)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	PUBLIC TRANSPORT NETWORK COVER (NUMBER OF KILOMETRES SERVED BY PUBLIC TRANSPORT COMPARED TO THE TOTAL NUMBER OF KILOMETRES OF STREETS IN THE CITY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
ENVIRONMENT	EMERGENCY SERVICES (FIRE SERVICE AND OTHER EMERGENCY SERVICES-NUMBER PER 1000 INHABITANTS)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	NUMBER OF m3 OF LIVING SPACE PER INHABITANT (LIVING SPACE PER INHABITANT IN EACH DISTRICT, OR PART OF CITY)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF POPULATION LIVING IN SUBSTANDARD DWELLINGS (IE DWELLINGS WHICH DO NOT HAVE EXCLUSIVE USE OF TOILET AND BATH OR SHOWER/TAP WATER INSIDE THE DWELLING)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y

SOCIO-ECONOMIC	ESTIMATED NUMBER OF HOMELESS PEOPLE (NUMBER OF PEOPLE HAVING NO HOUSING [NOT INCLUDING PEOPLE WHO LIVE IN MOBILE HOMES])		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	UNEMPLOYMENT RATE (PERCENTAGE OF THE WORKING POPULATION WHICH IS UNEMPLOYED)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	WORK ABSENTEEISM RATE (NUMBER OF DAYS PER YEAR NOT WORKED FOR HEALTH REASONS, COMPARED TO THE TOTAL NUMBER OF WORKED DAYS PER YEAR)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF FAMILIES BELOW THE NATIONAL POVERTY LEVEL (PERCENTAGE OF HOUSEHOLDS LIVING UNDER THE NATIONAL POVERTY THRESHOLD)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF TOTAL EMPLOYMENT PROVIDED BY THE TEN MOST IMPORTANT ECONOMIC ACTIVITIES		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF ONE-PERSON HOUSEHOLDS (HOUSEHOLD:OCCUPANTS OF MAIN RESIDENCE, WHETHER OR NOT. A HOUSEHOLD MAY BE MADE UP OF JUST ONE PERSON.)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF SINGLE PARENT FAMILIES (PART OF HOUSEHOLD COMPRISING AT LEAST TWO PEOPLE:EITHER A COUPLE, UN\MARRIED, ANY UNMARRIED CHILDREN AGED LESS THAN 25 OR SINGLE PARENT & CHILD)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF CHILDREN LEAVING SCHOOL AFTER COMPULSORY EDUCATION (NUMBER OF PUPILS AT SCHOOL DURING THE YEAR FOLLOWING COMPULSORY EDUCATION/NUMBER DURING LAST COMPULSORY YEAR)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	ILLITERACY RATE (THE FACT OF BEING UNABLE TO MASTER READING OR WRITING IN THE OFFICIAL LANGUAGE OF THE COUNTRY OF RESIDENCE)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF CITY'S BUDGET ALLOCATED TO HEALTH AND SOCIAL ACTIONS		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	CRIME RATE (DEFINITIONS OF CRIME VARY - NUMBER OF OFFENCES PER 1000)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF DWELLINGS FOR ELDERLY PEOPLE THAT HAVE EMERGENCY CALL FACILITIES (PERCENTAGE OF RESIDENCES HOUSING ELDERLY PEOPLE AGED OVER 65 EQUIPPED WITH A TELEALARM SYSTEM)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	MAIN CAUSES FOR EMERGENCY CALLS (ALL TELEPHONE CALLS RECEIVED BY THE MAIN 24 HOUR EMERGENCY SERVICES-POLICE, FIRE BRIGADE, AMBULANCE, SAMARITANS, TOWN HALL, CHILDLINE.....)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF YOUNG CHILDREN ON WAITING LISTS FOR CHILD CARE FACILITIES (% OF CHILDREN BELOW COMPULSORY SCHOOLING AGE WHOSE REQUEST FOR A CHILD CARE PLACE HAS NOT BEEN POSITIVELY MET)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	MEDIAN AGE OF WOMEN GIVING BIRTH FOR THE FIRST TIME (NOT FIRST PREGNANCIES)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y

SOCIO-ECONOMIC	ABORTION RATE IN RELATION TO TOTAL NUMBER OF BIRTHS (PERCENTAGE OF TOTAL NUMBER OF ABORTIONS AND MISCARRIAGES IN RELATION TO TOTAL NUMBER OF BIRTHS)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF PEOPLE UNDER 18 'UNDER POLICE SURVEILLANCE' (REFER TO COURT ORDERS FOR JUVENILES FOR: DETENTION, PROBATION, SURVEILLANCE OR SIMILAR JUDICIAL MEASURES)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
SOCIO-ECONOMIC	PERCENTAGE OF DISABLED PEOPLE IN EMPLOYMENT COMPARED TO TOTAL NUMBER OF DISABLED PEOPLE OF WORKING AGE (BETWEEN 18 AND 65) (INCLUDING PEOPLE IN PROECTED WORKSHOP EMPLOYMENT-UNPAID\PAID)		HEALTHY CITY INDICATORS		WHO-HEALTH FOR ALL	Y			Y
TRANSPORT	CURRENT STATUS INDICATORS REFLECTING REGIONAL INFRASTRUCTURE ENDOWMENTS-LENGTH OF MOTORWAYS PER 100000 INHABITANTS		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
TRANSPORT	PERFORMANCE INDICATORS RELATING TO QUALITY OF SERVICE-SURFACE OF ROAD NETWORK PER 1000km2		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
TRANSPORT	RESOURCE INDICATORS REFLECTING LEVELS OF INVESTMENTS-INVESTMENT IN TRANS-EC ROAD NETWORK AS A PERCENTAGE OF GDP		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENERGY	CURRENT STATUS OF INFRASTRUCTURE-PERCENTAGE OF HOUSEHOLDS CONNECTED TO GAS		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENERGY	QUALITY OF SERVICE:CONSUMPTION, EFFICIENCY, DIVERSIFICATION AND AIR POLLUTION-SHARE OF SOLID FUELS IN TOTAL NET ENERGY PRODUCTION		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENERGY	QUALITY OF SERVICE:CONSUMPTION, EFFICIENCY, DIVERSIFICATION AND AIR POLLUTION-SULPHUR DIOXIDE EMISSIONS FROM POWER STATIONS PER MEGAWATT OF ELECTRICITY PRODUCED		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENERGY	INVESTMENT IN SECTOR-GROSS INVESTMENT IN PRODUCTION AND DISTRIBUTION INFRASTRUCTURE		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
WATER SUPPLY	CURRENT STATUS:REFLECTING REGIONAL ENDOWMENT OF SUPPLY INFRASTRUCTURE-PER CAPITA ABSTRACTION OF WATER RESOURCES FOR ALL USES		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
WATER SUPPLY	QUALITY OF SERVICE PROVIDED BY AVAILABLE INFRASTRUCTURE-PERCENTAGE OF PEOPLE RECEIVING DRINKING WATER COMPLYING WITH EC DIRECTIVES		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
WATER SUPPLY	INVESTMENT IN INFRASTRUCTURE-GROSS INVESTMENT IN WATER SUPPLY INFRASTRUCTURE PER CAPITA AS A PERCENTAGE OF GDP		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENVIRONMENT	CURRENT STATUS OF REGIONAL ENDOWMENT OF INFRASTRUCTURE-RATIO OF TOTAL WASTE WATER ARISINGS REQUIRING TREATMENT TO TOTAL CAPACITY OF WASTE WATER TREATMENT PLANTS		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
ENVIRONMENT	QUALITY OF SERVICE PROVIDED BY AVAILABLE INFRASTRUCTURE-PERCENTAGE OF SEA WATER BATHING AREAS MEETING EC STANDARDS		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y

ENVIRONMENT	INVESTMENT IN ENVIRONMENTAL INFRASTRUCTURE-GROSS INVESTMENT IN WASTE WATER COLLECTION SYSTEMS AND TREATMENT INFRASTRUCTURE AS A PERCENTAGE OF GDP		PROPOSED 1993		CEC-PROGRAMME AND PROJECT INDICATORS				Y
CRITICAL ELEMENTS OF SUSTAINABILITY	HUMAN DEVELOPMENT INDEX		PILOT INDICATORS 5/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	GDP PER CAPITA IN REAL TERMS PPP (US$)		PILOT INDICATORS 5/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	INCOME SHARE:RATIO OF THE HIGHEST 20% OF HOUSEHOLDS TO THE LOWEST 20%		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	CONSUMPTION OF ENERGY PER CAPITA AND PER UNIT OF GDP (TONNES OF OIL EQUIVALENT)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	CONSUMPTION OF TIMBER (TONNES PER CAPITA)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	DEPLETION INDEX OF FOSSIL FUELS AND OTHER MINERAL RESOURCES (% OF PROVEN RESERVES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	AVERAGE CALORIE CONSUMPTION PROPORTION OF MINIMUM REQUIREMENTS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	ANNUAL RATE OF POPULATION GROWTH (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
CRITICAL ELEMENTS OF SUSTAINABILITY	POPULATION LIVING IN ABSOLUTE POVERTY:TOTAL (NO.) AND PROPORTION OF THE TOTAL (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
FINANCIAL RESOURCES AND MECHANISMS	OVERSEAS DEVELOPMENT ASSISTANCE GIVEN OR RECEIEVD AS % GDP (US$)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
FINANCIAL RESOURCES AND MECHANISMS	DEBT/SERVICE RATIO (DEBT SERVICE AS % OF EXPORT EARNINGS)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
FINANCIAL RESOURCES AND MECHANISMS	MILITARY EXPENDITURE AS A PROPORTION OF GDP (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
FINANCIAL RESOURCES AND MECHANISMS	GROSS DOMESTIC SAVINGS AS A PROPORTION OF GDP (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
EDUCATION, SCIENCE, TECHNOLOGY ETC TRANSFER	NET PRIMARY AND SECONDARY SCHOOL ENROLMENT RATES:TOTAL/FEMALE (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
EDUCATION, SCIENCE, TECHNOLOGY ETC TRANSFER	MEAN YEARS OF SCHOOLING:TOTAL/FEMALE (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
EDUCATION, SCIENCE, TECHNOLOGY ETC TRANSFER	ADULT LITERACY RATE (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
EDUCATION, SCIENCE, TECHNOLOGY ETC TRANSFER	PROPORTION OF GDP SPENT ON EDUCATION (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
EDUCATION, SCIENCE, TECHNOLOGY ETC TRANSFER	NO. OF VOCATIONAL (TECHNICAL) GRADUATES PER 100000 (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	

DECISION-MAKING STRUCTURES	PUBLIC EMPLOYEES ENGAGED IN ENVIRONMENTAL PROTECTION AND SOCIAL SERVICES (% OF TOTAL)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
DECISION-MAKING STRUCTURES	GLOBAL TREATIES RATIFIED (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ROLES OF MAJOR GROUPS	HUMAN FREEDOM INDEX		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ROLES OF MAJOR GROUPS	PARTICIPATION IN THE FORMAL LABOUR MARKET:TOTAL/FEMALE (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ROLES OF MAJOR GROUPS	ELECTED NATIONAL AND LOCAL REPRESENTATIVES PER 1 MILLION POPULATION (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ROLES OF MAJOR GROUPS	FEMALES IN NATIONAL ELECTED OFFICE AS PROPORTION OF TOTAL (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ROLES OF MAJOR GROUPS	MAJOR GROUP ORGANISATIONS CONSULTED IN NATIONAL REPORTS TO THE CSD (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	INDEX OF LIFE EXPECTANCY (RELATIVE TO THE OECD AVERAGE)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	INFANT AND UNDER 5 MORTALITY RATES (DEATHS PER 1000 BIRTHS)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	BURDEN OF DISEASE (DALYs PER 1000 PEOPLE)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	MATERNAL MORTALITY RATES (PER 1000 BIRTHS)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	POPULATION WITH ACCESS TO SANITATION: URBAN AND RURAL (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	POPULATION WITH ACCESS TO SAFE WATER: URBAN AND RURAL (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	WATER CONSUMPTION (ABSTRACTION AS A % OF RENEWABLE SUPPLY)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	BIOCHEMICAL OXYGEN DEMAND (BOD) AND DISSOLVED OXYGEN (DO) IN SURFACE WATERS (mg/l)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
HEALTH, HUMAN SETTLEMENTS & FRESHWATER	RATE OF GROWTH OF URBAN POPULATION (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATIO N,FORESTS & BIODIVERSITY	NET RATE OF DEFORESTATION (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	

LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	RED DATA BOOK SPECIES AS PROPORTION OF TOTAL SPECIES (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	NET RATE OF WETLAND LOSS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	PROTECTED AREAS (IUCN CLASSES II-V) AS PROPORTION OF TOTAL LAND AREA (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	FISH CATCH PER AVAILABLE STOCK:MARINE AND FRESHWATER (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	NET RATE OF SOIL EROSION OR % OF SOILS DEGRADED		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	FERTILISER AND PESTICIDE USE PER km2 OF CULTIVATED LAND (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	INDEX OF AGRICULTURAL PRODUCTION PER CAPITA		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
LAND,DESERTIFICATION,FORESTS & BIODIVERSITY	ENERGY INTENSITY OF AGRICULTURAL PRODUCTION (MJ/$US Agr GDP)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ATMOSPHERE, OCEANS AND ALL KINDS OF SEAS	FOSSIL FUEL CO2 EMISSIONS:TOTAL AND PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ATMOSPHERE, OCEANS AND ALL KINDS OF SEAS	EMISSIONS OF SO2 AND NOx:TOTAL AND PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ATMOSPHERE, OCEANS AND ALL KINDS OF SEAS	EXCEEDENCES OF WHO AIR QUALITY GUIDELINES IN MAJOR CITIES (% OF DAYS)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ATMOSPHERE, OCEANS AND ALL KINDS OF SEAS	APPARENT CONSUMPTION OF CFCs:TOTAL AND PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TOXIC CHEMICALS AND HAZARDOUS WASTES	HAZARDOUS WASTE AND SPECIAL WASTE GENERATION PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TOXIC CHEMICALS AND HAZARDOUS WASTES	GENERATION OF MUNICIPAL, INDUSTRIAL, NUCLEAR WASTE PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TOXIC CHEMICALS AND HAZARDOUS WASTES	IMPORTS AND EXPORTS OF HAZARDOUS WASTE (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TOXIC CHEMICALS AND HAZARDOUS WASTES	RECYCLING RATES FOR PAPER AND ALUMINIUM PRODUCTS (%) AND GLASS RECOVERY (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	

ENERGY	TOTAL PRIMARY ENERGY SUPPLY (TONNES OF OIL EQUIVALENT)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	ENERGY INTENSITY PER UNIT OF GDP (TONNES OF OIL EQUIVALENT)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	CONSUMPTION OF FUEL WOOD:PER CAPITA (TONNES), AS A PROPORTION OF TOTAL ENERGY CONSUMPTION (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	PROPORTION OF SUPPLY DELIVERED BY RENEWABLES RELATIVE TO FOSSIL AND NUCLEAR FUELS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	VOLUME OF RADIOACTIVE WASTE (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	EMISSIONS PER UNIT GDP AND PER CAPITA (TONNES)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
ENERGY	REAL END-USE PRICES BY FUEL TYPE (US$)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	PASSENGER CARS (PER 1000 PEOPLE)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	TRAFFIC VOLUME (VEHICLE-KM TRAVELLED BY ROAD)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	AVERAGE FUEL EFFICIENCY OF NEW CARS (km/l)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	ROAD DENSITY (km PER km2)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	MILES TRAVELLED BY PUBLIC TRANSPORT AS PROPORTION OF TOTAL MILES TRAVELLED (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	PROPORTION OF TRANSPORT PLANS PUT UP FOR PUBLIC ENQUIRY (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	PROPORTION OF PUBLIC EXPENDITURE ON PUBLIC VERSUS ROAD TRANSPORT (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	FUEL PRICE AND TAXATION BY FUEL TYPE (US$)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	BICYCLES OWNERSHIP PER CAPITA (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
TRANSPORT	ROAD TRAFFIC FATALITIES (NO. PER 1000 PEOPLE)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	HOUSE-PRICE-TO-INCOME RATIO		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	RENT-TO-INCOME RATIO		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	PROPORTION OF PUBLIC AND PRIVATE PROPERTIES MEETING DEFINED WARMTH/VENTILATION STANDARDS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	NUMBER OF HOMELESS OR LIVING IN TEMPORARY ACCOMMODATION (NO.)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	MEDIAN USABLE LIVING SPACE PER CAPITA (m2)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	

SHELTER	PROPORTION OF HOUSING UNITS WITH EXPECTED LIFETIME OF OVER 20 YEARS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
SHELTER	PROPORTION OF HOUSING STOCK IN COMPLIANCE WITH EXISTING REGULATIONS (%)		PILOT INDICATORS 6/94		WWF/NEF INDICATORS INITIATIVE			Y	
FOREST RESOURCES (PROBLEM/ISSUE INDICATORS)	AVERAGE ANNUAL DEFORESTATION RATE, CLOSED FOREST		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
FOREST RESOURCES (PROBLEM/ISSUE INDICATORS)	DEFORESTATION IMPACT INTENSITY INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
FOREST RESOURCES (PROBLEM/ISSUE INDICATORS)	PERSONS PER HECTARE OF CLOSED FOREST		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
FOREST RESOURCES (PROBLEM/ISSUE INDICATORS)	LAND USE RATIONALITY INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	INDEX OF AGRICULTURAL PRODUCTION PER HECTARE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	INDEX OF AGRICULTURAL PRODUCTION PER AGRICULTURAL WORKER		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	AVERAGE ANNUAL FERTILISER USE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	AVERAGE ANNUAL PESTICIDE USE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	AVERAGE ANNUAL INCREMENT OF AGRICULTURAL GDP (AGDP) PER CAPITA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND RESOURCES (PROBLEM/ISSUE INDICATORS)	AGRICULTURAL GDP (AGDP) AS A PERCENTAGE OF GDP		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
WATER RESOURCES (PROBLEM/ISSUE INDICATORS)	ANNUAL INTERNAL RENEWABLE WATER RESOURCES PER CAPITA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
WATER RESOURCES (PROBLEM/ISSUE INDICATORS)	PERCENTAGE OF POPULATION WITH ACCESS TO SAFE DRINKING WATER		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
WATER RESOURCES (PROBLEM/ISSUE INDICATORS)	PROTECTED AREAS AS A PERCENTAGE OF TOTAL LAND AREA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	

BIODIVERSITY (PROBLEM/ISSUE INDICATORS)	PROTECTED AREAS AS A PERCENTAGE OF TOTAL LAND AREA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	AVERAGE ANNUAL POPULATION RELATIVE CHANGE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	POPULATION DENSITY PER HECTARE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	RURAL POPULATION DENSITY PER HECTARE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	MINIMUM SALARY RATIO: URBAN VERSUS RURAL		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	ENERGY CONSUMPTION PER PERSON		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POPULATION (PROBLEM/ISSUE INDICATORS)	POTENTIAL DEMOGRAPHIC CARRYING CAPACITY AND POPULATION DENSITY RATIO		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
INCOME GAP (PROBLEM/ISSUE INDICATORS)	PERCENTAGE OF TOTAL CENTRAL GOVERNMENT EXPENDITURE FOR HEALTH		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
INCOME GAP (PROBLEM/ISSUE INDICATORS)	PERCENTAGE OF TOTAL CENTRAL GOVERNMENT EXPENDITURE FOR EDUCATION		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
INCOME GAP (PROBLEM/ISSUE INDICATORS)	GINI COEFFICIENT FOR INCOME		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
INCOME GAP (PROBLEM/ISSUE INDICATORS)	MINIMUM SALARY RATIO: URBAN VERSUS RURAL		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
INCOME GAP (PROBLEM/ISSUE INDICATORS)	PER CAPITA AVERAGE CALORIES AVAILABLE (AS A PERCENTAGE OF NEED)		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
LAND (PROBLEM/ISSUE INDICATORS)	GINI COEFFICIENT FOR LAND TENURE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EXTERNAL DEBT (PROBLEM/ISSUE INDICATORS)	TOTAL EXTERNAL DEBT DISBURSED AS A PERCENTAGE OF GDP		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EXTERNAL DEBT (PROBLEM/ISSUE INDICATORS)	TOTAL EXTERNAL DEBT DISBURSED PER CAPITA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	

EXTERNAL DEBT (PROBLEM/ISSUE INDICATORS)	EXTERNAL DEBT AS A PERCENTAGE OF EXPORTS		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
COMMODITY EXCHANGE TERMS (PROBLEM/ISSUE INDICATORS)	COMMODITY EXCHANGE INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POVERTY AND LIFE QUALITY (PROBLEM/ISSUE INDICATORS)	PERCENTAGE OF HOUSEHOLDS UNDER THE POVERTY LINE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POVERTY AND LIFE QUALITY (PROBLEM/ISSUE INDICATORS)	HUMAN DEVELOPMENT INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
POVERTY AND LIFE QUALITY (PROBLEM/ISSUE INDICATORS)	PERCENTAGE OF GRADUATES IN SCIENCE, ENGINEERING AND AGRICULTURE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	LAND USE RATIONALITY INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	INDEX OF AGRICULTURAL PRODUCTION PER HECTARE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	PERCENTAGE OF HOUSEHOLDS UNDER THE POVERTY LINE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	PERCENTAGE OF TOTAL CENTRAL GOVERNMENT EXPENDITURE FOR EDUCATION		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	PERCENTAGE OF TOTAL CENTRAL GOVERNMENT EXPENDITURE FOR HEALTH		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	AVERAGE ANNUAL POPULATION RELATIVE CHANGE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	

PRODUCTIVITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	AVERAGE INTERNAL RENEWABLE WATER RESOURCES PER CAPITA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	GINI COEFFICIENT FOR INCOME		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	GINI COEFFICIENT FOR LAND TENURE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	HUMAN DEVELOPMENT INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	PER CAPITA AVERAGE CALORIES AVAILABLE (AS A PERCENTAGE OF NEED)		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	PERCENTAGE OF POPULATION WITH ACCESS TO SAFE DRINKING WATER		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	MINIMUM SALARY RATIO: URBAN VERSUS RURAL		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
EQUITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	ENERGY CONSUMPTION PER PERSON		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
RESILIENCE (A.S.INDEX: SUSTAINABILITY INDICATORS)	DEFORESTATION IMPACT INTENSITY INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
RESILIENCE (A.S.INDEX: SUSTAINABILITY INDICATORS)	PERCENTAGE OF GRADUATES IN SCIENCE, ENGINEERING AND AGRICULTURE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
RESILIENCE (A.S.INDEX: SUSTAINABILITY INDICATORS)	PROTECTED AREAS AS A PERCENTAGE OF TOTAL LAND AREA		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
RESILIENCE (A.S.INDEX: SUSTAINABILITY INDICATORS)	EXTERNAL DEBT AS A PERCENTAGE OF EXPORTS		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
STABILITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	COMMODITY EXCHANGE INDEX		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
STABILITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	POTENTIAL DEMOGRAPHIC CARRYING CAPACITY AND POPULATION DENSITY RATIO		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
STABILITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	TOTAL EXTERNAL DEBT DISBURSED AS A PERCENTAGE OF GDP		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	

STABILITY (A.S.INDEX: SUSTAINABILITY INDICATORS)	POPULATION DENSITY PER HECTARE		PROPOSED 1994		E.F. GUTIERREZ-ESPELETA, COSTA RICA			Y	
NET RESOURCE DEPLETION	DEPLETION OF SOIL AND SOIL FERTILITY		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
NET RESOURCE DEPLETION	DEPLETION OF TIMBER STOCKS AND FOREST QUALITY		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
NET RESOURCE DEPLETION	DEPLETION OF FISHERY STOCKS AND FISHERY QUALITY		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
NET RESOURCE DEPLETION	(DEPLETION OF MINERAL ORES)		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
NET RESOURCE DEPLETION	(DEPLETION OF FUEL DEPOSITS)		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	EMISSIONS OF OZONE-DEGRADING GASES: CFC'S, HALONS		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	EMISSIONS OF GREENHOUSE GASES: CARBON DIOXIDE, METHANE, CFC'S, NITROUS OXIDE, HALONS		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	EMISSIONS OF ACIDIFYING GASES: SULPHUR OXIDES, NITROGEN OXIDES		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	EMISSIONS OF SUBSTANCES THAT CONTRIBUTE TO EUTROPHICATION: PHOSPHATE AND NITROGEN-CONTAINING MATERIALS		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	EMISSIONS OF TOXIC SUBSTANCES: PESTICIDES, RADIOACTIVE SUBSTANCES AND PRIORITY TOXIC SUBSTANCES		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
COMPOSITE POLLUTION	SOLID WASTES RETURNED TO ENVIRONMENT		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	HUMAN POPULATION DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	LIVESTOCK POPULATION DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	INFRASTRUCTURE DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	INDUSTRIAL EXTRACTIVE ACTIVITY OR POLLUTION DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	LAND CONVERSION ACTIVITY DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	PRESENCE OF OR EXPOSURE TO EXOTIC SPECIES DISTRIBUTION		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	ECOSYSTEM DISTRIBUTION BY TYPE OF ECOSYSTEM		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
ECOSYSTEM RISK	PROTECTED AREA DISTRIBUTIONS		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	POLLUTED DRINKING WATER EXPOSURE		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y

HUMAN WELFARE IMPACT	AIR POLLUTION EXPOSURE		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	ENVIRONMENTAL DISEASE VECTORS EXPOSURE		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	CONTAMINATED FOOD EXPOSURE		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	INADEQUATE SHELTER EXPOSURE		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	OCCUPATIONAL EXPOSURE TO TOXICS		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
HUMAN WELFARE IMPACT	(NOISE EXPOSURE)		PROPOSED S.D.INDICES 1994		WORLD RESOURCES INSTITUTE			Y	Y
CLIMATE CHANGE	CARBON DIOXIDE EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
CLIMATE CHANGE	CFC EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
CLIMATE CHANGE	METHANE EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
CLIMATE CHANGE	N2O EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
CLIMATE CHANGE	DEFORESTATION RATE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
OZONE LAYER DEPLETION	F12 EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
OZONE LAYER DEPLETION	F11 EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
OZONE LAYER DEPLETION	HALON EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
OZONE LAYER DEPLETION	NOX EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
OZONE LAYER DEPLETION	OTHER EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
LOSS OF BIODIVERSITY	FERTILISER USE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
LOSS OF BIODIVERSITY	PESTICIDE USE INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
LOSS OF BIODIVERSITY	CROP VARIETY INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
LOSS OF BIODIVERSITY	PROTECTED AREAS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
LOSS OF BIODIVERSITY	FRAGMENTATION INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
RESOURCE DEPLETION	FOSSIL ENERGY USE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y

RESOURCE DEPLETION	METAL CONSUMPTION INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
RESOURCE DEPLETION	FISH CONSUMPTION INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
RESOURCE DEPLETION	WATER EXTRACTION		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
RESOURCE DEPLETION	LOSS OF TOP SOIL		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
DISPERSION OF TOXICS	DIOXIN EMISSION EQUIVALENTS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
DISPERSION OF TOXICS	CHLORINE PRODUCTION		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
DISPERSION OF TOXICS	HEAVY METAL EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
DISPERSION OF TOXICS	PESTICIDE USE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
DISPERSION OF TOXICS	HOUSEHOLD CHEMICALS USE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WASTE	MUNICIPAL WASTE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WASTE	INDUSTRIAL WASTE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WASTE	HAZARDOUS WASTE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WASTE	LANDFILL AREA		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WASTE	INCINERATION		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
AIR POLLUTION	NOX EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
AIR POLLUTION	SO2 EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
AIR POLLUTION	PARTICLE EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
AIR POLLUTION	VOC EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
AIR POLLUTION	OTHER EMISSIONS (AMMONIA, CO,...)		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
MARINE ENVIRONMENT & COASTAL ZONES	OIL TRANSPORTS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
MARINE ENVIRONMENT & COASTAL ZONES	HC DISCHARGES		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y

MARINE ENVIRONMENT & COASTAL ZONES	NUTRIENT FLOWS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
MARINE ENVIRONMENT & COASTAL ZONES	TOXIC DISCHARGES		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
MARINE ENVIRONMENT & COASTAL ZONES	COASTAL TOURISM		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WATER POLLUTION & WATER RESOURCES	GROUNDWATER EXTRACTION		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WATER POLLUTION & WATER RESOURCES	COD OF WASTE WATER STREAMS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WATER POLLUTION & WATER RESOURCES	HEAVY METAL DISCHARGES		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WATER POLLUTION & WATER RESOURCES	OTHER TOXIC DISCHARGES		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
WATER POLLUTION & WATER RESOURCES	FERTILISER USE		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
URBAN PROBLEMS, NOISE & ODOURS	LOCAL VOC EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
URBAN PROBLEMS, NOISE & ODOURS	LOCAL NOX EMISSIONS		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
URBAN PROBLEMS, NOISE & ODOURS	NOISE LEVEL OF VEHICLE FLEET		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
URBAN PROBLEMS, NOISE & ODOURS	TOTAL URBAN TRAFFIC		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
URBAN PROBLEMS, NOISE & ODOURS	LOCAL ODOURS INDEX		ILLUSTRATIVE INDICATORS 1994		EUROSTAT: PRESSURE INDEX PROJECT			Y	Y
NATURAL RESOURCE STOCKS	FOREST STOCK (M3)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
NATURAL RESOURCE STOCKS	FOREST AREA (HECTARES)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
NATURAL RESOURCE STOCKS	FOREST AREA PER CAPITA (HA PER PERSON)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
ECONOMICS	PRODUCTION COST PER UNIT (COST PER UNIT OF OUTPUT)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
ECONOMICS	RELATIVE PRICE (RATIO)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y

RESOURCE PRODUCTIVITY	OUTPUT/DIRECT ENERGY INPUT (RATIO)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
RESOURCE PRODUCTIVITY	OUTPUT/DIRECT ENERGY INPUT (YIELD: TONNES/HA)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
ENVIRONMENT	BIODIVERSITY (INDEX/NUMBERS)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
ENVIRONMENT	SOIL EROSION (TONNES/HA)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
ENVIRONMENT	AIR & WATER POLLUTION (LEVELS)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
QUALITY OF LIFE	LIFE EXPECTANCY (YEARS)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
QUALITY OF LIFE	NUTRITIONAL LEVEL (%)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
QUALITY OF LIFE	POVERTY LEVEL (%)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
NATURAL RESOURCES/MACROEC ONOMICS	SHARE OF NATURAL RESOURCES (%)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
NATURAL RESOURCES/MACROEC ONOMICS	DOMESTIC RESOURCE GAP (RATIO)		COUNTRY CASE STUDY COMPARISONS		DIRGHA TIWARI, FAO			Y	Y
SOCIAL SUSTAINABILITY	HUMAN DEVELOPMENT: LITERACY RATE (LEVEL OF EDUCATION)		PROJECT MONITORING/EVALU ATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	HUMAN DEVELOPMENT: ECONOMIC CONDITION (OCCUPATION/INCOME/INCOME LEVEL)		PROJECT MONITORING/EVALU ATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	HUMAN DEVELOPMENT: ACCESS TO SAFE WATER (DRINKING WATER AVAILABILITY/HOUSEHOLDS WITH TAP WATER/HOUSEHOLDS WITH NO TAP WATER)		PROJECT MONITORING/EVALU ATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	CO-EVOLUTIONARY CHANGE: PROJECT DEVELOPMENT/FAILURE WITH ENVIRONMENTAL CHANGE (HISTORY OF ENVIRONMENTAL AND SOCIETAL CHANGE/ORGANISATIONAL PATTERN/ORGANISATION FAILURES & SUCCESSES)		PROJECT MONITORING/EVALU ATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	ORGANISATIONAL STRENGTH: FARMERS ORGANISATION (LEVEL OF ORGANISATION/MAIN LEVEL/BRANCH LEVEL/TERTIARY LEVEL)		PROJECT MONITORING/EVALU ATION		DIRGHA TIWARI, FAO	Y			

SOCIAL SUSTAINABILITY	ORGANISATIONAL STRENGTH: AGENCY ORGANISATION (LEVEL OF ORGANISATION/MAIN LEVEL/BRANCH LEVEL/TERTIARY LEVEL)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	INSTITUTIONAL CAPABILITY: WATER ALLOCATION RULES (O&M BASED RULES/LAND SIZE BASED RULES/ALLOCATION PER HH/ALLOCATION PER HA)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SOCIAL SUSTAINABILITY	INSTITUTIONAL CAPABILITY: CONFLICTS IN WATER DISTRIBUTION (NATURE OF CONFLICTS/WATER STEALING/O&M FAILURES/CONFLICTS RESOLVED/PUNISHMENT)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	SUSTAINABLE YIELD: CURRENT & BASE YEAR CROP YIELD DIFFERENCE (CROP YIELD/CROP YIELD & INPUT USE-BASE YEAR/CROP YIELD & INPUT USE-CURRENT YEAR)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	PUBLIC PERCEPTION ON ENVIRONMENTAL DAMAGE: ENVIRONMENTAL DAMAGE (DEFORESTATION/PRODUCTION CHANGE/CROP DAMAGE/HEALTH EFFECTS/FLOOD DAMAGE/SOIL SALINITY - DENOMINATORS:RATE OF CHANGE/LOSS OF PRODUCTIVITY/TOTAL LOSS/CASES & COSTS/AREA OF DAMAGE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	ENVIRONMENTAL IMPACTS: ENVIRONMENTAL DAMAGE (DEFORESTATION/PRODUCTION CHANGE/CROP DAMAGE/HEALTH EFFECTS/FLOOD DAMAGE/SOIL SALINITY/SOIL DEGRADATION/SOIL DEGRADATION/WATER QUALITY - DENOMINATORS: RATE OF CHANGE/LOSS/CASES/COSTS/AREA OF DAMAGE...)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	ENERGY USE/OUTPUT RATIO: ENERGY USE (NONRENEWABLE RESOURCES/RENEWABLE RESOURCES/DIESEL/CHEMICAL FERTILISER/OTHERS/LABOUR/ORGANIC MANURE/ANIMAL POWER/WATER USE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	WASTE GENERATION: EXCESS FERTILISER (AMOUNT MORE THAN RECOMMENDED DOSE/FERTILISER)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ENVIRONMENTAL SUSTAINABILITY	WASTE GENERATION: PESTICIDE USE (AMOUNT MORE THAN RECOMMENDED DOSE/PESTICIDE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ECONOMIC SUSTAINABILITY	BENEFIT-COST RATIO: COSTS (INPUT VALUES FOR DIFFERENT CROP TYPES/RICE/OTHER CROPS)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ECONOMIC SUSTAINABILITY	BENEFIT-COST RATIO: BENEITS (AREA OF DIFFERENT CROP TYPES/PRICE/RICE/OTHER CROPS/OUTPUT PRICE/INPUT PRICE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ECONOMIC SUSTAINABILITY	CHANGE IN ENVIRONMENTAL EXPENDITURES: COST OF POLLUTION (EXCESS FERTILISER USE/BASE YEAR USE/CURRENT YEAR USE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
ECONOMIC SUSTAINABILITY	CHANGE IN ENVIRONMENTAL EXPENDITURES: COST OF TREATMENT (HEALTH/VISITS TO HOSPITAL/APPROXIMATE COST PER VISIT)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			

ECONOMIC SUSTAINABILITY	CHANGE IN ENVIRONMENTAL EXPENDITURES: COST OF WATER (WILLINGNESS TO PAY [WTP]/WTP PER HECTARE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SPATIAL SUSTAINABILITY	HETEROGENITY INDEX: PLANNED VERSUS ACTUAL CROPPING AREA (CROP TYPES/CROP AREA PLANNED/AREA ACTUALLY PLANTED)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SPATIAL SUSTAINABILITY	LAND DISTRIBUTION: PHYSICAL DISTRIBUTION (DISTANCE FROM CANAL/PLOTS AT DIFFERENT LOCATION)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SPATIAL SUSTAINABILITY	LAND CAPABILITY CLASSIFICATION: POPULATION TO LAND RATIO (POPULATION/LAND SIZE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
SPATIAL SUSTAINABILITY	LAND CAPABILITY CLASSIFICATION: AGRO-CLIMATOLOGICAL FACTORS (SOILS/RAINFALL/TOPOGRAPHY/CHARACTERISTICS/TOTAL & DISTRIBUTION/SLOPE PERCENTAGE)		PROJECT MONITORING/EVALUATION		DIRGHA TIWARI, FAO	Y			
EDUCATION	PUBLIC HIGH-SCHOOL GRADUATION RATE (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	AVERAGE ACIEVEMENT-TEST PERCENTILE SCORES		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	PUBLIC-SCHOOL EXPENDITURES PER STUDENT ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	AVERAGE PUPIL-SCHOOL TEACHER SALARY ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	TEACHERS HOLDING ADVANCED DEGREES (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	STUDENTS ATTENDING DESEGREGATED SCHOOLS (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	FACULTY HOLDING TERMINAL DEGREES (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	HIGHER EDUCATION DEGREES AWARDED (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
EDUCATION	STUDENT PARTICIPATION IN HIGHER-EDUCATION PROGRAMS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	NET JOB GROWTH		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	TOTAL/BLACK UNEMPLOYMENT GAP (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	EFFECTIVE BUYING INCOME PER CAPITA ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	RETAIL SALES PER CAPITA ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	TAXABLE REAL-ESTATE VALUE (BILLIONS $)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			

THE ECONOMY	NEW HOUSING STARTS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	AFFORDABILITY OF SINGLE-FAMILY HOME		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	STUDENTS IN FREE/REDUCED LUNCH PROGRAM		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	TOURISM/BED-TAX REVENUES (MILLIONS $)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
THE ECONOMY	COST OF 1,000 KWH OF ELECTRICITY (JEA $)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	PEOPLE FEELING SAFE WALKING ALONE AT NIGHT (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	VIOLENT INDEX CRIMES PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	NONVIOLENT INDEX CRIMES PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	PEOPLE REPORTING BEING VICTIMS OF CRIME (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	AVERAGE RESCUE CALL RESPONSE TIME (MINUTES)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	AVERAGE FIRE CALL RESPONSE TIME (MINUTES)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	AVERAGE PRIORITY ONE POLICE CALL RESPONSE TIME (MINUTES)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	MOTOR VEHICLE ACCIDENT DEATHS PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	OTHER ACCIDENTAL DEATHS PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
PUBLIC SAFETY	MOTOR VEHICLE ACCIDENTS PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	DAYS WITH AIR QUALITY INDEX IN GOOD RANGE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	RIVER COMPLIANCE WITH METALS WATER STANDARDS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	RIVER COMPLIANCE WITH DISSOLVED OXYGEN STANDARDS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	STREAMS COMPLIANCE WITH DISSOLVED OXYGEN STANDARDS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	WATER LEVEL IN FLORIDAN-AQUIFER WELLS (FEET)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	NEW SEPTIC-TANK PERMITS ISSUED		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
NATURAL ENVIRONMENT	SIGN PERMITS ISSUED		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			

NATURAL ENVIRONMENT	TONS PER CAPITA OF SOLID WASTE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	INFANT DEATHS PER 1,000 LIVE BIRTHS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	AGE-ADJUSTED DEATH RATE PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	DEATHS FROM HEART DISEASE PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	DEATHS FROM LUNG CANCER PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	PACKS OF CIGARETTES SOLD PER CAPITA		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	NEW AIDS CASES PER 100,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	STUDENT FITNESS TEST SCORES, 50TH PERCENTILE (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	ALCOHOL USE REPORTED BY YOUTH (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	PEOPLE RATING HEALTH-CARE SYSTEM GOOD/EXCELLENT (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
HEALTH	PEOPLE REPORTING HAVING NO HEALTH INSURANCE (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	PEOPLE RACISM IS A LOCAL PROBLEM (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	SUBSTANCE-EXPOSED NEWBORNS PER 1,000 LIVE BIRTHS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	SUBSTANTIATED CHILD ABUSE/NEGLECT REPORTS PER 1,000 CHILDREN UNDER 18		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	BIRTHS TO FEMALES UNDER 18 PER 1,000 LIVE BIRTHS		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	EMPLOYMENT-DISCRIMINATION COMPLAINTS FILED WITH JEOC		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	PEOPLE REPORTING HAVING VOLUNTEERED IN THE PAST YEAR (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	CITY HUMAN-SERVICES EXPENDITURES PER CAPITA ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
SOCIAL ENVIRONMENT	CONTRIBUTIONS PER CAPITA TO UNITED WAY AND AGENCIES ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PEOPLE WHO RATE LOCAL GOVERNMENT LEADERSHIP GOOD/EXCELLENT (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PERCENT 18 AND OLDER REGSTERED TO VOTE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PERCENT REGSTERED WHO VOTE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			

GOVERNMENT/POLITICS	PERCENT OF CITY COUNCIL MEMBERS NONWHITE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PERCENT OF CITY COUNCIL MEMBERS FEMALE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PEOPLE ACCURATELY NAMING TWO CITY COUNCIL MEMBERS (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PEOPLE KEEPING UP WITH LOCAL GOVERNMENT NEWS FREQUENTLY (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
GOVERNMENT/POLITICS	PEOPLE FEELING LOCAL PUBLIC SERVICES ARE FREQUENTLY EFFECTIVE (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	CITY FINANCIAL SUPPORT PER CAPITA OF ARTS ORGANISATIONS ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	CITY PARKS AND RECREATION EXPENDITURES PER CAPITA ($)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	PUBLIC PARK ACREAGE PER 1,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	PUBLIC LIBRARY MATERIALS PER CAPITA		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	PUBLIC LIBRARY BOOK CIRCULATION PER CAPITA		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	EVENT/DAYS OF BOOKINGS AT MAJOR CITY FACILITIES		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	MUSEUM OF SCIENCE & HISTORY ATTENDANCE PER 1,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	SYMPHONY ATTENDANCE PER 1,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
CULTURE/RECREATION	ZOO ATTENDANCE PER 1,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	PEOPLE REPORTING COMMUTING TIME 25 MINUTES OR LESS (%)		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	WEEKDAY COMMERCIAL FLIGHTS IN AND OUT OF JIA		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	DESTINATIONS WITH DIRECT FLIGHTS IN OR OUT OF JIA		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	AVERAGE WEEKDAY JTA BUS RIDERSHIP PER 1,000 POPULATION		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	AVERAGE WEEKDAY MILES OF JTA BUS SERVICE		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			
MOBILITY	JTA BUS HEADWAYS WITHIN 30 MINUTES PEAK/60 MINUTES NON PEAK		1983-1992		LIFE IN JACKSONVILLE: QUALITY OF LIFE PROJECT	Y			

Appendix 2

Odds ratios for asthma and respiratory hospital admissions in the North Thames (West) Health Region - April 1992 to March 1994

First five pages - without adjustment for deprivation

Last five pages - with adjustment for Carstairs quintiles

	Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR1	loci1	hici1	OR2	loci2	hici2	OR3	loci3	hici3	OR4	loci4	hici4	OR5	loci5	hici5
(intercept)	0.165	(0.040-	0.678)	0.325	(0.059-	1.803)	0.170	(0.042-	0.697)	0.160	(0.039-	0.656)	0.162	(0.040-	0.662)
age	0.584	(0.349-	0.979)	0.591	(0.353-	0.989)	0.584	(0.349-	0.978)	0.595	(0.355-	0.996)	0.589	(0.352-	0.985)
sex	1.205	(0.780-	1.862)	1.239	(0.801-	1.919)	1.249	(0.806-	1.935)	1.220	(0.789-	1.887)	1.209	(0.782-	1.870)
hospCentral Middlesex	3.305	(1.141-	9.574)	3.199	(1.103-	9.279)	3.221	(1.110-	9.347)	3.305	(1.142-	9.571)	3.291	(1.137-	9.528)
hospCharing Cross	2.688	(1.240-	5.827)	2.754	(1.275-	5.949)	2.648	(1.230-	5.701)	2.669	(1.239-	5.749)	2.639	(1.226-	5.679)
hospEaling Central	2.887	(1.403-	5.938)	2.674	(1.291-	5.537)	2.770	(1.344-	5.710)	2.895	(1.407-	5.954)	2.881	(1.401-	5.926)
hospHammersmith	1.933	(0.852-	4.388)	1.819	(0.803-	4.122)	1.859	(0.822-	4.207)	1.902	(0.842-	4.294)	1.902	(0.842-	4.293)
hospHillingdon	1.826	(0.533-	6.260)	1.720	(0.501-	5.908)	1.768	(0.516-	6.061)	1.885	(0.550-	6.461)	1.851	(0.541-	6.330)
hospNorthwick Park	2.735	(1.027-	7.282)	2.418	(0.897-	6.514)	2.533	(0.948-	6.768)	2.763	(1.037-	7.360)	2.723	(1.023-	7.247)
carstairsq2	1.110	(0.293-	4.203)	1.168	(0.309-	4.418)	1.139	(0.301-	4.309)	1.105	(0.292-	4.182)	1.102	(0.291-	4.169)
carstairsq3	1.769	(0.510-	6.134)	1.849	(0.535-	6.392)	1.841	(0.532-	6.371)	1.761	(0.509-	6.094)	1.747	(0.505-	6.044)
carstairsq4	1.956	(0.573-	6.680)	2.061	(0.605-	7.019)	2.036	(0.598-	6.936)	1.951	(0.573-	6.647)	1.929	(0.566-	6.570)
carstairsq5	2.213	(0.642-	7.623)	2.354	(0.691-	8.017)	2.261	(0.666-	7.674)	2.169	(0.639-	7.363)	2.139	(0.630-	7.259)
popdens	0.995	(0.970-	1.021)												
age sex	0.964	(0.490-	1.896)	0.950	(0.482-	1.872)	0.946	(0.480-	1.864)	0.945	(0.479-	1.864)	0.961	(0.488-	1.894)
savish				0.982	(0.958-	1.008)									
caline							0.977	(0.950-	1.004)						
allflowperdist										1.000	(0.998-	1.001)			
mainflowperdist													1.000	(0.999-	1.001)
nox															
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$savish factorq2 36-39															
data$savish factorq3 39-42															
data$savish factorq4 42-46															
data$savish factorq5 46+															
data$caline factorq2 5-1.5															
data$caline factorq3 1 5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2 5															
data$allflowperdist factorq3 2 5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7 5															
data$mainflowperdist factorq3 7 5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.12716			1.93704			3.07066			0.38386			0.00329		
P-value	0.7214			0.16399			0.07972			0.53554			0.95427		

	Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR6	loci6	hici6	OR7	loci7	hici7	OR8	loci8	hici8	OR9	loci9	hici9	OR10	loci10	hici10
(intercept)	0.151	(0.036-	0.640)	0.188	(0.043-	0.822)	0.161	(0.039-	0.660)	0.170	(0.040-	0.726)	0.156	(0.038-	0.646)
age	0.583	(0.348-	0.977)	0.587	(0.351-	0.983)	0.585	(0.349-	0.981)	0.568	(0.338-	0.954)	0.607	(0.362-	1.019)
sex	1.204	(0.780-	1.861)	1.212	(0.785-	1.873)	1.206	(0.781-	1.864)	1.224	(0.790-	1.896)	1.285	(0.825-	2.004)
hospCentral Middlesex	3.348	(1.152-	9.728)	3.232	(1.115-	9.368)	3.320	(1.143-	9.644)	3.338	(1.144-	9.740)	3.342	(1.146-	9.752)
hospCharing Cross	2.627	(1.220-	5.657)	2.763	(1.266-	6.029)	2.634	(1.224-	5.669)	2.863	(1.312-	6.248)	2.696	(1.237-	5.877)
hospEaling Central	2.948	(1.422-	6.113)	2.728	(1.303-	5.713)	2.896	(1.405-	5.966)	2.838	(1.374-	5.861)	2.865	(1.387-	5.916)
hospHammersmith	1.920	(0.849-	4.341)	1.946	(0.859-	4.407)	1.920	(0.846-	4.357)	1.938	(0.851-	4.409)	1.886	(0.831-	4.281)
hospHillingdon	1.947	(0.558-	6.797)	1.686	(0.477-	5.957)	1.876	(0.545-	6.454)	1.812	(0.523-	6.285)	1.739	(0.506-	5.984)
hospNorthwick Park	2.837	(1.048-	7.677)	2.533	(0.929-	6.905)	2.753	(1.029-	7.363)	2.671	(0.997-	7.160)	2.724	(1.007-	7.373)
carstairsq2	1.109	(0.293-	4.202)	1.076	(0.284-	4.072)	1.096	(0.290-	4.151)	0.997	(0.260-	3.826)	1.051	(0.274-	4.039)
carstairsq3	1.764	(0.509-	6.118)	1.683	(0.485-	5.840)	1.740	(0.503-	6.023)	1.658	(0.474-	5.804)	1.647	(0.469-	5.789)
carstairsq4	1.937	(0.568-	6.605)	1.874	(0.550-	6.384)	1.917	(0.563-	6.534)	1.824	(0.529-	6.293)	1.829	(0.528-	6.338)
carstairsq5	2.120	(0.624-	7.203)	2.091	(0.617-	7.087)	2.118	(0.623-	7.200)	2.185	(0.627-	7.618)	1.991	(0.572-	6.934)
popdens															
age sex	0.967	(0.491-	1.904)	0.977	(0.496-	1.925)	0.969	(0.491-	1.911)	0.964	(0.488-	1.902)	0.913	(0.461-	1.808)
savish															
caline															
allflowperdist															
mainflowperdist															
nox	1.005	(0.985-	1.025)												
voc				0.989	(0.956-	1.024)									
so2							1.000	(0.998-	1.003)						
data$popdens factorq2 4-7										0.871	(0.504-	1.506)			
data$popdens factorq3 7-10										1.184	(0.713-	1.965)			
data$popdens factorq4 10-14										1.094	(0.649-	1.844)			
data$popdens factorq5 14+										0.719	(0.405-	1.274)			
data$savish factorq2 36-39													1.102	(0.647-	1.875)
data$savish factorq3 39-42													1.065	(0.608-	1.864)
data$savish factorq4 42-46													1.359	(0.767-	2.408)
data$savish factorq5 46+													0.844	(0.473-	1.507)
data$caline factorq2 5-1.5															
data$caline factorq3 1 5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2 5															
data$allflowperdist factorq3 2 5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7 5															
data$mainflowperdist factorq3 7 5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.20416			0.39744			0.05008			3.92252			3.22318		
P-value	0.65138			0.52842			0.82292			0.41659			0.52119		

	Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR11	loci11	hici11	OR12	loci12	hici12	OR13	loci13	hici13	OR14	loci14	hici14	OR15	loci15	hici15	OR16	loci16	hici16	OR17	loci17	hici17	OR18	loci18	hici18	OR19	loci19	hici19	OR20	loci20	hici20
(Intercept)	0.152	(0.036-	0.644)	0.191	(0.043-	0.851)	0.214	(0.048-	0.967)	0.202	(0.045-	0.895)	0.166	(0.040-	0.684)	0.111	(0.025-	0.490)	0.145	(0.035-	0.606)	0.177	(0.041-	0.472)	0.164	(0.039-	0.679)	0.153	(0.035-	0.662)
age	0.597	(0.356-	1.001)	0.592	(0.354-	0.992)	0.602	(0.359-	1.010)	0.602	(0.359-	1.010)	0.596	(0.356-	1.000)	0.577	(0.344-	0.968)	0.582	(0.347-	0.974)	0.583	(0.347-	0.978)	0.589	(0.352-	0.985)	0.589	(0.352-	0.987)
sex	1.290	(0.829-	2.005)	1.217	(0.787-	1.881)	1.239	(0.801-	1.919)	1.235	(0.798-	1.912)	1.264	(0.815-	1.962)	1.265	(0.815-	1.965)	1.202	(0.778-	1.857)	1.217	(0.786-	1.885)	1.206	(0.780-	1.865)	1.254	(0.807-	1.949)
hospCentral Middlesex	3.230	(1.108-	9.416)	3.286	(1.130-	9.554)	3.203	(1.102-	9.308)	3.195	(1.090-	9.369)	3.193	(1.096-	9.305)	3.275	(1.122-	9.557)	3.352	(1.157-	9.709)	3.493	(1.194-	10.221)	3.296	(1.138-	9.548)	3.351	(1.152-	9.744)
hospCharing Cross	2.586	(1.198-	5.585)	2.611	(1.175-	5.803)	2.682	(1.221-	5.891)	2.832	(1.291-	6.211)	2.682	(1.239-	5.807)	2.624	(1.214-	5.670)	2.624	(1.219-	5.648)	2.549	(1.179-	5.507)	2.633	(1.224-	5.667)	2.583	(1.195-	5.587)
hospEaling Central	2.758	(1.333-	5.705)	2.859	(1.373-	5.956)	2.763	(1.315-	5.809)	2.884	(1.390-	5.984)	2.742	(1.323-	5.681)	2.905	(1.404-	6.011)	2.936	(1.425-	6.048)	2.924	(1.416-	6.038)	2.891	(1.401-	5.967)	2.870	(1.387-	5.940)
hospHammersmith	1.823	(0.804-	4.135)	1.924	(0.846-	4.375)	1.901	(0.830-	4.355)	1.903	(0.830-	4.361)	1.815	(0.798-	4.129)	1.916	(0.845-	4.346)	1.885	(0.834-	4.259)	1.754	(0.772-	3.983)	1.905	(0.843-	4.305)	1.927	(0.850-	4.370)
hospHillingdon	1.660	(0.480-	5.744)	1.740	(0.489-	6.192)	1.486	(0.410-	5.389)	1.559	(0.433-	5.607)	1.747	(0.501-	6.085)	1.707	(0.494-	5.905)	1.917	(0.559-	6.579)	1.914	(0.553-	6.633)	1.860	(0.542-	6.385)	1.695	(0.492-	5.837)
hospNorthwick Park	2.566	(0.956-	6.887)	2.588	(0.933-	7.180)	2.318	(0.833-	6.446)	2.416	(0.875-	6.667)	2.722	(1.016-	7.294)	2.852	(1.059-	7.685)	2.785	(1.045-	7.422)	3.206	(1.187-	8.664)	2.732	(1.025-	7.284)	2.708	(1.013-	7.245)
carstairsq2	1.138	(0.300-	4.316)	1.062	(0.279-	4.040)	1.066	(0.279-	4.066)	1.041	(0.273-	3.971)	1.138	(0.297-	4.366)	1.223	(0.318-	4.700)	1.136	(0.300-	4.302)	1.061	(0.276-	4.087)	1.103	(0.291-	4.174)	1.146	(0.299-	4.392)
carstairsq3	1.791	(0.516-	6.224)	1.669	(0.478-	5.824)	1.729	(0.494-	6.053)	1.695	(0.487-	5.901)	1.838	(0.524-	6.452)	1.969	(0.560-	6.926)	1.806	(0.521-	6.260)	1.775	(0.506-	6.224)	1.749	(0.505-	6.053)	1.756	(0.501-	6.151)
carstairsq4	1.994	(0.583-	6.821)	1.833	(0.533-	6.299)	1.882	(0.546-	6.491)	1.835	(0.535-	6.297)	2.024	(0.588-	6.974)	2.103	(0.608-	7.272)	1.990	(0.584-	6.787)	2.026	(0.587-	6.989)	1.926	(0.566-	6.559)	1.998	(0.579-	6.892)
carstairsq5	2.210	(0.649-	7.528)	2.040	(0.598-	6.957)	2.066	(0.604-	7.066)	2.065	(0.602-	7.077)	2.186	(0.633-	7.544)	2.301	(0.667-	7.929)	2.153	(0.635-	7.298)	2.220	(0.648-	7.602)	2.133	(0.629-	7.238)	2.185	(0.636-	7.512)
popdens																														
age.sex	0.910	(0.458-	1.806)	0.963	(0.489-	1.899)	0.930	(0.470-	1.840)	0.940	(0.475-	1.858)	0.926	(0.468-	1.829)	0.968	(0.490-	1.914)	0.979	(0.497-	1.929)	0.939	(0.474-	1.858)	0.961	(0.488-	1.892)	0.937	(0.474-	1.853)
savish																														
caline																														
allflowperdist																														
mainflowperdist																														
nox																														
voc																														
so2																														
data$popdens factorq2 4-7																														
data$popdens factorq3 7-10																														
data$popdens factorq4 10-14																														
data$popdens factorq5 14+																														
data$savish factorq2 36-39																														
data$savish factorq3 39-42																														
data$savish factorq4 42-46																														
data$savish factorq5 46+																														
data$caline factorq2 5-1 5	1.180	(0.720-	1.935)																											
data$caline factorq3 1 5-3	1.210	(0.718-	2.038)																											
data$caline factorq4 3-6	1.098	(0.631-	1.910)																											
data$caline factorq5 6+	0.703	(0.398-	1.243)																											
data$nox factorq2 65000-80000				0.823	(0.465-	1.458)																								
data$nox factorq3 80000-120000				0.812	(0.483-	1.365)																								
data$nox factorq4 120000-200000				0.886	(0.476-	1.648)																								
data$nox factorq5 200000+				0.952	(0.516-	1.758)																								
data$voc factorq2 40000-75000							0.743	(0.430-	1.283)																					
data$voc factorq3 75000-100000							0.738	(0.427-	1.276)																					
data$voc factorq4 100000-160000							0.624	(0.331-	1.178)																					
data$voc factorq5 160000+							0.888	(0.446-	1.766)																					
data$so2 factorq2 3000-5000										0.783	(0.439-	1.397)																		
data$so2 factorq3 5000-9000										0.689	(0.394-	1.204)																		
data$so2 factorq4 8000-60000										0.866	(0.485-	1.546)																		
data$so2 factorq5 60000+										0.768	(0.420-	1.407)																		
data$allflowperdist factorq2 1-2 5													1.061	(0.666-	1.691)															
data$allflowperdist factorq3 2 5-5													1.103	(0.647-	1.881)															
data$allflowperdist factorq4 5-30													0.833	(0.497-	1.394)															
data$allflowperdist factorq5 30+													0.713	(0.416-	1.223)															
data$mainflowperdist factorq2 4.5-7 5																1.385	(0.794-	2.416)												
data$mainflowperdist factorq3 7.5-12																1.694	(1.002-	2.864)												
data$mainflowperdist factorq4 12-25																1.510	(0.877-	2.599)												
data$mainflowperdist factorq5 25+																0.953	(0.536-	1.697)												
data$rddist																			1.008	(0.990-	1.026)									
data$rddist factorq2 11-17																						0.872	(0.511-	1.488)						
data$rddist factorq3 7-11																						0.930	(0.542-	1.597)						
data$rddist factorq4 3-7																						1.217	(0.703-	2.106)						
data$rddist factorq5 <3																						0.614	(0.359-	1.858)						
data$mrddist																									1.000	(0.999-	1.001)			
data$mrddist factorq2 200-300																												0.864	(0.504-	1.481)
data$mrddist factorq3 120-200																												1.189	(0.717-	1.971)
data$mrddist factorq4 75-120																												1.350	(0.808-	2.255)
data$mrddist factorq5 <75																												0.816	(0.489-	1.361)
data$allrdden																														
data$allrddens factorq2 10-13																														
data$allrddens factorq3 13-16																														
data$allrddens factorq4 16-19																														
data$allrddens factorq5 >19																														
data$mrdden																														
data$mrddens factorq2 >0 - 1 75																														
data$mrddens factorq3 1 75-3																														
data$mrddens factorq4 3-5																														
data$mrddens factorq5 >5																														
Deviance of exposure terms	4.78169			0.89455			3.35303			1.98106			2.96231			7.15778			0.75976			7.07069			0.0109			4.90966		
P-value	0.31044			0.92534			0.50057			0.73924			0.56415			0.12778			0.3834			0.1322			0.91685			0.29669		

	Asthma			Asthma			Asthma			Asthma					
Variable	OR21	loci21	hici21	OR22	loci22	hici22	OR23	loci23	hici23	OR24	loci24	hici24	OR25	loci25	hici25
(Intercept)	0.137	(0.031-	0.610)	0.194	(0.045-	0.831)	0.146	(0.035-	0.607)	0.132	(0.031-	0.561)	0.200	(0.050-	0.799)
age	0.596	(0.356-	0.999)	0.563	(0.334-	0.948)	0.596	(0.356-	0.999)	0.586	(0.349-	0.986)	0.567	(0.342-	0.939)
sex	1.227	(0.793-	1.901)	1.250	(0.805-	1.941)	1.220	(0.790-	1.887)	1.200	(0.775-	1.860)	1.205	(0.790-	1.840)
hospCentral Middlesex	3.365	(1.159-	9.767)	3.382	(1.159-	9.869)	3.492	(1.197-	10.192)	3.364	(1.153-	9.814)	2.637	(0.942-	7.382)
hospCharing Cross	2.568	(1.189-	5.548)	2.463	(1.135-	5.344)	2.684	(1.244-	5.791)	2.670	(1.234-	5.778)	2.321	(1.132-	4.757)
hospEaling Central	2.952	(1.429-	6.097)	2.962	(1.424-	6.158)	3.057	(1.471-	6.352)	2.901	(1.398-	6.022)	2.436	(1.252-	4.740)
hospHammersmith	1.891	(0.837-	4.270)	1.755	(0.772-	3.990)	1.991	(0.877-	4.519)	1.955	(0.859-	4.452)	1.527	(0.708-	3.294)
hospHillingdon	1.874	(0.548-	6.408)	2.026	(0.585-	7.010)	1.951	(0.568-	6.708)	1.994	(0.580-	6.857)	1.587	(0.495-	5.088)
hospNorthwick Park	2.792	(1.045-	7.458)	3.010	(1.108-	8.176)	2.889	(1.077-	7.748)	2.764	(1.028-	7.431)	2.204	(0.860-	5.648)
carstairsq2	1.110	(0.293-	4.203)	1.138	(0.298-	4.348)	1.110	(0.293-	4.211)	1.171	(0.306-	4.476)	1.159	(0.308-	4.358)
carstairsq3	1.748	(0.505-	6.052)	1.930	(0.552-	6.748)	1.745	(0.503-	6.053)	1.913	(0.545-	6.707)	1.859	(0.537-	6.433)
carstairsq4	1.921	(0.564-	6.547)	2.023	(0.589-	6.955)	1.889	(0.553-	6.454)	2.086	(0.603-	7.213)	2.131	(0.626-	7.263)
carstairsq5	2.134	(0.629-	7.244)	2.401	(0.699-	8.251)	2.093	(0.615-	7.123)	2.364	(0.685-	8.151)	2.543	(0.741-	8.724)
popdens													0.993	(0.968-	1.018)
age sex	0.943	(0.478-	1.861)	0.937	(0.473-	1.855)	0.943	(0.478-	1.858)	0.954	(0.481-	1.890)	0.964	(0.497-	1.870)
saviah															
caline															
allflowperdist															
mainflowperdist															
nox															
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$saviah factorq2 36-39															
data$saviah factorq3 39-42															
data$saviah factorq4 42-46															
data$saviah factorq5 46+															
data$caline factorq2 .5-1.5															
data$caline factorq3 1.5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2.5															
data$allflowperdist factorq3 2.5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7.5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden	1.010	(0.981-	1.040)												
data$allrddens factorq2 10-13				0.623	(0.365-	1.064)									
data$allrddens factorq3 13-16				0.619	(0.365-	1.051)									
data$allrddens factorq4 16-19				0.729	(0.415-	1.282)									
data$allrddens factorq5 >19				0.983	(0.576-	1.677)									
data$mrdden							1.031	(0.975-	1.091)						
data$mrddens factorq2 >0 - 1.75										1.075	(0.632-	1.829)			
data$mrddens factorq3 1.75-3										1.728	(1.000-	2.986)			
data$mrddens factorq4 3-5										1.004	(0.592-	1.703)			
data$mrddens factorq5 >5										1.257	(0.780-	2.025)			
Deviance of exposure terms	0.45611			5.90429			1.14599			4.42891					
P-value	0.49945			0.20641			0.28439			0.35106					

	Respiratory			Respiratory			Respiratory			Respiratory					
Variable	OR26	loci26	hici26	OR27	loci27	hici27	OR28	loci28	hici28	OR29	loci29	hici29	OR30	loci30	hici30
(Intercept)	0.446	(0.083-	2.391)	0.203	(0.051-	0.806)	0.191	(0.048-	0.758)	0.193	(0.049-	0.766)	0.184	(0.045-	0.755)
age	0.575	(0.347-	0.951)	0.570	(0.344-	0.944)	0.580	(0.350-	0.961)	0.574	(0.347-	0.950)	0.570	(0.344-	0.944)
sex	1.245	(0.814-	1.905)	1.248	(0.816-	1.909)	1.225	(0.802-	1.872)	1.215	(0.796-	1.856)	1.210	(0.793-	1.846)
hospCentral Middlesex	2.543	(0.906-	7.135)	2.569	(0.916-	7.205)	2.643	(0.944-	7.394)	2.631	(0.940-	7.360)	2.662	(0.948-	7.473)
hospCharing Cross	2.387	(1.166-	4.887)	2.269	(1.113-	4.627)	2.298	(1.126-	4.690)	2.269	(1.113-	4.627)	2.259	(1.108-	4.606)
hospEaling Central	2.229	(1.137-	4.367)	2.344	(1.202-	4.571)	2.451	(1.260-	4.769)	2.440	(1.254-	4.747)	2.479	(1.263-	4.865)
hospHammersmith	1.414	(0.656-	3.050)	1.456	(0.677-	3.134)	1.493	(0.695-	3.207)	1.493	(0.695-	3.207)	1.504	(0.699-	3.235)
hospHillingdon	1.477	(0.459-	4.748)	1.554	(0.485-	4.977)	1.658	(0.517-	5.313)	1.626	(0.509-	5.197)	1.685	(0.516-	5.504)
hospNorthwick Park	1.909	(0.736-	4.950)	2.053	(0.798-	5.281)	2.236	(0.872-	5.735)	2.196	(0.857-	5.626)	2.263	(0.868-	5.895)
carstairsq2	1.226	(0.326-	4.601)	1.180	(0.314-	4.433)	1.151	(0.306-	4.326)	1.148	(0.306-	4.315)	1.152	(0.306-	4.336)
carstairsq3	1.948	(0.565-	6.715)	1.909	(0.553-	6.594)	1.840	(0.533-	6.356)	1.825	(0.529-	6.302)	1.836	(0.531-	6.349)
carstairsq4	2.258	(0.665-	7.669)	2.191	(0.644-	7.447)	2.114	(0.622-	7.188)	2.089	(0.615-	7.102)	2.090	(0.614-	7.108)
carstairsq5	2.701	(0.796-	9.161)	2.535	(0.749-	8.577)	2.449	(0.724-	8.288)	2.416	(0.714-	8.172)	2.394	(0.707-	8.103)
popdens															
age sex	0.951	(0.490-	1.847)	0.947	(0.488-	1.839)	0.941	(0.485-	1.829)	0.958	(0.494-	1.859)	0.965	(0.498-	1.872)
saviah	0.979	(0.955-	1.004)												
caline				0.979	(0.954-	1.005)									
allflowperdist							1.000	(0.998-	1.001)						
mainflowperdist										1.000	(0.999-	1.001)			
nox													1.003	(0.984-	1.023)
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$saviah factorq2 36-39															
data$saviah factorq3 39-42															
data$saviah factorq4 42-46															
data$saviah factorq5 46+															
data$caline factorq2 .5-1.5															
data$caline factorq3 1.5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2.5															
data$allflowperdist factorq3 2.5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7.5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	2.90331			2.65114			0.59146			0.03494					
P-value	0.0884			0.10348			0.44186			0.85172					

	Respiratory			Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR31	loci31	hici31	OR32	loci32	hici32	OR33	loci33	hici33	OR34	loci34	hici34	OR35	loci35	hici35
(Intercept)	0.228	(0.054-	0.971)	0.193	(0.049-	0.767)	0.213	(0.051-	0.883)	0.189	(0.047-	0.757)	0.181	(0.044-	0.743)
age	0.572	(0.345-	0.946)	0.572	(0.345-	0.949)	0.549	(0.330-	0.914)	0.592	(0.357-	0.981)	0.580	(0.349-	0.962)
sex	1.215	(0.796-	1.855)	1.212	(0.794-	1.850)	1.224	(0.800-	1.874)	1.290	(0.839-	1.984)	1.280	(0.834-	1.963)
hospCentral Middlesex	2.571	(0.917-	7.204)	2.634	(0.939-	7.391)	2.658	(0.942-	7.499)	2.712	(0.961-	7.654)	2.564	(0.910-	7.225)
hospCharing Cross	2.375	(1.151-	4.902)	2.262	(1.110-	4.611)	2.439	(1.182-	5.034)	2.382	(1.154-	4.916)	2.219	(1.085-	4.539)
hospEaling Central	2.290	(1.155-	4.544)	2.440	(1.252-	4.753)	2.371	(1.213-	4.634)	2.431	(1.243-	4.753)	2.331	(1.190-	4.563)
hospHammersmith	1.527	(0.709-	3.289)	1.496	(0.694-	3.229)	1.513	(0.699-	3.274)	1.498	(0.694-	3.238)	1.430	(0.662-	3.086)
hospHillingdon	1.461	(0.442-	4.832)	1.628	(0.507-	5.235)	1.576	(0.485-	5.119)	1.545	(0.481-	4.964)	1.465	(0.453-	4.735)
hospNorthwick Park	2.023	(0.770-	5.314)	2.203	(0.856-	5.669)	2.136	(0.827-	5.515)	2.167	(0.831-	5.646)	2.069	(0.801-	5.348)
carstairsq2	1.117	(0.297-	4.196)	1.145	(0.305-	4.307)	1.024	(0.268-	3.906)	1.115	(0.292-	4.254)	1.175	(0.312-	4.428)
carstairsq3	1.750	(0.506-	6.055)	1.820	(0.527-	6.286)	1.717	(0.491-	6.004)	1.756	(0.502-	6.148)	1.872	(0.540-	6.493)
carstairsq4	2.019	(0.594-	6.862)	2.079	(0.612-	7.068)	1.955	(0.567-	6.735)	2.027	(0.587-	6.999)	2.150	(0.630-	7.341)
carstairsq5	2.350	(0.696-	7.937)	2.401	(0.709-	8.134)	2.454	(0.706-	8.531)	2.307	(0.665-	7.999)	2.473	(0.728-	8.403)
popdens															
age sex	0.978	(0.503-	1.898)	0.963	(0.496-	1.872)	0.971	(0.499-	1.890)	0.911	(0.467-	1.777)	0.919	(0.470-	1.796)
saviah															
caline															
allflowperdist															
mainflowperdist															
nox															
voc	0.988	(0.955-	1.022)												
so2				1.000	(0.998-	1.002)									
data$popdens factorq2 4-7							0.819	(0.479-	1.397)						
data$popdens factorq3 7-10							1.168	(0.714-	1.912)						
data$popdens factorq4 10-14							1.053	(0.633-	1.753)						
data$popdens factorq5 14+							0.681	(0.390-	1.189)						
data$saviah factorq2 36-39										1.047	(0.624-	1.755)			
data$saviah factorq3 39-42										1.031	(0.599-	1.776)			
data$saviah factorq4 42-46										1.277	(0.731-	2.230)			
data$saviah factorq5 46+										0.777	(0.441-	1.369)			
data$caline factorq2 5-1 5													1.207	(0.744-	1.959)
data$caline factorq3 1 5-3													1.230	(0.738-	2.051)
data$caline factorq4 3-6													1.077	(0.624-	1.860)
data$caline factorq5 6+													0.728	(0.418-	1.269)
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2 5															
data$allflowperdist factorq3 2 5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4 5-7 5															
data$mainflowperdist factorq3 7 5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1 75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.51262			0.00382			4.91218			3.54232			4.816		
P-value	0.47401			0.95074			0.29643			0.47147			0.3067		

	Respiratory			Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR36	loci36	hici36	OR37	loci37	hici37	OR38	loci38	hici38	OR39	loci39	hici39	OR40	loci40	hici40
(Intercept)	0.229	(0.053-	0.989)	0.247	(0.056-	1.080)	0.235	(0.055-	1.014)	0.199	(0.050-	0.798)	0.136	(0.032-	0.581)
age	0.578	(0.349-	0.956)	0.585	(0.353-	0.970)	0.582	(0.351-	0.965)	0.584	(0.352-	0.968)	0.561	(0.338-	0.932)
sex	1.221	(0.800-	1.865)	1.242	(0.812-	1.900)	1.232	(0.806-	1.883)	1.267	(0.827-	1.941)	1.254	(0.817-	1.923)
hospCentral Middlesex	2.615	(0.931-	7.347)	2.551	(0.909-	7.158)	2.524	(0.892-	7.142)	2.537	(0.901-	7.143)	2.602	(0.922-	7.345)
hospCharing Cross	2.259	(1.071-	4.765)	2.321	(1.116-	4.827)	2.346	(1.131-	4.868)	2.309	(1.126-	4.736)	2.254	(1.100-	4.619)
hospEaling Central	2.404	(1.218-	4.743)	2.318	(1.166-	4.608)	2.429	(1.237-	4.769)	2.303	(1.174-	4.519)	2.433	(1.243-	4.763)
hospHammersmith	1.511	(0.698-	3.271)	1.526	(0.700-	3.327)	1.487	(0.683-	3.237)	1.417	(0.655-	3.067)	1.507	(0.698-	3.255)
hospHillingdon	1.510	(0.452-	5.039)	1.326	(0.390-	4.505)	1.408	(0.417-	4.747)	1.495	(0.458-	4.874)	1.461	(0.451-	4.727)
hospNorthwick Park	2.066	(0.774-	5.519)	1.874	(0.700-	5.015)	1.966	(0.740-	5.225)	2.178	(0.844-	5.620)	2.255	(0.870-	5.845)
carstairsq2	1.105	(0.292-	4.173)	1.124	(0.297-	4.257)	1.099	(0.290-	4.173)	1.187	(0.312-	4.525)	1.277	(0.334-	4.878)
carstairsq3	1.743	(0.501-	6.066)	1.841	(0.527-	6.433)	1.773	(0.510-	6.167)	1.935	(0.553-	6.773)	2.075	(0.590-	7.293)
carstairsq4	1.987	(0.580-	6.808)	2.087	(0.606-	7.181)	2.005	(0.585-	6.874)	2.201	(0.640-	7.565)	2.286	(0.661-	7.901)
carstairsq5	2.303	(0.678-	7.824)	2.355	(0.690-	8.032)	2.304	(0.674-	7.881)	2.463	(0.716-	8.470)	2.601	(0.756-	8.948)
popdens															
age sex	0.962	(0.495-	1.868)	0.926	(0.475-	1.806)	0.953	(0.489-	1.856)	0.925	(0.475-	1.800)	0.979	(0.503-	1.907)
saviah															
caline															
allflowperdist															
mainflowperdist															
nox															
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$saviah factorq2 36-39															
data$saviah factorq3 39-42															
data$saviah factorq4 42-46															
data$saviah factorq5 46+															
data$caline factorq2 5-1 5															
data$caline factorq3 1 5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000	0.822	(0.470-	1.438)												
data$nox factorq3 80000-120000	0.822	(0.494-	1.365)												
data$nox factorq4 120000-200000	0.872	(0.475-	1.601)												
data$nox factorq5 200000+	0.927	(0.509-	1.690)												
data$voc factorq2 40000-75000				0.751	(0.439-	1.287)									
data$voc factorq3 75000-100000				0.811	(0.476-	1.382)									
data$voc factorq4 100000-160000				0.616	(0.330-	1.147)									
data$voc factorq5 160000+				0.889	(0.453-	1.743)									
data$so2 factorq2 3000-5000							0.778	(0.440-	1.375)						
data$so2 factorq3 5000-9000							0.760	(0.441-	1.307)						
data$so2 factorq4 8000-60000							0.884	(0.501-	1.562)						
data$so2 factorq5 60000+							0.821	(0.455-	1.481)						
data$allflowperdist factorq2 1-2 5										1.040	(0.658-	1.642)			
data$allflowperdist factorq3 2 5-5										1.139	(0.679-	1.910)			
data$allflowperdist factorq4 5-30										0.801	(0.483-	1.329)			
data$allflowperdist factorq5 30+										0.707	(0.418-	1.196)			
data$mainflowperdist factorq2 4 5-7 5													1.322	(0.766-	2.280)
data$mainflowperdist factorq3 7 5-12													1.728	(1.035-	2.884)
data$mainflowperdist factorq4 12-25													1.455	(0.855-	2.475)
data$mainflowperdist factorq5 25+													0.902	(0.512-	1.590)
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1 75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.80023			3.42284			1.29281			3.56901			8.45288		
P-value	0.93842			0.48971			0.86259			0.46746			0.07633		

	Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR41	loci41	hici41	OR42	loci42	hici42	OR43	loci43	hici43	OR44	loci44	hici44	OR45	loci45	hici45	OR46	loci46	hici46	OR47	loci47	hici47	OR48	loci48	hici48
(Intercept)	0.171	(0.042-	0.694)	0.218	(0.053-	0.903)	0.197	(0.049-	0.794)	0.177	(0.042-	0.743)	0.176	(0.041-	0.756)	0.243	(0.058-	1.008)	0.177	(0.044-	0.714)	0.161	(0.039-	0.661)
age	0.566	(0.342-	0.938)	0.566	(0.340-	0.940)	0.574	(0.347-	0.950)	0.573	(0.346-	0.950)	0.578	(0.349-	0.957)	0.548	(0.329-	0.913)	0.581	(0.351-	0.962)	0.571	(0.343-	0.950)
sex	1.204	(0.789-	1.839)	1.215	(0.794-	1.860)	1.209	(0.792-	1.846)	1.245	(0.812-	1.910)	1.223	(0.800-	1.871)	1.246	(0.812-	1.910)	1.223	(0.801-	1.867)	1.202	(0.786-	1.840)
hospCentral Middlesex	2.674	(0.956-	7.483)	2.810	(0.994-	7.943)	2.638	(0.942-	7.383)	2.652	(0.944-	7.451)	2.659	(0.949-	7.454)	2.649	(0.941-	7.461)	2.758	(0.979-	7.766)	2.674	(0.949-	7.532)
hospCharing Cross	2.239	(1.098-	4.567)	2.180	(1.064-	4.465)	2.257	(1.107-	4.601)	2.216	(1.081-	4.543)	2.231	(1.090-	4.564)	2.119	(1.030-	4.359)	2.291	(1.122-	4.680)	2.277	(1.112-	4.663)
hospEaling Central	2.478	(1.272-	4.827)	2.478	(1.268-	4.842)	2.455	(1.257-	4.794)	2.429	(1.240-	4.758)	2.469	(1.265-	4.821)	2.442	(1.242-	4.803)	2.556	(1.302-	5.016)	2.445	(1.246-	4.795)
hospHammersmith	1.471	(0.684-	3.164)	1.367	(0.632-	2.957)	1.499	(0.697-	3.223)	1.508	(0.699-	3.254)	1.487	(0.692-	3.194)	1.369	(0.632-	2.966)	1.550	(0.718-	3.346)	1.527	(0.706-	3.303)
hospHillingdon	1.686	(0.526-	5.407)	1.651	(0.510-	5.352)	1.639	(0.511-	5.259)	1.484	(0.461-	4.778)	1.628	(0.509-	5.200)	1.707	(0.528-	5.516)	1.701	(0.530-	5.462)	1.740	(0.542-	5.588)
hospNorthwick Park	2.247	(0.876-	5.762)	2.599	(0.998-	6.765)	2.211	(0.862-	5.672)	2.189	(0.850-	5.636)	2.226	(0.866-	5.719)	2.356	(0.903-	6.151)	2.303	(0.893-	5.936)	2.221	(0.859-	5.741)
carstairsq2	1.180	(0.314-	4.437)	1.108	(0.290-	4.236)	1.150	(0.306-	4.323)	1.185	(0.312-	4.499)	1.151	(0.306-	4.330)	1.188	(0.313-	4.509)	1.155	(0.307-	4.351)	1.217	(0.321-	4.617)
carstairsq3	1.890	(0.547-	6.534)	1.864	(0.533-	6.525)	1.828	(0.529-	6.316)	1.845	(0.529-	6.440)	1.823	(0.528-	6.296)	2.011	(0.577-	7.012)	1.820	(0.526-	6.301)	1.988	(0.569-	6.953)
carstairsq4	2.158	(0.634-	7.340)	2.199	(0.639-	7.572)	2.080	(0.612-	7.072)	2.157	(0.628-	7.410)	2.079	(0.612-	7.068)	2.191	(0.639-	7.513)	2.045	(0.600-	6.968)	2.244	(0.651-	7.736)
carstairsq5	2.431	(0.720-	8.214)	2.500	(0.732-	8.539)	2.399	(0.709-	8.117)	2.459	(0.719-	8.410)	2.405	(0.711-	8.133)	2.693	(0.786-	9.219)	2.359	(0.696-	8.001)	2.643	(0.770-	9.078)
popdens																								
age sex	0.981	(0.505-	1.904)	0.939	(0.481-	1.831)	0.958	(0.494-	1.859)	0.943	(0.484-	1.836)	0.951	(0.489-	1.848)	0.945	(0.485-	1.843)	0.942	(0.485-	1.830)	0.950	(0.487-	1.856)
savish																								
caline																								
allflowperdist																								
mainflowperdist																								
nox																								
voc																								
so2																								
data$popdens factorq2 4-7																								
data$popdens factorq3 7-10																								
data$popdens factorq4 10-14																								
data$popdens factorq5 14+																								
data$savish factorq2 36-39																								
data$savish factorq3 39-42																								
data$savish factorq4 42-46																								
data$savish factorq5 46+																								
data$caline factorq2 5-1 5																								
data$caline factorq3 1 5-3																								
data$caline factorq4 3-6																								
data$caline factorq5 6+																								
data$nox factorq2 65000-80000																								
data$nox factorq3 80000-120000																								
data$nox factorq4 120000-200000																								
data$nox factorq5 200000+																								
data$voc factorq2 40000-75000																								
data$voc factorq3 75000-100000																								
data$voc factorq4 100000-160000																								
data$voc factorq5 160000+																								
data$so2 factorq2 3000-5000																								
data$so2 factorq3 5000-9000																								
data$so2 factorq4 8000-60000																								
data$so2 factorq5 60000+																								
data$allflowperdist factorq2 1-2 5																								
data$allflowperdist factorq3 2 5-5																								
data$allflowperdist factorq4 5-30																								
data$allflowperdist factorq5 30+																								
data$mainflowperdist factorq2 4.5-7 5																								
data$mainflowperdist factorq3 7,5-12																								
data$mainflowperdist factorq4 12-25																								
data$mainflowperdist factorq5 25+																								
data$rddist	1.009	(0.992- | 1.026)																					
data$rddist factorq2 11-17				0.833	(0.495- | 1.400)																		
data$rddist factorq3 7-11				0.894	(0.528- | 1.519)																		
data$rddist factorq4 3-7				1.188	(0.698- | 2.023)																		
data$rddist factorq5 <3				0.582	(0.345- | 0.981)																		
data$mrddist							1.000	(0.999- | 1.001)															
data$mrddist factorq2 200-300										0.944	(0.558- | 1.596)												
data$mrddist factorq3 120-200										1.218	(0.741- | 2.003)												
data$mrddist factorq4 75-120										1.393	(0.841- | 2.307)												
data$mrddist factorq5 <75										0.854	(0.517- | 1.411)												
data$allrdden													1.006	(0.977- | 1.035)									
data$allrddens factorq2 10-13																0.610	(0.363- | 1.027)						
data$allrddens factorq3 13-16																0.613	(0.367- | 1.023)						
data$allrddens factorq4 16-19																0.707	(0.407- | 1.226)						
data$allrddens factorq5 >19																0.911	(0.541- | 1.535)						
data$mrdden																			1.027	(0.972- | 1.085)			
data$mrddens factorq2 >0 - 1.75																						1.046	(0.621- | 1.762)
data$mrddens factorq3 1.75-3																						1.677	(0.978- | 2.877)
data$mrddens factorq4 3-5																						0.998	(0.599- | 1.661)
data$mrddens factorq5 >5																						1.236	(0.776- | 1.969)
Deviance of exposure terms	0.98945			8.30008			0.0459			4.6195			0.15304			5.8392			0.92308			4.1391		
P-value	0.31988			0.08118			0.83035			0.32861			0.69564			0.21148			0.33667			0.38751		

	Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR49	loci49	hici49	OR50	loci50	hici50	OR51	loci51	hici51	OR52	loci52	hici52	OR53	loci53	hici53
(Intercept)	0.278	(0.131-	0.590)	0.517	(0.143-	1.875)	0.312	(0.150-	0.650)	0.285	(0.138-	0.587)	0.285	(0.138-	0.587)
age	0.598	(0.359-	0.998)	0.596	(0.358-	0.993)	0.592	(0.355-	0.986)	0.600	(0.360-	1.001)	0.595	(0.357-	0.992)
sex	1.229	(0.799-	1.890)	1.249	(0.811-	1.924)	1.265	(0.820-	1.950)	1.236	(0.803-	1.903)	1.226	(0.796-	1.887)
hospCentral Middlesex	3.145	(1.106-	8.941)	3.057	(1.074-	8.702)	3.081	(1.083-	8.772)	3.148	(1.107-	8.951)	3.142	(1.105-	8.932)
hospCharing Cross	2.675	(1.242-	5.763)	2.804	(1.304-	6.031)	2.720	(1.269-	5.828)	2.729	(1.273-	5.850)	2.702	(1.262-	5.789)
hospEaling Central	2.977	(1.455-	6.094)	2.833	(1.377-	5.830)	2.887	(1.409-	5.918)	2.998	(1.465-	6.136)	2.983	(1.458-	6.106)
hospHammersmith	2.134	(0.947-	4.808)	2.119	(0.948-	4.736)	2.133	(0.954-	4.766)	2.169	(0.972-	4.840)	2.164	(0.970-	4.830)
hospHillingdon	2.109	(0.622-	7.155)	2.009	(0.591-	6.833)	2.028	(0.597-	6.893)	2.136	(0.628-	7.261)	2.099	(0.618-	7.123)
hospNorthwick Park	2.508	(0.967-	6.508)	2.267	(0.860-	5.972)	2.342	(0.899-	6.102)	2.524	(0.972-	6.552)	2.505	(0.965-	6.498)
popdens	1.003	(0.979-	1.027)												
age sex	0.954	(0.487-	1.868)	0.948	(0.484-	1.858)	0.940	(0.479-	1.843)	0.942	(0.480-	1.850)	0.957	(0.488-	1.876)
savish				0.986	(0.962-	1.011)									
caline							0.979	(0.952-	1.006)						
allflowperdist										1.000	(0.999-	1.001)			
mainflowperdist													1.000	(0.999-	1.001)
nox															
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$savish factorq2 36-39															
data$savish factorq3 39-42															
data$savish factorq4 42-46															
data$savish factorq5 46+															
data$caline factorq2 .5-1.5															
data$caline factorq3 1.5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2.5															
data$allflowperdist factorq3 2.5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7.5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.05133			1.20738			2.60045			0.20996			0.00623		
P-value	0.82076			0.27185			0.10683			0.6468			0.93711		

	Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR54	loci54	hici54	OR55	loci55	hici55	OR56	loci56	hici56	OR57	loci57	hici57	OR58	loci58	hici58
(Intercept)	0.259	(0.119-	0.565)	0.321	(0.144-	0.720)	0.279	(0.134-	0.580)	0.276	(0.126-	0.607)	0.242	(0.106-	0.549)
age	0.589	(0.353-	0.983)	0.594	(0.357-	0.990)	0.590	(0.353-	0.985)	0.583	(0.349-	0.976)	0.619	(0.370-	1.034)
sex	1.222	(0.794-	1.879)	1.232	(0.801-	1.894)	1.224	(0.796-	1.883)	1.257	(0.815-	1.938)	1.315	(0.847-	2.041)
hospCentral Middlesex	3.230	(1.131-	9.224)	3.093	(1.087-	8.801)	3.199	(1.120-	9.135)	3.170	(1.108-	9.067)	3.203	(1.117-	9.186)
hospCharing Cross	2.687	(1.254-	5.758)	2.848	(1.309-	6.197)	2.699	(1.260-	5.782)	2.813	(1.300-	6.086)	2.729	(1.257-	5.922)
hospEaling Central	3.073	(1.492-	6.328)	2.838	(1.367-	5.893)	3.011	(1.469-	6.172)	2.938	(1.431-	6.029)	2.981	(1.450-	6.126)
hospHammersmith	2.175	(0.974-	4.857)	2.229	(0.994-	5.000)	2.195	(0.980-	4.917)	2.164	(0.959-	4.883)	2.115	(0.942-	4.750)
hospHillingdon	2.243	(0.650-	7.734)	1.920	(0.550-	6.699)	2.148	(0.630-	7.324)	2.155	(0.629-	7.384)	1.942	(0.569-	6.630)
hospNorthwick Park	2.668	(1.007-	7.064)	2.317	(0.870-	6.171)	2.556	(0.979-	6.675)	2.426	(0.928-	6.345)	2.591	(0.979-	6.855)
popdens															
age sex	0.960	(0.490-	1.881)	0.971	(0.495-	1.905)	0.965	(0.492-	1.894)	0.957	(0.487-	1.880)	0.897	(0.455-	1.771)
savish															
caline															
allflowperdist															
mainflowperdist															
nox	1.007	(0.987-	1.027)												
voc				0.989	(0.956-	1.023)									
so2							1.000	(0.998-	1.003)						
data$popdens factorq2 4-7										0.866	(0.504-	1.489)			
data$popdens factorq3 7-10										1.211	(0.733-	2.000)			
data$popdens factorq4 10-14										1.177	(0.705-	1.967)			
data$popdens factorq5 14+										0.862	(0.501-	1.482)			
data$savish factorq2 36-39													1.201	(0.713-	2.023)
data$savish factorq3 39-42													1.144	(0.663-	1.975)
data$savish factorq4 42-46													1.494	(0.856-	2.606)
data$savish factorq5 46+													0.915	(0.518-	1.614)
data$caline factorq2 .5-1.5															
data$caline factorq3 1.5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2.5															
data$allflowperdist factorq3 2.5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4.5-7.5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	0.42008			0.44006			0.15357			2.91575			3.86834		
P-value	0.5169			0.50709			0.69515			0.57202			0.42412		

	Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma			Asthma		
Variable	OR59	loci59	hici59	OR60	loci60	hici60	OR61	loci61	hici61	OR62	loci62	hici62	OR63	loci63	hici63	OR64	loci64	hici64	OR65	loci65	hici65	OR66	loci66	hici66	OR67	loci67	hici67	OR68	loci68	hici68
(Intercept)	0.266	(0.118-	0.597)	0.320	(0.140-	0.728)	0.373	(0.162-	0.856)	0.348	(0.155-	0.783)	0.295	(0.136-	0.639)	0.210	(0.092-	0.479)	0.258	(0.122-	0.548)	0.332	(0.149-	0.741)	0.293	(0.138-	0.619)	0.271	(0.121-	0.604)
age	0.605	(0.362-	1.010)	0.600	(0.360-	1.001)	0.611	(0.366-	1.021)	0.608	(0.364-	1.014)	0.608	(0.364-	1.015)	0.583	(0.349-	0.975)	0.589	(0.353-	0.982)	0.590	(0.353-	0.987)	0.597	(0.358-	0.994)	0.596	(0.357-	0.995)
sex	1.307	(0.845-	2.022)	1.238	(0.804-	1.906)	1.262	(0.819-	1.944)	1.258	(0.816-	1.938)	1.285	(0.832-	1.986)	1.278	(0.827-	1.975)	1.218	(0.792-	1.875)	1.233	(0.800-	1.901)	1.222	(0.794-	1.881)	1.265	(0.817-	1.957)
hospCentral Middlesex	3.088	(1.080-	8.830)	3.160	(1.107-	9.023)	3.094	(1.084-	8.833)	3.008	(1.046-	8.650)	3.074	(1.075-	8.792)	3.112	(1.086-	8.918)	3.230	(1.134-	9.201)	3.311	(1.153-	9.511)	3.163	(1.111-	9.004)	3.192	(1.115-	9.141)
hospCharing Cross	2.643	(1.229-	5.681)	2.657	(1.202-	5.876)	2.743	(1.254-	5.999)	2.826	(1.297-	6.159)	2.744	(1.275-	5.906)	2.671	(1.242-	5.741)	2.701	(1.260-	5.787)	2.625	(1.222-	5.640)	2.696	(1.259-	5.776)	2.634	(1.225-	5.665)
hospEaling Central	2.881	(1.400-	5.927)	2.981	(1.441-	6.165)	2.876	(1.380-	5.995)	2.973	(1.442-	6.129)	2.842	(1.379-	5.861)	3.000	(1.458-	6.171)	3.048	(1.486-	6.249)	3.041	(1.481-	6.245)	3.016	(1.469-	6.192)	2.983	(1.449-	6.137)
hospHammersmith	2.081	(0.928-	4.663)	2.182	(0.971-	4.906)	2.156	(0.950-	4.895)	2.143	(0.943-	4.874)	2.048	(0.910-	4.609)	2.156	(0.962-	4.829)	2.134	(0.955-	4.769)	2.018	(0.899-	4.528)	2.172	(0.973-	4.849)	2.197	(0.981-	4.918)
hospHillingdon	1.899	(0.554-	6.508)	1.991	(0.567-	6.998)	1.672	(0.466-	5.996)	1.752	(0.492-	6.237)	1.960	(0.567-	6.768)	1.921	(0.561-	6.584)	2.178	(0.640-	7.415)	2.192	(0.637-	7.538)	2.129	(0.626-	7.246)	1.927	(0.564-	6.579)
hospNorthwick Park	2.383	(0.909-	6.246)	2.397	(0.886-	6.488)	2.143	(0.790-	5.809)	2.187	(0.816-	5.864)	2.535	(0.971-	6.617)	2.685	(1.019-	7.078)	2.598	(0.998-	6.764)	2.879	(1.098-	7.551)	2.533	(0.973-	6.595)	2.480	(0.948-	6.488)
popdens																														
age sex	0.900	(0.456-	1.777)	0.953	(0.486-	1.871)	0.925	(0.470-	1.821)	0.946	(0.481-	1.858)	0.913	(0.464-	1.796)	0.963	(0.489-	1.893)	0.970	(0.495-	1.903)	0.935	(0.475-	1.841)	0.951	(0.485-	1.864)	0.931	(0.473-	1.831)
savish																														
caline																														
allflowperdist																														
mainflowperdist																														
nox																														
voc																														
so2																														
data$popdens factorq2 4-7																														
data$popdens factorq3 7-10																														
data$popdens factorq4 10-14																														
data$popdens factorq5 14+																														
data$savish factorq2 36-39																														
data$savish factorq3 39-42																														
data$savish factorq4 42-46																														
data$savish factorq5 46+																														
data$caline factorq2 .5-1.5	1.227	(0.754-	1.998)																											
data$caline factorq3 1.5-3	1.255	(0.748-	2.107)																											
data$caline factorq4 3-6	1.153	(0.666-	1.997)																											
data$caline factorq5 6+	0.743	(0.423-	1.305)																											
data$nox factorq2 65000-80000				0.803	(0.456-	1.413)																								
data$nox factorq3 80000-120000				0.804	(0.483-	1.337)																								
data$nox factorq4 120000-200000				0.891	(0.482-	1.648)																								
data$nox factorq5 200000+				0.988	(0.540-	1.805)																								
data$voc factorq2 40000-75000							0.709	(0.417-	1.203)																					
data$voc factorq3 75000-100000							0.725	(0.423-	1.243)																					
data$voc factorq4 100000-160000							0.625	(0.333-	1.174)																					
data$voc factorq5 160000+							0.872	(0.442-	1.719)																					
data$so2 factorq2 3000-5000										0.715	(0.407-	1.257)																		
data$so2 factorq3 5000-9000										0.705	(0.407-	1.222)																		
data$so2 factorq4 8000-60000										0.851	(0.481-	1.508)																		
data$so2 factorq5 60000+										0.782	(0.429-	1.427)																		
data$allflowperdist factorq2 1-2.5													1.096	(0.694-	1.732)															
data$allflowperdist factorq3 2.5-5													1.163	(0.688-	1.965)															
data$allflowperdist factorq4 5-30													0.850	(0.511-	1.416)															
data$allflowperdist factorq5 30+													0.745	(0.437-	1.270)															
data$mainflowperdist factorq2 4.5-7.5																1.393	(0.804-	2.414)												
data$mainflowperdist factorq3 7.5-12																1.729	(1.028-	2.909)												
data$mainflowperdist factorq4 12-25																1.574	(0.921-	2.690)												
data$mainflowperdist factorq5 25+																0.998	(0.564-	1.767)												
data$rddist																			1.009	(0.991-	1.026)									
data$rddist factorq2 11-17																						0.836	(0.493-	1.416)						
data$rddist factorq3 7-11																						0.899	(0.527-	1.535)						
data$rddist factorq4 3-7																						1.104	(0.648-	1.879)						
data$rddist factorq5 <3																						0.605	(0.356-	1.026)						
data$mrddist																									1.000	(0.999-	1.001)			
data$mrddist factorq2 200-300																												0.861	(0.505-	1.469)
data$mrddist factorq3 120-200																												1.232	(0.747-	2.032)
data$mrddist factorq4 75-120																												1.377	(0.826-	2.295)
data$mrddist factorq5 <75																												0.852	(0.514-	1.413)
data$allrdden																														
data$allrddens factorq2 10-13																														
data$allrddens factorq3 13-16																														
data$allrddens factorq4 16-19																														
data$allrddens factorq5 >19																														
data$mrdden																														
data$mrddens factorq2 >0 - 1.75																														
data$mrddens factorq3 1.75-3																														
data$mrddens factorq4 3-5																														
data$mrddens factorq5 >5																														
Deviance of exposure terms	4.69301			1.22994			3.53417			2.08778			2.9883			7.3429			0.94781			6.08683			0.07945			5.03887		
P-value	0.32027			0.87315			0.4727			0.71962			0.55979			0.11884			0.33028			0.19276			0.77805			0.28333		

	Asthma			Asthma			Asthma			Asthma					
Variable	OR69	loci69	hici69	OR70	loci70	hici70	OR71	loci71	hici71	OR72	loci72	hici72	OR73	loci73	hici73
(Intercept)	0.236	(0.099-	0.564)	0.354	(0.157-	0.799)	0.248	(0.116-	0.530)	0.249	(0.116-	0.536)	0.364	(0.181-	0.733)
age	0.604	(0.362-	1.007)	0.573	(0.342-	0.961)	0.605	(0.363-	1.008)	0.598	(0.357-	1.000)	0.581	(0.352-	0.958)
sex	1.248	(0.810-	1.923)	1.266	(0.820-	1.957)	1.241	(0.806-	1.909)	1.225	(0.794-	1.888)	1.234	(0.812-	1.875)
hospCentral Middlesex	3.221	(1.130-	9.178)	3.221	(1.127-	9.200)	3.381	(1.179-	9.699)	3.218	(1.122-	9.232)	2.445	(0.891-	6.705)
hospCharing Cross	2.624	(1.220-	5.642)	2.532	(1.174-	5.460)	2.758	(1.284-	5.921)	2.746	(1.277-	5.906)	2.283	(1.122-	4.646)
hospEaling Central	3.066	(1.492-	6.300)	3.070	(1.486-	6.340)	3.193	(1.545-	6.599)	3.040	(1.473-	6.273)	2.530	(1.308-	4.893)
hospHammersmith	2.145	(0.961-	4.791)	2.038	(0.908-	4.574)	2.263	(1.009-	5.074)	2.251	(1.002-	5.059)	1.712	(0.800-	3.663)
hospHillingdon	2.128	(0.627-	7.217)	2.303	(0.672-	7.892)	2.221	(0.652-	7.570)	2.260	(0.663-	7.709)	1.878	(0.593-	5.950)
hospNorthwick Park	2.577	(0.989-	6.712)	2.708	(1.027-	7.145)	2.709	(1.034-	7.098)	2.573	(0.980-	6.755)	1.952	(0.783-	4.869)
popdens													1.002	(0.979-	1.026)
age.sex	0.935	(0.476-	1.836)	0.933	(0.474-	1.836)	0.934	(0.476-	1.832)	0.938	(0.476-	1.848)	0.954	(0.494-	1.841)
savish															
caline															
allflowperdist															
mainflowperdist															
nox															
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$savish factorq2 36-39															
data$savish factorq3 39-42															
data$savish factorq4 42-46															
data$savish factorq5 46+															
data$caline factorq2 5-1 5															
data$caline factorq3 1 5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2 5															
data$allflowperdist factorq3 2 5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4 5-7 5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
data$mainflowperdist factorq5 25+															
data$rddist															
data$rddist factorq2 11-17															
data$rddist factorq3 7-11															
data$rddist factorq4 3-7															
data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden	1.011	(0.982-	1.042)												
data$allrddens factorq2 10-13				0.657	(0.388-	1.115)									
data$allrddens factorq3 13-16				0.683	(0.408-	1.145)									
data$allrddens factorq4 16-19				0.749	(0.428-	1.311)									
data$allrddens factorq5 >19				1.014	(0.596-	1.723)									
data$mrdden							1.037	(0.981-	1.096)						
data$mrddens factorq2 >0 - 1.75										1.069	(0.632-	1.808)			
data$mrddens factorq3 1.75-3										1.635	(0.954-	2.802)			
data$mrddens factorq4 3-5										1.070	(0.636-	1.799)			
data$mrddens factorq5 >5										1.296	(0.807-	2.081)			
Deviance of exposure terms	0.58022			4.74067			1.62009			3.802			0.02478		
P-value	0.44623			0.31496			0.20308			0.43347			0.8749		

	Respiratory			Respiratory			Respiratory			Respiratory					
Variable	OR74	loci74	hici74	OR75	loci75	hici75	OR76	loci76	hici76	OR77	loci77	hici77	OR78	loci78	hici78
(Intercept)	0.751	(0.218-	2.593)	0.402	(0.205-	0.792)	0.370	(0.190-	0.722)	0.370	(0.190-	0.722)	0.340	(0.164-	0.701)
age	0.578	(0.351-	0.953)	0.576	(0.349-	0.949)	0.584	(0.354-	0.963)	0.579	(0.351-	0.954)	0.573	(0.348-	0.945)
sex	1.256	(0.826-	1.911)	1.264	(0.830-	1.925)	1.242	(0.817-	1.889)	1.233	(0.811-	1.874)	1.226	(0.807-	1.863)
hospCentral Middlesex	2.363	(0.860-	6.491)	2.393	(0.871-	6.570)	2.447	(0.892-	6.711)	2.441	(0.890-	6.695)	2.505	(0.909-	6.903)
hospCharing Cross	2.397	(1.177-	4.882)	2.306	(1.137-	4.678)	2.323	(1.145-	4.714)	2.298	(1.133-	4.660)	2.286	(1.127-	4.638)
hospEaling Central	2.379	(1.222-	4.630)	2.452	(1.265-	4.753)	2.544	(1.315-	4.923)	2.533	(1.309-	4.900)	2.603	(1.336-	5.069)
hospHammersmith	1.683	(0.791-	3.580)	1.699	(0.799-	3.613)	1.731	(0.815-	3.675)	1.727	(0.814-	3.667)	1.737	(0.817-	3.690)
hospHillingdon	1.767	(0.556-	5.616)	1.813	(0.572-	5.750)	1.909	(0.602-	6.059)	1.874	(0.592-	5.936)	1.991	(0.618-	6.416)
hospNorthwick Park	1.732	(0.684-	4.387)	1.832	(0.732-	4.589)	1.968	(0.789-	4.911)	1.947	(0.781-	4.855)	2.066	(0.811-	5.260)
popdens															
age.sex	0.950	(0.492-	1.834)	0.943	(0.488-	1.821)	0.940	(0.486-	1.818)	0.955	(0.494-	1.844)	0.960	(0.497-	1.853)
savish	0.984	(0.960-	1.008)												
caline				0.981	(0.956-	1.007)									
allflowperdist							1.000	(0.998-	1.001)						
mainflowperdist										1.000	(0.999-	1.001)			
nox													1.006	(0.987-	1.026)
voc															
so2															
data$popdens factorq2 4-7															
data$popdens factorq3 7-10															
data$popdens factorq4 10-14															
data$popdens factorq5 14+															
data$savish factorq2 36-39															
data$savish factorq3 39-42															
data$savish factorq4 42-46															
data$savish factorq5 46+															
data$caline factorq2 5-1 5															
data$caline factorq3 1 5-3															
data$caline factorq4 3-6															
data$caline factorq5 6+															
data$nox factorq2 65000-80000															
data$nox factorq3 80000-120000															
data$nox factorq4 120000-200000															
data$nox factorq5 200000+															
data$voc factorq2 40000-75000															
data$voc factorq3 75000-100000															
data$voc factorq4 100000-160000															
data$voc factorq5 160000+															
data$so2 factorq2 3000-5000															
data$so2 factorq3 5000-9000															
data$so2 factorq4 8000-60000															
data$so2 factorq5 60000+															
data$allflowperdist factorq2 1-2 5															
data$allflowperdist factorq3 2 5-5															
data$allflowperdist factorq4 5-30															
data$allflowperdist factorq5 30+															
data$mainflowperdist factorq2 4 5-7 5															
data$mainflowperdist factorq3 7.5-12															
data$mainflowperdist factorq4 12-25															
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data$rddist															
data$rddist factorq2 11-17															
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data$rddist factorq5 <3															
data$mrddist															
data$mrddist factorq2 200-300															
data$mrddist factorq3 120-200															
data$mrddist factorq4 75-120															
data$mrddist factorq5 <75															
data$allrdden															
data$allrddens factorq2 10-13															
data$allrddens factorq3 13-16															
data$allrddens factorq4 16-19															
data$allrddens factorq5 >19															
data$mrdden															
data$mrddens factorq2 >0 - 1.75															
data$mrddens factorq3 1.75-3															
data$mrddens factorq4 3-5															
data$mrddens factorq5 >5															
Deviance of exposure terms	1.7716			2.12483			0.34056			0.00082			0.36348		
P-value	0.18318			0.14493			0.55951			0.9771			0.54658		

	Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR79	loci79	hici79	OR80	loci80	hici80	OR81	loci81	hici81	OR82	loci82	hici82	OR83	loci83	hici83	OR84	loci84	hici84	OR85	loci85	hici85	OR86	loci86	hici86	OR87	loci87	hici87	OR88	loci88	hici88
(Intercept)	0.422	(0.198-	0.899)	0.365	(0.186-	0.717)	0.368	(0.176-	0.767)	0.320	(0.149-	0.689)	0.340	(0.160-	0.723)	0.416	(0.192-	0.899)	0.476	(0.218-	1.040)	0.444	(0.208-	0.949)	0.386	(0.188-	0.792)	0.278	(0.129-	0.599)
age	0.577	(0.350-	0.950)	0.575	(0.348-	0.949)	0.565	(0.341-	0.935)	0.601	(0.364-	0.993)	0.586	(0.355-	0.968)	0.584	(0.354-	0.963)	0.593	(0.359-	0.979)	0.586	(0.355-	0.967)	0.594	(0.359-	0.981)	0.566	(0.342-	0.935)
sex	1.236	(0.813-	1.877)	1.230	(0.809-	1.868)	1.263	(0.829-	1.924)	1.320	(0.862-	2.022)	1.296	(0.849-	1.979)	1.243	(0.818-	1.890)	1.264	(0.830-	1.924)	1.253	(0.823-	1.906)	1.288	(0.844-	1.964)	1.266	(0.829-	1.934)
hospCentral Middlesex	2.394	(0.872-	6.575)	2.470	(0.897-	6.801)	2.471	(0.895-	6.820)	2.523	(0.912-	6.983)	2.393	(0.867-	6.601)	2.452	(0.890-	6.757)	2.403	(0.873-	6.616)	2.311	(0.834-	6.404)	2.384	(0.864-	6.577)	2.409	(0.871-	6.664)
hospCharing Cross	2.417	(1.175-	4.969)	2.293	(1.131-	4.650)	2.372	(1.160-	4.849)	2.378	(1.158-	4.881)	2.244	(1.103-	4.566)	2.280	(1.087-	4.781)	2.346	(1.134-	4.854)	2.315	(1.124-	4.767)	2.338	(1.147-	4.765)	2.269	(1.114-	4.621)
hospEaling Central	2.394	(1.217-	4.709)	2.546	(1.314-	4.933)	2.474	(1.275-	4.799)	2.543	(1.308-	4.946)	2.447	(1.257-	4.762)	2.520	(1.287-	4.934)	2.422	(1.229-	4.773)	2.510	(1.288-	4.894)	2.395	(1.228-	4.672)	2.524	(1.298-	4.910)
hospHammersmith	1.776	(0.833-	3.788)	1.743	(0.818-	3.713)	1.716	(0.800-	3.680)	1.711	(0.800-	3.657)	1.658	(0.778-	3.537)	1.745	(0.816-	3.733)	1.757	(0.813-	3.796)	1.690	(0.782-	3.650)	1.623	(0.758-	3.475)	1.725	(0.809-	3.678)
hospHillingdon	1.698	(0.521-	5.540)	1.901	(0.597-	6.048)	1.919	(0.599-	6.147)	1.766	(0.555-	5.618)	1.704	(0.533-	5.449)	1.771	(0.538-	5.828)	1.516	(0.451-	5.089)	1.601	(0.480-	5.339)	1.694	(0.525-	5.471)	1.671	(0.522-	5.351)
hospNorthwick Park	1.790	(0.698-	4.589)	1.975	(0.787-	4.953)	1.882	(0.748-	4.738)	2.001	(0.787-	5.090)	1.866	(0.741-	4.703)	1.852	(0.711-	4.822)	1.677	(0.643-	4.370)	1.722	(0.668-	4.441)	1.966	(0.784-	4.934)	2.063	(0.815-	5.225)
popdens																														
age sex	0.972	(0.503-	1.879)	0.962	(0.498-	1.861)	0.963	(0.497-	1.863)	0.897	(0.461-	1.742)	0.910	(0.468-	1.770)	0.952	(0.492-	1.840)	0.922	(0.475-	1.789)	0.961	(0.496-	1.861)	0.912	(0.471-	1.768)	0.974	(0.502-	1.889)
savish																														
caline																														
allflowperdist																														
mainflowperdist																														
nox																														
voc	0.988	(0.956-	1.021)																											
so2				1.000	(0.998-	1.003)																								
data$popdens factorq2 4-7							0.814	(0.480-	1.382)																					
data$popdens factorq3 7-10							1.203	(0.739-	1.958)																					
data$popdens factorq4 10-14							1.156	(0.701-	1.905)																					
data$popdens factorq5 14+							0.844	(0.499-	1.429)																					
data$savish factorq2 36-39										1.162	(0.701-	1.926)																		
data$savish factorq3 39-42										1.125	(0.663-	1.909)																		
data$savish factorq4 42-46										1.439	(0.838-	2.471)																		
data$savish factorq5 46+										0.861	(0.495-	1.498)																		
data$caline factorq2 .5-1.5													1.271	(0.790-	2.045)															
data$caline factorq3 1.5-3													1.289	(0.776-	2.139)															
data$caline factorq4 3-6													1.141	(0.664-	1.959)															
data$caline factorq5 6+													0.780	(0.451-	1.351)															
data$nox factorq2 65000-80000																0.795	(0.458-	1.381)												
data$nox factorq3 80000-120000																0.821	(0.500-	1.349)												
data$nox factorq4 120000-200000																0.879	(0.482-	1.604)												
data$nox factorq5 200000+																0.978	(0.542-	1.763)												
data$voc factorq2 40000-75000																			0.705	(0.419-	1.186)									
data$voc factorq3 75000-100000																			0.799	(0.473-	1.350)									
data$voc factorq4 100000-160000																			0.619	(0.334-	1.147)									
data$voc factorq5 160000+																			0.871	(0.448-	1.692)									
data$so2 factorq2 3000-5000																						0.700	(0.403-	1.218)						
data$so2 factorq3 5000-8000																						0.780	(0.457-	1.330)						
data$so2 factorq4 8000-60000																						0.872	(0.497-	1.527)						
data$so2 factorq5 60000+																						0.834	(0.464-	1.499)						
data$allflowperdist factorq2 1-2.5																									1.076	(0.687-	1.685)			
data$allflowperdist factorq3 2.5-5																									1.217	(0.732-	2.022)			
data$allflowperdist factorq4 5-30																									0.817	(0.495-	1.349)			
data$allflowperdist factorq5 30+																									0.744	(0.442-	1.252)			
data$mainflowperdist factorq2 4.5-7.5																												1.346	(0.786-	2.304)
data$mainflowperdist factorq3 7.5-12																												1.784	(1.076-	2.959)
data$mainflowperdist factorq4 12-25																												1.543	(0.915-	2.602)
data$mainflowperdist factorq5 25+																												0.957	(0.546-	1.676)
data$rddist																														
data$rddist factorq2 11-17																														
data$rddist factorq3 7-11																														
data$rddist factorq4 3-7																														
data$rddist factorq5 <3																														
data$mrddist																														
data$mrddist factorq2 200-300																														
data$mrddist factorq3 120-200																														
data$mrddist factorq4 75-120																														
data$mrddist factorq5 <75																														
data$allrdden																														
data$allrddens factorq2 10-13																														
data$allrddens factorq3 13-16																														
data$allrddens factorq4 16-19																														
data$allrddens factorq5 >19																														
data$mrdden																														
data$mrddens factorq2 >0 - 1.75																														
data$mrddens factorq3 1.75-3																														
data$mrddens factorq4 3-5																														
data$mrddens factorq5 >5																														
Deviance of exposure terms	0.5194			0.07204			3.62411			4.14782			4.75725			1.16148			3.6623			1.81161			3.73015			8.79558		
P-value	0.4711			0.78839			0.45926			0.38637			0.31312			0.8844			0.45363			0.77036			0.44376			0.06642		

	Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR89	loci89	hici89	OR90	loci90	hici90	OR91	loci91	hici91	OR92	loci92	hici92
(Intercept)	0.334	(0.166-	0.668)	0.449	(0.212-	0.950)	0.387	(0.193-	0.773)	0.339	(0.160-	0.717)
age	0.572	(0.347-	0.943)	0.572	(0.346-	0.945)	0.581	(0.353-	0.957)	0.578	(0.350-	0.954)
sex	1.221	(0.803-	1.856)	1.231	(0.808-	1.876)	1.224	(0.805-	1.861)	1.256	(0.822-	1.918)
hospCentral Middlesex	2.507	(0.913-	6.887)	2.590	(0.935-	7.174)	2.467	(0.898-	6.775)	2.473	(0.895-	6.831)
hospCharing Cross	2.281	(1.124-	4.628)	2.219	(1.090-	4.515)	2.285	(1.127-	4.634)	2.239	(1.099-	4.561)
hospEaling Central	2.579	(1.331-	4.998)	2.580	(1.329-	5.009)	2.572	(1.325-	4.992)	2.538	(1.304-	4.939)
hospHammersmith	1.694	(0.797-	3.603)	1.595	(0.746-	3.408)	1.737	(0.818-	3.689)	1.751	(0.822-	3.730)
hospHillingdon	1.947	(0.613-	6.189)	1.924	(0.599-	6.179)	1.909	(0.601-	6.065)	1.718	(0.539-	5.475)
hospNorthwick Park	2.022	(0.809-	5.055)	2.253	(0.893-	5.683)	1.984	(0.793-	4.966)	1.948	(0.774-	4.899)
popdens												
age:sex	0.974	(0.504-	1.882)	0.938	(0.483-	1.820)	0.948	(0.491-	1.831)	0.938	(0.484-	1.817)
saviah												
caline												
allflowperdist												
mainflowperdist												
nox												
voc												
so2												
data$popdens factorq2 4-7												
data$popdens factorq3 7-10												
data$popdens factorq4 10-14												
data$popdens factorq5 14+												
data$saviah factorq2 36-39												
data$saviah factorq3 39-42												
data$saviah factorq4 42-46												
data$saviah factorq5 46+												
data$caline factorq2 .5-1.5												
data$caline factorq3 1.5-3												
data$caline factorq4 3-6												
data$caline factorq5 6+												
data$nox factorq2 65000-80000												
data$nox factorq3 80000-120000												
data$nox factorq4 120000-200000												
data$nox factorq5 200000+												
data$voc factorq2 40000-75000												
data$voc factorq3 75000-100000												
data$voc factorq4 100000-160000												
data$voc factorq5 160000+												
data$so2 factorq2 3000-5000												
data$so2 factorq3 5000-9000												
data$so2 factorq4 8000-60000												
data$so2 factorq5 60000+												
data$allflowperdist factorq2 1-2.5												
data$allflowperdist factorq3 2.5-5												
data$allflowperdist factorq4 5-30												
data$allflowperdist factorq5 30+												
data$mainflowperdist factorq2 4.5-7.5												
data$mainflowperdist factorq3 7.5-12												
data$mainflowperdist factorq4 12-25												
data$mainflowperdist factorq5 25+												
data$rddist	1.010	(0.993-	1.027)									
data$rddist factorq2 11-17				0.797	(0.477-	1.331)						
data$rddist factorq3 7-11				0.865	(0.051-	1.455)						
data$rddist factorq4 3-7				1.073	(0.640-	1.801)						
data$rddist factorq5 <3				0.573	(0.342-	1.820)						
data$mrddist							1.000	(0.999-	1.001)			
data$mrddist factorq2 200-300										0.945	(0.562-	1.590)
data$mrddist factorq3 120-200										1.279	(0.783-	2.089)
data$mrddist factorq4 75-120										1.428	(0.865-	2.357)
data$mrddist factorq5 <75										0.905	(0.551-	1.484)
data$allrdden												
data$allrddens factorq2 10-13												
data$allrddens factorq3 13-16												
data$allrddens factorq4 16-19												
data$allrddens factorq5 >19												
data$mrdden												
data$mrddens factorq2 >0 - 1.75												
data$mrddens factorq3 1.75-3												
data$mrddens factorq4 3-5												
data$mrddens factorq5 >5												
Deviance of exposure terms	1.20474			7.23921			0.20732			4.73583		
P-value	0.27238			0.12377			0.64887			0.31549		

	Respiratory			Respiratory			Respiratory			Respiratory		
Variable	OR93	loci93	hici93	OR94	loci94	hici94	OR95	loci95	hici95	OR96	loci96	hici96
(Intercept)	0.330	(0.146-	0.744)	0.480	(0.224-	1.028)	0.327	(0.162-	0.658)	0.328	(0.162-	0.666)
age	0.584	(0.354-	0.963)	0.557	(0.336-	0.923)	0.588	(0.357-	0.970)	0.582	(0.352-	0.964)
sex	1.245	(0.818-	1.895)	1.264	(0.829-	1.929)	1.244	(0.819-	1.892)	1.229	(0.807-	1.872)
hospCentral Middlesex	2.477	(0.901-	6.806)	2.460	(0.893-	6.777)	2.604	(0.942-	7.196)	2.497	(0.903-	6.908)
hospCharing Cross	2.255	(1.108-	4.590)	2.156	(1.056-	4.405)	2.330	(1.147-	4.734)	2.317	(1.139-	4.714)
hospEaling Central	2.573	(1.326-	4.995)	2.543	(1.302-	4.966)	2.682	(1.375-	5.233)	2.572	(1.320-	5.013)
hospHammersmith	1.716	(0.808-	3.645)	1.618	(0.757-	3.458)	1.795	(0.842-	3.826)	1.786	(0.836-	3.815)
hospHillingdon	1.879	(0.593-	5.947)	1.977	(0.619-	6.316)	1.973	(0.620-	6.276)	2.004	(0.630-	6.380)
hospNorthwick Park	1.981	(0.792-	4.956)	2.049	(0.809-	5.192)	2.089	(0.831-	5.252)	2.003	(0.794-	5.050)
popdens												
age:sex	0.943	(0.487-	1.823)	0.938	(0.484-	1.820)	0.933	(0.483-	1.804)	0.934	(0.481-	1.813)
saviah												
caline												
allflowperdist												
mainflowperdist												
nox												
voc												
so2												
data$popdens factorq2 4-7												
data$popdens factorq3 7-10												
data$popdens factorq4 10-14												
data$popdens factorq5 14+												
data$saviah factorq2 36-39												
data$saviah factorq3 39-42												
data$saviah factorq4 42-46												
data$saviah factorq5 46+												
data$caline factorq2 .5-1.5												
data$caline factorq3 1.5-3												
data$caline factorq4 3-6												
data$caline factorq5 6+												
data$nox factorq2 65000-80000												
data$nox factorq3 80000-120000												
data$nox factorq4 120000-200000												
data$nox factorq5 200000+												
data$voc factorq2 40000-75000												
data$voc factorq3 75000-100000												
data$voc factorq4 100000-160000												
data$voc factorq5 160000+												
data$so2 factorq2 3000-5000												
data$so2 factorq3 5000-9000												
data$so2 factorq4 8000-60000												
data$so2 factorq5 60000+												
data$allflowperdist factorq2 1-2.5												
data$allflowperdist factorq3 2.5-5												
data$allflowperdist factorq4 5-30												
data$allflowperdist factorq5 30+												
data$mainflowperdist factorq2 4.5-7.5												
data$mainflowperdist factorq3 7.5-12												
data$mainflowperdist factorq4 12-25												
data$mainflowperdist factorq5 25+												
data$rddist												
data$rddist factorq2 11-17												
data$rddist factorq3 7-11												
data$rddist factorq4 3-7												
data$rddist factorq5 <3												
data$mrddist												
data$mrddist factorq2 200-300												
data$mrddist factorq3 120-200												
data$mrddist factorq4 75-120												
data$mrddist factorq5 <75												
data$allrdden	1.007	(0.979-	1.036)									
data$allrddens factorq2 10-13				0.644	(0.385-	1.076)						
data$allrddens factorq3 13-16				0.678	(0.411-	1.118)						
data$allrddens factorq4 16-19				0.727	(0.421-	1.254)						
data$allrddens factorq5 >19				0.941	(0.561-	1.579)						
data$mrdden							1.035	(0.980-	1.092)			
data$mrddens factorq2 >0 - 1.75										1.037	(0.620-	1.735)
data$mrddens factorq3 1.75-3										1.580	(0.930-	2.686)
data$mrddens factorq4 3-5										1.072	(0.650-	1.769)
data$mrddens factorq5 >5										1.286	(0.810-	2.041)
Deviance of exposure terms	0.23787			4.58725			1.4971			3.54056		
P-value	0.62575			0.33233			0.22112			0.47174		

References

Adriaanse A. 1993 *Environmental policy performance indicators: a study on the development of indicators for environmental policy in the Netherlands.* SDU Uitgeverij Koninginnegracht: Netherlands

AEA 1993 *UK Nitrogen Dioxide Survey Results for the first year - 1993.* AEA/CS/RAMP/16419032/002. Culham: AEA.

Alexander L. 1994a *Health-Related Indicators for a Sustainable Community.* Environmental Epidemiology Research Unit, Lancaster University. EERU Report No. 9. Lancaster: Lancaster University.

Alexander L. 1994b *Health-Related Indicators for a Sustainable Community: progress in Lancashire.* Environmental Epidemiology Research Unit, Lancaster University. EERU Report No. 10. Lancaster: Lancaster University.

Alfsen K.H. and Saebø H.V. 1993 Environmental quality indicators: background, priciples and examples from Norway. *Environmental and Resource Economics* **3**:415-435.

Archer V.E. 1990 Air pollution and fatal lung disease in three Utah counties. *Archives of Environmental Health* **45**:325-334.

Bailey T.C. 1995 A review of statistical spatial analysis in geographical information systems. In: Fotheringham S. and Rogerson P. *Spatial analysis and GIS.* London: Taylor & Francis. 13-44.

Bailey T.C. and Gatrell A.C. 1995 *Interactive spatial data analysis.* Harlow: Longman Scientific & Technical,

Bakkes J., van den Born G. J., Helder J.C., Swart R.J., Hope C.W. and Parker J.D.E. 1994 *An overview of environment indicators: state of the art and perspectives.* Nairobi: UNEP.

Benson P.E. 1992 A review of the development and application of the CALINE-3 and 4 models. *Atmospheric Environment,* **26B**:379-390.

Bhopal R.S., Phillomore P., Moffatt S. and Foy C. 1994 Is living near a coking works harmful to health? A study of industrial air pollution. *Journal of Epidemiology and Community Health*, **48**, 237.

Bithell J.F. 1990 An appliction of density estimation to geographical epidemiology. *Statistics in Medicine*, **9**, 691-701.

Bobak B. and Leon D.A. 1992 Air pollution and infant mortality in the Czech Republic 1986-1988. *Lancet* **340**:1010-1014.

Brandt W. 1980 *North - South: a programme for survival* London: Pan.

Brandt W. 1983 *Common crisis. North - South: co-operation for world recovery* London: Pan.

Briggs, D.J. 1992 *The comparability of national environmental statistics in Europe*. Institute of Environmental and Policy Analysis, University of Huddersfield. IEPA Research Report No. 92/2. Huddersfield: IEPA, University of Huddersfield.

Briggs D.J. 1993a *Environmental data in the EC: towards an integrated emissions inventory*. Consultation on environment and health indicators for use with a health and environment GIS (HEGIS) for Europe. Bilthoven, Netherlands, 11-13/3/1993. ICP/CEH 246/10. Copenhagen: WHO.

Briggs D.J. 1993b *An Integrated Emissions Inventory for Europe*. IEPA Research Report No. 93/1. Huddersfield: Institute of Environmental and Policy Analysis, University of Huddersfield.

Briggs, D. J. 1993c State of environment reporting. In: Nath, B. Hens, L. and Devuyst, D. (Ed's) *Environmental management. Volume 3 - instruments for implementation*. VUB University Press: Brussels. 125-144.

Briggs D.J. 1995 Environmental statistics for environmental policy: genealogy and data quality. *Journal of Environmental Management* **44**:39-54.

Briggs D.J. 1996 Mapping environmental exposure. In: Elliott P., Cuzick J., English D. and Stern R. (Ed's) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 158-176.

Briggs D.J. 1997 Using geographical information systems to link environment and health data. In: Corvalan C., Nurminen M. and Pastides H. (Eds) *Linkage methods for environment and health analysis: technical guidelines.* A report of the Health and Environment Analysis for Decision-making Project (HEADLAMP). UNEP, USEPA &WHO. Geneva: Office of Global and Integrated Environmental Health, WHO. 125-153.

Briggs D.J., Collins S., Elliott P. and Martuzzi M. 1993 *Infant mortality in Huddersfield District Health Authority, 1982-1991. Report of a study on behalf of West Yorkshire Helth Authority.* Huddersfield: Institute of Environmental and Policy Analysis, University of Huddersfield, London School of Hygiene and Tropical Medicine.

Briggs D.J., Elliott P. and Libretto E. 1994 Analysing small area variations in air quality and health: the EC SAVIAH study. Paper presented to the *6th International Medical Geography Symposium*, Vancouver, British Columbia, Canada, 12-16 July, 1994.

Briggs D.J. and Elliott P. 1995 The use of geographical information systems in studies on environment and health. *World Health Statistics Quarterly* **48**, No. 2: 85-94

Briggs D.J., Collins S., Elliott P., Kingham S., Lebret E., Pryl K., van Reeuwijk H., Smallbone K. and van der Veen A. 1997 Mapping urban air pollution using GIS: a regression-based approach. *International Journal of Geographical Information Science,* **11** No. 7:699-718.

Brown P.J.B., Batey W.J. and Hirschfield A. 1991 Prerequisites for the Poisson chi square mapping and geodemographic analysis of relatively rare conditions. In: *Proceedings of a Workshop on Geographical Data Structures for Small Area Statistical Analysis.* London: London School of Hygiene and Tropical Medicine.

Brown P.B., Hirschfield A. and Marsden J. 1995 Analysing spatial patterns of disease: some issues in the mapping of incidence data for relatively rare conditions. In: Lepper M. de, Scholten H. J. and Stern R. M. (Eds) *The added value of geographical information systems in public and environmental health.* Kluwer academic publishers: Dordrecht. 145-163.

Brown R.M., McClelland N.I., Deininger R.A. and O'Connor M.F. 1972 A water quality index - crashing the psychological barrier. In: Thomas W. (Ed) *Indicators of environmental quality.* Proceedings of a symposium held during the AAAS meeting in Philadelphia, Pennsylvania, December 26-31, 1971. New York: Plenium Press, 173-182.

Brunekreef B., Janssen N.A.H., de Hartog J., Harssema H., Knape M. and van Vliet P. 1997 Air pollution from truck traffic and lung function in children living near motorways. *Epidemiology* **8**, No. 3:298-303.

Burrough P.A. 1986 *Principles of Geographical Information Systems for land resources assessment*. Monographs on soil and resources survey, No. 12. Oxford: Clarendon Press.

Campbell G.W., Stedman J.R. and Stevenson K. 1994 A survey of nitrogen dioxide concentrations in the United Kingdom using diffusion tubes, July to December 1991. *Atmospheric Environment*, **28**:477-486.

Canadian Ministry of Supply and Services 1990 *Canada's Green Plan*. Ottawa: Canadian Ministry of Supply and Services.

Carson R. 1962 *Silent Spring*. Boston: Houghton Miflin.

CEC 1992a *Towards sustainability: a European community programme of policy and action in relation to the environment and sustainable development*. Vol. II. COM(92) 23. Brussels: Commission of the European Communities.

CEC 1996 *Amended proposal for a European parliament and council decision on the review of the European Community programme of policy and action in relation to the environment and sustainable development "Towards Sustainability" (presented by the Commission pursuant to Article 189 a (2) of the EC-Treaty)*. COM(96) 648. Brussels: Commission of the European Communities.

CEC and Eurostat 1996 *Environmental indicators and green accounting. Practical steps towards the implementation of the communication from the commission to the council and the European parliament on "Directions for the European Union on environmental indicators and green accounting"*. COM(94)670. Brussels: Commission of the European Communities.

Chan L.Y. and Wu H.W.Y. 1993 A study of bus commuter and pedestrian exposure to traffic air pollution in Hong Kong. *Environment International*, **19**:121-132.

Chappie M. and Lave L. 1982 The health effects of air pollution: a re-analysis. *Journal of Urban Economics* **12**:346-376.

Chestnut L.G., Schwartz J., Savitz D.A. and Burchfiel C.M. 1991 Pulmonary function and ambient particulate matter: epidemiological evidence from NHANES I. *Archives of Environmental Health* 46:135-144.

City of Seattle Planning Department 1991 *Environmental risks in Seattle: a comparative assessment*. Seattle: City of Seattle Planning Department.

City of Seattle Planning Department 1992 *The city of Seattle's environmental action agenda: environmental stewardship in Seattle*. Seattle: City of Seattle Planning Department.

City of Seattle Planning Department 1993 *Towards a sustainable Seattle: Seattle's plan for managing growth*. Public review draft. Seattle: City of Seattle Planning Department.

Clayton D. and Bernardinelli L. 1996 Bayesian methods for mapping disease risk. In: Elliott P., Cuzick J., English D. and Stern R. (Eds) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 205-220.

Collins S., Smallbone K. and Briggs D.J. 1994 A GIS approach to modelling small area variations in air pollution within a complex urban environment. In: Fisher P. (Ed) *Proceedings of GIS Research UK 1994, 2nd National Conference, 11-13th April 1994*. London: Taylor & Francis. 245-253.

Corson W. 1994 *An inventory of local and regional programs using goals and indicators to define and measure quality of life, progress and sustainability at the city, county and state level*. Washington, D.C.: Global Tomorrow Coalition.

Corvalan C. 1994 *Indicators and data linkage for environmental health management*. Geneva: Office of Global and Integrated Environmental Health, WHO.

Corvalan C. and Kjellström T. 1996 Health and environment analysis for decision-making. In: Briggs D., Corvalan C., and Nurminen M. (Eds) *Linkage methods for environment and health analysis: general guidelines*. A report of the Health and Environment Analysis for Decision-making Project (HEADLAMP). UNEP, USEPA &WHO. Geneva: Office of Global and Integrated Environmental Health, WHO. 1-18.

Corvalan C., Briggs D. and Kjellström T. 1996 Development of environmental health indicators. In: Briggs D., Corvalan C., and Nurminen M. (Eds) *Linkage methods for environment and health analysis: general guidelines*. A report of the Health and

Environment Analysis for Decision-making Project (HEADLAMP). UNEP, USEPA &WHO. Geneva: Office of Global and Integrated Environmental Health, WHO. 19-54.

Corvalan C., Nurminen M. and Pastides H. (Eds) 1997 *Linkage methods for environment and health analysis: technical guidelines*. A report of the Health and Environment Analysis for Decision-making Project (HEADLAMP). UNEP, USEPA &WHO. Geneva: Office of Global and Integrated Environmental Health, WHO.

Council on Environmental Quality 1972 *Environmental quality: third annual report*. Washington D.C.: Executive Office of the President.

Cressie N. 1992 Smoothing regional maps using empirical bayes predictors. *Geographical Analysis*, **24**, 75-95.

Cutter S.L. 1993 *Living with risk. The geography of technological hazards.* London: Arnold.

Deininger R.A. and Maciunas J.J. 1971 *A water quality index for public water supplies*. Report of a research study. Michigan: University of Michigan.

Department of the Environment 1995 *Digest of environmental statistics*. No. 17. London: HMSO.

Department of the Environment 1996a *The United Kingdom national air quality strategy: consultation draft - summary and overview*. DOE: London.

Department of the Environment 1996b *Expert panel on air quality standards: nitrogen dioxide*. HMSO: London.

Department of the Environment 1997 *The United Kingdom national air quality strategy*. London: DOE.

Department of the Environment and Department of Health 1996 *United Kingdom national environmental health action plan.* HMSO: London

Department of Transport 1994 *Design manual for roads and bridges.* HMSO: London.

Dockery D.W., Speizer F.E., Stram D.O., Ware J.H., Spengler J.D. and Ferris B.G. 1989 Effects of inhalable particles on respiratory health of children. *American Review of Respiratory Disease* **139**:587-594.

Dockery D.W., Pope C.A. III, Xu X., Spengler J.D., Ware J.H., Ray M.E., Ferris B.G. Jr. and Speizer F.E. 1993 An association between air pollution and mortality in six U.S. cities. *New England Journal of Medicine* **329**:1753-1759.

Dunn C. and Kingham S. 1996 Establishing links between air quality and health: searching for the impossible? *Social Science and Medicine*, **42**, 831-841.

Edwards J., Walters S. and Griffiths R.K. 1994 Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom. *Archives of Environmental Health*, **49** No. 4:223-227.

EEA 1995 *Europe's environment: the Dobris assessment.* Copenhagen: European Environment Agency.

Eerens H., Sliggers C. and van der Hout K. 1993 The CAR model: the Dutch method to determine city street air quality. Atmospheric Environment, **27B**:389-399.

Elkin T., McLaren D. and Hillman M. 1991 *Reviving the city: towards sustainable development.* London: Friends of the Earth.

Elliott P., Martuzzi M. and Shaddick G. 1995 Spatial statistical methods in environmental epidemiology: a critique. *Statistical Methods in Medical Research*, **4**.

Elliott P., Beresford J.A., Jolley D.J., Pattenden S.H. and Hills M. 1996 Cancer of the larynx and lung near incinerators of waste solvents and oils in Britain. In: Elliott P., Cuzick J., English D. and Stern R. (Eds) *Geographical and environmental epidemiology: methods for small-area studies.* Oxford: Oxford University Press. 359-367.

English D. 1996 Geographical epidemiology and ecological studies. In: Elliott P., Cuzick J., English D. and Stern R. (Ed's) *Geographical and environmental epidemiology: methods for small-area studies.* Oxford: Oxford University Press. 3-13.

Environment Canada 1991 *A report on Canada's progress towards a national set of environmental indicators.* SOE Report No. 91-1. Ottawa: Environment Canada.

Environment Canada 1992 Environmental indicator bulletin: stratospheric ozone depletion. SOE Bulletin No. 92-1. Ottawa: Environment Canada.

Environment Canada 1993 Environmental indicator bulletin: stratospheric ozone depletion. SOE Bulletin No. 93-2. Ottawa: Environment Canada.

Environment Canada 1994 National environmental indicator series: stratospheric ozone depletion. SOE Bulletin No. 94-6. Ottawa: Environment Canada.

Environment Canada 1995 National environmental indicator series: stratospheric ozone depletion. SOE Bulletin No. 95-5. Ottawa: Environment Canada.

ESRI 1990 *Understanding GIS: The ARC/INFO Method.* Redlands, California: Environmental Systems Research Institute.

Euler G.L., Abbey D.E., Magie A.R. and Hodgkin J.E. 1987 Chronic obstructive pulmonary disease symptom effects of long-term cumulative exposure to ambient levels of total suspended particulates and sulphur dioxide in California Seventh-Day Adventist residents. *Archives of Environmental Health* **42**:213-222.

European Commission 1994 *Corinair technical annexes, volume 2: default emission factors handbook.* EUR 12586/2 EN. Luxembourg: Office for the Official Publications of the European Communities.

European Commission 1995a *Corinair technical annexes, volume 1: nomenclature and software*. EUR 12586/1 EN. Luxembourg: Office for the Official Publications of the European Communities.

European Commission 1995b *Corinair Inventiare des émissions de dioxyde de soufre, d'oxydes d'azote et de composés organiques volatils dans la Communauté européenne en 1985*. EUR 13232 FR. Luxembourg: Office for the Official Publications of the European Communities.

Eurostat 1994 *Environmental Pressure Index Project.* Excerpt from the documents of the call to tender published in the Official Journal of the European Communities, No. S129 on 8th July 1994 and C186 on 8th July 1994. Luxembourg: Eurostat.

Evans J.S., Tosteson T. and Kinney P.L. 1984 Cross-sectional mortality studies and air pollution risk assessment. *Environment International* **10**:55-83.

Federal Planning Office of Belgium 1995 *Indicators of sustainable development for decision-making*. Report of a workshop in Ghent, Belgium, 9-11 January, 1995 submitted to the UN Commission on Sustainable Development. Brussels: Federal Planning Office of Belgium.

Fisher P.F. and Langford M. 1995 Modelling the errors in areal interpolation between zonal systems by Monte Carlo simulation. *Environment and Planning*, **27**, 211-224.

Flowerdew R. and Green M. 1994 Areal interpolation and types of data. In: Fotheringham S. and Rogerson P. *Spatial analysis and GIS*. London: Taylor & Francis. 121-146.

Gardner M.J. 1996 Childhood leukaemia around the Sellafield nuclear plant. In: Elliott P., Cuzick J., English D. and Stern R. (Eds) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 291-309.

Gatrell A.C. and Dunn C.E. 1995 Geographical informtion systems and spatial epidemiology: modelling the possible association between cancer of the larynx and incineration in north-west England. In: Lepper M. de, Scholten H. J. and Stern R. M. (Eds) *The added value of geographical information systems in public and environmental health*. Kluwer academic publishers: Dordrecht. 215-231.

Gatrell A. and Rowlingson B. 1995 Spatial point process modelling in a GIS environment. In: Fotheringham S. and Rogerson P. *Spatial analysis and GIS*. London: Taylor & Francis. 147-164.

Gillam, C.A., Leech, P.K. and Eggleston, H.S. 1992. *National Atmospheric Emissions Inventory*. London: Department of the Environment.

Glass G.E., Schwartz B.S., Morgan J.M., Johnson D.T., Noy P.M. and Israel E. 1995 Environmental roask factors for lyme disease identified with geographic informtion systems. *American Journal of Public Health*, **85**, 7, 944-948.

Goldstein G. 1994 Healthy and sustainable cities: the role of a healthy cities project. In: Britt D.P. (Ed) *Health and the urban environment: promoting practice globally*. Proceedings of a symposium organised jointly by the UK Health For All Network, the Public Health Trust and the British Council in association with Global Forum 1994. Manchester: British Council.

Greenland S. and Morgenstern H. 1989 Ecological bis, confounding and effect modification. *International Journal of Epidemiology*, **18**, 269-274.

Hammond A., Adriaanse A., Rodenburg E., Bryant D. and Woodward R. 1995 *Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development.* Washington: World Resources Institute.

Harrison P. 1984 Inside the inner city. In: Black N. Boswell D., Gray A., Murphy S. and Popay J. (Eds) *Health and Disease: A Reader.* Buckingham: Open University Press.

Hennekens C.H. and Buring J.E. 1987 *Epidemiology in medicine.* Boston: Little, Brown & Company.

Henschen F. 1966 *The history of diseases.* London, and Hippocrates transl. Jones, W.H.S. 1923, Cambridge.

Hewitt C.N. 1991 Spatial variations in nitrogen dioxide concentration in an urban area. *Atmospheric Environment* **25B**:429-34.

HMSO 1996 *Indicators of sustainable development for the United Kingdom.* A set of indicators produced for discussion and consultation by an interdepartmental working group, following a commitment in the UK's sustainable development strategy of 1994. London: HMSO.

Hoek G. and Brunekreef B. 1993 Acute effects of a winter air pollution episode on pulmonary function and respiratory symptoms of children. *Archives of Environmental Health,* **48**:328-335.

Holland W.W. 1991 *European Community atlas of 'aviodable death'.* 2nd edition. EC working group on health services and 'avoidable deaths'. Oxford: Oxford University Press.

Howe G.M. 1981 Mortality from selected malignant neoplasms in the British Isles: the spatial perspective. In: Learmonth A.T.A (Ed) *The geography of health.* Selected papers from the 24th international geographical congress, Tokyo, 26-30 August, 1980. Oxford: Pergamon Press. 199-211.

Howe G.M. 1982 Disease and the environment. In: Rees A. and Purcell H. *Disease and the environment.* Proceedings of the inaugral conference of the society for environmental therapy, Oxford, 21-33 March 1981. London: John Wiley & Sons, 1-9.

Howe G.M. and Phillips D.R. 1983 Medicl geography in the United Kingdom, 1945-1982. In: McGlashan N.D. and Blunden J.R. (Eds) *Geographical aspects of health. Essays in honour of Andrew Learmonth*. London: Academic Press. 33-52.

Inhaber H. 1974 Environmental quality: outline for a national index for Canada. *Science*: **186**:798-805.

Inhaber H. 1976 *Environmental indices*. London: John Wiley & Sons.

Jacksonville Community Council 1993a *Life in Jacksonville: quality indicators for progress*. Jacksonville: Jacksonville Community Council.

Jacksonville Community Council 1993b *Life in Jacksonville: quality indicators for progress. Executive summary*. Jacksonville: Jacksonville Community Council.

Jarman B. 1990 Identification of underprivileged areas. *British Medical Journal* **286**:1705-1709.

Jeffcote M. and Allen M. 1995 *Indicators of sustainable development in Leicester - progress and trends*. Leicester: Environ Ltd. and Leicester City Council.

Johnston R.J. 1981 *The dictionary of human geography*. Oxford: Blackwell Reference

Jolley D.J., Jarman B. and Elliott P. 1996 Socio-economic confounding. In: Elliott P., Cuzick J., English D. and Stern R. (Ed's) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 115-124.

Jones K. and Moon G. 1987 *Health, disease and society: an introduction to medical geography*. London: Routledge.

Kent D., Reimold R.J., Kelly J.M. and Tammi C.E. 1992 Coupling wetlands structure and function: developing a condition index for wetlands monitoring. In: McKenzie, D., Hyatt D.E. and McDonald V.J. (Eds) *Ecological Indicators: Volume 2*. London: Elsevier Applied Science, 559-570.

Kerr A. 1994 *Canada's national environmental indicators project*. Prepared for the global environmental indicators workshop, World Resources Institute, December 7-8 1992. Updated 1994. Ottawa: Environment Canada.

Kimball T.L. 1972 Why environmental quality indices? In: Thomas W. (Ed) *Indicators of environmental quality*. Proceedings of a symposium held during the AAAS meeting in Philadelphia, Pennsylvania, December 26-31, 1971. New York: Plenium Press, 7-14.

Kolsky P.J. and Blumenthal U.J. 1995 Environmental health indicators and sanitation-related disease in developing countries: limitations to the use of routine data sources. *World Health Statistics Quarterly* **48**, No. 2:132-139.

Krzyzanowski M. (Ed) 1997 *Exposure of urban population in the WHO region to major air pollutants: summary of the WHO-ECEH air pollution database*. EUR/ICP/TRNS 02 01 02. WHO: Bilthoven.

Lancashire County Council 1991 *Lancashire: a green audit*. Preston: Lancashire County Council.

Landon M. 1996 Intra-urban health differentials in London - urban health indicators and policy implications. *Environment and Urbanisation*, **8** No. 2:119-128.

Last J.M. (Ed) 1995 *A Dictionary of Epidemiology*. Oxford: Oxford University Press.

Lave L.B. and Seskin E.P. 1970 Air pollution and human health. *Science* **169**:723-733.

Laxan D. and Noordally E. 1987 Nitrogen dioxide distribution in street canyons. *Atmospheric Environment* **9**, 1899.

Learmonth A.T. 1988 *Disease ecology: an introduction*. Oxford: Basil Blackwell.

Lebret E., Briggs D., Collins S., van Reeuwijk H., Fischer P., Harssema H., Kriz B. and Gorynski P 1997 Small area variations in ambient NO_2 exposures in four European areas. *Atmospheric Environment* - in press.

LGMB 1993 *UK local government declaration on sustainable development*. Luton: Local Government Managament Board.

LGMB 1995 *Sustainability indicators reserch project: consultants' report of the pilot phase*. Luton: Local Government Managament Board.

Lilienfeld A.M. and Lilienfeld D.E. 1980 *Foundations of Epidemiology*. Second edition. Oxford: Oxford University Press.

Linaker C.H., Chauhan A.J., Inskip H., Frew A.J., Sillence A., Coggon D. and Holgate S.T. 1996 Distribution and determinants of personal exposure to nitrogen dioxide in school children. *Occupational and Environmental Medicine*, **53**:200-203.

Lipfert F.W. 1984 Air pollution and mortality: specification searches using SMSA-based data. *Journal of Environmental and Economic Management* **11**:208-243.

Lipfert F.W., Malone R.G., Daum M.L., Mendell N.R. and Yang C.C. 1988 *A statistical study of the macroepidemiology of air pollution and total mortality*. Prepared for the Office of Environmental Analysis, U.S. Department of Energy.

Liu L.J.S., Rossini A. and Koutrakis P. 1995 Development of cokriging models to predict 1- and 12-hour ozone concentrations in Toronto. (Abstract). *Epidemiology*, **6**, S69.

Livingstone A.E., Shaddick G., Grundy C. and Elliott P. 1996 Do people living near inner cirt main roads have more asthma needing treatment? Case-control study. *British Medical Journal*, **312**:676.

Lloyd O.L. 1995 The exploration of the possible relationship between deaths, births and air pollution in Scottish towns. In: Lepper M. de, Scholten H. J. and Stern R. M. (Eds) *The added value of geographical information systems in public and environmental health*. Kluwer academic publishers: Dordrecht. 167-180.

Ludwig J. and Tongway D. 1992 Monitoring the condition of Australian arid lands: linked plant-soil indicators. In: McKenzie D., Hyatt D.E. and McDonald V.J. (Eds) *Ecological Indicators: Volume 1*. London: Elsevier Applied Science, 765-772.

MacGillivray, A. (Ed) 1994 *Environmental measures: indicators for the UK environment*. London: Environmental Challenge Group.

Mattson M.D. and Godfrey P.J. 1994 Identification of road salt contamination using multiple regression and GIS. *Environmental Management*, **18**, 767-773.

McGlashan N.D. 1972 Medical Geography: An introduction. In: *Medical Geography: techniques and field studies*. London: Methuen & Co Ltd. 3-15.

McGlashan N.D. 1983 The use of cluster anlysis with mortality data. In: McGlashan N.D. and Blunden J.R. (Eds) *Geographical aspects of health. Essays in honour of Andrew Learmonth*. London: Academic Press. 349-360.

Meadows D.H., Meadows D.L., Randers J. and Behrens W. 1972 *The limits to growth*. A report for the Club of Rome's Project on the Predicament of Mankind. London: Earth Island.

Ministry of Environment 1992 *Environmental quality indicators*. Oslo: Ministry of Environment .

Minowa M., Shigematsu I., Nagai M. and Fukutomi K. 1981 Geographical distribution of lung cancer mortality and environmental factors in Japan. In: Learmonth A.T.A (Ed) *The geography of health*. Selected papers from the 24th international geographical congress, Tokyo, 26-30 August, 1980. Oxford: Pergamon Press. 225-231.

Murakami M., Ono M. and Tamura K. 1990 Health problems of residents along heavy-traffic roads. *Journal of Human Ergol.* **19**:101-106.

Murnaghan J. 1981 Health indicators and information systems for the year 2000. *Annual Review of Public Health* **2**:299-361.

Muschett F.D. 1981 Spatial distribution of urban atmospheric particulate concentrations. *Annals of the Association of American Geographers*, **71**, 552-565.

Nakai S., Nitta H. and Maeda K. 1995 Respiratory health associated with exposure to automobile exhaust II. personal NO_2 exposure levels according to distance from the roadside. *Journal of Exposure Analysis and Environmental Epidemiology* **5**, No.2:125-136.

National Academy of Sciences 1975 *Planning for Environmental Indices*. A report of the Planning Committee on Environmental Indices. Washington D.C.: National Academy of Sciences.

Nitta H., Sato T., Nakai S., Maeda K., Aoki S. and Ono M. 1993 Respiratory health associaed with exposure to automobile exhaust. 1 results of cross-sectional studies in 1979, 1982 and 1983. *Archives of Environmental Health,* **48** No. 1:53-58.

Noack H. 1987 Concepts of Health and Health Promotion. In: Abelin Z.J., Brzezinski, V. and Carstairs D.L. (Eds) 1987 *Measurement in health promotion and protection.* WHO Regional Publications, European Series No.22. ICP/HST 101/s04. Copenhagen: WHO Regional Office for Europe.

Nurminen T., Nurminen M., Corvalán C. and Briggs D. 1996 Exposure assessment. In: Briggs D., Corvalan C., and Nurminen M. *Linkage methods for environment and health analysis: general guidelines.* A report of the Health and Environment Analysis for Decision-making Project (HEADLAMP). UNEP, USEPA &WHO. Geneva: Office of Global and Integrated Environmental Health, WHO. 55-67

O'Connor M.F. 1971 *The application of multi-attributable scaling proceedures to the development of indices of water quality.* PhD dissertation. Michigan: University of Michigan.

OECD 1991a *Recommendation of the council on environmental indicators and information.* Adopted by the council at its 750th session, 31st january 1991. Paris: OECD.

OECD 1991b *Environmental indicators: a preliminary set.* Paris: OECD.

OECD 1993 *Draft synthesis report.* Group on the state of the environment - workshops on indicators for use in environmental performance reviews. 3rd workshop on indicators for use in environmental performance reviews, 28-29th September 1993. Paris: OECD.

Oliver M.A. and Webster R. 1990 Kriging: a method of interpolation for geographical information systems. *International Journal of Geographical Information Systems* **4**, 313-332.

Oosterlee A., Drijver M., Lebret E. and Brunekreef B. 1996 Chronic respiratory symptoms in children and adults living along streets with high traffic density. *Occupational and Environmental Medicine* **53**:241-247.

OPCS 1991 *Local statistics, small area statistics: explanatory notes.* (38). London: HMSO.

Openshaw S., Craft A.W., Charlton M. and Birch J.M. 1988 Investigation of Leukaemia Clusters by use of a geographical analysis machine. *The Lancet*, February 6, 1998. 272-273.

Ott W.R. 1978 *Water quality indices: a survey of indices used in the United States*. EPA-600/4-78-005. Washington D.C.: U.S. Environmental Protection Agency.

Ott W.R. 1979 *Environmental indices: theory and practice*. Ann Arbor: Ann Arbor Science.

Özkaynak H. and Thurston G.D. 1987 Associations between 1980 U.S. mortality rates and alternative measures of airborne particle concentration. *Risk Analysis* 7:449-461.

Pepper D. 1984 *The roots of modern environmentalism*. London: Croom Helm.

Pepper D. 1996 *Modern environmentalism: an introduction*. London: Routledge.

Pershagen G., Rylander E., Norberg S., Eriksson M. and Nordvall S.L. 1995 Air pollution involving nitrogen dioxide exposure and wheezing bronchitis in children. *International Journal of Epidemiology*, **24** No. 6:1147-1153.

Phillips D. 1990 *Health and health care in the third world*. Harlow: Longman.

Pikhart H., Bobak M., Kriz B., Danova J., Celko M., Prikazsky V., Pryl K., Briggs D. and Elliott P. 1997 Outdoor air concentrations of nitrogen dioxide and sulphur dioxide and prevalence of wheezing in school children in two districts of Prague. Submitted to the *American Journal of Epidemiology*, May 1997.

Pope C.A. 1989 Respiratory disease associated with community air pollution and a steel mill, Utah Valley. *American Journal of Public Health*, **79**:623-628.

Pope C.A. 1991 Respiratory hospital admissions associated with PM_{10} pollution in Utah, Salt Lake and Cache Valleys. *Archives of Environmental Health*, **46**:90-97.

Pope C.A. and Dockery D.W. 1992 Acute health effects of PM_{10} pollution on symptomatic and asymptomatic children. *American Review of Respiratory Disease*, **145**:1123-1128.

Pope C.A., Bates D.A. and Raizenne M.E. 1995a Health effects of particulate air pollution: time for reassessment? *Environmental Health Perspectives*, **103**:472-480.

Pope C.A. III, Dockery D.W. and Schwartz J. 1995b Review of epidemiological evidence of health effects of particulate air pollution. *Inhalation Toxicology* 7:1-18.

Pope C.A. III, Thun M.J., Namboodiri M.M., Dockery D.W., Evans J.S., Speizer F.E. and Heath C.W. 1995c Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. *American Journal of Respiratory Critical Care Medicine* **151**:669-674.

Portney P.R. and Mullahy J. 1990 Urban air quality and chronic respiratory disease. *Regional Science and Urban Economics* **20**:407-418.

Pullen J. 1997 Indoor air quality assesment techniques. *Clean Air and Environmental Protection.* Vol. **27**, No. 4, 99-105.

Quarrie, J. (Ed) 1992 *Earth Summit 92: The United Nations Conference on Environment and Development.* London: Regency Press.

Raaschou-Nielsen O., Olsen J.H., Hertel O., Berkowicz R., Skov H., Hansen Å.M. and Lohse C. 1996 Exposure of Danish children to traffic exhaust fumes. *The Science of the Total Environment,* **189/190**:51-55.

Raizenne M., Neas L., Damokosh A., Dockberg D., Spengler J., Koutrakis P., Ware J. and Speizer F. 1993 *Health effects of acid aerosols on North American children: pulmonary function.* Paper presented at the American Lung Association/ American Thoracic Society International Conference, San Francisco, CA, May 16-19.

Richardson S. and Hémon D. 1990 Ecological bias and confounding. *International Journal of Epidemiology,* **19**, 764-766.

Richardson S. 1996 Statistical methods for geographical correlation studies. In: Elliott P., Cuzick J., English D. and Stern R. (Eds) *Geographical and environmental epidemiology: methods for small-area studies.* Oxford: Oxford University Press. 181-204.

Roemer W., Hoek G. and Brunekreef B. 1993 Effect of ambient winter air pollution on respiratory health of children with chronic respiratory symptoms. *American Review of Respiratory Disease,* **147**:118-124.

Rothman K.J. 1986 *Modern Epidemiology.* Toronto: Little, Brown & Company.

Rowland A. and Cooper P. 1983 *Environment and health.* London: Edward Arnold.

Royal Commission on Environmental Pollution 1992 *Transport and the environment study*. Joint memorandum by the Departments of Environment and Transport. London: Department of the Environment and Department of Transport.

Schwartz J. 1989 Lung function and chronic exposure to air pollution: a cross-sectional analysis of NHANES II. *Environmental Research* **50**:309-321.

Schwartz J. 1993 Particulate air pollution and chronic respiratory disease. *Environmental Research*, **62**:7-13.

Schwartz J. 1993 Air pollution and daily mortality in Birmingham, Alabama. *American Journal of Epidemiology*, 137: 1136-1147.

SCOPE (Scientific Committee on Problems of the Environment) 1995 *Environmental Indicators: a systematic approach to measuring and reporting on the environment in the context of sustainable development*. Paper presented at the workshop on Indicators of Sustainable Development for Decision-Making, Ghent, January 9-11 1995.

Selvin S., Merrill D., Schulman J., Sacks S., Bedell I. and Wong L. 1988 Transormations of maps to investigate clusters of disease. *Social Science and Medicine*, **26**, 215-221.

Shimada A., Kamiyama S., Caminha J.A.N. and Morigichi Y. 1981 Regional differences of death from chronic diseases in Rio Grande do Sul, Brasil from 1970 to 1976. In Learmonth A.T.A (Ed) *The geography of health*. Selected papers from the 24th international geographical congress, Tokyo, 26-30 August, 1980. Oxford: Pergamon Press. 178-198.

Sluyter R.J. (Ed) 1995 *Air quality in major European cities. Part 1: scientific background document to Europe's environment*. RIVM Report No. 722401004. Bilthoven: Rijksinstitut voor Volksgezondheid en Milieuhygiene.

Smith K.R. 1993 Fuel combustion, air pollution exposure and health: the situation in developing countries. *Annual Review of Energy and the Environment*, **18**:529-566.

Snow J. 1854 *On the mode of communication of cholera*. 2nd edition. London: Churchill Livingstone.

Stamp L.D. 1964 *The geography of life and death*. London: The Fontana Library.

Stedman J.R. 1995 *Estimated high resolution maps of the United Kingdom air pollution climate*. AEA/CS/16419035/001. Abingdon: AEA Technology.

Stephens C. and Harpham T. 1992 Health and environment in urban areas of developing countries. *Third World Planning Review* **14**(3):267-82.

Stephens C., Akerman M. and Maia P.B. 1995 Health and environment in Sao Paulo, Brazil: methods of data linkage and questions of policy. *World Health Statistics Quarterly* **48**, No. 2:95-107.

Stern R.M. 1992 *Environment and health data in Europe as a tool for risk management: needs, uses and strategies*. Bilthoven: WHO-European Centre for Environment and Health.

Stimson R.J. 1983 Research design and methodological problems in the geography of health. In: McGlashan N.D. and Blunden J.R. (Eds) *Geographical aspects of health. Essays in honour of Andrew Learmonth*. London: Academic Press. 321-334.

Sustainable Seattle 1993a *The sustainable Seattle indicators of sustainable community*. Unpublished draft. Seattle: Sustainable Seattle.

Sustainable Seattle 1993b *The sustainable Seattle 1993 indicators of sustainable community: a report to citizens on long-term trends in our community*. Seattle: Sustainable Seattle.

Tamashiro H., Enomoto N., Minowa M., Shibata S. and Ashizawa M. 1981 Geographical distributions of cerebrocardiovascular diseases in Japan: 1969-1974. In: Learmonth A.T.A (Ed) *The geography of health*. Selected papers from the 24th international geographical congress, Tokyo, 26-30 August, 1980. Oxford: Pergamon Press. 173-186.

Terracini B. 1996 Environmental epidemiology: a historical perspective. In: Elliott P., Cuzick J., English D. and Stern R. (Eds) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 253-263.

Thom G.C. and Ott W.R. 1976 *Air Pollution Indices: A Compendium and Assessment of Air Pollution Indices in the United States and Canada*. Ann Arbor: Ann Arbor Science Publishers.

Thomas R. 1992 *Geomedical systems - intervention and control*. London: Routledge.

Thomas W. (Ed) 1972 *Indicators of environmental quality*. Proceedings of a symposium held during the AAAS meeting in Philadelphia, Pennsylvania, December 26-31, 1971. New York: Plenium Press.

Thouez J.P., Beauchamp Y. and Simard A. 1981 Cancer and the physiochemical quality of drinking water in Quebec. In: Learmonth A.T.A (Ed) *The geography of health*. Selected papers from the 24th international geographical congress, Tokyo, 26-30 August, 1980. Oxford: Pergamon Press. 213-223.

Thunhurst C. 1989 *Towards a core set of indicators: a report to the UK healthy cities network*. UK Healthy Cities Network core indicators group. Leeds: Nuffield Institute for Health Services Studies, University of Leeds.

Touche Ross 1994 *Local government management board sustainability indicators - guidance to pilot authorities*. London: Touche Ross & Co.

Townsend P. 1987 Deprivation. *Journal of Social Policy* **16**(2):125-146.

Train R.E. 1972 The quest for environmental indices. *Science* **178:**4057-4121.

Trinity Consultants Inc. 1979 *User's Guide for CALINE-3*. Sacramento: California Department of Transportation.

United Nations 1995 *Work programme on indicators of sustainable development of the commission on sustainable development*. Division for Sustainable Development, United Nations Department for Policy Coordination and Sustainable Development. United Nations: New York.

UNCHS 1995a *Monitoring human settlements. Volume 1: introduction, background and rationale*. Indicators programme. A joint programme of the United Nations Centre for Human Settlements and the World Bank. Nairobi: UNCHS.

UNCHS 1995b *Monitoring human settlements. Abridged survey*. Indicators programme. A joint programme of the United Nations Centre for Human Settlements and the World Bank. Nairobi: UNCHS.

UNCHS 1995c *Monitoring human settlements. Volume 2: Urban indicators review: the survey instrument.* Indicators programme. A joint programme of the United Nations Centre for Human Settlements and the World Bank. Nairobi: UNCHS.

UNECE 1992 *The Environment in Europe and North-America: Annotated Statistics 1992.* New York: United Nations.

van Reeuwijk H., Lebret E., Fischer P.H., Smallbone K., Celko M. and Harssema H. 1995 Performance of NO2 passive smplers in ambient air in dense networks. (Abstract). *Epidemiology*, **6**, S60.

Vincent P. and Gatrell A. 1991 The spatial distribution of radon gas in Lancashire (UK) - a kriging study. In: Harts J., Ottens H.F.L. and Scholten H.J. (Eds) *Proceedings, second European Conference on Geographical Information Systems.* Utrecht: EGIS Foundation. 1179-1186.

Wagner E. 1995 Impacts on air pollution in urban areas. *Environmental Management*, **18**, 759-765.

Waldron G., Pottle B. and Dod J. 1995 Asthma and the motorways - one district's experience. *Journal of Public Health Medicine*, **17** No. 1:85-89.

WCED 1987 *Our Common Future* Oxford: Oxford University Press.

Weiland S.K., Mundt K.A., Rückmann A. and Keil U. 1994 Self-reported wheezing and allergic rhinitis in children and traffic density on street of residence. *Annals of Epidemiology*, **4** No. 3:243-247.

Whitmyre G.K., Driver J.H., Givevan M.E., Tardiff R.G. and Baker S.R. 1992 Human exposure assessment 1: understanding the uncertainties. *Toxicology and Industrial Health* **8**, No. 5:297-320.

WHO 1980 The inequality of death: assessing socioeconomic influences on mortality. *WHO Chronicle*. Geneva: World Health Organisation 34: 9-15.

WHO 1985 *Targets for health for health for all.* Copenhagen: WHO.

WHO 1987 *Air quality guidelines for Europe*. WHO Regional Publications, European Series, No. 23. Copenhagen: WHO.

WHO 1989 *Environment and health: the European charter and commentary*. First European Conference on Environment and Health, Frankfurt, 7-8 December 1989. WHO Regional Publications. European series no. 35. WHO: Copenhagen.

WHO 1990a *Summary report*. Working group on indicators for a healthy city. Workshop on indicators for a healthy city, Nancy, 14-17 May 1990. ICP/RUD 158. Copenhagen: WHO.

WHO 1990b Information support to the Global Strategy for Health for All by the year 2000. *World Health Statistics Annual*. Geneva: WHO

WHO 1992a *Our Planet, Our Health*. Report of the WHO Commission on Health and Environment. Geneva: WHO.

WHO 1992b *Twenty steps for developing a healthy cities project.* WHO: Copenhagen.

WHO 1993a *Global environmental monitoring system: A global programme for urban air quality monitoring and assessment*. GEMS/Air (Unpublished.). Geneva: WHO.

WHO 1993b *WHO consultation on the development and use of environmental health indicators in the management of environmental risks to human health.* Dusseldorf 15-18 December 1992. WHO/EHE/93.3. Copenhagen: WHO.

WHO 1993c *Environment and health indicators for use with a health and environment geographic information system (HEGIS) for Europe*. Consultation on HEGIS, Bilthoven, Netherlands, 11-13 March 1993. EUR/ICP/CEH 246. Copenhagen: WHO.

WHO 1994a *Multi city action plan: indicators for healthy cities*. Copenhagen: WHO Regional Office for Europe.

WHO 1994b *Informal consultation on Health and Environment Analysis for Decision-making (HEAD-LAMP) methods and field studies - Summary report*. WHO/EHG/94.15. Geneva: WHO.

WHO 1994c *Consultation on development of a national health and environment geographic information system (HEGIS) for countries in central and eastern Europe*. Bilthoven, Netherlands, 13-15 December 1994. EUR/ICP/CEH 257. Copenhagen: WHO.

WHO 1994d *Health for all: list of statistical indicators*. Copenhagen: WHO.

WHO 1994e *Concern for Europe's tomorrow: summary*. WHO Regional Publications, European Series, No. 53. Copenhagen: WHO.

WHO 1994f *Environmental health action plan for Europe*. Second European conference on environment and health, Helsinki, 20-22 June 1994. Copenhagen: WHO.

WHO 1995 *City health profiles. How to report on health in your city*. Copenhagen: WHO.

WHO 1997 *Atlas of mortality in Europe: sub-national patterns 1980/81-1990/91*. WHO Regional Publications European Series No. 75. Bilthoven: WHO.

Wilkinson P., Elliott P., Grundy C., Shaddick G., Thakrar B., Walls P. and Falconer S. 1997 Case-control study of hospita admission with asthma in children aged 5-14 years: relation with road traffic in North West London. *Thorax* -: in press.

Wills J.T. and Briggs D.J. 1995 Developing indicators for environment and health. *World Health Statistics Quarterly* **48**, No. 2:155-163.

Wjst M., Reitmeir P., Dold S., Wulff A., Nicolai T., von Loeffelholz-Colberg E. and von Mutius E. 1993 Road traffic and adverse effects on respiratory health in children. *British Medical Journal*, **307**:596-600.

WRI 1994 *World Resources 1994-95: a guide to the global environment (people and the environment: resource consumption, population growth and women)*. A report by the World Resources Institute in collaboration with the United Nations Environment Programme and the United Nations Development Programme. Oxford: Oxford University Press.

WRI 1995 *Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development*. Washington D.C.: World Resources Institute.

WRI 1996 *World Resources 1996-97: a guide to the global environment (the urban environment)*. A joint publication by the World Resources Institute, the United Nations Environment Programme, the United Nations Development Programme and the World Bank. Oxford: Oxford University Press.

Zapponi G.A. 1996 Estimating environmental exposure. In: Elliott P., Cuzick J., English D. and Stern R. (Ed's) *Geographical and environmental epidemiology: methods for small-area studies*. Oxford: Oxford University Press. 151-157.