AIR AND PUBLIC HEALTH: AN INVESTIGATION USING FOUR HISTORICAL CASE STUDIES

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Declaration

The work presented in this thesis is entirely my own.

Signed ..... Date

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Statement

Some of the material in this thesis was part of a PhD thesis submitted to the University of Wales in January 2004. That PhD thesis was examined in September 2004, and I was asked to make changes within one year. Due to a combination of personal circumstances (new job in December 2004; pneumonia and complications in early 2005 resulting in several months off work; retirement and emigration of supervisors) I decided to deregister from the University of Wales, and subsequently registered for the Univ. of London MD degree in April 2005. This position was discussed with, and approved by, the MD office in April 2005. Significant further work has been undertaken on this MD project in the period (over two years) between registration and submission, and the presentation of this thesis is in full accordance with the current Univ. of London MD regulations. My supervisor, Dr John Porter, is in agreement with this statement.

Signed ..... Date

Anthony S Kessel

MD Abstract

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Air and public health: an investigation using four historical case studies

This MD thesis explores the relationship between air and public health from early civilisations to the present day. Through examination of the changing relationships the thesis aims to identify, and critically explore, contemporary problems in public health theory and practice.

This is a thesis primarily in the history of medicine or, more specifically, the history of public health. The thesis adopts an accepted five-stage framework for historical research. Within the framework, the thesis utilises two further, well established aspects of historical enquiry. First, it addresses the research questions by using historical case studies. Secondly, the historical research incorporates inter-disciplinary components, in particular the inclusion of ethics.

The first case study initially explores air and health in ancient civilisations, especially within Greek medicine and philosophy, and then examines connections and relationships with ideas about air and health in mid-nineteenth century Britain.

The second case study traces the changing relationship between air and public health from the mid-nineteenth century until about 1970, through examining developments in smoke pollution policy and scientific understanding of the effects of smoke on health.

The third case study covers a period of three decades up to the present day. A piece of air pollution epidemiological research called quantitative risk assessment (QRA) is used as a vehicle through which to investigate philosophical, ethical and policy considerations in contemporary public health theory and practice.

The fourth case study explores the approach to dealing with climate change. The approach is used as an instrument to probe utilitarianism as the moral foundation of public health, to explore other ethical frameworks, and to examine the relevance for environmental work within public health.

Conclusions from each case study are drawn, and analysis of the links between the four case studies provides recommendations for public health theory and practice.

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Publications from this thesis

The following book has been published, and is based on this thesis:

Kessel AS. *Air, the environment and public health.* Cambridge: Cambridge University Press, 2006.

The following articles have been published. Some of the content of these articles is contained within the thesis, and overlap is indicated in the text:

Kessel AS. Public health ethics education in the United Kingdom: questionnaire survey. *Social Science and Medicine* 2003;56:1439-1445.

Kessel AS, McMichael AJ, Watts CJ. Quantitative risk assessment of the impact of air pollution in Barking and Havering Health Authority. *Public Health Medicine* 2000;2(1):13-19.

The following book chapter is in press:

Kessel AS, Stephens C. The climate change dilemma: the environment, ethics and public health. In: Dawson A, Verwaj M eds. *Public health ethics*. Cambridge: Cambridge University Press, 2007/8 (in press).

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TABLES AND FIGURES

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Tables

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Glossary of terms and abbreviations

AOSIS	Association of Small Island States
APHEA	Short term effects of Air Pollution on HEAlth project
ASEAN	Association of South-east Asian Nations
BHHA	Barking and Havering Health Authority
BMJ	British Medical Journal
BS	Black smoke
CIAP	Committee for the Investigation of Atmospheric Pollution
COMEAP	Committee on the Medical Effects of Air Pollution
COP	Conference of the Parties
CSAS	Coal Smoke Abatement Society
DPH	Diploma in Public Health
DSIR	Department for Scientific and Industrial Research
EHO	Environmental health officer
EU	European Union
FCCC	Framework Convention on Climate Change
FCM	Faculty of Community Medicine (UK)
FPH	Faculty of Public Health (UK)
FPHM	Faculty of Public Health Medicine (UK)
GBH	General Board of Health
GCI	Global Commons Institute
GDP	Gross domestic product
GIS	Geographical information system(s)
GP	General practitioner
Gt	Giga-tonne
HES	Hospital Episode Statistics
IPCC	Intergovernmental Panel on Climate Change
LAQM	Local Air Quality Management
LBBD	London Borough of Barking and Dagenham
LBH	London Borough of Havering
LGB	Local Government Board
MFPH	Membership of the Faculty of Public Health (UK)
MFPH Part 1	Membership of the Faculty of Public Health (UK) Part 1 examination
MFPH Part 2	Membership of the Faculty of Public Health (UK) Part 2 examination
MFPHM	Membership of the Faculty of Public Health Medicine (UK)
MFPHM Part 1	Membership of the Faculty of Public Health Medicine (UK) Part 1 examination
MFPHM Part 2	Membership of the Faculty of Public Health Medicine (UK) Part 2 examination
MOH	Medical Officer of Health
NAQS	UK National Air Quality Strategy
NEHAP	United Kingdom National Environmental Health Action Plan

NHS	National Health Service
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NIMBY	Not In My Back Yard
NSAC	National Smoke Abatement Committee
NSAS	National Smoke Abatement Society
OECD	Organization of Economic Co-operation and Development
$PM_{2.5}$	Particulate matter less than 2.5 micrometers in diameter
PM_{10}	Particulate matter less than 10 micrometers in diameter
PCT	Primary Care Trust
QRA	Quantitative risk assessment
RCT	Randomised clinical trial
RCP	Royal College of Physicians (UK)
RMS	Royal Meteorological Society
RR	Relative risk
SAC	Smoke Abatement Committee
SO_2	Sulphur dioxide
StHA	Strategic Health Authority
TSP	Total suspended particulates
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
WHO	World Health Organization

INTRODUCTION

The introduction to this thesis is divided into three parts. Initially there is a description of the historical background to the theme of air and public health. Next, there is a section that provides a personal account of how the thesis topic, and the methodological skills needed to undertake the work, have developed over time. In the final section of this introductory chapter, the two previous sections are brought together by providing an overview of how the historical methods and the topic developed and became more focused as the thesis evolved. This then leads into the more detailed discussion of methods that is contained in the following chapter.

Background: air and public health

Medical ideas and remedies began to be written down about 2000BC, and from the records of these ancient civilisations onwards appear beliefs about health and illness, cause and cure. The connection between air and health in early societies can be first seen in the medical belief systems of at least three ancient civilisations: Egyptian, Chinese and Judeo-Christian.[1]

In the medical belief system of ancient Egypt, air had a formative place in two different ways. Firstly, as part of an explanatory physiological system, air was thought to be contained in one of a mesh of vessels emerging from the heart, others carrying blood, urine, semen, tears, and solid wastes. This idea, air as part of the physiological functioning of the body, was not exclusive to the Egyptians, and was widely held within Greek medicine.

The second way in which air was significant in Egyptian medical thought can be seen in the belief that 'life lay in breath'. This idea encapsulates a special,

supernatural, place for air in the creation, or sustenance, of life, and was not restricted to the Egyptians. For example, for ancient Chinese medicine and natural philosophy one of the two fundamental entities of nature is *qi*. Although impossible to translate, *qi* has been variously interpreted as air, vapours, or life-force, that which for living beings is the vital energy sustaining life itself.[i] Ho and Lisowski suggest *qi* can be thought of as the instrument "composing all forms from below, and the tools and raw material with which all things are made", something not dissimilar to the Greek idea of *pneuma* (covered further in the next chapter) or the modern concept of matter energy.[2] *Qi* permeates the wider cosmos, reflecting further Chinese natural philosophical similarities with Greco-Roman thought, that the human body represents a microcosm of nature and society, and that demarcation makes no sense:

> "Unlike in Europe, science and the humanities have never parted company in traditional China, where every conceivable object or phenomenon, from astronomy to astrology, from alchemy to magic, from ethics to politics, and from philosophy to the art of healing, was considered to operate under the same principles of *li*, *qi* and *shu*[ii]."[3]

In early Judeo-Christian culture the idea of the breath of life, contained within a religious framework, is also evident. Christians accepted Greek doctrines of humours and temperaments, but it was God who created healthy balance and who allowed unhealthy imbalance. Ideas of *pneuma* were similarly accepted but imbued with animistic vitalism,[iii] with life produced by the Spirit of God breathed into inanimate clay. Alongside a strong emphasis on hygiene in Jewish medicine (physical cleanliness bespoke spiritual purity), disease was essentially understood as an expression of the wrath of God, with evil

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[i] The second is *li*, the entity that organises all forms from above and the roots from which all things are produced. All beings, including humans, receive *li* in their moment of coming into existence, and so obtain their specific nature.
[ii] *Shu* is what comes between *li* and *qi*, the way that the forces of nature operate.
[iii] Vitalism embodies the idea that the origin of life lies in a vital principle.

connotations, and could therefore only be remedied by prayer, sacrifice and moral reform.[4]

These three ancient civilisations indicate that the earliest ideas of air and health relate to two intertwined notions. The first is the place of air in understanding the physiological functioning of the body, and the second embodies the spiritual significance of air as a life-giver. The overlapping nature of these ideas reflects the inseparable understanding of mind, body and spirit, which is also seen in the best known of ancient medical systems, Greek medicine.

As authors have pointed out, it is something of a myth to consider Greek medicine as a unified medical system, widely accepted at the time. Instead, there were different theories and practices competing in the Greek medical market-place, and the individual citizen was free, cost permitting, to pick and choose between alternatives.[5] Collectively, however, Greek medicine provided the first rational medical theory, based on understanding humans as part of nature and illness as a natural phenomenon ('naturalism'), complemented by an ontological view of diseases as specific entities best understood through empirical observation.[6]

Within Greek medicine, especially the Hippocratic texts as well as the writings of Aristotle and Plato, ideas connecting air and health were strong. These included: how air as part of the natural environment (climate, atmosphere, winds) affected health; how air as part of astronomical conditions affected health; how air caused specific diseases, such as the 'sacred disease', now understood as epilepsy; air as the bodily-sustaining pneuma; and air as one of the four elements responsible for balancing the body's health.[7] Later, in Roman medicine, the relationship between air and health was similarly strong, as can be seen in the writings of the most famous Roman author, Galen, who drew heavily on Hippocratic texts.[1]

* * *

The association between air and health, and more specifically air and public health, has endured through more recent times. As has been well described, the development of professional public health in England in the mid-nineteenth century occurred against a backdrop of fears about the effects on the workforce of filthy air from unsanitary living conditions.[8] The barrister Edwin Chadwick's famous report on the living conditions of the working classes may have galvanised sanitary reform, but it was the stench from decaying matter and the diseases that were perceived to ensue that caused greatest political concern in a period of industrialisation.[9] In one notorious summer, 1858, a long period of hot weather together with lack of breeze combined to create an atmosphere in London filled with the smells of excrement and putrid organic matter. The outdated sewage system, and a stagnant rotting Thames, were unable to cope, and that summer has since been coined 'the great stink'.[10]

At the centre of this association between air and early developments in professional public health was the charged scientific debate over whether infectious diseases, the scourge of expanding economies of the nineteenth century, were transmitted by contagious persons or conveyed to individuals through the air as miasma.[11] Whichever position one held (and the distinctions were sometimes blurred) air was still important, but particularly so with miasmatic theory.[12] There was a distinction, however, between miasmatic air, poisoned from largely organic sources, and other ways in which the atmosphere was dirtied.

Throughout the eighteenth and nineteenth centuries smoke pollution, from factories and homes, was also a public health concern. It has been argued, however, that ideas about smoke pollution changed significantly around the turn of the twentieth century.[13] Prior to that, belief in the health effects of smoke pollution were mixed. While some held smoke to be detrimental others believed it might have a hygienic effect. In this respect, when the germ theory of disease largely dispelled miasmatic beliefs at the end of the nineteenth century, the focus on smoke pollution increased, perhaps to the extent that its impact was exaggerated.

In the course of the twentieth century the relationship between air and public health has continued. Atmospheric pollution, indoors and outdoors,[14 15] has remained important, and the notorious smog of 1952 and subsequent Clean Air Act have become embedded as part of public health history.[16 17] Developments in epidemiology, including air pollution epidemiology, have bolstered the relationship.[18 19] Most recently, public health and environmental health concerns pertaining to climate change provide an example that the relationship between air and health remains important.[20 21]

Development of the thesis: a personal journey

It is suggested that two elements should provide the backdrop to a focused piece of historical research. The first is that the researcher should be familiar with the general research topic area, and that this should be achieved through extensive background reading. The second element is around the benefit of the researcher being enthusiastic about the particular area of study.[22] Clearly these two elements are likely to be connected, and both can be demonstrated in relation to development of this thesis by providing a brief account of the personal journey undertaken.

After qualifying in medicine I completed a mandatory year as house officer, and then immediately undertook an MPhil degree in History and Philosophy of Science at Cambridge University. This Masters degree, which was completed in 1992, helped develop an already longstanding interest in the history and philosophy of medicine, and has proved formative in terms of learning about academic methodologies and in shaping this doctorate thesis. During the MPhil year my examined papers were on philosophy of biology, Darwin, informed consent, and Freud. The Masters thesis was entitled Social Darwinism before and After Darwin, and was predominantly a piece of work in the social history of science. These papers entailed significant background reading on historical

methods, medical ethics, and specifically the nineteenth-century period around the beginnings of professional public health in England.

After several years in general medicine, which included honing academic skills in clinical ethics, I completed a public health MSc at the London School of Hygiene & Tropical Medicine (LSHTM) and then in 1997 began public health training. These four years (1997-2001) of post-graduate training were always split between academic and NHS public health, and in LSHTM I began a research project in air pollution, supervised by Prof. Tony McMichael. This project was the quantitative risk assessment (QRA) that provides the scientific backdrop to one of the case studies in this thesis: this piece of research was published.[23] The QRA project was further developed as an 'air pollution needs assessment' for the Membership of the Faculty of Public Health Medicine (MFPHM) Part2 exam, which was passed in 1999 without any amendments.[24] Undertaking both the QRA research and also the air pollution needs assessment involved extensive background reading around air pollution and health which has informed this thesis.

Around this time discussions began about undertaking a larger piece of work for a doctorate degree, around historical developments in air and public health. Supervised by Dr David Greaves (expertise in history of public health and the medical humanities) Prof. McMichael (expertise in epidemiology, climate change), and Dr John Porter (expertise in public health, medical ethics, and inter-disciplinary work), with additional input from Prof. Virginia Berridge, this thesis has progressed from approximately 2000 until submission (see Statement at front). I was encouraged to develop the work, in parallel, for a book, and *Air, the Environment and Public Health* was duly published by Cambridge University Press in 2006.[25]

Development of the historical research and methods

Historical research: background

There is a well-noted distinction between history and historiography. As defined by Austin, history is "an integrated written record of past events, based on the results of a search for truth."[26] In contrast, historiography is about the study, writing and interpretation of history, and has been defined by the same author as "a synthesis, building into a related whole, of facts which have to be verified."[26]

These two notions – history as the recording of the past, and historiography as the amalgamation and analysis of how history is done – may be considered complimentary, and are certainly inter-related within the debates about the academic discipline of history.[27] This connectedness is illustrated in LoBiondo-Wood and Haber's definition of historical research as "the systematic compilation of data resulting from evaluation and interpretation of facts regarding people, events, and occurrences of the past."[28]

Although there are well known historical documentarians from earlier eras, for instance the Roman author Pliny, history only really began to become established as an academic enterprise in the second half of the nineteenth century. For example, in Britain the Royal Historical Society was founded in 1868 and the Historical Association in 1906; and in the United States the American Historical Association was set up in 1884.[29]

In the second half of the twentieth century, however, there were two important developments in academic history that are of particular significance to this thesis. The first relates to the compartmentalisation of academic history and the approach to undertaking historical research. During the last century demarcated sub-areas of historical research emerged: examples are political history, economic history, cultural history, and indeed history of medicine. Prior to the 1960s research in the history of medicine and the history of public health had been largely undertaken by notable medical figures.

With the advent of the new sub-speciality, however, non-medical historians began to dominate (part of a more general expansion in social history), and they challenged the academic approach of their predecessors. In particular, they critiqued what has been termed 'Whig history', an approach in which the past is seen as a precursor to the achievements of the present. This approach got its name from the eighteenth-century political party which represented a progressive view of history.[30] This positivist view of medical and scientific progress was superseded in the 1960s and 1970s by social historians attempting to understand medicine in its context and exploring the social production of health and disease.[31]

The second development in academic history began earlier in the last century, but gathered pace with the evolution of history of medicine. This was the gradual incorporation within academic history of some of the ideas and methods of other disciplines. Historians began to understand better and accept the importance of sociological, anthropological and philosophical approaches.[29] This can be seen today in the acceptance of 'oral history', a technique in researching contemporary history that is based on social science methodology.[30]

This second development is of salience to this thesis in two ways. First, the use of case studies within historical research is a reflection of their position as an important social science research method. And second, examination of ethical issues plays an important part in the historical case studies of this thesis. Like sociology and anthropology, ethics provides another approach that historians have absorbed. Within history of medicine this can be explicitly seen in continental Europe, where over recent years a number of universities have combined the two by creating departments of ethics and history in medicine.[32]

Historical research in the thesis: an overview

Although the exact delineations vary between historians,[33] undertaking a piece of historical research can be helpfully divided up into five stages:

i) identification of a researchable phenomenon;

ii) forming research questions and hypotheses, and identification of a theoretical framework;

iii) systematic location of source materials;

iv) analysis/evaluation of evidence and information, forming generalisations and conclusions; and

v) writing the report, involving description and interpretation of findings.[34]

In this introductory chapter, only the first stage has been discussed. The first stage is about identification of a researchable phenomenon through wide reading of the relevant literature. The preceding sections in this chapter have described how interest in the theme of air and public health emerged over time, from different perspectives, and through extensive reading of the literature. The theme of air and public health is, however, not only of personal interest, but of importance and significance in terms of the public's health.[35] This importance is magnified because air is part of the broader natural environment, and is considered as such in this thesis – general environmental issues are therefore discussed where relevant, especially in the latter parts of the thesis.

The main details on methods are presented in the next chapter.

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CHAPTER 1

RESEARCH METHODS

In the previous chapter Sweeney's five stages of undertaking a piece of historical research were introduced, and the first stage – identification of a researchable phenomenon – was discussed.[1] It should be noted that other authors may divide up the elements of the historical research slightly differently, but Sweeney's approach captures all such elements within its five stages.[2 3]

In this chapter the research methods are described, in sections that pertain to the remaining four stages of the historical research process. Each section, or stage, has sub-sections that elaborate on aspects of relevance to this thesis.

Forming research questions and hypotheses, and identification of a theoretical framework (Stage 2)

Research questions

From the background reading of the broader context, four research questions developed. The research questions that this thesis has aimed to address are as follows:

- What is our understanding of the historical relationship between air and public health?
- How has the relationship between air and public health changed over time?
- What does this relationship tell us about developments in professional public health, in particular in England and Wales?

- What does the relationship between air and public health tell us about problems in contemporary public health theory and practice, and how these problems relate to current environmental issues?

In historical research the generation of specific hypotheses is not always necessary, or even appropriate. This contrasts with, say, medico-scientific research, in which formation of a hypothesis is the a starting-point and the norm. In this thesis, it was felt that the research questions alone were a sufficient and apt way to direct the thesis.

Periodisation: historical time frame

The past can be divided up in different ways in historical research, not only to produce manageable chunks, but also to help organise thoughts. Jordanova gives examples of ways to compartmentalise the past in historical research, for instance by: rulers and dynasties (e.g. Viking, Napoleonic, Tudor); events and periods (e.g. after the birth of Christ, since the French Revolution, the First World War); descriptions of a time period (e.g. medieval, early modern); or types of government (e.g. Communist Russia).[4]

In deciding on the mode of periodisation, it is important that the mode is chosen in order to address the research goals, and that there is awareness of the advantages and disadvantages of the mode selected. Whichever form of periodisation is adopted, decisions still have to be made about the amount of time that the historical research covers – its scale or compass.[5] In terms of scale, a distinction is usually made between two approaches. The first involves examining a particular idea or area in great depth over a specified (usually short) time period. This is so-called micro-history, which has received a growth of interest in recent years.[4]

The second approach involves adopting a much longer time-span, which allows for taking a broader look at historical change.[6] From an historical perspective tracing an idea or a theme over, say, two millennia is challenging. Not only is the time frame huge, but it encompasses vastly differing epochs, cultures and civilisations. Some areas are inevitably covered in less detail than others, and trends in themes can be difficult to identify and defend. Efforts to compare periods on such a large scale are inevitably open to criticism of failing to understand ideas, beliefs and events in relation to the context in which they appear.[7]

However, in medical and public health history there has been renewed interest in longer time-frame historical investigations.[8] This is because of their advantage in terms of the ability to explore historical trends and flows that do not need to be temporally sharply circumscribed, and do not have to be demarcated by location, such as by country. It has been argued, for instance, that the fragmentation within social history of medicine and public health history in recent times can be attributed, in part, to the country-specific histories that have developed as a consequence of the continued emphasis on the social context as framing developments in medicine and public health.[9] While the fragmentation has inevitably enriched our understandings of particular histories, it has possibly been at the expense of broader syntheses of different histories and better understanding of a more global picture of public health.[10 11]

In this thesis, emergence of the four research questions shaped the periodisation. In terms of length of periodisation, this thesis adopted the second of the two approaches outlined earlier, that of a time-frame of over two-thousand years. This was deemed most appropriate to the project envisaged. In terms of the nature of the periodisation, this evolved with the decision to use case studies as a historical research tool. The use of historical case studies is discussed in the following section, but the case studies provided a means to frame the periodisation.

As is described further below, the case studies are predominantly chronologically determined, but have elements of dynasty (ancient civilisations), events (around the origins of professional public health), and time period (modern). The first case study looks at air and health in early civilisations and the relationship with public health in nineteenth century England; the second case study looks at air pollution and public health in England between 1850 and 1950; the third case study uses a piece of air pollution research in relation to developments in epidemiology and public health, 1950 to 1990; and the fourth case study looks at climate change and public health, 1990 to the present.

Historical case studies

As was discussed in the previous chapter, developments in academic history since the 1960s have included incorporation of research tools and approaches of other disciplines, such as sociology and anthropology. In this thesis, the methodological approaches from two other disciplines are pertinent. The first of these is the use of case studies in historical research. The second is the inclusion of ethics in historical research, which was mentioned in the introduction and will be discussed in more detail later in this chapter.

Case studies may have originated clinically. Case reports have certainly been long used in the clinical setting to describe, present and study interesting or unusual clinical cases – by doctors and other clinical staff. And a set of (clinical) case reports has been termed a (clinical) case series, when connections between cases are either being investigated or described.[12]

In contemporary qualitative research there is no consensus on precisely what constitutes a case study, but there is some agreement that it is a useful multi-dimensional method. Bowling, for instance, defines a case study as a "research method which focuses on the circumstances, dynamics and complexity of a single case", and a case series is a small number of cases. She continues that it is a

"valuable method for the study of complex social settings", but notes that it can also be used as a biographical research method.[13]

Green and Thorogood, however, are less exact. They describe how a case study, for some, merely identifies the way in which the study is selected or the data reported (for instance the investigation of small number of naturally occurring cases, rather than an experiment), whereas for others a case study should be used when asking questions about a contemporary set of events over which the investigator has little control.[14] Yin, for example, suggests that a case study usually has a phenomenological perspective, meaning that it is studying a phenomenon that is happening, such as a change in health services management structures.[15]

In his book *The Art of Case Study Research*[16] Stake echoes the phenomenological perspective. He indicates that what is occurring is what is important and argues, in this respect, that the case could constitute different things and flexibility about boundaries is vital. For instance, in the example he gives of investigating schooling in Sweden, he proposes that a case (for the case study) could be a schoolchild, a teacher, an innovative teaching programme, or all the schools in Sweden.

The flexibility around what constitutes a case study is valuable in historical research because of the importance of the historical methods meeting the needs and goals of the project. Examples of where case studies have been used in historical research show that the case study may be defined variably: by quite a discrete time period and place (e.g. diaries kept by superintendents of an asylum in Philadelphia between 1814 and 1840)[17]; by subject and institution over a longer time period (e.g. medicinal plant research at the London School of Hygiene and Tropical Medicine over 100 years)[18]; or by using two case studies to compare differences in caring/nursing practices between the nineteenth century and the 1970s.[19]

This thesis adopts a similarly flexible approach to what constitutes a historical case study. Each of the four case studies examined has a demarcated periodisation, as discussed earlier in this chapter. But the periodisation is different for each case study, with each representative of a relationship between air and public health. Together the four historical case studies could be seen as representing a historical case series on air and public health.

Theoretical framework(s)

It has been suggested that historical research combines science and literature. The scientific component relates to the gathering of (historical) data to support or refute a research hypothesis or question – the gathering of evidence is addressed later in this chapter. The reference to literature acknowledges that there is an art to historical research, since there is no single underpinning theoretical framework, and the analytical and interpretative components inevitably involve a degree of subjectivity.[20]

Since historical research has absorbed some of the methodological approaches of other disciplines, it has also taken in the theoretical frameworks of those disciplines.[21] Berridge, like Jordanova,[22] highlights the potential value to historical research of being theoretically eclectic.[2] It has also been suggested that, although it is important to be theoretically informed as a historian, it is not advisable to spend huge amounts of time on theoretical development at the expense of quality of the actual historical research.[3]

The primary research methodology in this thesis is historical, but the theoretical frameworks are mixed. The sub-sections below describe the frameworks in the context of inter-disciplinary investigation in historical research.

Inter-disciplinary investigation in historical research

There are different theories about the social world and how it works. The over-arching theoretical approach of this thesis lies between large-scale, or macro, theory, which allows questions at a higher level of social organisation (e.g. the effects of globalisation on health), and middle-range theories that link general, abstract concepts, with grounded, observable behaviour. Middle-range theories are often rooted in particular disciplines, but a large-scale theoretic approach may require working across disciplines to avoid the implicit reductionism in uni-disciplinary work.[14]

Using different disciplinary approaches has become an established part of mainstream public health research, because of the added value and depth it can give. However, there are different kinds of so-called multi-disciplinary research. A traditional public health needs assessment, for example, may involve epidemiological investigation, comparative policy analysis and interviews with patients and stakeholders. Here the different approaches provide different information, and triangulation of the results informs the recommendations. A similar, recent public health example is a piece of research examining the relationships between green spaces and community health, which combined epidemiological analysis using Geographical Information Systems (GIS) with ethnography – the combined methods helped understand concepts such as access to green space.[23] Both of these multi-disciplinary public health examples involve investigation using different disciplinary approaches with the different methods working largely in parallel. This is sometimes, and perhaps most appropriately, called multiple methods research.

Inter-disciplinary research (sometimes called trans-disciplinary), however, involves integrating the different methodological approaches and working, literally, between the disciplines. As Green and Thorogood point out, the aim in such endeavours is to "integrate the different theoretical and methodological insights from each discipline throughout the project, rather than at the point of combining the findings."[24]

Yach puts forward that community health research used to be more naturally integrated, but after the Second World several factors have led to disciplinary separation: the growing establishment of the disciplines of epidemiology, ethnography, and sociology; separate funding streams for different disciplines; and the dominance of the medical profession within public health, with its emphasis on quantitative methods.[25] Like Yach, Inhorn promotes the value of an integrated approach, and laments the opportunities lost from demarcating the disciplines. Although writing about integration of epidemiology and anthropology, she argues that intellectually the disciplines converge more than is understood or accepted, and that the divergences are more illusory than real.[26]

This thesis uses a flexible historical research strategy, working across theoretical frameworks of different disciplines, because different disciplines have different epistemological assumptions, and addressing the bigger questions requires being able to get above each particular discipline or worldview.[27] The theoretical framework that this thesis draws significantly on is social constructionist, in that it asks questions throughout about how, and for what reasons, have the relationships between air and public health changed over time.[28] But there is also a phenomenological component, especially in the third case study, in the sense that there is examination of a particular phenomenon (air pollution epidemiology). Ethics is also incorporated into the historical research (and its inter-disciplinary nature), so it is important to outline the background to this theoretical framework.

Philosophy and ethics as part of historical research

Philosophy can be divided into different fields, and has classically been separated into epistemology, metaphysics, logic, and axiology. Axiology deals with values, and is itself divided into questions about what is beautiful (aesthetics) and questions about what is good or right (ethics, or moral philosophy). In academia further philosophical study areas have developed such as philosophy of education, philosophy of science, history of philosophy, and political philosophy.[29] [30]

Of the fields described above ethics is of special significance to this thesis, and within ethics there is a broad separation into three tiers (sometimes called orders). First is what might be considered to be 'common sense' ethics, which can be thought of as our moral intuition. This in itself is, naturally, a reflection of an individual's learned environment, through for instance cultural beliefs and religion. The second tier is what has been termed 'normative ethics' and relates to the systematically developed moral theories, such as utilitarianism and Kantianism. The final tier is meta-ethics, which concerns the nature and existence of ethics, and is literally translated as 'behind ethics' or 'about ethics'; concepts such as moral relativism fall into this category.[31]

Philosophy can also be divided by its nature, and some authors make a distinction between critical (or analytical) and speculative philosophy. At the heart of all philosophy is conceptual clarity, but within analytical philosophy the emphasis is particularly on linguistic and logical analysis of symbols, terms and basic premises used in discourse. Speculative philosophy, on the other hand, is less precise and addresses broader questions and how pieces fit together in the bigger picture. Clarity and consistency are still important, but problems need not be categorised and broken down. Speculation about the human condition, our existence, and what gives meaning to our lives, requires a more open palette and a wider perspective.[32]

The philosophical and ethical methods employed in this thesis are a combination of the fields and techniques outlined above. Conceptual clarity plays a central part, so attention is paid through the thesis to the meanings and interpretations of terms such as 'public health', 'environment', and 'environmental health'. The thesis in general, however, involves more speculative than analytical philosophy, exploring connections between history of philosophy, normative moral theories, and historical developments in the relationship between air and public health.

Systematic location of source materials (Stage 3)

Resources

A distinction can be made in historical research between the sources (materials used in terms of data) and where or how these were obtained (locations / resource bases). A variety of resource bases / locations were used in order to gather the historical data. These included:

- Libraries: e.g. Wellcome History of Medicine Library London), British Library (London), National Society for Clean Air and Environmental Protection library (Brighton).
- Electronic resources (websites): e.g. journals available on electronic websites (e.g. British Medical Journal), and other web-based resources (e.g. History and Policy website).
- Institutions and archives: that may hold particular historical sources or journals, such as the Royal College of Physicians.

Types of sources used and search methods

This thesis has extensively used *primary historical sources*, to look at exactly what was written and thought at the time. Primary sources have been categorised in different ways by different authors. The most common way of categorising is quantitative (e.g. original statistical data), qualitative (e.g. original documents) or oral history (undertaking interviews, for historical research of recent periods).[33] Another is symbolic (e.g. manuscripts) or non-symbolic (e.g. collections).[21] In most historical research, as in this thesis, a combination is used.[2]

The primary sources used include: original journal articles; legal documents (e.g. different drafts of Bills to explore how they changed before being enacted); policy documents (e.g. from local government); documentation and statements from medical bodies and other establishments (e.g. Royal College of Physicians,

Faculty of Public Health Medicine, Sanitary Inspectors Association); documentation, statements, leaflets and pamphlets from campaign and pressure groups, and charities (e.g. Coal Smoke Abatement Society); publications from conferences; and also newspapers and magazines.

Secondary sources have include articles and books written by others, such as academic historians and other scholars, as well as dictionaries.

Primary philosophical data used include original articles and books on the particular philosophical subject area (for example, analysis of original pieces by Darwin, Spencer, or contemporary environmental philosophers), and secondary material includes books that provide a commentary or overview of an area, for instance reflections on different philosophers' contribution to ethics.

The *search methods* used to locate sources involved a combination of: electronic database searching; hand-searching of journals; snowballing (emerging leads as the study unfolded); tracking of referenced citations; use of personal contacts and guidance from peers; and serendipitous discovery.[34]

Cataloguing / recording of data

Different methods were used to record and document historical data. This included notes made during reading, either on paper or directly onto computer. Card cataloguing was also used to group data into particular themes, and allowed for cross-referencing as the research was in progress.

Analysis/evaluation of evidence and information, forming generalisations and conclusions (Stage 4)

In scientific research, there is often a clear point at which gathering of data ceases and quantitative analysis of that data begins, from which there is evaluation and the drawing of conclusions. However, in historical research (as with inter-disciplinary research),[13] there is no such distinctive point and the process is more fluid and iterative.

Throughout the researching period of this thesis, data was gathered and analysed in an ongoing manner. One aspect of analysis of historical data involves verification of authenticity (e.g. of manuscripts). Verification can be through external criticism (e.g. cross-checking of the data of an event, for instance when recorded in different sources) or internal criticism (e.g. checking credibility or reliability of information, for instance using different accounts or reports of an event): both types were employed in the thesis.[35]

Broader analysis, however, occurs as an integrated part of evaluation of the data. As evidence was marshalled, progressive assessment attempted to form a coherent discourse, always with a view to the aims and objectives outlined earlier.[1] This process of assessment involved an interpretive analytical approach looking for correspondence and patterns,[16] and the synthesising of themes and concepts.[36] Within each case study (and chapter) in this thesis, such analysis, evaluation and interpretation is contained within the written text, and a distinctive 'analysis' section of each chapter would be inappropriate.[5] However, at the end of each chapter conclusions are drawn about the case study. And the final chapter of the thesis also brings together what conclusions can be drawn about the case series.

Note on data gathering and analysis for third case study

The third case study in this thesis (chapter four) involves an analytical piece of epidemiological research, the quantitative risk assessment. This assessment required use of primary air quality data as well as a literature review: a summary of methods employed is provided in that chapter, as well as reference to a more detailed description.

Writing the report, involving description and interpretation of findings (Stage 5)

Although the relationship between data gathering and analysis/interpretation in historical research may be fluid, a point is inevitably reached in when the search for more data ends, and the focus is on further interpretation, drawing conclusions, and writing the report. In this thesis it is very difficult to demarcate how long was spent on data gathering and analysis, as this happened over several years, as described in the previous chapter. Writing of the thesis took place (not full time) over a period lasting probably two to three years prior to submission.

Each case study, hence each chapter, was written up in turn. With evidence synthesised and conclusions drawn, the challenge was to create a coherent narrative for each case study.[3] In this thesis this was aided by following a chronological pattern, both within each case study, and also in terms of the thesis as a whole (through the temporally sequential pattern of the chapters). The building and articulation of an argument (or arguments) in such a manner has been advocated.[37]

The engaging in, and writing of, history in a chronological manner relates to an important debate within academic history about how we approach the study of the past. Different positions see history as either cyclical or a as a sequential process,[3] and this is reflected in different approaches to reasoning within academic history – the analogical mode (reasoning by analogy) or the processual mode (reasoning by sequence or process).[38, 39] This is looked at further in the conclusions of the thesis.

Efforts have been made to convey personal enthusiasm and interest in the subject, as well as its relevance. The importance of these aspects in writing academic history has been stated.[20] Enthusiasm and interest in the subject matter are evident, as described in the previous chapter, and it is hoped that this has been

conveyed in the text. Considerable attention has been given to the relevance of the research to contemporary public health theory and practice, and this is elaborated upon in the conclusions of this thesis.

Throughout the writing of the thesis there has been extensive re-reading and revision, as well as proof-reading (personal and external) of the final product.

Summary of methods used in each case study

Case study 1

The first case study initially explores air and health in ancient civilisations, especially within Greek medicine and philosophy, and then examines connections and relationships with ideas about air and health in mid-nineteenth century Britain. This historical case study (history of medicine and history of public health) also involves inter-disciplinary elements (Greek philosophy, history of philosophy, Social Darwinism). Primary and secondary data sources were used, as described above, and inter-disciplinary connections are examined.

Case study 2

The second case study traces the changing relationship between air and public health from the mid-nineteenth century until about 1970, through examining developments in smoke pollution policy and scientific understanding of the effects of smoke on health. This historical case study (history of medicine and history of public health) also considers developments in health policy (smoke pollution policy, public health policy). Primary and secondary data sources were used, as described above, and inter-disciplinary connections are examined.

Case study 3

This case study covers a period of three decades up to the present day, during which important shifts have occurred in the way air is conceptualised in epidemiology and public health. A piece of epidemiological research using a modern public health technique called quantitative risk assessment (QRA) is initially described. The findings of my QRA have already been published in the journal *Public Health Medicine*[40] and, although it will be necessary to summarise these, the aim of this chapter is instead to use the QRA as a vehicle through which to investigate philosophical, ethical and policy considerations in contemporary public health theory and practice. This is a historical case study (history of epidemiology, public health and health policy) but has strong inter-disciplinary components (epidemiology, philosophy, ethics). Primary and secondary data sources were used for the non-epidemiological aspects, as described in chapter one, and inter-disciplinary connections are examined.

Case study 4

This fourth historical case study of the relationship between air and public health explores the approach to dealing with climate change. The case study begins with a description of the scientific basis of global warming and climate change. The approach to dealing with climate change is then used as an instrument to probe utilitarianism as the moral foundation of public health. This historical case study (history of medicine and public health, history of science, history of philosophy) again has strong inter-disciplinary components: basic science (of climate change) and philosophy (moral philosophy, political philosophy, and environmental philosophy). Primary and secondary data sources were used, as described in chapter one, and inter-disciplinary connections are examined.

An Appendix (p231) contains additional information on methods.

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CHAPTER 2

CASE STUDY 1: AIR AND HEALTH IN ANCIENT CIVILISATIONS TO THE MID-NINETEENTH CENTURY

Overview of case study 1

The first case study initially explores air and health in ancient civilisations, especially within Greek medicine and philosophy, and then examines connections and relationships with ideas about air and health in mid-nineteenth century Britain. This historical case study (history of medicine and history of public health) also involves inter-disciplinary elements (Greek philosophy, history of philosophy, Social Darwinism). Primary and secondary data sources were used, as described in chapter one, and inter-disciplinary connections are examined.

Introduction

The relationship between air and health is evident in the medical belief systems of several ancient civilisations. In the introductory chapter of this thesis, connections between air and health were presented in three ancient civilisations: Egyptian, Chinese, and Judeo-Christian. Two related notions were described: the place of air in understanding the physiological functioning of the body; and the spiritual significance of air as a life-giver.

The overlapping nature of these two notions reflects the inseparable understanding of mind, body and spirit in those civilisations. In the first part of this first case study, these notions are explored in more detail in the best known of ancient medical systems, Greek medicine, as well as in Roman

medicine. The second part of the chapter then examines the place of such ideas around the time of the emergence of professional public health in Britain.

Greek medicine

The first substantial medical texts were penned by the Greeks, and collectively known as the Hippocratic Corpus. These 62 books – and indeed those of rival natural philosophy based medical theories of the time – represented, in the main, a departure from belief systems based on supernatural ideas of disease causation, such as expressions of the wrath of the gods.[1]

Replacing this was the first rational medical theory, based on understanding humans as part of nature and illness as a natural phenomenon ('naturalism'), complemented by an ontological view of diseases as specific entities best understood through empirical observation.[2] But while the physician's role was expected to be that of observer and treater, it was the domain of the natural philosopher to explain the place of mankind in the universe and how the functioning of the human body (microcosmos) reflected the workings of the all-encompassing macrocosmos.

A result of this division saw physicians trying to uncomfortably marry their observational findings with existing natural philosophical theory, metaphorically akin to square pegs in round holes. And, although Greek medicine had a firm rational basis, also evident were strong traces of supernaturalism, sometimes overlooked when Greek medicine is held up today as the early bedrock of western scientific medicine.[3]

Nevertheless, the extensive influence of Greek medicine for the following two millennia is unquestionable, making it important to explore closely the relationship between air and health in the Hellenistic period. Given the breadth of Greek medical writing, it is impossible to look at all authors and instead the

chapter now focuses mainly on Hippocrates, Plato and Aristotle, whose key works reflected much of the natural philosophical thought of the time.

Air as the natural environment, and its effects on health

Written mostly between 430 and 330 BC, the Hippocratic Corpus is composed of 62 books covering various aspects of medical thought, including ideas about health, disease, prevention and cure. Originating out of the Hippocratic medical school on the island of Cos, the books were written in Ionian dialect by a number of different authors, and there is uncertainty over which, if any, were written by Hippocrates himself.[1]

Despite this, Hippocrates was almost certainly a physician of high standing and it is likely that he oversaw much of the writing. His reputation was wide, the king of Persia famously asking his wisdom in an unusual case of love-sickness and, centuries later, the famous Roman physician Galen regaled Hippocrates' curing of an Athenian plague through bonfires lit to purify the air.[4]

For the less noted Greek physician, local reputation as a successful healer was important, as income was dependent on demand. Although a few physicians were paid by the state and resided long-term in a city, most were itinerant, travelling from town to town in the hope of business. Within this peripatetic life lay a second related role of the physician, prediction of the health of a town based on its location and surroundings. This was useful not just in relation to anticipation of health problems that might affect the inhabitants, but also when physicians were called upon to assist in the siting of a new settlement.[5]

In contrast to internal causes of disease, air – in the general sense of what comprises the atmosphere – was considered a possible direct external cause of

disease. In *Breaths* Hippocrates comments that "it has been said that all living things participate to a large extent in air. After this, it must be remarked that it is likely that diseases come about from no other source than this ..."[6]

This theme is elaborated further in *The Nature of Man*. Although contradicting the quotation above in suggesting that air alone may not be responsible for all diseases (reflecting that different treatises were written by different authors), the passage reiterates how air may be responsible for illness, and also a way towards improvement of health:

> "When an epidemic of one particular disease is established, it is evident that it is not the regimen but the air breathed which is responsible. Plainly, the air must be harmful because of some morbid secretion which it contains.... Care should be taken that the amount of air breathed should be as small as possible and as unfamiliar as possible."[7]

However, probably the clearest indication of the importance placed on air as the external environment comes in the introductory section of *Airs, Waters, and Places*. Written in a style suggesting use perhaps both as a lecture and as a guidebook for physicians, this Hippocratic text asserts the overall relevance of the seasons, air temperature and winds:

> "Whoever would study medicine aright must learn of the following subjects. First he must consider the effect of each of the seasons of the year and the differences between them. Secondly he must study the warm and cold winds, both those which are common to every country, and those peculiar to a particular locality. Lastly, the effect of water on the health must not be forgotten ..."[8]

Following from the general comments implicating air as an external cause of disease, more specific relationships between aspects of air and disease causation can be traced. For example, in *Aphorisms* (one of the strangest Hippocratic texts, composed of hundreds of individual pointers about medicine) Hippocrates asserts that the "changes of the seasons are especially productive of disease, as are great fluctuations of heat or cold within the

seasons."[9] And to predict the seasons, the physician needs to be both in the "business of the meteorologist" and must also "learn that astronomy plays a very important part in medicine since the changes in the seasons produce changes in diseases."[10]

Finally, air is perhaps most vividly portrayed as an external factor affecting disease when represented by wind. A Hippocratic author suggests that when a district has cold prevailing winds from the quarter between north-west and north-east, and the water supply is hard and cold and usually brackish, the inhabitants will be "sturdy and lean, tend to constipation, their bowels being intractable, but their chests will move easily."[11] The most troublesome winds, however, are the north and south winds, cited as responsible for specific health problems:

> "South winds cause deafness, misty vision, headache, sluggishness and a relaxed condition of the body ... The north wind brings coughs, sore throats, constipation, retention of urine, accompanied by rigors, pains in the sides and breast."[12]

Air as the supernatural environment, and its effects on health

It was important for a physician to be able to use astronomical skills to assess seasonality, and to combine this with understanding or prediction of climate, in order to foretell health concerns. But the Hippocratic texts did not represent a complete departure from unnatural explanations of health and disease.

Although the gods were generally no longer implicated, the physician was advised to take into consideration a supernatural element akin to present-day astrology. Sometimes this seemed to be mainly as an indication of seasonality, for instance in *Epidemics* when it is observed that at the time of Arcturus, if southerly rains continue until the equinox, then "under such circumstances,

cases of paralysis started to appear during the winter and became common, causing an epidemic."[13] But on other occasions the link is less specific:

> "Now let us consider the seasons and let us predict whether it is going to be a healthy or unhealthy year. It is most likely to be healthy if the signs observed at the rising and the setting of the stars occur normally, when there is rain in the autumn, when the winter is moderate being neither too mild nor excessively cold, and when rain falls seasonably in spring and late summer."[14]

The confused and incomplete transition from unnatural to natural explanations is perhaps most clearly apparent in the book devoted to *The Sacred Disease*, known now as epilepsy. Here the author seems keen to invoke alternative explanation for the disease most traditionally attributed to divine origin, but cannot quite make the leap:

> "This so-called 'sacred disease' is due to the same causes as all other diseases, to the things we see come and go, the cold and the sun too, the changing and inconsistent winds. These things are divine so that there is no need to regard this disease as any more divine than any other; all are alike divine and all human."[15]

Air and the causation of specific diseases

Despite lack of consistency over the metaphysical basis of disease, causal factors were often cited as contributory to specific diseases, and epilepsy again provides a good example. Continuity of thought is evident if one looks firstly at what Plato said about epilepsy, and then looks back at what Hippocrates suggested two centuries earlier.

Plato's *Timaeus* is an unusual text, almost a stand-alone book, which has been lauded by some as providing important insight into Plato's cosmology as well as his views on health and disease,[16 17] but has also been criticised by others as confusing, inconsistent and poorly conceived.[18]

The text itself takes the form of a dialogue between four characters, one of whom, Socrates, is expecting a reciprocal lecture to his own, *The Republic*, given the previous day. After a brief introductory section, the character of Timaeus provides Socrates with a lengthy monologue and, although it is mentioned that the other characters will speak later, they never do, suggesting an unfinished piece.[19]

What we are left with is a fascinating, albeit difficult to follow, polemic on the nature of the universe (cosmos or macrocosmos, made of a World Soul and World Body), modelled by the divine artisan (Demiurge) from the cosmic paradigm (or Ideal) called The Living Animal. Given that the Demiurge is good, his product must be good in itself – ordered, intelligent, beautiful, and in perfect balance or harmony. It has been claimed that Plato's form of 'holism' lies at the roots of modern ecological thinking.[20]

Naturally, in a text concerned with the cosmological order, the place of mankind is integral. Plato saw Earth and the natural world as part of the cosmos, with each human being portrayed as a microcosmos, constituted by the same principles that govern the cosmos. Harmony and balance are the natural state and allow health, while imbalance and disorder result in illness and disease. It is worth mentioning here the link with ethics, for Plato similarly felt that microcosmic imbalance caused emotional perturbation, resulting in loss of moral propriety, or the inability to make good judgements – the inability to lead a good life.[21]

So, drawing on previous ideas about humors and elements, Plato invoked air – or imperfections in the nature or distribution of air – as causal of disease. For example, a third kind of serum (the first two are blood and another derived from black and acid bile) involves air and is a product of the dissolution from new and tender flesh, the decomposition of tender flesh intermixed with air described as 'white phlegm'. And this may be responsible for skin problems:

> "White phlegm, also is dangerous when it is blocked inside because of the air in its bubbles; but when it has air-vents outside the body it is milder, although it marks the body with spots by breeding white scabs and tethers and the maladies akin thereto."[22]

More specifically, Plato goes on to suggest that when the flow of air through the lungs is blocked, white phlegm, in combination with bile, may cause "countless diseases of a painful kind" and rotting of those body parts "deprived of respiration".[23] However, the most direct causal relationship is once again suggested in connection with the sacred disease. Following a necessary passage explaining the route of inspired air (first to the brain, then most to the stomach and some to the lungs and blood-vessels) Plato asserts that air must be continually moving and, most vividly, Plato links air, white phlegm, and vessel blockage with the striking symptoms of an epileptic fit:

> "Therefore, when the blood-vessels are shut up from this supply of air by the accumulation of phlegm and thus cannot afford it passage, the patient loses his voice and wits. The hands become powerless and move convulsively for the blood can no longer maintain its customary flow."[24]

Air as pneuma

The doctrine of pneumatism has a long ancestry, and appears in various forms. According to Phillips, the medical sect of pneumatists, philosophically aligned with the Stoics, was founded around the middle of the first century BC, but the general notion of pneuma can be historically traced further back and was more non-specifically affiliated with the developing tradition of science.[4]

In Coan medicine, for example, the concept of pneuma, or 'vital air' developed under the influence of natural philosophers such as Diogenes of Apollonia, and is well documented in the Hippocratic Corpus. *The Sacred Disease* represents air as responsible for consciousness or intelligence and, as

discussed in the previous section, epileptic seizures were thought to result from blockage of air (or 'pneumato') in vessels within the body.

In the *Timaeus* Plato similarly described pneuma as causing diseases such as tetanus, as well as pulmonary complaints, and pleurisy; but his student Aristotle equated air, and breathing, more firmly with the spiritual notion of soul. In *On Breath* Aristotle theorises that breath, maintained and increased by nutriment, is the purest of all substances.

Aristotle wonders whether breath (divided into innate breath and inspired breath) is different to external air, but suggests that respiration has its "motive principle from the inward parts" although he is unsure "whether we ought to call this principle a power of the soul, the soul, or some other combination of bodies ..."[25] However, he clearly links air with spirit or soul, although he speculates over its relative contribution:

> "But if the soul resides in this air, the air is at any rate a neutral substance. Surely, if it becomes animate, or becomes soul, it suffers some change or alteration ... air is not the whole of soul but is something which contributes to this potentiality ..."[26]

Some time later the pneumatic school incorporated and developed these ideas into a concept of pneuma, or spirit, which in both the universe and man bound everything together, any alteration causing illness. Pneuma was seen as a fifth element which flowed through the arteries, sustaining vitality.[27] And, in the early centuries after Christ Galen, who is looked at later in this chapter, drew on the idea of pneuma as the life breath of the cosmos.

Air and the balance required for health

As mentioned in previous sections, later Greek medicine held balance within the body as key to health, disturbance of this balance resulting in disease. The

causes of perturbations of equilibrium were explained in rational and natural terms, moving away from previous beliefs about the supernatural basis of illness.

There were, however, a number of different theories regarding what exactly was supposed to be in balance – elements, humors, a combination of these, or something else. But within all these categories air had an integral place, either as an element in itself, as part of a humor, or as the external natural environment.

As Lund describes, the older philosophers of the Ionic school had regarded one single element as forming the substance of things, but the Pythagorean and Sicilian schools of medicine based a system on all four elements (earth, air, fire and water), and from this arose the doctrine of mixture or 'crasis' in the body.[28] The variety of ideas based on such a system is again well represented by Hippocrates and Plato.

Hippocratic thought is perhaps the most complex. In *Nature of Man*, the author refutes monism, and instead introduces an elaborate theory correlating the four elements (earth, air, fire, water) with the four basic humors (black bile, blood, yellow bile, phlegm) and the four temperaments (melancholy, sanguine, choleric, phlegmatic), and further linking these with the four seasons, the four stages of man (infancy, youth, adulthood, old age), as well as the four primary qualities of hot, cold, dry and wet. Diseases were explained as a consequence of specific alterations of ratios within this finely tuned matrix.[i] Health, on the other hand, was preserved when appropriate proportions were maintained.

[i] Three humours are also depicted in Ayurvedic writings of ancient India: *vaya* (air), *pitta* (bile), and *kapha* (phlegm).

The diversity, and also inconsistency, of thought is well illustrated in the *Timaeus*. First of all, like Hippocrates, Plato believes in a universe created by God, made up of four elements in important relation to one another:

> "... in the midst between fire and earth God set water and air, and having bestowed upon them so far as possible a like ration towards another – air being to water as fire to air, and water being to earth as air to water, – he joined together and constructed a Heaven visible and tangible."[29]

Later on, however, Plato mentions an unnamed fifth element, and refers to them all as compounds. By doing so, Plato alludes to combination rather than purity, a departure reinforced by suggesting there are different kinds of air including "the most translucent kind which is called by the name of aether, and the most opaque which is mist and darkness",[30] as well as another form without a name. Nevertheless, the consistent belief in the balance of the elements required for health remains unwavering:

> "The origin of disease is plain, of course, to everybody. For seeing that there are four elements of which the body is compacted, – earth, fire, water, and air, – when, contrary to nature, there occurs either an excess or deficiency of these elements, or a transference thereof from their native region to an alien region; or again, seeing that fire and the rest have each more than one variety, every time that the body admits an inappropriate variety, then these and all similar occurrences bring about internal disorders and disease."[31]

What is clear from the first half of this chapter is that air had a central place in the medical belief systems of many early civilisations. Even in the natural philosophy of the Greeks the conceptions of air reflect that health, disease and healing were understood as part of a bigger picture – humanity and the cosmos – and in terms of balance and harmony. This holistic, and often spiritual, way of thinking was to have an impact for many centuries to come.

Roman medicine

Although there were other important Roman contemporaries, the physician Galen stands out significantly for his influence in the history of medicine. His ideas built broadly on Hippocratic writings, so retaining the central place of air, but Galen synthesised Greek beliefs with his own insights in a way that proved long-lasting. A self-assured individual, Galen was happy to play to the crowds, and this arrogance and showmanship helped perpetuate his reputation.

Galen was actually Greek, born to a wealthy family in Pergamon in Asia Minor (now Turkey) around AD 129. He had an extensive education and learned medicine from Alexandrian teachers, including visits to Egypt where he gained insights about treatments in India and Africa. He only arrived in Rome in AD 162, but soon gained a reputation and became physician to the powerful.[3]

Galen wrote prodigiously, possibly 35 books, although few originals survived. Broadly speaking, Galen took the Hippocratic framework of health as balance, disease as imbalance, incorporated Platonic speculations on the macrocosm, and added a mixture of his own philosophical ideas and anatomical findings. As a physician, he treated people with concoctions of herbal and vegetable remedies (combined with heavy doses of confidence), causing some to label him as the first polypharmacist. Galen removed the Hippocratic emphasis on empiricism, on collating understanding of disease through observation of the ill, and focused instead on theorising and experimentation.[32]

Because Galenic medicine drew so heavily on what went before, the significance of air remained, and can be found in three areas that have already been looked at in more detail earlier this chapter. First, Galen held on to the Greek notion of balance of the four humours (black bile, yellow bile, phlegm, and blood), which were in turn representations of the four elements – earth, air, fire, and water. Next, Galen augmented pneumatism with his own ideas about circulation and anatomy. He believed that air, taken in through the lungs, combined in the heart with blood to generate pneuma, or vital spirit, the

life breath of the cosmos. Pneuma was also modified in the liver (which formed blood from food) to create a natural spirit, which supported vegetative functions of growth and nutrition. From the heart blood flowed to all organs, including the brain where a third alteration of pneuma resulted in animal spirit, distributed through the nerves to sustain movement and sensation, and without which animal life did not exist. Galen's system fitted in with Plato's divisions of the soul into the vegetative, animal and rational.[33]

Last, Galen held on to the view that diseases were carried or transmitted by contaminated, polluted air – or miasma. This he defended in part on observational grounds, having witnessed occupational ailments, for instance slaves in copper mines who were obliged to make themselves masks from animal bladders as protection against the pungent, harmful atmosphere.

It was Galen, through his prolific output and social stature, who cleverly articulated Greek medical ideas, and the Roman empire that fostered their dissemination. But the legacy proved so enduring because Galenic medicine captured, in *pneuma*, the ingredient that allowed acceptance by (rising) Christianity, a vital spirit that could be considered close to the religious perception of soul. The Roman empire eventually collapsed, Europe descended into the Middle Ages, and it was not until emergence from the medieval period that Renaissance interest in science saw Galenic and Greek medical beliefs challenged. But new theoretical ideas did not really begin to appear until advances in anatomical and physiological knowledge of the Enlightenment. And by the middle of the nineteenth century the place held by air in western medical theory was changing.[2]

Air and health in nineteenth-century Britain

In his wide-ranging review of the history of public health, the historian George Rosen has suggested that, not only did Hippocrates set the tone for 2000 years

of medical thought, but the works of the Greek physician also provided the epidemiological reference upon which modern scientific medicine would be based.[34] Although the hagiography and historiography contained in Rosen's book now appear somewhat out-of-date, there is value in his kind of overview, an effort which has perhaps not been superseded in public health history since its first publication in 1958.[35] The links that Rosen draws between Greek medicine and the origins of public health provide a grounding framework for practitioners today. The place of the environment, and air in particular, in Hippocratic thought about disease causation was firmly echoed in the mid-nineteenth century.

The remainder of this case study explores the place of air in nineteenth-century medical thought in Britain. This leap of almost two millennia is not intended to diminish what happened in medicine in the intervening time, but is used to highlight significant developments in the relationship between air and health around this important time in public health history. In particular air – objectified as a putative vehicle of disease – became the focus of debates about miasmatism and contagionism. And linked to this theoretical debate air, foul and dirty, became the object of environmental reform, which was itself at the heart of early public health efforts.

Miasmatism and contagionism

According to Rosen, in the seventeenth and eighteenth centuries there were two conflicting conceptual explanations of epidemic disease causation: contagion or epidemic constitution. Ideas about contagion drew strongly on the works of the sixteenth century Italian Girolmo Fracastoro, in particular his seminal book of 1546, *On Contagion, Contagious Diseases and their Treatment*.[36] In this Fracastoro argued that epidemic diseases were caused by transmissible and self-propagating minute infective agents, and these seeds, or *seminaria*, were specific for individual diseases. Such particles were

speculation until technologically revealed by the microscope, and first reported to the Royal Society in 1676 by the linen draper Antony van Leeuwenhoek, who had observed wriggling creatures in soil, water and human excrement.[37]

In contrast epidemic constitution, the alternative explanation of disease causation, held that epidemics were caused by development of a state (or constitution) of the atmosphere, resulting from a constellation of weather conditions and local circumstances. This explanation drew strongly on Hippocratic ideas that local atmospheric conditions were at the root of diseases capable of spreading as long as the particular conditions lasted. Certain diseases were understood in relation to the broad environment and air was understood to be the mediator.

The seventeenth-century English clinician Thomas Sydenham, who first described the term 'epidemic constitution', divided febrile diseases into 'epidemic distempers' (e.g. smallpox) produced by atmospheric changes, and 'intercurrent diseases' (e.g. scarlet fever) which, although able to arise independent of the atmospheric state, were affected by it, but were also dependent on susceptibility of the body.

The influential Sydenham believed that the atmospheric change was due to a 'miasma' arising from the earth and Rosen argues that for most of the nineteenth century three theoretical positions on disease causation can be distinguished: miasmatic theory (epidemic outbreaks were caused by a state of the local atmosphere created by poor sanitary conditions); contagion (minute particles were the sole cause of infectious and epidemic diseases); and limited or contingent contagionism (infections were caused by contagion, but only arose if other elements existed such as appropriate atmospheric conditions).[38]

In contrast to Rosen's classical perspective on beliefs about disease causation in the nineteenth century, the historian Christopher Hamlin has postulated that

the terms contagion and miasm belonged to a larger and more complex system of causation. The distinction between contagion (the vehicle of person-to-person disease transmission, only received from a previous human host) and miasm (pathogenic emanations dispersed into the atmosphere in which disease could spontaneously generate) was not always accepted. Sometimes the terms were used synonymously, sometimes not; sometimes they were used to answer different questions.[39]

Hamlin argues convincingly that, although the terms implied disease specificity, they were in fact vaguely and variously used and might be among many malignant forces felt to harm bodily constitution. What was clear, however, was that with both contagion and miasm disease reached victims through the air. Although distance from the source differed with each term, air was the medium of disease.

So, two thousand years after the Hippocratic texts were written, the theory of miasmatism apparently remained part of at least two broad, competing, understandings of disease causation. The etymological roots of such an important word are revealing. Stemming from the Greek *Mia-* word group – whose basic meaning is that of defilement or impairment of a thing's form or integrity – miasma essentially refers to pollution or impurity.

The impurity, however, could relate to something physical or moral and in Greek times the two were often interwoven. Parker, for instance, suggests that in classical antiquity the word miasma could equally have been used to refer to a form of communicable religious danger, the gods seeming irrelevant, or a dangerous dirtiness that individuals rub off one another like a physical taint.[40]

This multiplicity of meaning remained highly significant in the nineteenth century. The polluted air felt to be, in one way or another, causally related to infectious diseases, was held by some to result from the immoral behaviour of the poor. In miasma, physical and moral pollution were bound together

linguistically and metaphysically and, as described in the next section, the debate about infectious disease causation was shaped by the developing theory of evolution by natural selection with its emphasis on the environment. And, later, the extension of this theory into the realm of moral evolution occurred simultaneously with the establishment of professional public health in Britain.

Air and the beginnings of professional public health

A somewhat traditional notion of public health purports Chadwick as the founder, and places the origins in the first half of the nineteenth century. However, as Dorothy Porter points out, public health – defined by her as collective action in relation to the health of populations – had been going on for centuries, but only really acquired a professional and institutional foundation in the middle of the nineteenth century.[41]

Taking this distinction on board, air was at the heart of the traditional notion of the birth of (professional and institutional) public health in Britain in two inter-related ways. First, the debate about disease causation was central because it underpinned efforts made to improve conditions and thereby reduce diseases, which formed the mainstay of early public health efforts. And second, the place of the environment – of which air was a crucial component – in directing human progress was being explored. Inextricably linked to these was the issue of responsibilities: individual responsibility for creation of the conditions in which one lives; and State responsibility for improving the living and working conditions of its citizens.

The barrister Edwin Chadwick was first notable as the architect and enforcer of the unpopular new Poor Law of 1834, a law designed to make the conditions under which public relief could be guaranteed so unpleasant that most would refuse to request it. Believing that easy charity contributed to, or even created,

indigence, the law sought to focus on prevention, which was felt to be cheaper than relief.[42]

Chadwick has been described as an inductive social scientist, who built up data on mortality, diet and the environment to test generalisations that diseases caused by environmental filth engendered destitution. These investigations led to publication of his famous 1842 *Report on the Sanitary Conditions of the Working Classes*, in which Chadwick argued that insanitary conditions led to social, biological and psychological problems and, by inference, good sanitation should lead to a happy, healthy proletariat.[43]

Like others, Chadwick believed that local atmospheric conditions were responsible for certain infectious diseases affecting communities. Processes such as putrefaction at ground level, combined with poor urban sanitation and drainage, created a residue of filth that contaminated the air, and these local atmospheric states caused disease. Believing cause and cure to be linked Chadwick labelled "atmospheric impurity, occasioned by means within the control of legislation, as the main cause of the range of endemic and contagious diseases among the community, and as aggravating most other diseases."[44]

As well as identifying the single main cause of ill health, Chadwick specified that control of insanitary conditions was within the State's remit and jurisdiction. The Public Health Act of 1848, which followed from Chadwick's *Report*, put this control in motion by providing local boards of health with legislative powers and money to improve local sewage and sanitation, which would in turn improve atmospheric conditions. Although often invoked as marking the birth of public health in Britain, this somewhat compromising bill, which failed to cover smoke prevention or insanitary burial, did not really get teeth until updated as the 1875 Public Health Act, which finally curbed much of what the previous bill had pronounced as permissive.

Yet underscoring both of these bills lay the reasons for the desired improvement in living and atmospheric conditions. Chadwick may have engendered the notion that people's health was a matter of social concern, but this position was grounded in the perceived need to have a healthy workforce in a time of rapid industrialisation and economic development. There certainly was, as Hamlin has described,[45] a utopianism to the early public health efforts of Chadwick, but this was founded on the utilitarian requirements of an expanding Empire. As is well-known, Chadwick was Jeremy Bentham's secretary and follower in earlier years.[ii]

Where air fitted in was in bringing together the need for healthy workers with the scientific explanation of ill-health. If insanitary environmental conditions caused atmospheric impurity, and atmospheric impurity was responsible for disease, then improving the health of the poor should result from better environmental conditions. However, though framed in terms of social justice and welfare, the movement was not driven by the same passion and egalitarianism which motivated others such as Engels, at a similar time, to carefully observe and document the association between working conditions and disease.[46]

Instead, the movement made sense politically and economically, and fitted into the growing belief in the scientific explanation of human progress driven by the environment. If the environment directed evolution in the animal kingdom, then it made sense that the environment could induce debility in human beings. And if the character of the poor, considered morally inferior by some, could not be trusted to improve conditions, then the State needed to act.

Here, however, the explanation provided by environmental determinism seemed to be at odds with the action advocated by believers in social evolution. Therefore, to understand better how the place of air in the scientific debate about infectious disease causation fitted in with public health action recommended to improve the

[ii] Bentham, one of the founding figures of utilitarianism, is discussed further in chapter five.

air, it is essential to look more closely at the inextricably linked debate going on about the place of the environment in directing human progress.

Air, the environment and evolution

Although Charles Darwin did not publish *The Origin of Species by Means of Natural Selection* until 1859,[47] it is well established that he had developed the main tenets of his theory at least two decades earlier in his transmutation notebooks, as well as in a 35-page *Sketch* of 1842 and a longer *Essay* of two years later.[48] [49] It was not, however, until 1858, prompted by a letter from Alfred Wallace Russell[iii] and urged by his close friends Charles Lyell and Thomas Huxley, that Darwin openly revealed his ideas by reading a joint paper with Wallace to the Linnaen Society.[50] The following year his classic work was published.

A number of reasons for Darwin's almost two decade long delay have been put forward including Darwin's psychological state,[51] [52] scientific concerns[53] [54], and explanations that the changing religious climate became more accepting of evolutionary ideas.[55] [56] [57] [58] Of significance to this chapter is that, during the whole period around 'Darwin's delay' and the emergence of public health in Britain, there was a growing debate about mankind's place in nature, a debate which allowed for the articulation and acceptance of Chadwick's beliefs about disease causation and the remedial action required. Although fuelled by scientific developments, the debate, of which Darwin was one of many central figures, was largely socio-political and was manipulated for a variety of purposes.

Before looking at these purposes, it is worth recapping the relevant basic tenets of evolutionary theory. Building on the ideas of the earlier writers, Darwin's theory of evolution by natural selection described the environment as being the space

[iii] In this letter Wallace outlined a theory similar to Darwin's own.

that directed development of a species. The environment was understood in a broad physical sense including geography, climate and predation. Individual members of a species best adapted to the environment were most likely to survive and procreate. This concept of 'relative adaptation', combined with competition between individuals for scarce resources, resulted in survival of the fittest members. In turn, this was most likely to lead to flourishing and perpetuation of the species, that was considered the evolutionary purpose.

Apart from the biological and scientific importance of these new ideas, evolutionary theory held huge social significance. Although the theory was formulated mainly from research on the non-organic and organic non-human worlds, Darwin was interested in universality from early on. And, although he refrained from discussing humans at length until much later, in the summary of *Origin of Species* Darwin gave an early indication that the operation of natural law could be extended to all organic beings, presumably including mankind:

> "In the survival of favoured individuals and races, during the constantly-recurrent Struggle for Existence, we see a powerful and ever-acting form of Selection. The struggle for existence inevitably follows from the high geometrical ratio of increase which is common to all organic beings."[59]

If mankind was included, the question faced was to which human characteristics would such laws apply, and to what ends? On a simple, physical level, extension to humans could explain different physical characteristics of individuals within different races, determined by human evolutionary adaptation to different surroundings. Darwin himself noticed this early on, commenting on the physical attributes of native islanders on his sea-faring journey. Taken further it was not difficult to see how, within a given race of humans, the strongest individuals might be most likely to survive, whether in the harsh undeveloped surroundings of distant islands or elsewhere.[60]

However, evolutionary theory held the greatest impact when applied to human beings at a level higher than the individual. Although individuals undoubtedly

competed with each other, if evolution acted within human societies at the group or race level, then success or failure of groups or races could be explained, and more importantly legitimated, as being in the best – and natural – interests of the species, mankind. Although Darwin, late in his life, did indeed defend Imperialist success as evidence that natural selection had done much for the progress of civilisation through elimination of the lower races, such beliefs were widespread much earlier that century.[61]

One of the foremost proponents of such views was Herbert Spencer, a philosopher regarded as one of the founders of sociology, best known for his 10 volume *System of Synthetic Philosophy*, a work spanning 40 years beginning with the 1862 *First Principles*.[62] Within this work Spencer attempted to show how his Principle of Evolution is exemplified throughout organic and inorganic nature, including the individual, social and moral life of humanity. Spencer argued that the evolutionary direction of flow of events is from simple to complex, incoherent to coherent, undifferentiated to differentiated, homogenous to heterogeneous, uniform to multiform.

Spencer's deterministic theory was based upon a complete belief in universal and inevitable development to perfection, which included mankind and morality. Society passes through necessary stages, of which the industrial was simply the present, *en route* to the social state which – corresponding to the transition from egoism to altruism – Spencer called the "end-product of history."[63] At this point the ideal man, exhibiting perfect morality, would live in the ultimate co-operative society where no evil existed.

Although competition between societies was natural and for an ultimate reason, Spencer felt that nations acting with malevolent force would not flourish long-term. He did not believe in the existence of Bentham's transcendental unitary human nature, instead supporting a sort of moral and political relativism, all explained as part of the path to perfect adaptation. But he disagreed vehemently with any State intervention, since it was interference with the natural process,

believing there "cannot be more good done than of letting social progress go on unhindered."[64]

Spencer's ideas – influential from the Athenium to the United States[65] – held great appeal to industrialists, part of the rising professional middle class who wanted to reap the benefits of their own work. With unlimited competition considered natural, and State interference unwarranted, Spencer provided the perfect justification for both the behaviour of the capitalist and *laissez-faire* opposition to State-induced reform. Several decades earlier Adam Smith has also espoused free trade and an open market, as well as subtly connecting how the hidden hand of economics shapes political arrangements, our values, and ultimately how people behave.[66]

Evolutionary ideas, interestingly, did not only appeal to the right-wing.[67] In *The Politics of Evolution*, the historian Adrian Desmond shows how in the 1820s and 1830s the evolutionary ideas of earlier writers such as Lamarck were used to argue for a levelling of nature and redistribution of privilege.[68] A little later, focussing on socialists and their connection to Darwin, Himmelfarb quotes Karl Marx suggesting in 1861 after reading *Origin of Species*, that the book provides "a basis in natural science for the class struggle in history."[69] Marx valued the book as he felt it moved away from studies which tended to exclude history and its processes. Engels, however, heralded not Darwin, but Marx as the foremost social evolutionist:

> "Just as Darwin discovered the law of evolution in organic nature, so Marx discovered the law of evolution in human history."[70]

Nevertheless, for those with political leanings towards both extremes, as strong as the biological arguments upholding the legitimacy of human social evolution were, the concept was necessarily tied in with developing ideas about moral evolution. For industrialists and expansionists in particular there was a problem since, although evolutionary theory placed humans squarely within the same laws of nature as other species, surely humans remained different by virtue of cognition

and morality. And some felt that, despite scientific support, it still did not seem right to behave so aggressively and unsympathetically towards other humans.

This problem could be circumvented if one accepted mind as matter, with human mental characteristics subject to the same evolutionary laws as physical characteristics. It was then possible to postulate a hierarchy of social morality grounded in degree of social development. Evolutionary forces shaped moral progress with the most superior or successful races having the highest degree of morality. Darwin was himself a believer in philosophical materialism and the inheritability of acquired psychological traits. By 1871 he had developed ideas that complex social instincts in animals, resulting from natural selection acting on simple instincts, provided the foundation for evolution of "the most noble of all the attributes of man",[71] morality:

> "... any animal whatever, endowed with well-marked social instincts, would inevitably acquire a moral sense of conscience, as soon as its intellectual powers had become as well developed, or nearly as well developed as in man."[72]

Progression to morality within nature continued within the groups and races of mankind. Near the beginning of *Descent of Man* Darwin set out a scale in which 'civilised man' appears at the top, then natives, followed by barbarians, savages and apes, lending additional support to the morally questionable aggressiveness required for colonial expansion.[73] And closer to home the "careless, squalid, unaspiring Irishman ... who multiplies like rabbits"[74] exemplified how it became possible to cast the worse off groups in society as being in that position by virtue of their morally inferior behaviour. So the environment weeded out not only the most unfit physically, but also the most unfit morally. And in this way groups such as the poor and destitute could be blamed, at least in part, for their situation.

In this milieu of inter-woven scientific and social thought, the beliefs of Chadwick and others that the environment – and air in particular – determined health and disease, life and death, made sense. The idea that adverse environmental

conditions were causally responsible for disease which might weed out those exposed to such conditions, the unfit, was commensurate with the ideas of human social evolution. By virtue of their morally inferior behaviour the unfit were, at least in part, responsible for the conditions which caused their ill health.

It was therefore not surprising to find comments such as those in a *British Medical Journal* editorial of 1870, connecting morality and social position, and placing partial blame for their own welfare with those who suffered most directly from the bad air and poor sanitation:

> "To members of the medical profession it must be well known, how intimately overcrowding, dirt, and low moral condition, are connected. Medical officers of health, and indeed all who are engaged in the treatment and prevention of disease, meet with great hindrance through the ignorance or carelessness of those with whom they have to deal. They may succeed in enlightening people as to the evil of this or that habit ..."[75]

Of course, the sanitary reform advocated by Chadwick and his followers – support of the poor via improvement to environmental conditions – seemed to be working against the forces of nature. Increasing the chances of survival of the weakest members of the race would appear to run counter to the dictates of biological determinism. But it was here that the early public health efforts could be defended from a higher level of social and moral progress. The reforms served to improve the overall condition of the working nation, which was essential to economic growth and further colonial development. In the long-term the human species would be the beneficiary of the continued expansion and domination of the English race, believed to represent the finest physical and moral characteristics of the species.

Further evidence was provided by upholders of scientific racism (part of the doctrine of biological determinism[iv]), who tried to demonstrate scientifically the

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[iv] Stephen Jay Gould describes biological determinism as the doctrine stating that shared behavioural norms, and the social and economic differences between human groups – primarily races, classes and sexes – arise from inherited, inborn distinctions, and that society, in this sense is an accurate reflection of biology.[60]

inborn inferiority of some races relative to others.[76] Observed racial differences in body shape, brain size[77] and brain complexity,[78] provided empirical justification for actions explained by evolutionary superiority, and laid the foundations for the most extreme versions of Social Darwinism to follow – eugenics (defended as giving nature a helping hand) and National Socialism.[60]

Michel Foucault ties together the apparent ideological conflict between those supporting and those opposing support of the poor through environmental improvement with his concept of 'biopower' – the controlled insertion of bodies into the machinery of production and the adjustment of the phenomenon of 'population' to economic processes.[79] During industrialisation the workforce needs to be carefully managed, and biopower, indispensable to capitalism, involved redefining the poor according to their economic usefulness, placing for example the 'healthy poor' into the circuit of production.[80]

This digression into the evolutionary debate is not intended to paint a purely calculating and bleak picture of the origins of public health in nineteenth century Britain. As pointed out earlier there was a certain degree of utopianism, and a feel for social justice in the ideals of those involved. But these ideals were allowed to take root in practice because understanding the environment as a substantial explanation of human wellbeing fitted in with corresponding biological theories of the environment as the determinant of human social and moral progress, as well as the economic and political dictates of the time.

Conclusions

This case study has explored air and health over two millennia. In ancient civilisations – Egyptian, Chinese, and Judeo-Christian – air was a spiritual essence in the conceptualisation of human health and disease, a provider and sustainer of life. This theme continued in Greek medicine, within which the conception of air and health had both natural and supernatural dimensions, and

was associated with a holistic conception of health and disease, linked to balance and harmony with nature and the universe.

These conceptions were largely lost with the advent of scientific medicine in the west. Air became the object of scientific deliberation in nineteenth-century Britain, and its role in disease causation became linked to wider questions about human evolution and progress, as well as the economic and political requirements of the period.

So the nature of the relationship between air and health and the place of air in medical thought had changed dramatically. From being an essential, inseparable part of holistic understanding of human health and disease, air had become the medium around which a scientific debate focused, a debate which itself was framed within a larger debate about the environment and human progress.

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CHAPTER 3

CASE STUDY 2: HISTORICAL PERSPECTIVES ON AIR POLLUTION AND PUBLIC HEALTH IN ENGLAND, 1800 – 1970

For reference, a tabulated historical overview of smoke and air pollution legislation in England is provided at the end of the chapter [Table 2.1, p112].

Overview of case study 2

The second case study traces the changing relationship between air and public health from the mid-nineteenth century until about 1970, through examining developments in smoke pollution policy and scientific understanding of the effects of smoke on health. This historical case study (history of medicine and history of public health) also considers developments in health policy (smoke pollution policy, public health policy). Primary and secondary data sources were used, as described in chapter one, and inter-disciplinary connections are examined.

Background

The first raw material used for heat was wood, the burning of which creates dense smoke and particles which are irritants to the respiratory tract. On a world-wide scale today, the ill health resulting from the indoor use of wood-burning stoves in low income countries remains a more significant global public health problem than outdoor air pollution, despite the greater attention the latter receives.[1 2 3]

Possibly the earliest concerns about the effects of coal smoke are evident in an Ordinance of 1273 which prohibited the use of coal in London as being

prejudicial to health. By the end of the thirteenth century an appreciable quantity of coal was being used in London, resulting in smoke objectionable to noble lords coming to the metropolis to attend Parliament. Their complaint to Edward I resulted in the king issuing a royal proclamation in 1306 forbidding the use of coal by artificers, who were to return to charcoal. One offender was apparently executed.[4] Queen Elizabeth I forbade the use of coal when Parliament was in session, complaining that smoke from breweries in the vicinity of her palace caused her grievous annoyance. [5]

By the seventeenth century, concern about the pall of coal smoke over cities, particularly London, had increased, with wealthier individuals and families already choosing to reside on the fringes of the capital. In 1648 Londoners petitioned Parliament to prohibit the importation into London of coal from Newcastle.[6]

A decade later the diarist John Evelyn published a famous tract titled *Fumifugium, or the Smoake of London Dissipated*, which he dedicated to Charles II.[7] In this vivid piece Evelyn drew a dramatic picture of London darkened and eclipsed by a hellish and dismal cloud of sea coal, belched forth from the sooty jaws of the tunnels of brewers, dyers, lime burners, salt, and soap boilers. And, presaging early twentieth century smoke control advocates' focus on aesthetics and cleanliness, Evelyn powerfully depicted the dirtiness of "this horrid Smoake which obscures our Churches, and makes our Palaces look old, which fouls our Clothes, and corrupts the Waters ... diffuses and spreads a Yellownesse upon our choycest Pictures and Hangings ... and kills our *Bees* and *Flowers* [author's italics] ..."[8]

Evelyn's tract is also important because it highlighted the perceived adverse health effects of prolonged exposure to foul air, and also illustrated a simple method (supported by statistics) – to be used often from the nineteenth century onwards– of demonstrating these effects. This involved showing that town dwellers, in this case Londoners, experienced more of certain health complaints

than others, with the underlying belief that smoke was the cause of this discrepancy:

> "... that her *Inhabitants* breathe nothing but an impure and thick Mist, accompanied with a fuliginous and filthy vapour,... corrupting the *Lungs*, and disordering the entire habit of their Bodies; so that *Catharrs*, *Phthisicks*, *Coughs* and *Consumptions* rage more in this one City than in the whole Earth besides [author's italics]."[9]

Medical opinion was not particularly supportive of this perspective. Although concurring with smoke being an infernal nuisance, the Royal College of Physicians (RCP) was displeased with Evelyn, regarding smoke as protective against infections. The king, however, responded to the tract by proposing an Act of Parliament to have the troublesome factories removed many miles from London – to Greenwich and other areas down the river – but the Bill was dropped.[10]

More than a century later, in 1772, a new edition of *Fumifugium* was published, in which the editor laments the increase in smoke, invoking magistrates to take steps to check the evil, and urging investigation into production of a smokeless fuel. But nothing was done for 50 years, by which time the conversion of England from an agricultural to an industrial community had been substantial, as was the spread of smoke.

'As far as practicable': air pollution policy and public health in the nineteenth century

The industrialisation and urbanisation of the eighteenth century expanded almost exponentially during the nineteenth. These two elements compounded the smoke problem: growth of industry – itself creating increasing amounts of smoke – attracted people to the cities, and more people needed more coal for domestic heating.

Strong concern was evident from 1818, when a parliamentary committee was appointed to see what could be done in relation to smoke, in particular how far steam engines and furnaces could be constructed in a manner less prejudicial to public health and comfort.[6] The committee confidently noted the "hope that the nuisance so universally and justly complained of may at least be considerably diminished, if not altogether removed."[11] But these were wishes without solutions, and no further action was taken.

The middle of the nineteenth century witnessed the growing concerns with environmental and sanitary conditions outlined in the previous chapter. Chadwick's influential 1842 *Report of an Inquiry into the Sanitary Conditions of the Labouring Population of Great Britain* has been mentioned already, and the following year a Royal Commission for *Inquiry into the State of Large Towns and Populous Districts* spelt out the terrible conditions in urban areas including, poverty, overcrowding, congestion, crime and poor health. It was around this time that the conception of air in medicine really began to shift towards polluted air and its effects on health. And, as the century progressed, the shift became more and more apparent.

In the same year as the afore-mentioned Royal Commission, a Select Committee examined the smoke problem and recommended introduction of legislation to control nuisances from furnaces and steam engines, and expressed the hope that black smoke, including that from private dwellings, might eventually be entirely prevented.[6] Just two years later another Select Committee reported that any Bill to control smoke should be restricted to furnaces producing steam, and should not extend to fireplaces of common houses. As a result of this, in 1845 an updated Railways Clauses Consolidation Act contained a clause requiring railway locomotives to consume, "as far as practicable", their own smoke. And two years later a regulation applying to factory furnaces, with consumption requirements analogous to those applying to railways, was inserted into the Town Improvement Clauses Act, 1847, once again with the same qualifying phrase.[10]

It was around this period that municipalities began to grant authority to town councils to appoint a Medical Officer of Health (MOH), a physician with responsibility to examine the health of the local population, oversee provision of certain medical services and provide medical advice to the local authorities. For example, the Liverpool Sanitary Act of 1846, the first comprehensive sanitary measure passed in England, enabled the town council to appoint a MOH, and also a Borough Engineer and Inspector of Nuisances.

In 1848 the City of London appointed John Simon as MOH and, following the Metropolis Management Act, 1851, appointment of MOsH for various London districts became compulsory. By 1856 there were 48, and the same year the Metropolitan Association of Medical Officers of Health was formed. Other large municipalities made similar appointments – Leeds (1866), Manchester (1868), Birmingham (1872), Newcastle (1873) – until the Public Health Act, 1875 made it mandatory for all districts to have a MOH.[12] Two years earlier, with the number of MOsH outside London increasing, the Metropolitan Association of Medical Officers of Health expanded nationally to become the Society of Medical Officers of Health.

The MOH, working closely with the local population, saw at close hand the abject living and working conditions of the urban environment, and their effects on health. Furthermore, the work remit of the MOH placed him in a unique position to investigate and research the relationship locally between environmental conditions and health, and to act as a professional voice for improvement. As is shown later in this chapter, with regard to smoke pollution the MOH was to embrace this dual role – as advocate and local researcher – and for decades to come a number of these figures spoke up passionately about the smoke evil, investigated links with health, and assisted pressure groups and campaigners. But, crucially, the lingering problem was what could actually be done about smoke? Whereas sewage and other sanitation issues could be more readily addressed, smoke was far harder, primarily because of its association with desired economic expansion.

One approach was to try and monitor more strictly the enforcement of legislation that already existed and create further powers if necessary. In 1853 the General Board of Health (GBH)[i] led an inquiry into inventions for the prevention of smoke, and recorded that a 9-hour observation of a cotton mill in Manchester showed smoke emission for 8 hours and 52 minutes. The inquiry recommended employment of police constables to make observations, and qualified officers to superintend them and to advise manufacturers.[4]

In consequence of this report Lord Palmerston's Smoke Acts of 1853 and 1856, applying to London only, empowered the police to enforce provisions against smoke from furnaces used in steam raising, as well as smoke from other furnaces employed in factories, public baths, and furnaces used in the working of steam vessels on the Thames. Sanitary authorities in other parts of England and Wales were similarly empowered to take action in cases of smoke nuisances within the Sanitary Act,1866. But this power was never exercised in London, where the police continued to try to enforce the Smoke Acts until passing of the Public Health (London) Act of 1891.[13] The Sanitary Act was repealed by the Public Health Act, 1875, within which legislation regarding smoke pollution was to be situated for the next 50 years.

The difficulties of enforcement of smoke legislation were multi-fold. First was the question of manpower. Both police officers and local authority officials were faced with time constraints and had to balance enforcement of the smoke laws with many other competing concerns. Next was the issue of skills, with the enforcers provided with training insufficient to monitor the enforcement of somewhat confusing legislation. Third was the matter of penalties, which were often too small to act as a significant deterrent – a theme that continued with

[i] The General Board of Health (GBH) was a central agency, established after the Public Health Act, 1848, with the role of guiding and aiding local authorities, and empowered to set up local Boards of Health. Chadwick was a member of the GBH, and John Simon was appointed medical officer to the Board. In 1858 medical functions of the GBH, including public health, were transferred to the Privy Council, where they remained until 1871.

subsequent legislation during the next century and is discussed in more depth later in this chapter. And finally, another recurring theme is that the legislation, dishearteningly for enforcers, focused mainly on tackling the problem after it had arisen, instead of specifying means of reducing smoke production *before* plumes were thrown out on a huge scale into the skies.

Despite commercial and industrial opposition to efforts to legislate against smoke pollution, there was support for reform from campaigners and, importantly, from the medical profession. Just a year after enactment of the second Smoke Act, the journal of the British Medical Association, the *British Medical Journal* (*BMJ*), reported a parliamentary question about whether the Government would actually enforce the 1856 Act, which received the response that there had been 54 convictions in the previous six months with more expected.[14]

Measuring the health effects of polluted air: statistics and research

Around this period was the emergence of journal discussion and research around the putative association of atmospheric pollution and poor health. Replacing earlier attempts at association which had been largely anecdotal or theoretically framed, new statistical approaches were being developed, often using data on the number of deaths from certain diseases in each registration county, collected and published by the Registrar-General from 1848 onwards. For example, using this mortality data along with local documents and population figures from the 1851 census, Bakewell examined mortality ratios from "fever" in different districts. He suggested poverty (percentage of paupers) was most responsible for fever deaths, although probable amount of ventilation (average number of inhabitants in each house) was also important and, in a comment on causation, concluded that fever was due to "food deficient in quantity and quality, especially as associated with filth and foul air ..."[15]

Bakewell's article of 1858 illustrates from an early date what has proven to be an intractable difficulty for epidemiologists: how to prove a causal association between an environmental factor – such as atmospheric pollution – and health, when operating within a scientific (later biomedical) model of health. Connected to this point, the article also shows how air within western medicine was starting to be conceptually fragmented in order to accommodate the new epidemiology: if it was not possible to measure air pollution directly, then a proxy indicator, in this case overcrowding as a measure of ventilation, could be used instead. And, in time, the possibility would arise of reducing air to smaller polluting components.

Although the 1850s were early days for epidemiology, the theoretical space was unfolding for medico-scientific investigation of the association between air and health, regardless of one's position on contagionism or miasmatism. At the end of that decade the Epidemiological Society held that some epidemic and endemic diseases have their origin (irrespective of specific poison) in atmospheric variations and, in their classification of disease, the third and last class included diseases originating in meteorological variations but not transmissible.[16] Atmospheric and climatic conditions, in combination with polluted air, were believed to cause disease whether mediated by specific agents or not.

Urban areas were most heavily affected by the awful atmospheric conditions although, in comparison with previous centuries, town living had substantially improved in terms of health. The average life expectancy of a Londoner in the sixteenth century was 20, whereas in 1858 one could expect to live to the age of 37. But for the new medical scientists, and also the sanitary reformers, these figures were still unpalatable, life expectancy being much lower in the least healthy parts of towns. In a leading article of the Public Health section of the *BMJ*, the anonymous author refers to the large number of redundant deaths caused principally by "foul air ..., water and deficient light – the three spectres that are to be found in the cupboards of most poor men living in large towns."[17]

One of the difficulties facing MOsH was their position on the role of ventilation in combating the foul urban air. In some ways it was a losing battle. On the one hand it seemed that opening the windows should be advocated, the air indoors being heavily polluted with domestic smoke and other emanations resulting from over-crowding. And, generally, ventilation of the home as well as public buildings such as schoolrooms was encouraged.[18] But, on the other hand, the outdoor air was often so bad that uncertainty existed over whether bringing it indoors was advisable.

Of course home ventilation would be more desirable if ventilation of the towns could be improved. Writing in 1870 Oliver argues that the "influence of the atmosphere on the general health and mortality of the inhabitants of towns, is beyond suspicion", and he promotes efforts made to purify the atmosphere of towns by encouraging street-ventilation, and the application of legislative enactments to obtain the complete combustion of fuel, opening of streets and alleys to allow ventilation of towns, and the formation of parks.[19] There was talk about the benefits of living by the sea, and the healthy influence of sea-winds that followed river tracts into towns close to the coast.

Attempts were being made to epidemiologically correlate meteorological aspects of the atmosphere with measured morbidity, just as in the cities investigators would begin to turn towards correlating distinct elements of polluted air with ill health or death. But before correlation could be drawn, quantification of polluted air was needed, and in 1890 in the *BMJ* one of the first accounts appeared discussing measurement of the amount of particles in air. The unauthored piece describes a communication made by John Aitken to the Royal Society of Edinburgh about an experiment in which air was tested for the amount of dust particles per cubic centimetre. It fails, however, to elaborate on how the air was tested or the particles counted.

The researchers found that the number of particles in the air – felt to affect the brilliance and transparency of the atmosphere – varied depending on wind

direction. For example in Cannes the number spread from 1,500 when the wind was blowing from the mountain to 140,000 when blowing from the town. Importantly, particle numbers were shown to differ widely between urban and rural air, attributed largely to human activity:

> "Observations made in Scotland and elsewhere indicated how extraordinary was the pollution in the air due to human agency. In regions clear of human habitations, the number of particles fell as low as 200, while in and around villages the particles amounted to thousands, and in towns to hundreds of thousands."[20]

Progress, however, in mitigating the smoke problem in the last quarter of the nineteenth century was desperately slow. One reason was that smoke pollution was not viewed negatively by all. Some manufacturers and local residents felt comforted that "the greater the smoke the greater the considered prosperity."[21] In a similar vein, an article playfully entitled 'Cherishing the smoke demon' comments that although Londoners like to groan "they cling on to smoke as a privilege of property."[22]

In the main, though, failure to improve the polluted atmosphere was due to lack of political and economic will, despite the emerging scientific evidence of illness being associated not only with outdoor air, but also with air inside factories. For example, microscopic analysis had revealed small, rough jagged pieces of iron in the air of an iron factory, filaments of linen and cotton in shirt factory air, and Scottish mills were branded as "human slaughter-houses" because of the spongy, spiky dust found in their air.[23]

As worrying as air quality inside factories was, those exposed represented (just a proportion of) the workforce, and a much bigger problem remained the pollution by coal smoke which affected urban communities on a huge scale. In fact, the extent of the problem seemed to be escalating. The legislative response, however, remained woefully inadequate.

The Public Health Act, 1875: landmark and deficiencies

The Public Health Act, 1875, organised public health administration on a nation-wide basis. It divided the country into urban and rural sanitary districts subject to supervision of the Local Government Board (LGB), which had replaced the Privy Council in 1871. Existing local authorities fitted into the new pattern as far as possible, and borough councils became local health authorities. And, as mentioned earlier, it became mandatory for all districts to have a MOH.

Although the Act may have been a landmark in the development of public health in England and Wales, it skirted carefully around the smoke problem. Provisions made within the new legislation to counter smoke were essentially two-fold. First, the Act provided that any fireplace or furnace in trade premises must, so far as practicable, consume its own smoke. And, second, it enabled action to be taken – by an individual or local authority – against those responsible for factory chimneys emitting black smoke in sufficient quantity to be a nuisance.[6]

A closer look at Section 91 of the Act shows the following listed as summarily punishable 'nuisances':

> (a) factories, workshops, and workplaces "not ventilated in such a manner as to render harmless *as far as practicable* [my italics] any gases, vapours, dust or other impurities generated in the course of the work carried on therein that are a nuisance or injurious to health";
> (b) fireplaces and furnaces which do not "*as far as practicable* [my italics] consume the smoke arising from the combustible used therein" and are "used for working engines by steam or in any mill, factory, dyehouse, brewery, bakehouse, or gaswork, or in any manufacturing or trade process whatsoever";
> (c) "any chimney (not being the chimney of a private dwelling house) sending forth black smoke in such a quantity as to be a nuisance."[24]

The main problem with this Act was that every punishable offence had a broad caveat. Factories were required to ventilate their premises and use steam-raising equipment that consumed its own smoke, but only 'as far as practicable'. Writing in 1949 Jervis argues that 'best practicable means' became the loophole for routine legal defence, and did not require demonstration that much was actually being done to alleviate the smoke output. A growing range of new equipment was becoming available but it was expensive and, with uncertainty over how well it would work, was generally considered not worth the investment. Fines were cheaper.[25]

For prosecutors, 'blackness' and 'nuisance' became the standards that needed to be proved. This was difficult since often the smoke was arguably grey; and because divergent opinions existed in local authorities as to what constituted a nuisance. For instance, at the turn of the century Popplewell pointed out that in Bolton a fine could be imposed for three minutes in a half-hour (or six in an hour) of dense, black smoke from a chimney, whereas in Oldham 12 minutes in an hour were allowed. He also felt the fines were completely inadequate.[11]

Perhaps most significant, however, was that the Act did not apply to private homes, known to be substantial contributors to smoke production. Although heating alternatives were limited at that time, there was soon to be an expansion in options, but the 1875 Act set the tone for decades to come in not applying the legislation domestically. Moreover, no definition of 'private dwelling-house' was provided in the Act, allowing further leeway for interpretation.

The Act also did not apply to the capital, and similar provisions were not conferred until the Public Health (London) Act, 1891. An attempt had been made four years earlier to tackle London's smoke from private houses and other premises not included in the 1853 and 1856 Smoke Acts, when the Smoke Abatement (Metropolis) Bill was introduced to the House of Lords. But it had failed to become law.[13]

Organised campaigning, however, was beginning on a much wider scale. In 1881, due to the extent of the smoke problem in London, the Kyrle Society and the National Health Society acted to form the Smoke Abatement Committee (SAC), a body aiming for reduction of smoke from all sources but especially private dwelling-houses. The SAC organised what the historian Harold Platt has called a propitious event in urban environmental reform, the Smoke Abatement Exposition of 1881-1882. Attracting over 115,000 visitors in London, and 31,000 in Manchester, the convention was a "dazzling showcase for an international array of heating, lighting, cooking, and power hardware."[26]

Nevertheless, the picture at the end of the century was still rather bleak, in spite of the establishment in London of another pressure group, the Coal Smoke Abatement Society (CSAS) in 1899. To the frustration of many, alternative appliances for improved coal burning had been invented, and were duly being tested by organisations such as the Smoke Abatement Institution and the Association for Testing Smoke Preventing Appliances. Reports of the testing were available, but very little change in practice was actually occurring.[27]

Visibility, sunshine, and dirt: air pollution and policy 1900-1939

The first four decades of the twentieth century were an illuminating and formative period in the history of smoke pollution and policy. During that time, as this section of the case study will show, the campaign against smoke pollution grew stronger, groups becoming more organised through affiliations and collaborations. But the face of the campaign needed to change. As the germ theory of disease took hold of scientific thought, medical interest in chronic diseases of environmental origin waned, especially given the lack of obvious microbiological aetiology. So the campaigners turned elsewhere, towards aesthetics, as well as back to nature, in the guise of greenery.

At the turn of the century, however, it seemed little had changed. Popplewell, a consulting engineer and earlier author of *Steam Engines and The Strength and Testing of Materials*, captured the feeling of the time in his 1901 publication *The Prevention of Smoke Combined with the Economical Combustion of Fuel.* Here he complains that over the previous 80 years various Acts have passed but "in spite of all of this, the evil has been growing worse year by year, the law having to a great extent failed to effect any real improvement."[28] He paints a picture of blackened vegetation and lungs, the health of plants and humans alike suffering from smoke deposits. And, lastly, he puts forward his concern about the loss of urban sunshine.

The formation of smoke, and accompanying loss of sunlight, was a developing area of shared interest for both meteorologists and anti-smoke campaigners. First invented around 1850, the 'sunshine recorder'[ii] was soon in general use and in 1880 the Weekly Weather Report of the Meteorological Office included, for the first time, results from 16 stations around the UK. By 1910 there were 131 stations, 66 of which had consistent readings for 30 years, and Brodie, a Fellow of the Royal Meteorological Society (RMS), presented results for these stations in the *Quarterly Journal of the Royal Meteorological Society.*[29]

For many places in north Britain, Brodie showed the mean duration of sunshine, over the 30 years between 1880 and 1910, to be less than one hour per day in December; and, for the month of December 1890 (the darkest month in the 30-year period), the sunshine record at Westminster was completely blank. The situation in large manufacturing towns was worst, especially in winter when rays were weak and domestic coal use high. Interestingly, however, Brodie points out that, over the three decades, the sunshine in London (stations at Kew, Westminster and Bunhill Row), although awful, had improved slightly. The mean

[ii] The sunshine recorder was originally a wooden bowl with a lens (first filled with water, then solid glass), the sun's rays charring the inside of the bowl, and charring was compared between bowls exposed for the same period. It was first used in 1855 and in 1879 Sir George Stokes replaced the bowl with a metal frame with grooves into which a strip of cardboard was inserted which received the rays and could be replaced daily.[29]

percentage of possible light had increased from 26% to 31% over a five-year rolling period from 1881-85 to 1906-1910; and, during the winter months, had increased from 7 to 14 % at Westminster. The author suggests this change might be due to "regulations affecting factories, to the improvements in the construction of domestic grates, and to the largely increased use of gas for cooking and heating purposes."[30] A colleague of Brodie's, JE Clark, referred to the lack of sunlight during daytime phenomenon as 'day darkness'.[31 32]

For the cities, which were most affected, there was a circular element to the problem. When it was cold, domestic coal fires were needed for warmth, which produced huge amounts of smoke. The smoke, as well as affecting health, kept out the sun's rays, creating darkness requiring the generation of electricity for artificial lighting. And generation of electricity resulted in further release of smoke into the atmosphere, exacerbating the problem. The Public Health (Amendment) Act, 1907 addressed an element of the problem by enabling local authorities to make by-laws regarding the construction of chimney shafts for furnaces of steam engines and certain factories. But the legislation still only related to black smoke.[33]

Campaigns, exhibitions and committees

Owing to frustration with ineffectual legislation, officials began to work more closely with campaigners. A number of local authorities attended the 1909 Smoke Abatement Exhibition, held in Sheffield under the auspices of the Sheffield Federated Health Association, after which it was decided to create a National Smoke Abatement Committee (NSAC).[13] Around the country other towns were similarly keen to address the smoke problem, or at least show that they were trying to do so. The 1911 Smoke Abatement Exhibition in Manchester was reported in the *BMJ* as designed to show the need for a cleaner atmosphere in Manchester and Salford, and to exhibit appliances that could reduce the amount of smoke emitted from chimneys. Smoke was calculated to cost Greater Manchester

£1,000,000 a year – without taking into account damage to fabrics and its effect on health – with household fires responsible for 60% of the output. Promoting alternative fuel use, the piece goes on to suggest that "if gas and electricity were sold at even a slight loss so as to induce people to use them instead of coal fires the gain in health and in other ways would be ample compensation."[34]

Just a year later the CSAS held another large display of possible solutions to the coal-burning problem – the International Smoke Abatement Exhibition – at the Agricultural Hall in Islington, London. At this meeting a Committee for the Investigation of Atmospheric Pollution (CIAP) was formed which, though representing yet another 'expert group' set up to look at the problem, was notable for being a collaborative venture of the CSAS and the Meteorological Office, signalling new relations in the quest for cleaner skies.

The committee – which later became part of the Department for Scientific and Industrial Research and in 1956 was a committee of the Fuel Research Board – collaborated widely with local authorities and played an important part in establishing the daily recording of air pollution around the country. The degree of air pollution was measured as impurities suspended in the air – deposits which subside or are carried down by rain into gauges, and the photoelectric intensity of light reaching the ground (i.e. ultra-violet radiation).[10]

Some authorities had independently started monitoring before the CIAP was set up, notably in Glasgow on the suggestion of the Glasgow Health Authorities, and in other large towns in Scotland.[35] While public health committees in individual authorities were usually responsible for carrying out the monitoring, the CIAP initiative stood out for its systematic co-ordination of monitoring of smoke output on a reasonably wide scale. This organised monitoring of air pollution indicators would prove of particular value because it allowed assessment of trends and changes over time.

The kind of collaboration that the CIAP programme generated had been fostered for some time by one of the committee's parent organisations, the CSAS. As well as being Honorary Treasurer of the new central committee HA Des Voeux was also an ardent campaigner for the CSAS, arguing in that organisation's 1912 publication *More Sunshine for London*[36] that darkness and dirt are close friends of disease, darkness favouring the growth of germs that sunshine kills.

With sunshine and clean air the precursors of good health, Des Voeux stressed that it was the desire of the CSAS to "arouse public opinion to the need of reducing materially the constant fouling of London's air with soot and sulphur from the crude combustion of coal."[37] Yet despite the rousing words of such campaigners, the economic advantage of switching combustion machinery was not evident to industrialists or factory owners, and less polluting alternatives were beyond the means of most who lived in private homes in the cities. And incentives for change – both privately and in industry – were weak, and existing legislation was toothless in promoting or demanding change.

Such legal failings were emphasised by the Public Control Committee in a 1911 report recommending various alterations to the law, the main points repeating those made when the laws were passed: a) not restricting smoke nuisance to *black* smoke as per the 1875 Public Health Act (1891 for London); b) expanding the definition of a chimney to any opening through which smoke is emitted from a building where manufacturing goes on or furnaces are used in operations carried out under statutory power, *including* any Government workshop or factory; and c) extension of the power of sanitary authorities to take proceedings regarding nuisance *outside* of their area.[38] This last point stands out in reflecting growing recognition that pollution travels, and legislation needed expansion to allow local authorities to address smoke nuisance arising outside their immediate jurisdiction.

But the Government was not keen to radically change policy, a move that would be economically disadvantageous, in the short term at least. A Smoke Abatement Bill introduced by a private member to the House of Commons in 1913 did not

proceed, and it was only when Lord Newton introduced a Smoke Abatement Bill to the House of Lords the following year that the Government felt obliged to take the matter more seriously.

Backed up by the Corporations of many large boroughs expressing the need for tougher legislation directly to the LGB, Lord Newton's Bill was withdrawn before a second reading upon assurance that the President of the Board would appoint, as soon as possible, a Departmental Committee with all interests represented that would examine carefully the existing law and its administration, and make proposals for consideration to Parliament.[11] That year, however, the country went to war and, although the President of the LGB, Sir Herbert Samuel, made appointments as promised, the work was suspended and the Committee was not reconstituted until 1920.

The inter-war years

Lord Newton's Departmental Committee did eventually publish its investigative report in 1921 (Newton Report) following an interim version a year earlier. After over 50 meetings, interviewing 150 witnesses, and visits to many towns in England, Wales and Germany the inquiry blamed the prevalence of smoke pollution in this country on the indiscriminate and wasteful use of raw coal for all purposes, whether industrial or domestic, and to lax administration of the law by the responsible authorities.[13]

The report was especially severe on domestic pollution, calculating that about 2.5 million tonnes of soot from domestic fireplaces pollute the atmosphere annually (compared with 500,000 tonnes from industrial chimneys), a practice described as dirty, wasteful, and unscientific. On the grounds of economy, loss of sunlight and damage to public health, the report recommended that this domestic practice should be restricted as much as possible. But the committee fell disappointingly short of proposing significant legislative advance, advocating instead that

Government should encourage further research into domestic heating, that gas and electricity providers should be encouraged to cheapen supply, and the practice of municipal authorities over-charging on gas and electricity in order to allocate profits to relief of rates be discontinued.

In spite of knowledge that smokeless heating agents could almost completely eliminate domestic smoke production, the report weakly concluded that "after full consideration, we do not consider it practicable at present to propose legislation dealing with smoke from private dwelling-houses."[39] On industrial smoke the report was similarly lacking teeth, advocating only that the Minister of Health's powers be extended (to act on a defaulting authority, and to fix emission standards from time to time), that duty to enforce be transferred to larger authorities, and that fines be increased. Paradoxically, the report suggested the 'best practicable means' imposed on manufacturers should also take account of cost, adding a further string to the defence bow.

According to the Chairman of the Smoke Abatement League of Great Britain, JW Graham, existing legislation in that area was, without any further caveats, already a dead letter. This, he suggested, was because fines were insufficient to act as a deterrent, and health committees and magistrates were often connected with the offenders socially or by family ties.[40]

Developments in researching the health effects of air pollution

At the end of the Committee's 1924 report the authors describe an attempt made to correlate atmospheric pollution with mortality in London by plotting the amount of suspended impurity in the air (daily impurity and six-day average) against number of deaths. They failed to find a definite relationship between pollution and mortality, although a relationship between death rate and minimum temperature "appeared to be fairly definite". The report concludes that a relationship between atmospheric impurity and deaths would likely only be seen

over very long periods, but maintains that it is probable that "the incidence of respiratory diseases and of fogs would show a definite relationship, although ... the low temperatures usually prevailing during foggy weather would be a complicating factor."[41] These findings reiterate the already ongoing difficulties of demonstrating epidemiologically a causal relationship between an environmental factor, such as atmospheric pollution or a proxy for it, and a health outcome such as mortality.

An inability to drum up medical interest compounded the problem. Whereas atmospheric pollution occupied the minds and time of public health workers, MOsH, smoke inspectors, campaigners, meteorologists and the public, the medical profession was increasingly occupied elsewhere. The germ theory of disease was widely accepted by this time, and interest in chronic diseases with environmental components was declining along with miasmatism. As the historian and health policy analyst Daniel Fox points out, in both the UK and the United States medical attention – along with health care and research funding – shifted heavily in the first half of the twentieth century away from chronic diseases and towards acute infectious diseases and the technological developments that accompanied this rapidly expanding area of knowledge.[42]

An opening paper in a 1923 edition of the *BMJ* captures this change in orientation of the profession. While it had been accepted the previous century that insanitary conditions caused foul-smelling air which was responsible for disease, from the turn of the century attention was directed towards identifying the element(s) of foul air that might be responsible. But, as the article tells, attempts to isolate micro-organisms in the foulest air, sewer and drain air, were proving fruitless.[43]

With medical interest diverted, and correlational analyses limited, researchers continued to consider the epidemiology of adverse events. This kind of descriptive epidemiology drew on bouts of particularly bad environmental conditions, notoriously episodes of smog, to demonstrate the corresponding short-term health

effects. Although some of the same scientific problems still applied, the figures often spoke for themselves.

The opposite pole of the adverse event occurred when the 1921 coal strike presented a natural experiment in observing the effects of a dramatic reduction in smoke output. Advocates of alternative, low carbonisation fuels grasped the opportunity to point out that the death rate from respiratory disease in Glasgow during the twelve week period of the strike was half that of the year before.[44] Organised groups of women joined the voices heralding the healthy by-products of the strike, Lady Melville commenting in her pamphlet published by the Women's Printing Society *Choose Ye: Darkness or Light!* that "probably for the first time since coal was generally used, we are enjoying, owing to the coal shortage, a pure atmosphere."[45]

The 1926 Public Health (Smoke Abatement) Act

A combination of the Newton Report, the CIAP observational data, ceaseless campaigning, and a cross-sectoral deputation[iii] to the Minister of Health contributed collectively to the eventual legislative change.[46] Several Smoke Abatement Bills were, in fact, discussed by Parliament between 1922 and 1924. And, given the tone of the Newton Report, it was perhaps not surprising that the 1926 Public Health (Smoke Abatement) Act[47] was, in the minds of many, dreadfully inadequate.

Despite the broad support for significant change, the Act was a watered down hotchpotch of earlier ideas. Even the Newton Report recommendation, included in a 1924 Bill, that heating and cooking arrangements in new private dwelling

[iii] Primarily concerned with the effects of smoke on child health the deputation consisted of representatives from the British Medical Association, Society of Medical Officers of Health, National Association for the Prevention of Infant Mortality, National League for Health, Maternity and Child Welfare, National Health Society, and the National Housing and Town Planning Association.

houses be subject to any constructional by-laws, was rejected by the Minister of Health from the final Act "principally on the grounds that it would be unwise, in view of the national shortage of dwellings, to take any step, which might tend to hinder their erection or which might make them more costly."[48]

In other areas the Act, which also applied to London, made some advances: (i) it was no longer necessary to prove the smoke was black when emitted in such quantities as to be a nuisance; (ii) the definition of smoke was extended to include soot, ash, grit and gritty particles; (iii) it became the duty of local authorities "to enforce the provisions of any Act in force within their own district requiring fireplaces and furnaces to consume their own smoke",[49] and required them to inspect their districts and enforce the nuisance provisions generally, reinforced by granting the Minister of Health power to nominate a county council to take over the task in an authority defaulting on its responsibility; and (iv) the by-law based powers of urban authorities were extended to include "the provision in new buildings, other than private dwelling-houses, of such arrangements for heating and cooking as are calculated to prevent or reduce the emission of smoke."[50]

But, in significant areas the Act was a disappointment. It failed to deal with domestic smoke at all, and Section 1(3) still allowed the same loophole for the industrial offender – in any proceedings against a smoke other than black – through the 'best practicable means' defence:

> "... it shall be a defence for the person charged to show that he has used the *best practicable means* [my italics] for preventing the nuisance, having regard to the cost and to local conditions and circumstances, and for the purposes of this subsection, the expression *best practicable means* [my italics] has reference not only to the provision and efficient maintenance of adequate and proper plant for preventing the creation and emission of smoke, but also to the manner in which such plant is used."[51]

Two additional, albeit less significant, points of the new Act rankled with anti-smoke campaigners.[25] First, although fines were increased they still fell well short of their expectations. For example, the maximum penalty that could be imposed

on persons against whom an abatement order was made went up from £5 under the 1875 Act to £50 – a ten-fold rise but too low to act as a deterrent, and far less than the cost of replacement combustion machinery. And, second, more industrial processes were *added* to those excluded from the law: reheating, annealing, hardening, forging, converting and carburising iron, as well as any other process specified by the Minister of Health in a provisional order.[52] So the new law was deemed to be largely ineffectual, an instrument to procrastinate the introduction of policy that would create real change.

Other effects of smoke pollution

In 1929 the National Smoke Abatement Society (NSAS) was formed by a merger of the Coal Smoke Abatement Society and the Smoke Abatement League.[53] Through the 1930s the NSAS, along with other campaigners working to reduce smoke pollution, drew on speculative or presumptive health effects, and increasingly the effects of smoke pollution on other aspects of human, animal and vegetable life. Linked to this, what scientific research there was continued efforts to break down smoke-polluted air into constituent components – essentially particles, gases and elements emitted from the imperfect combustion of raw bituminous coal – to which these adverse effects could putatively be attributed. [54] [55] [56]

With regard to humans, the Medical Research Council set up in 1935 a Committee on Pulmonary Disease, which looked initially at the methods for estimating the dust content in air samples. Although focusing mainly on diseases affecting industrial workers, of relevance to general smoke pollution was that the committee found that 80 to 90% of particles inhaled by stonemasons – of whom silicosis was reported to cause more than 300 deaths per year – were less than two micrometers in diameter, and recommended that stonemasons wear respirators on calm days and preferably worked the stone wet.[57]

Elsewhere, speculative evidence was building; carbon monoxide from domestic smoke in living rooms had been labelled as causing morning headaches, shortness of breath and lassitude, as well as predisposing to pulmonary tuberculosis;[58] polluted air, through its impact on grass, was blamed for poor quality cow's milk, which in turn was postulated by the National Baby Week Council to affect child health: and the lungs of city-dwellers were shown to be pathologically similar to those of coal-miners,[iv] with Taylor suggesting smoke as the cause and adverse mortality as the outcome. He supported his case by showing that the 1928 infant mortality rate[v] for rural districts in England was far lower than that for county boroughs (55.5 Vs 74.4), and the infant mortality rate due to pneumonia and bronchitis showed a similar difference (8.8 Vs 16.27). [59] Lack of the sun's ultra-violet light was also felt to cause rickets and Taylor, among others, believed the gloom to have serious psychological sequelae and a strongly negative impact on quality of life.[60]

However, the oft-quoted and widely presumed health effects failed to advance policy. So attempts were made to cost out the damage done by smoke, especially to buildings and household contents such as curtains. In 1920 the Manchester Public Health Committee had calculated the extra cost incurred in cleaning materials (soap, starch, fuel) as 7.5d per week for lower rental households, higher costs in higher rental households, with a conservative total estimate of £242,705 per annum.[60] By 1929 soot deposits were calculated to cost the nation £80 million per year,[44] and *The Times* reported in 1939 that the newly formed London Advisory Council for Smoke Abatement had calculated that, in addition to the centre of London receiving half the winter sunshine of nearby Kew, the annual 240 tons of soot deposited in each square mile cost the London County Council approximately £4m per year. [61]

[iv] This was coined 'townsman's lung'.

[v] The infant mortality rate, an important public health indicator, is the number of deaths under one year of age per one thousand live births.

But while costs of cleaning could always be viewed as unfortunate yet absorbable by-products of economic progress, there was some concern about the effects of poor visibility on flying. Work was being carried out by the Meteorological Office Air Ministry on the conditions and mechanisms of bad visibility,[62] and the Aviation Services Division of the same office showed that poor visibility increased markedly around aerodromes situated near large cities and industrial centres such as Croydon, Castle.Bromwich (near Birmingham), Manchester, and Alexandra Park where visibility was less than 2000 yards one day out of two.[63]

As the second world war approached little had really changed in air pollution policy. A realisation of the rising contribution made by motor vehicles to pollution and ill health[55] had led to new legislation on the construction and equipment in motor vehicles,[64] but the 1936 Public Health Act failed to do more than re-enact existing smoke legislation without any real material change.[65] Industries continued to pollute without much of a legal reason not to, and domestic coal use carried on unrestricted, change being determined purely by affordability and personal inclination. Some smokeless housing estates were beginning to appear, but many new buildings were still being built to accommodate coal.[66 67]

Disaster, reductionism and personal responsibility: air pollution policy and public health, 1939-1970

Post-war decline and resurgence

Production demands during the second world war meant an inevitable increase in smoke pollution during that period. Industrial requirements continued after the war as a nation attempted to rebuild itself, bolstered by the community spirit that fostered regeneration needs over less immediate issues such as cleaner skies. But it did not take long for atmospheric concerns to regain momentum after the war.

In 1946 the awaited Report of the Fuel and Power Advisory Council *Domestic Fuel Policy* (also known as the Simon Report) was published, which brought back to the forefront the urgent need for attention to the smoke problem. Stressing that the moulding of public opinion was essential, the report recommended that any new town should be smokeless, and advocated by-laws necessitating prior approval (through certification) of new fuel-burning plants as well as their efficient maintenance. The report also encouraged production of improved heating appliances (including domestic), as well as the introduction of minimum standards for such appliances, and advocated the need for adequate supplies of smokeless fuels at reasonable prices.[68] [69]

Following from this report, the second half of the 1940s saw the creation of new sets of powers – in the form of local legislation – to tackle pollution in a variety of ways. These powers are especially significant, because of the historical tendency to emphasise the 1952 'great smog' in London as the catalyst of substantial change, the turning-point in the battle against smoke pollution. Although that episode was undoubtedly important (as were the legal changes it engendered), what had been initiated beforehand is often overlooked in favour of stressing a dramatic incident, especially one with such a critical health component.

Local authorities in industrial parts of the country began to press forward after the war by creating by-laws. Sometimes, prior legislation was needed to allow for new by-laws. For example, the City of London Act, 1946 extended provisions under the 1936 Public Health Act to make by-laws requiring that heating arrangements in new buildings, or substantial heating alterations in existing buildings, must include calculations that "... prevent or reduce to a minimum the emission of visible smoke."[70]

The by-laws often had several components and attempted to grapple with pollution from different angles. Stringent local regulations, for example, were placed on the production of industrial smoke. An act passed in Birmingham in

1948 stipulated that no person "... shall install in any building ... any furnace for steam raising or for any manufacturing or trade purpose unless such furnace is *so far as practicable* [my italics] capable of being operated continuously without emitting smoke."[71] Similar measures were enforced elsewhere, sometimes alongside new efforts to overcome the problem of (the distribution of) industrial smoke by stipulation of the minimum height of industrial chimneys.

This particular preventive initiative captures another enduring problem around measuring, and understanding, the health effects of air pollution – it is the nature of inhaled (ground level) air that is most significant from the clinical epidemiological perspective, rather than smoke *output* in a region, or even atmospheric concentrations (neither of which may truly reflect what an individual actually breathes in). Nevertheless, it makes intuitive sense that getting the dirty smoke away from humans, higher into the skies, will *likely* be beneficial and, as an example, a by-law was drawn up in Dudley in 1947 which specified that every chimney erected in the borough "... be raised to such height measured from the level of the centre of the street nearest thereto as the Corporation shall reasonably require having regard to the use of such chimney the position of houses or other buildings near..."[72] Similar regulations about chimney height were enacted in other towns.

Of all the new by-laws the most significant class, however, contained those that involved the creation of areas in which smoke production was prohibited. Although often held up as the much vaunted outcome of the 1952 great smog and ensuing Clean Air Act, such areas were already being set up in a number of cities around the country. For example, the Manchester Corporation Act of 1946 stated that "no smoke shall be emitted from any premises in the central area ...", demarcating that zone as "bounded by the following highways or streets that is to say St. Mary's Gate Market Street, Piccadilly, Portland Street, Oxford Street, Peter Street and Deansgate." The by-law continued that smoke included soot ash, grit and gritty particles, and the occupier of emitting premises would be liable to

"a penalty not exceeding ten pounds and to a daily penalty not exceeding five pounds."[73] A similar smokeless zone was established in Crewe in 1949.[74]

The post-war period has additional pertinence as in 1948 the National Health Service (NHS) was established, with important implications for public health. These are looked at further in the next chapter, but it is worth noting here that public health was moved to local authorities, losing its role in the management of municipal hospitals (which essentially became State-run NHS hospitals), and being somewhat marginalised with the provision of community clinics.[vi] Although involvement in environmental health matters continued, these changes heralded the start of what some have considered the decline of public health, or at least the diminishing of its status.

Still, in 1951, air pollution did not seem high on the government's agenda. When the matter was raised in Parliament of whether enough was being done around smoke pollution, loss of sunshine and use of smokeless fuels, a respondent for the Ministry of Local Government and Planning commented that the Public Health Act, 1936 provided legal machinery, that smokeless zones were appearing, and that there should be less domestic pollution on newly built housing estates.[75] But all was about to change.

The straw that broke the camel's back – the great smog of 1952

There is no doubt that the awful smog[vii] that occurred in London in the winter of 1952 was memorable for those that experienced it, and was important for its

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[vi] The running of community clinics was intended to come under the remit of newly created general practitioners, but in practice this only happened to a small degree.

[vii] A smog typically refers to an episode of particularly heavy 'smoke and fog'. Under certain atmospheric conditions known as a temperature inversion (a motionless shallow ground-level layer of cold air with warmer air above), fog, smoke, or smog cannot rise above the boundary or ceiling between the air masses and becomes trapped and concentrated. Smoke production from fires lit for heat, and from coal burning for additional electric lighting, compounds matters further.

deleterious effects on human (and also animal) morbidity and mortality as well as causing huge physical damage. Yet its central policy significance was probably more as the spark for change. After all, noteworthy legal changes were already in process as described earlier, and the price of alternative, smokeless, fuels had already begun to fall. And it was certainly not a stand-alone event.

There had been a number of documented severe fogs or smogs in the previous decades in British cities and overseas. For example, 60 people died in an episode in the Meuse Valley in Belgium in 1930, and at Donora, Pennsylvania, 20 people died and 7000 were ill during a fog in 1948.[76] And there had been at least four previous notable London fogs or smogs. In 1873 a 3-day episode in December was associated with a 1.4-fold increase in mortality in the week of the fog compared to deaths in the previous week (mortality ratio of 1.4); a 4-day episode in 1880 had a mortality ratio of 1.5; and a 3-day episode in 1892 had a ratio of 1.3. And only four years before the great smog a record (in duration) 6-day episode affected London and much of the country and was associated with a mortality ratio of 1.3.[77]

The 1952 episode caused by far the largest increase in deaths, a mortality ratio of 2.6, but the misery of the experience has perhaps also contributed to its longstanding prominence. Although many journal articles provide statistics of the effects of the smog, one of the most evocative descriptions of the happening itself was printed in the *Readers Digest* in 1953, a condensed piece from an article that appeared in *La Croix du Paris* earlier that same year:

> "On the afternoon of Thursday, December 4, 1952 there was nothing to indicate that this would be the Fog of the Century – that it would kill about 4,000 people, cause property damage of many thousands of pounds and bring the activities of the great metropolis almost to a halt.
>
> By Friday morning a heavy, wet blanket had closed down. You could just see your own feet ... As you groped along the pavement, blurred faces without bodies floated past you. Sounds were curiously muffled: motor-car horns, grinding brakes, the alarming cries of pedestrians trying to avoid the traffic and one another. This was a real "pea-souper", a "London particular" ...

At London airport a few planes made instrument landings. One pilot, after landing, got lost trying to taxi to the terminal. After an hour a search party went out to look for him. But it too got lost. Soon all air traffic was suspended.

As the day went on, the fog changed colour. In the early morning it had been a dirty white. When a million chimneys began to pour coal smoke into the air it became light brown, dark brown, black. By afternoon all London was coughing.

On Saturday morning thousands of Londoners began to be frightened. They were those people, mostly over 50, who had a tendency to bronchitis or asthma. In a long black fog such people are in acute distress. Their lungs burn, their hearts labour, they gasp for breath. They feel as if they are choking to death – and sometimes they do.

By Saturday noon all the doctors were on the run. But there wasn't much to suggest – except to try to get to an oxygen tent. All hospitals were overworked ...

Police patrolled the docks in life jackets because people who couldn't see the ground walked into the water; a policeman at the Albert Docks pulled out eight. But too often the victims, though their cries were heard, couldn't be found ...

On Sunday morning the fog was thicker than ever. At times visibility got down to 11 inches: literally you couldn't see your hand held out in front of your face ...

It was cold that day. On the outskirts of town men and women, lost in the murk, sat down – and later were found dead of exposure ...

Towards noon on Monday the fog lifted a little, then came down again. Then it rose a little more. Finally it was gone.

Londoners rubbed the soot out of their eyes and saw a city covered with dirt. Every piece of furniture had a slimy, black film. Curtains were so encrusted with soot that when they were cleaned they went to pieces. Blonde women became brunettes. It was weeks before the hairdressers and laundries and cleaners caught up with their work."[78]

The great smog was clearly an awful event. Statistical analyses attempted to quantify the mortality, and sometimes the morbidity, attributable to the episode. The Chief Medical Statistician WPD Logan reported in the *Lancet* that there were at least 4000 deaths during the two weeks following the start of the episode. Deaths assigned to bronchitis and pneumonia increased 8-fold and 3-fold respectively in one week, and the overall mortality ratio of 2.6 showed most additional death to be in the older age groups, although some was in the very young: a ratio of 2.7 in those aged 75 and over; of 2.8 in those aged 45-64 and 65-

74; of 1.8 in babies under 4 weeks old; and of 2.2 in infants aged 4 weeks to one year.[79]

The speed of increase of deaths was astounding, rising markedly on the first day of the smog, December 5th, peaking on December 7th and 8th. Most deaths, as per previous episodes, were assigned to bronchitis and pneumonia, but increases were also seen in lung cancer, coronary disease, myocardial degeneration, and other respiratory diseases. The *BMJ* reported that the total deaths were more than double that of the two weeks before the smog, and more than treble that for the corresponding period in 1951.[80] These deaths were felt to be additional, rather than simply brought forward.[81] Emergency hospital admissions for general acute cases rose in parallel over the period.[82] In addition to the damage to human health there were substantial material costs from accidents and filth, as well as economic costs such as production losses. And in addition to these were the costs of injury to livestock, other animals, plants and vegetation.

What the great smog appeared to be was something akin to the straw that broke the camel's back. Episodes of severe smog were not uncommon, but people seem to have finally had enough, and were genuinely scared by the event. This was accompanied by an apparent disbelief that nothing could really be done to attenuate the pollution problem, especially given the public's awareness of the growing availability of alternative fuels to coal; all this in the waning, but still present, post-war spirit of a fresh start and the opportunity to collectively rebuild.

The Clean Air Acts, politics and policy

Pressed by campaigners and the vociferous public response to the great smog, the government reacted in not atypical fashion by setting up a committee, under the chairmanship of Sir Hugh Beaver, to examine the national problem of smoke pollution – origins, causes, health and other impacts – and to make recommendations and provide policy options. The setting up of an expert

committee to look at smoke pollution has been a regular political strategy for hundreds of years and Harold MacMillan (then Minister of Housing and Local Government) was, initially at least, derisory and dismissive of the problems associated with smoke pollution.

MacMillan believed such problems to be both a matter outside the scope of governmental responsibility (domestic pollution was about personal behaviour) and also an inevitable consequence of economic development, which was essentially desired and in the overall public interest. In a memorandum to the government in late 1953 McMillan wrote:

> "Today everybody expects the government to solve every problem. It is a symptom of the Welfare State ... For some reason or another 'smog' has captured the imagination of the press and the people ... Ridiculous as it appears at first sight I would suggest that we form a committee. We cannot do very much, but we can seem to be very busy – and that is half the battle nowadays."[83]

The Beaver Committee, as it became known, was perhaps different to its predecessors. The chairman was a highly respected individual, which gave the committee crucial credibility and, along with the other committee members, worked tirelessly in gathering information. But, perhaps critically, Sir Hugh Beaver was also passionate about the subject.

Set up in the summer of 1953 the Beaver Committee met frequently and took expert depositions. As well as looking at the historical, meteorological, epidemiological and economic evidence, the committee made trips overseas to compare and contrast the experiences of other countries. In 1954 the committee published its findings, which came to be known as the Beaver report. The report was honest and tough on the problem of smoke pollution, documenting methodically the causes and consequences, and urging the need for intervention and change. The findings were broad, for instance including an estimation that cleaning and depreciation of buildings (other than houses) cost about £20million

per annum, extra painting and decorating £30million, and corrosion of metals £25million.

The committee made a number of recommendations [Table 2.2, p113]. The most significant of these were: (i) prohibition of the emission of dark smoke (defined as darker than shade 2 on the Ringlemann Chart (i.e. 40% black), including for the first time domestic fireplaces; (ii) local authorities to be empowered to make orders to establish smokeless zones and smoke-control areas; (iii) obligatory arrangements to arrest dust and grit for certain industrial plant; (iv) the Alkali Inspectorate to be responsible for industrial premises with special technical difficulties around pollution control; (v) financial assistance for conversion to smokeless fuel use; (vi) domestic heating appliances in new premises to be of approved types; and (vii) the establishment of the Clean Air Council to co-ordinate and encourage research, and review progress made in implementing any legislation.[84]

The groundswell of public opinion meant the findings of the report had to be taken seriously. This was reinforced when a private member's Bill, introduced by Gerald Nabarro MP, was withdrawn after debate clarified that the Beaver committee's findings had the general support of the House of Commons, and a comprehensive government measure was promised.[85]

The first draft of this measure appeared in July 1955 as the Clean Air Bill. However, the Bill had an extended parliamentary stay, with numerous drafts and alterations along its chequered path to legislation.[86] By the time the Bill was enacted as the Clean Air Act, some important elements had been either removed or significantly tailored. The main differences were:

- that smokeless zones were abandoned in favour of the less stringent concept of smoke control areas, in which emission of chimney smoke would constitute an offence, and smokeless fuels must be burnt unless fuels capable of emitting smoke could be burnt smokelessly;

- that there was no provision in the Act requiring domestic heating appliances in new buildings to be of approved types;
- that the Act would not apply to industrial premises covered by the Alkali Inspectorate;
- omission of the Beaver committee's recommendation that the Government Loan Scheme for fuel-saving projects be extended to include projects specifically directed to secure the reduction of air pollution;
- omission of the Beaver committee's recommendation that purchase tax on gas and electric heaters be abolished;
- that in planned smoke control areas any owner or occupier incurring expenditure on adaptation or replacement of fireplace or chimney would be entitled to repayment of 70% of the cost by the local authority (who could themselves recover 40% of the total cost from the Exchequer and could also repay the whole or part of the remainder). The owner was therefore left with paying up to a maximum of 30% of the cost.[87]

Finally passed in 1956 the Clean Air Act still promised much, but it would take time to deliver.[88] As has been outlined above the main contentions were that, although offering improvement in industrial smoke output, the Act still left domestic pollution both unchecked and in the hands of local authorities and those who elected them – individual citizens. Given that the domestic chimney was felt to contribute almost half of atmospheric pollution, many lamented this abrogation of responsibility; and there was no specific attention paid to increasing availability of smokeless fuels at a reasonable price.

Smoke control areas were a very watered down version of smokeless zones. It was likely that the impact of legislation that was clearly prohibitive, would be significantly less than the impact of legislation that promised to do the best it could. Only chimney emissions were under the new remit, and burning of garden fires and industrial waste in the open were both allowed.[89] Penalties would be

fines (maximum of £10 a day), incurred at the discretion of the local authority. A memorandum on the subject clarified the matter:[90]

The Act was, perhaps, a reflection of the huge swing that would gain pace in the 1960s towards personal responsibility, for both lifestyle choices (such as around sexual freedom with development of the contraceptive pill) and also for matters related to health. In the smoke pollution domain, the onus moved squarely onto individuals to make the domestic changes recommended in the Clean Air Act, although the changes became easier with support of local authority grants and the falling prices of smokeless fuels. This will be revisited in the next section.

Progress was slow but steady through the late 1950s as specific elements of the Clean Air Act began to be implemented and the general ramifications filtered through. A questionnaire review of local authorities undertaken by the National Society for Clean Air[viii] in 1960 showed that prevention of smoke from industrial processes was improving with the better fuel efficiency and new techniques, that industrial contraventions were being reported, and that many plans for chimney heights had been submitted. In that year there were 157 smoke control areas in operation, with another 587 orders confirmed or submitted, compared with the 44 smokeless zones that existed in 1956.[91]

The government issued circulars in 1962 asking local authorities to speed up their smoke-control programmes, and reiterated that arrangements had been put in place to substitute smokeless fuel or cash payments for coal, to alleviate the monetary concerns of those receiving coal at concessionary rates from the National Coal Board.[92] [93] And that same year a White Paper on cleaner air, *Smoke Control*, was produced. Some local authorities, however, still did not envisage completing their smoke control programmes until the mid-1970s.

[viii] In 1957 the National Smoke Abatement Society voted to become a company, without share capital, with the new name of the National Society for Clean Air.

The Clean Air Act 1968 extended the 1956 Act, making it an offence to emit dark smoke from industrial or trade premises (emission of dark smoke from chimneys was covered in the earlier Act), and amended the requirement for certain kinds of industrial furnace to be fitted with grit and dust arrestment plant approved by the local authority.[94] By 1970 London had not had a smog in eight years, and many suspected would not have another one.

Economics, smoke and smokeless fuels

Although the great smog might have galvanised policy change, it only worked because the changes it engendered took place in the context of already levelling coal consumption and smoke production, and the increasing availability of alternative fuels. It was a blip on the improvement curve, really propelled forward in the 1960s by issues of economics and personal behaviour.

As shown in the accompanying table, coal production rose dramatically with increasing population size and changing industrial patterns from around 1700 onwards [Table 2.3, p114]. Coal output (coal produced for national use and for export) rose from 10-15million tons/annum in England in 1800 to 287m tons/annum in 1913, before falling somewhat with the advent of the first world war. By the outbreak of the second world war 180m tons/annum were being consumed nationally, 28% of which were for domestic (home) use. In 1953, after the great smog but prior to the Clean Air Act, total coal consumption had levelled off to just over 200m tons/annum, the domestic contribution of which had fallen to around 36m tons/annum (18%). It was not really until the mid-1960s that total consumption began to fall more substantially, with the domestic contribution falling proportionally at slightly greater speed than the industrial component.

Of particular importance to atmospheric pollution, however, is the smoke produced from the coal consumed. And here the proportional contribution from domestic smoke is key. As Table 2.3 shows, although domestic coal consumption

through the 1940s, 50s and 60s made up only 15-20% of the total coal consumed, this domestic use consistently contributed 45-65% of total atmospheric smoke pollution. By the late 1960s this proportion had risen, despite a fall in total smoke production. The enduring apparent mismatch arose because of the type and quality of the coal used (for instance, whether it was cleaned first), and the nature of the coal-burning apparatus – the domestic fire.

So domestic fires were highly significant to the Beaver Committee's estimated £250million of damage caused by smoke pollution – felt to be a conservative approximation.[95] But the sources and availability of home energy had been changing. Domestic oil and gas use increased 50% between 1938 and 1956, with the rise in solid smokeless fuels only slightly less. Domestic electricity use in that period, however, went up almost four-fold. Between 1956 and the mid-1960s, domestic smokeless fuel consumption rose a further 50%, oil consumption a further 150%, and electricity use doubled again.[96] [97]

The government was keeping a careful eye on the situation, the main concern being that demand for alternative fuels to coal might outstrip supply, with costs checked by an open competitive market. A 1960 report from the Committee on Solid and Smokeless Fuels reported that sales of specially reactive fuels for unimproved open grates (basic domestic fires) increased from 735,000 tons in 1958 to 910,000 in 1959, and were set to top 1m tons in 1960. For improved open grates the committee was confident that the gas industry could make available the additional required gas coke.[98]

A circular in 1963 pointed to evidence that householders were increasingly changing to gas, electricity and oil, largely because "... recent price trends and the development of new appliances have resulted in these fuels becoming increasingly competitive in running costs with the solid open fire fuels."[99] This picture of transition was reflected in the White Paper *Domestic Fuel Supplies and the Clean Air Policy*, supplemented by concern that further rising demand might, by 1970, result in a shortfall of supply.[100] But this shortfall did not arise, as producers

responded by widening consumer choice with more varieties of solid smokeless fuels, as well as further availability of gas coke, gas, oil and electricity.[101] The Consumer Advisory Council helped people make their choices.[102]

Epidemiology, health and personal behaviour

Significant social changes occurred during the late 1950s, 1960s and 1970s, changes profoundly inter-linked with the issues of smoke production and smoke pollution. These included, in particular, the growing emphasis on personal responsibility around issues of lifestyle and health, and in health care the continued orientation towards chronic diseases, especially cancer. While these two came together around the personal preventive orientation of health promotion, the changes also set the tone for later developments towards the end of the century that emphasised the importance of health services in improving health (rather than say environmental or economic improvement), and individuals' rights in relation to provision of those services.

During the 1950s, as Doll and others demonstrated the causal association between tobacco use and lung cancer[103] [104], epidemiological research also progressed in demonstrating the association between atmospheric pollution and other forms of chronic lung disease. In a classic article of 1959,[105] reprinted in 1997,[106] Fairbain and Reid investigated whether there was an association between morbidity and smoke pollution. What made their study innovative was the use of sickness absence records of an occupational cohort, the British Civil Service, as the measure of morbidity (in addition to the usual mortality data) and the use of a Fog Index[ix] as an indicator of exposure. They found total sickness to be significantly associated with fog and population density, and bronchitis wastage[x] to be

[ix] The Fog Index measured visibility, as a proxy for atmospheric pollutant concentrations.
[x] The bronchitis wastage score took account of total sickness rates of postmen, place of work, deaths, retirements, and population of postmen in an area.

significantly associated with fog. Bronchitis mortality was also highly significantly associated with fog in both sexes.

The international nature of the problem interested the World Health Organization (WHO), whose Expert Committee on Environmental Sanitation produced a summary account of air pollution in 1958 as part of its technical report series. This stated that, despite much epidemiological work, current knowledge on specific pollutants remained insufficient to establish standards.[107] Under the auspices of the WHO just a few years later, EC Halliday produced a historical review in 1961 that stated, somewhat heavily, that at the turn of the twentieth century almost everything known six decades later about the causes of smoke and their elimination had been said, but still hardly anything had been done. He lamented the repetition of experiments and observations, and the huge waste of research effort.[108]

Perhaps surprised by Halliday's lambaste, the WHO produced a less controversial summary document in 1962, *Epidemiology of Air Pollution*, and a further report in 1964,[109] both of which acknowledged the evidence that air pollution causes health problems, but reminded of the lack of knowledge of which elements in polluted air – apart from smoke and sulphur dioxide – were responsible.[110] The situation was not dramatically different at the middle[111] or end of that decade, with a report of a special committee of the Royal College of Physicians of London highlighting the known correlation between levels of certain pollutants in air and mortality from bronchitis, but having nothing especially new to add.[112]

The measurement of atmospheric pollution through monitoring networks co-ordinated by the Department of Scientific and Industrial Research[xi] had fostered

[xi] In 1927 the Advisory Committee on Atmospheric Pollution transferred from the Meteorological Office to the Department for Scientific and Industrial Research (DSIR). In 1945, the Atmospheric Pollution Research Committee was reconstituted as a Committee of the Fuel Research Board of the DSIR. Work on atmospheric pollution at the DSIR, including the monitoring networks, involved close co-operation with the Meteorological Office, Ministry of Housing and Local Government, Ministry of Fuel and Power, Ministry of Health, Medical Research Council, and of course the local authorities.

development of such epidemiological work. And monitoring also showed that atmospheric pollution levels were generally falling.[113]

Scientific understanding grew, however, in a climate of changing stress on personal responsibility. The 1960s in particular saw a shift from environmentalism to an emphasis on personal prevention in relation to health. If smoking was responsible for cancer, it was up to the individual to stop, and efforts could be made to facilitate that process. It was also, paradoxically, a person's right to participate in activities deleterious to one's own health should the individual so desire – as the following decade more strongly affirmed.

Similarly, if smoke pollution was bad for health, the individual should do what she can to keep healthy and to avoid harming others. This of course meant people needed to be made aware, and health workers needed to be more involved. It was therefore no surprise to find the Minister of Housing and Local Government, Dr C Hill, stressing in 1962 that there were plenty of good reasons for cleaning up the air, including 30,000 chronic bronchitis deaths a year and 20 million working days lost, but speeding up improvements meant individuals needed to be better informed and localities needed to start acting appropriately:

> "We can and must get rid of the filthy smoke blanket which shrouds our big towns ... That means the local authorities must make smoke control orders under the Clean Air Act, and that the man in the street ... must stop sending smoke up his castle chimney. Success in cleaning ... will not be achieved without the co-operation and support of the householders ... and ... housewives ... but they will not give their support unless they know that smoke is bad for them, and that smoke control will bring them better health, cleaner towns, cleaner homes, and less drudgery."[114]

So the general practitioner was called upon to foster enlightened public opinion by explaining the ill-effects on health of atmospheric pollution, and by dispelling misconceived ideas about various forms of domestic heating.[115] And in 1965 the British Medical Association produced a 'Family Doctor Special' called *Clean Air*,[116] which covered the health effects of pollution, and what can be done about it in the home – fuel options, grants, ventilation, insulation and safety. The public

could only be enlightened if the general practitioner was armed and equipped with all the relevant information.

Conclusions

The relationship between air and public health in this case study looks rather different to that presented in the previous chapter. The harmonious orientation of mankind and nature, with its holistic and sometimes spiritual dimension, disappeared with the earlier civilisations. As the industrial revolution progressed, polluted air was associated with infectious diseases according to miasmatic theory. But advances in medical science in the late nineteenth century, and acceptance of the germ theory of disease, led to a de-emphasis of the place of the environment in relation to health. Air became associated with 'seeing' the more direct ill-health effects as those visible in the atmosphere as smoke pollution.

Smoke pollution came to symbolise concerns about the atmosphere, but alleviation of smoke pollution was not politically palatable while industrial development was paramount. Legislation to reduce air pollution levels and attenuate the adverse effects on health has generally either failed to appear or failed to deliver. The story of procrastination and undelivered promises has continued despite the relentless campaigning of pressure groups and, in the first half of the twentieth century, by public health professionals.

Developments in air pollution policy have mainly been dictated by economics and politics. Reducing pollution costs money and requires lifestyle changes generally felt to be politically unpalatable. Eventually, a mixture of concerns about visibility, aesthetics and washing, falling prices of alternative fuels to coal, market competition, and a public tired of choking smogs and willing to take more responsibility, combined to turn the tide.

At the mid-1970s the epidemiological understanding of the effects of air pollution on human health had progressed, albeit to a limited degree. Infants, children, the elderly, certain occupational groups and those with pre-existing respiratory or cardio-vascular disease had been shown to be most susceptible to air pollutants, particularly in acute pollution episodes. But this had been observed for a long time.

The extent to which polluted air causes long-term ill health, however, remained more difficult to quantify and more poorly understood. To grapple with this, polluted air has been gradually re-conceptualised as its constituent air pollutant components, and air pollution epidemiology has correspondingly tended towards reductionism in exposure and outcome measurement.

Table 2.1 Overview of smoke and air pollution legislation in England, 1273-1968

Date	Legislation	Details
1273	Ordinance	Ordinance prohibiting use of coal in London as being prejudicial to health.
1306	Royal Proclamation	Issued by Edward I forbidding the use of coal by artificers, who were to return to charcoal.
1388	English Sanitary Act	First English Sanitary Act, dealt with offal and slaughter-houses, and prohibited casting of animal filth and refuse into rivers or ditches, and corrupting of the air.
1467	Local law	Law passed in Yorkshire forbidding the building of any more kilns because of the stink and badness of the air, and detriment to fruit trees.
1845	Railways Clauses Consolidation Act	Required railway locomotives to consume, as far as practicable, their own smoke.
1847	Town Improvement Clauses Act	Required factory furnaces to consume, as far as practicable, their own smoke.
1853	Smoke Nuisance Abatement (Metropolis) Act	Empowered Home Office to appoint an inspector, working in consultation with metropolitan police, to abate nuisance from the smoke of furnaces in the metropolis and from steam vessels above London Bridge.
1863	Alkali, etc. Works Regulation Act	Empowered appointment of inspectors to inspect air pollution from certain factories.
1875	Public Health Act	Legislated that any fireplace or furnace in trade premises must as far as practicable consume its own smoke, and enabled action to be taken against those responsible for factory chimneys emitting black smoke in sufficient quantity to be a nuisance. The Act did not cover private dwelling-houses and did not apply to London.
1891	Public Health (London) Act	Conferred similar provisions against smoke nuisance to London as contained within 1875 Act.
1907	Public Health (Amendment Act)	Empowered local authorities to make by-laws regarding construction of chimney shafts for furnaces of steam engines and certain factories.
1926	Public Health (Smoke Abatement) Act	No longer necessary to prove smoke was black when emitted in sufficient quantity to be a nuisance; extended definition of smoke to include soot, ash, grit and gritty particles; enabled local authorities to make by-laws to control emission of smoke.
1956	Clean Air Act	Control of smoke emissions from factories; introduction of smoke control areas.
1968	Clean Air Act	Revised the Clean Air Act 1956, and extended it to prohibiting emission of dark smoke from industrial and trade premises.

Table 2.2 The Beaver Report, Clean Air Bill and Clean Air Act: comparison of main areas

Beaver Report (1953)	Clean Air Bill (1955)	Clean Air Act (1956)
❑ *Emission of dark smoke*: prohibited from any chimney including domestic fireplaces (s1). ❑ *Smokeless zones*: local authorities empowered to make orders, subject to confirmation by appropriate Minister. ❑ *Industrial dust and grit*: obligatory plant for arresting dust and grit on certain installations (s6); measurement of grit emission (s7); grit emission should be minimised (s5). ❑ *Special industrial premises*: where special technical difficulties Alkali Inspectorate responsible for ensuring best practicable means for pollution prevention (s17). ❑ *Domestic heating appliances*: installed in new premises should be of approved types. ❑ *Grants*: assistance by local authorities and Exchequer for updating appliances. ❑ *Railways and pit-heaps*: laws need updating; local authorities to enforce. ❑ *Annual report*: on smoke abatement required by local authorities to appropriate Minister. ❑ *Penalties*: for smoke offences increased. ❑ *Clean Air Council*: set up, chaired by Minister of Housing and Local Government, or in Scotland by the Secretary of State.	❑ *Emission of dark smoke*: an offence from any chimney, except as permitted by regulations. ❑ *Smoke control areas*: local authorities enabled to establish smoke control areas, the new title for the old smokeless zones. ❑ *Industrial grit and dust*: new furnaces to be smokeless; local authorities to approve plans and specifications to indicate compliance with this provision. ❑ *Special industrial premises*: the Act will not apply to premises controlled under the Alkali etc. Works Regulation Act, 1906; proceedings cannot be brought without consent of Minister. ❑ *Grants*: for adaptation of fireplaces in private dwellings in planned smoke-control areas. ❑ *Smoke nuisances*: other than from a private dwelling or dark smoke from other building, may be dealt with under the Public Health Acts if a nuisance to local inhabitants. ❑ *Building by-laws*: in future may be required with regard to heating and cooking to prevent as far as practicable the emission of smoke. ❑ *Research and publicity*: gives local authorities powers to promote or assist research, and engage in education and publicity.	**Significant differences:** • Smoke control areas not smokeless zones. • Domestic heating appliances in new premises were not obliged to be of approved type. • The Act would not apply to special premises under the Alkali etc. Works Regulation Act, 1906, and proceedings could not be brought without ministerial consent.

Table 2.3 Trends in coal use, smoke production, and pollutants in England

Year	Coal output [O] / OR consumption [C]			Smoke production		
	Total (million tons / annum)	Domestic million tons / annum (% of total)	Industry million tons / annum (% of total)	Total (million tons / annum)	Domestic million tons / annum (% of total)	Industry million tons / annum (% of total)
1700	3 [O]					
1800	10-15 [O]					
1900	220 [O] 160-70 [C]					
1913	287 [O]					
1925	230 [O]					
1936-38	180 [C]	51 (28%)	129* (72%)	2.3	1.2 (52%)	1.1*(48%)
1948	190 [C]	37 (19%)	153* (81%)	2.0	0.9 (45%)	1.1*(55%)
1952	224 [C]	36.8 (16%)	187.2*(84%)	2.3	1.3 (57%)	1.0*(43%)
1953	205 [C]	36.8 (18%)	168.2*(82%)	2.1	0.9 (43%)	1.2*(57%)
1958	200 [C]	36.0 (18%)	164*(82%)	1.7	1.1 (65%)	0.6*(35%)
1959	221 [C]	33.6 (15%)	187.4*(85%)	1.9	1.2 (63%)	0.7*(37%)
1964	184.7 [C]	27.9 (15%)	156.8*(85%)			
1967	161.7 [C]	23.0 (14%)	138.7*(86%)	0.87	0.75 (86%)	0.12*(14%)

* As well as industrial works this includes railways, collieries, gas works, coke ovens, and electric power stations

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CHAPTER 4

CASE STUDY 3: QUANTITATIVE RISK ASSESSMENT EPIDMEIOLOGICAL RESEARCH – PHILOSOPHY, POLICY AND PUBLIC HEALTH

Overview of case study 3

This case study covers a period of three decades up to the present day, during which important shifts have occurred in the way air is conceptualised in epidemiology and public health. A piece of epidemiological research using a modern public health technique called quantitative risk assessment (QRA) is initially described. The findings of my QRA have already been published in the journal *Public Health Medicine*[1] and, although it will be necessary to summarise these, the aim of this chapter is instead to use the QRA as a vehicle through which to investigate historical, philosophical, and policy considerations in contemporary public health theory and practice.

This is a historical case study (history of epidemiology, public health and health policy) but has strong inter-disciplinary components (epidemiology, philosophy, ethics). Primary and secondary data sources were used for the non-epidemiological aspects, as described in chapter one, and inter-disciplinary connections are examined.

Background: developments in national and international environmental policy, 1970-1988

As the epidemic shift from acute infectious diseases to chronic diseases in high income populations became established by the second half of the twentieth century,[2] awareness of the damaging aspects of western lifestyles mounted.

Concerns about the impact of industrialisation and urbanisation on the environment grew from around the 1960s,[3] accompanied by a rethinking of humankind's relationship with the natural world,[4] and alongside sometimes radical reappraisals of the role and limitations of scientific medicine.[5 6 7]

In the international policy arena the changing social climate was first reflected at the 1972 United Nations (UN) Environment Conference. World Health Organization (WHO) interest in air pollution impacts and monitoring continued,[8 9] then in 1987 the UN published *Our Common Future*, prepared by the World Commission on Environment and Development, a document that identified several trends in environmental deterioration and also discussed in detail for the first time the now widely used term 'sustainable development'.[10] In 1992 WHO held a Commission on Health and the Environment, the same year as the landmark Earth Summit in Rio de Janeiro, Brazil. At Rio the signing of 'Agenda 21' was significant in stating clearly the need for integration of environmental, economic and social planning at national and international levels.

Within this changing atmosphere it was not surprising to see a reorientation of ideas towards how the physical environment, including air, might affect human well-being. Increase in attention given to environmental health in the UK was evident in the 1992 White Paper *Health of the Nation*, which stressed a "growing acceptance of responsibility for the quality of the environment" as well as "an understanding that the efforts of individuals are as important to the creation of a healthy environment as the actions of the Government."[11] In 1994 the Government's *Sustainable Development* strategy made clear its commitment to environmental protection.[12]

In 1996 the Government (Department of the Environment) published the significant *United Kingdom National Environmental Health Action Plan* (NEHAP). This document defined environmental health as "those aspects of human health, including quality of life, that are determined by physical, biological, social and psychosocial factors in the environment" and refers to the

theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations."[13]

One section of the NEHAP deals specifically with air quality, and informs the reader of the imminent *UK National Air Quality Strategy (NAQS),* which duly arrived in 1997 in part fulfilment of Part IV of the 1995 Environment Act: Local Air Quality Management (LAQM).[14] The NAQS sets out a comprehensive approach to maintaining and improving the quality of ambient outdoor air in the United Kingdom. It sets "health-based air quality standards, air quality objectives which it is intended should be achieved by the end of 2005, and the process by which those objectives will be achieved".[15] Although the NAQS acknowledges the importance of national policies in improving air quality, it places significant responsibilities with local authorities and promises resources to assist.

So, within these national and international contexts, an opportunity existed to undertake a unique piece of practical, service-based public health work, using a modern epidemiological method.

Quantitative risk assessment

The quantitative risk assessment (background methodology, data gathering, process and calculations) will be presented here in outline only, focusing on what is salient to this case study of the thesis. Further details are available in the published journal article[1] or in the report *Air Pollution and Health in Barking and Havering Health Authority*, which is held at the faculty of Public Health library.

Background methodology: time-series studies in epidemiology

QRA was developed initially in relation to environmental cancer risks. It is an applied procedure that uses literature-derived dose-specific risk estimates to predict the health impact of some specified (usually population-based) distribution of exposure to an identifiable factor.[16] In air pollution QRA the risk estimates are predominantly derived from time-series studies so, before looking at the QRA itself, it is necessary to look at the preceding step.

The time-series analysis – or study – is a fairly new epidemiological method designed to assess associations between health indicators such as mortality and levels of air pollution that are not perceived as severe, but fall within existing air quality standards or guidelines.[17 18 19] In other words, time-series studies can look at the health effects of mild diurnal fluctuations in air pollution, rather than focusing on the effects of acute severe episodes such as smogs.

More specifically, time-series studies examine the relationship between an exposure variable – air pollutant(s) – and an outcome variable such as deaths over the same time units (usually days) for a period of usually one or more years.[20 21] The end-product of a time-series analysis is a regression coefficient of the association of one variable with the other. For example, Schwartz found – over an 11-year period in Steubenville, Ohio – that an increase in total daily particulates of 100ug/m^3 was significantly associated with a 4% increase in mortality on the succeeding day.[22]

There have now been many such studies performed in various geographical locations, looking at different air pollutants and different health outcomes. Importantly, it is the pool of these study results that informs quantitative risk assessment (QRA)[23] and a literature review of these studies was undertaken.[i] The review found that the four major outdoor air pollutants – particulate matter, sulphur dioxide, nitrogen oxides, and ozone – are associated with adverse health

[i] The literature review involved a search strategy including on-line databases, publications from specialist centres and Government departments, hand searching of Index Medicus and other key journals, and guidance towards articles from my academic supervisor.

outcomes. Increasing levels of the pollutants are associated with an increase in deaths (from all causes) and an increase in respiratory hospital admissions.

Quantitative risk assessment: the method

There have been several descriptions of methods for air pollution quantitative risk assessment (QRA).[24] I chose to follow, as closely as possible, those described in the 1998 publication by the Department of Health Committee on the Medical Effects of Air Pollution (COMEAP) entitled *Quantification of the Effects of Air Pollution on Health in the United Kingdom*.[25] There are four essential components to QRA:[26]

1. *Identification of a health hazard.* I focused on two health outcomes – deaths (all-cause) and respiratory hospital admissions.
2. *Definition of dose-response relationship.* The same exposure-response (risk) coefficients were used as those worked out by COMEAP.
3. *Estimation of the population's profile of exposure to the health hazard.* I used data from local air pollution monitors when possible, and the nearest available monitor otherwise.
4. *Estimation of aggregate additional health risk attributable to that exposure profile.* I calculated the number of theoretically preventable deaths and respiratory hospital admissions caused by air pollution, as well as the total of those attributable to air pollution.

Quantitative risk assessment: the location and data collected

Barking and Havering Health Authority (BHHA) is situated at the north-east corner of the London region, bordered by the River Thames to the south and

enclosed in an arc from east to west by the health authorities of South-Essex, North Essex, Redbridge and Waltham Forest, and East London and the City.[ii]

BHHA comprises two local authorities: London Borough of Barking & Dagenham (LBBD) and London Borough of Havering (LBH). Located in the south-west part of the health authority the urban and more deprived LBBD is geographically smaller than LBH, has less people, more industry and lower car ownership.

Through liaison with Environmental Health Officers data on air pollutant levels were obtained from records of monitoring equipment owned by the two boroughs. When this was unavailable data from the nearest London monitoring station were used instead. The two health outcomes used in the air pollution QRA were all-cause mortality and respiratory hospital admissions, and data for these were obtained from the Public Health Common Data Set and the Hospital Episode Statistics (HES) respectively.

Quantitative risk assessment: the process and final results

The stages involved in the QRA process (annualization values; calculation; attributable vs. preventable health outcomes; sensitivity analyses) are described in the academic article, with accompanying tables.

Piecing together all the calculations performed provided one final table for the whole health authority, showing deaths and respiratory hospital admissions attributable to air pollution and preventable. Although there were difficulties with data collection in most years, *the final estimates produced by the QRA showed that in BHHA in 1997 there were approximately 180 deaths and 226 respiratory hospital admissions attributable to air pollution, and theoretically preventable.*

[ii] In the restructuring of the NHS in 2001 Barking and Havering Health Authority was dissolved, and Barking Primary Care Trust (PCT) and Havering PCT were created.

Overall, the results of the QRA suggest that existing levels of air pollution have significant effects on mortality and morbidity at the local level.[27] In BHHA – a district with about 385,000 residents – the 180 preventable deaths in 1997 attributable to air pollution made up just over 4% of the total 4,404 deaths for that year. This compares with 44 deaths from breast cancer and 30 deaths from diabetes mellitus in BHHA in 1996.[28] The impact of air pollution will be mostly on individuals with existing chronic respiratory disease, and is likely to be greater in LBBD than in LBH, (inner city; higher population density; higher deprivation; higher concentration of industry; higher smoking rates; higher death rates; and respiratory hospital admission rates) although this disparity was not strikingly evident due to the limitations of available local pollutant data.

Scientific considerations: technical and methodological limitations

Having described the process of the quantitative risk assessment (QRA) undertaken locally, the main part of this case study will explore the meaning and implications of this piece of work and the science that underpins it. The scientific (methodological) issues will summarised only, to allow for discussion of the historical, philosophical and policy issues represented in – or reflected by – the work, and the meaning of these for epidemiological theory and public health practice. The division is used to facilitate discussion, and is not meant to suggest the categories are mutually exclusive or extricable.

The earliest scientific problems along the QRA pathway relate to exposure measurement, and are technical. Despite advances, there remains inconsistency in equipment used and monitoring sites chosen, both of which limit the validity of data obtained.

Next are methodological concerns. Ambient levels of pollutants are actually only proxy measures of true population exposure; the annualization procedure is really

a default option in the absence of more accurate exposure data. Other methodological limitations relate more directly to interpretation of the data. Many of the deaths attributed to air pollution under the algorithm used in this analysis are likely to entail only minor bringing forward in time rather than being "new" deaths (i.e. otherwise unexpected). This effect has been termed 'harvesting'.[29] It is also difficult to separate out the effects of air pollutants. In using single pollutant models there may be double-counting of deaths causing over-estimation of effect. Along similar lines, it is hard to discern whether hospital admissions are repeat events on the same individual or on different people, although this does not necessarily diminish the significance of the event

In contrast to concerns about over-estimation, it could be argued that the impact of air pollution on health is likely to be under-estimated by the QRA because time-series analyses tell us only about the acute effects of increased pollutant levels and tell us nothing about the long-term effects of air pollution on the incidence of chronic diseases.[30] [31] Additionally, the QRA undertaken in BHHA looked only at two health outcomes, whereas the true impact of air pollution is likely to be substantially higher. For instance, very recent evidence highlights the effects of air pollution on individuals with cardiovascular disease.[32]

Epidemiological theory

Having looked firstly at how and why QRA is done, then the methodological limitations of the procedure, it is now necessary to take a step back and examine critically what QRA tells us about the larger picture of epidemiological theory and public health philosophy and practice. Once again, this section is sub-divided for convenience and obvious links exist between the sub-sections.

Historical developments in epidemiology

The quantitative risk assessment (QRA) presented in this chapter has two fundamental components: the time-series epidemiological studies that determine the risk coefficients; and application of these coefficients to enumerate in a given population the impact of the air pollutants. While technological and methodological problems have been looked at in the previous section, to better understand QRA it is necessary to explore how the constituent components fit into the broader picture of developments in epidemiological theory, and changes in the relationship between this theory and public health practice.

Epidemiology is difficult to define, in part because what is considered to be modern epidemiology differs markedly from earlier conceptions. The *Shorter Oxford English Dictionary on Historical Principles* places the first appearance of the word in 1873 and describes epidemiology succinctly as " that branch of medical science which treats of epidemics".[33] However, a well-known classroom epidemiology textbook of today chooses to draw on a "useful and comprehensive" 1970 definition of epidemiology as "the study of the distribution and determinants of disease frequency", to which the phrase "in human populations" is added.[34] And, tellingly, a 1994 edition of the highly regarded *Essential Public Health Medicine*[iii] vaguely limits its definition of epidemiology to "one of the population sciences basic to public health".[35]

What these three varying definitions reveal is both the developmental transitions through which epidemiology has passed, and the confusion over what constitutes epidemiological theory today. As exemplified in the previous chapter, when epidemiology was borne in the late nineteenth century, it was largely a descriptive enterprise. Drawing on demography, and using basic statistics, medical scientists described differences in disease patterns between population groups. The incidence of diseases in communities could be compared classically by area, but also by parameters such as age, sex and occupation.

[iii] This successful book, co-written by the present Chief Medical Officer for the United Kingdom (Prof. Liam Donaldson), has been considered the key textbook for those training in public health for over a decade. The name has recently been changed to *Essential Public Health*.

Based on observed differences in diseases between communities, medical scientists speculated on disease aetiologies. So, for instance, noticing differences between urban and rural communities in rates of respiratory diseases, such as pneumonia, led to the belief that smoke pollution might be responsible. This was reinforced by statistics suggesting rates increased in cities after episodes of smog. In charting broad historical developments in epidemiology Susser and Susser have labelled this period 'the era of sanitary statistics', with its paradigm of miasma and an analytical approach of demonstrating clustering of morbidity and mortality.[36] Like others, as discussed in the previous case study, they link this epidemiological era to the preventive approach (at a population level) of public health of that time, characterised by efforts to better health through improving drainage, sanitation and sewage disposal.

Towards the end of the 19th century germ theory became the dominant paradigm. As the Henle-Koch postulates[iv] were accepted, the scientific community began to search for single agents responsible for specific diseases.[37] This era of infectious disease epidemiology, that lasted well into the twentieth century, focused on laboratory culture from disease sites, experimental transmission of diseases and reproduction of lesions. Prevention of illness centred on interruption of disease transmission through vaccines, isolation of cases, and later antibiotics.[36]

The transition between these two eras, from sanitary statistics to infectious diseases, marked an important turning-point in epidemiology, one that forms the roots of some of the problems in current epidemiological thought. Whereas originally epidemiology was interested in examining the fundamental social and biological factors that could explain population patterns of disease, a reorientation occurred towards investigating specific factors associated with particular diseases. And, in tandem, there was a conceptual shift from thinking about what makes

[iv] Henle-Koch postulates were criteria for assessing the causal relationship of organism to lesion. Robert Koch confirmed conditions put forward some years earlier by Jacob Henle, and acceptance of these marked the birth of medical bacteriology.

populations ill to what makes individuals ill.[38] Within public health a biomedical model of disease was gradually replacing a broadly social model of community ill health.

For western medicine models of human disease aetiology had a certain linear progression in the second half of the twentieth century. As the impact of chronic diseases began to overshadow that of acute infectious disease in western countries, models incorporated the relevance of the host and the environment – in addition to the agent – in disease causation, and later introduced the importance of bio-psychosocial factors. But this backdrop created a state of uncertainty for a population science, and in the 1950s and 1960s epidemiology found itself at something of a crossroads.

One reaction to these developments was 'social medicine', defined by its first professor, John Ryle, in the 1940s as a holistic socio-biology of health and disease, grounded in holistic epistemology and a deep rejection of mechanistic positivism.[39] But epidemiology went in a different direction, one that followed the reductionist leanings of western medicine. From the 1960s onwards epidemiology has increasingly focused on simply examining the relationship, or association, between an 'exposure' and an 'outcome'. Variously termed 'risk factor epidemiology', 'analytical epidemiology' or 'modern epidemiology'[v] all refer to the same academic practice of using epidemiological methods to measure putative associations between ever more specific risk factors to which groups may be exposed, and health outcomes in those groups.[40]

And here it is possible to begin to see how the time-series studies that inform the QRA fit in. Each study is basically an investigation of the relationship between the local atmospheric concentration of specific air pollutants (the exposure) and

[v] Although these terms all refer to the same methodological practice, semantically they can be separated: risk factor epidemiology specifies the notion of risk; analytical epidemiology differentiates from descriptive epidemiology; and modern epidemiology is – not surprisingly – the most recent, but also reflects that contemporary epidemiology *is* this methodological endeavour.

the amount of death or hospital admission for respiratory disease in that locality (the outcome). For the exposure, the pollutant researched has historically been a progressively more reduced version of that previously examined. For instance, originally smoke was investigated, then this became black smoke, then total suspended particulates, then particulates less than 10 microns in diameter, and the latest research indicates that particulates less than 2.5 microns in diameter are those most relevant. To these other specific pollutants – nitrogen dioxide, sulphur dioxide, and ozone – have gradually been added. And the public health response to these studies, such as the National Air Quality Strategy Standards and Objectives (UK), specifies desired levels of these pollutants in the atmosphere.

This present period has been coined the era of chronic disease epidemiology, with its paradigm 'the black box'. Sometimes simply referred to as 'black box epidemiology', the phrase represents a belief in the discipline that what goes on inside the box is of secondary importance to associations found between the factors either side of the box, as illustrated below:[41]

Exposure (e.g. environmental carcinogen, air pollutant)

:

:

BLACK BOX

:

:

Outcome (e.g. cancer, respiratory disease)

Black box epidemiological research is really just risk factor epidemiology with an emphasis on searching for environmental causes of disease, born out of a belief in the 1980s that perhaps 80% of cancers might be caused by environmental factors.[42] Each study analysis in risk factor or black box epidemiology provides a statistical summary, the relative risk (RR) of exposure to outcome. Given that most epidemiological studies measure exposure and outcome on individuals (e.g.

do you smoke, and do you have coronary heart disease?) the RR informs of risk to the individual, and tallies with the individual preventive approach of much modern public health work, for instance through advocating lifestyle change.

The time-series studies informing the QRA, however, measure exposure and outcome repeatedly over time at the population level and the end-product, the risk coefficient, tells something about the risk to a population of any given level of exposure to a pollutant. The low hierarchical place of these 'correlational studies' for advocates of evidence based medicine is looked at later in this chapter, but first it is important to explore some of the conceptual limitations of black box epidemiology and, by extension, of time-series studies and the QRA.

Limitations of modern epidemiology

The major criticism of risk factor or black box epidemiology, and that from which other criticisms stem, is that there is little in the way of theory underpinning it. For at least 30 years there has been a huge effort in improving methodological technique, through more and more sophisticated ways of minimising the possibility that an association found could be explained by errors in data collection or by chance. Technological advances have enabled complex statistical modelling and multi-variate analyses to facilitate this process, and risk factor epidemiology has become a technical exercise obsessed with refining its methods. One commentator reviewed 21 American textbooks and anthologies of epidemiology published between 1970 and the early 1990s, and found discussion of epidemiological theory, and history, to be almost non-existent.[38]

A corollary of the focus on method has been the distancing of epidemiology from activities in the real world that result in improvement to public health.[43] An editor of the *American Journal of Public Health* expresses his fears over the separation as follows:

> "In the absence of a central concern with subject matter, the satisfactions of technical command are held within narrow bounds; in the absence of broader purpose, an arsenal of methods might not necessarily be directed to the benefit of the public health."[44]

The times-series studies, and the QRA itself, certainly reflect this devotion to methodological precision. Most time-series studies involve large datasets, and use complex modelling and statistical analysis to find the 'purest' possible association between an atmospheric pollutant and a health outcome. Therefore, the effects of aspects of the environment that might 'interfere' with the association are adjusted for, such as temperature, climate, seasonality, influenza outbreaks, and smoking. The questionable meaning of controlling out these factors (when in the reality of population exposure they exist) will be returned to later, but now serves to reflect the preoccupation with method.

Attention to method can be partly explained by the ongoing search for risk factors of ever-diminishing importance. The associations between major risk factors, such as smoking, and disease could 'hardly be missed', but with most of these now found researchers have been obliged over the last two or three decades to focus on much smaller associations. These of course require more sophisticated methods to elucidate, and often one study revealing a positive association between a risk factor and health outcome will be countered by another showing a negative association between the same factors. Hence the huge numbers of air pollution time-series studies repeatedly examining the same or very similar associations. There is a limit, some believe, to the status of black box epidemiology posed by the number of erroneous scare stories that arise, and the public toleration of these.[45]

Yet, in spite of all the methodological improvement, technological advances and the repeated studies, risk factor epidemiology often appears not particularly helpful. This is in part, as mentioned earlier, due to its distancing from public

health practice but, connected to this, risk factor epidemiology actually tells us very little about what makes populations ill.

Modern epidemiological research is underscored by biomedical model(s) of what makes individuals sick. Exposures have centred on factors pertaining to individuals, especially lifestyle choices (smoking, alcohol, caffeine, exercise), and outcomes have tended towards that which can be clinically detected, or has a clinical orientation (blood test results, cancer, hospital admissions). And what goes on inside the black box, although of less importance than associations detected, will nevertheless require a pathological basis for medico-scientific acceptance.

Fundamentally, however, what makes individuals sick is not the same as what makes populations sick.[46] It is insufficient, and inappropriate, to hold that the population experience of illness simply reflects the sum of individual experiences. Although time-series studies do measure exposure and outcome at the population level, their design strips away relevant aspects of those population experiences, thereby failing to provide substantial integrated explanations for any association revealed. In doing their best to separate populations from their context, they tell us little about the social, political and economic factors that crucially shape population experience.[47]

In addressing this, Loomis and Wing discuss whether black box epidemiology is today's miasma theory and molecular biology is the contemporary equivalent of germ theory. While black box epidemiology, with its search for environmental determinants, has redirected attention to an environmental theory of disease – and away from starting with clinical endpoints[44] – they lament that it has increasingly taken on the logic and research methods focused on identifying single aetiological agents and quantification of their independent effects. Both black box epidemiology and molecular biology are misguided:

> "The modern incarnations of these theories are centred on agents of disease that are differently conceptualized, but similarly alienated from the ecological framework from which they exist. Neither approach effectively addresses the interdependence of multiple agents or how human populations become exposed and susceptible to them. This failure derives from a view of populations as mere aggregations of individuals (i.e. vehicles for quantifying exposure-disease associations) rather than as organized groups with relational properties that cannot be deduced by measurements on individuals."[48]

Time-series studies divorce the association between exposure and outcome from the context in which a population experiences the association in two related ways. Firstly, the statistical controlling for confounding factors, as mentioned before, removes the effects of factors such as temperature and influenza epidemics. The danger is that "attempting to eliminate the influence of all other causes of diseases – in an attempt to control confounding – strips away the essential historical and social context, as well as the multiple moderating influence that constitute true causation."[49]

Secondly, deliberately excluding social, political and economic factors from the research framework suggests that these factors are irrelevant to a population's experience of atmospheric pollution and the consequences of that exposure. For the time-series air pollution studies the following would therefore not be considered: region/population of high poverty/low social class with correspondingly high smoking rates; region where historically housing provided by the State has been built on cheap land close to industries; low affordability of transport to get to hospital with an exacerbation of chronic respiratory disease.

It makes little sense for a science supposedly interested in what makes populations ill to remove populations in the scientific analyses from the deep-rooted factors that make them ill. But as well as making little sense, such research makes a significant commitment to reductionistic biomedical models of disease:

> "... because control over measurement and extraneous factors is hindered when investigations are embedded in complex social and historical situations, this combination of influences supports the movement of the

> discipline away from engagement with issues of social theory, population biology and human ecology, and towards a more fundamental commitment to biomedical approaches."[50]

Also, as Wing continues, there is an agenda that makes a political statement about the underlying reasons why populations are ill, and the actions that could be taken to improve their health:

> "The choice is not between objective science and a science that is contaminated by social and political values. Risk factor epidemiology does not achieve objectivity by systematically examining exposure-disease associations separated from contexts of military, energy, or agriculture policy, and issues of economic inequalities and democracy. Rather, it makes a political commitment to the status quo by excluding these issues from public health consideration."[51]

So, for QRA, the verdict seems quite damning. What appears to be a reasonable, and scientific, way to assess the impact of atmospheric pollution on a local population may simply reflect the misguided approach of contemporary epidemiology. The time-series studies on which the QRA process is based have deep conceptual flaws, despite ever-improving methodological precision.

Putting the context back into epidemiology

Attempts at philosophical discussion of epidemiological theory have been limited. From the late 1970s to the early 1990s there was quite extensive debate – mainly in the American academic journals – on the philosophical dimensions of scientific enquiry in epidemiology. But this was almost entirely restricted to consideration of causal inference in epidemiology, and the differences between inductive and hypothetico-deductive methods of building knowledge within the discipline.[52] [53] [54]Although some articles lamented the general lack of philosophical debate, what emerged remained strongly within the positivist tradition – for instance sometimes lengthy discussion of what Karl Popper's ideas might offer epidemiology[55] [56] [57] [58] [59] – with only occasional passing reference to alternative views on how science progresses and the social construction of knowledge.

What has slowly appeared in the 1990s, however, is a growing awareness and belief that epidemiology needs to be able to understand populations, their health and disease, as entities embedded in a complex matrix of environmental, social, economic and political processes.[60 61 62] Perhaps the best known attempt to put context back into epidemiology is Krieger's social production of disease model, that "alludes to understanding that patterns of health and disease *among* persons in these groups requires viewing these patterns as the consequence of the social relationships *between* the specified groups, with these relationships expressed through people's everyday living and working conditions, including daily interactions with others [author's italics]."[63] Krieger is concerned that the model excludes human history and origins, thereby discouraging epidemiologists from considering why population patterns of health and disease exist and persist or change over time.

She puts forward instead an 'ecosocial framework', with its image of the continually-constructed scaffolding of society. Here different population epidemiological profiles reflect interlinked and diverse patterns of exposure and susceptibility created by the dynamic connectedness of human existence. She presents a model specifying questions about social structure, cultural norms, ecological milieu, politics, economics, and biology, and directs epidemiologists to think about individuals in the context of their everyday lives, as shaped by their intertwined histories as members of a particular society, and as biological creatures who grow, develop, interact, and age. The ecosocial framework has an evolutionary and sociological dimension, and focuses on broader determinants of health that can only be changed through more widespread social action.

Evidence based medicine and evidence based policy

Having looked at developments in epidemiological theory, it now follows to critically examine some parallel developments in the health policy arena, and how these relate to the QRA.

The time-series epidemiological studies that underpin the QRA aim to increase knowledge about the relationship between an atmospheric pollutant and an aspect of health or health service use. More specifically, the objective of each study is to acquire evidence for or against the hypothesis of that study, for instance that increase in the level of a pollutant studied is associated with increase in an adverse health outcome or greater health service use.[vi] But what is 'evidence', what constitutes good evidence, and why?

To appreciate the place of time-series studies and QRA in contemporary medicine and health policy, it is necessary to explore aspects of these questions. Some of the issues discussed in this section are closely connected to elements of the previous section, and these links will be highlighted.

What is evidence based medicine?

Evidence based medicine has flourished over the last decade or so.[64 65] But despite the exposure evidence based medicine has received, there is still some uncertainty about what evidence based medicine really means.

In 1991, the practice of evidence based medicine was described as involving the following five stage process: (a) formulate for a chosen clinical problem an answerable question, for instance about patient diagnosis, prognosis, therapy or the organisation of services; (b) search the medical literature and other sources for information pertaining to that question i.e. find all available evidence; (c)

[vi] The 'null hypothesis' would be that increase in the level of a pollutant studied is *not* associated with increase in an adverse health outcome or greater health service use.

critically appraise the validity and usefulness of the evidence identified; (d) apply the results by managing the patient accordingly; and (e) evaluate that practice.[66] [67]

As straightforward as this process may sound, five years later an editorial in the *British Medical Journal* attempted to clear up continuing confusion. First-authored by a chief proponent, David Sackett, evidence based medicine was defined as "the conscientious, explicit and judicious use of current 'best' evidence in making decisions about the care of individual patients".[68]

Both the five-stage process and the definition predicate that evidence based medicine is an endeavour to ensure that clinical practice is based on the best available evidence. Underlying this effort is the recognition that a lot of contemporary medical practice (and health policy) is not based on reliable evidence. And this is an important leap, because it is now over thirty years since Archie Cochrane pointed out that the effectiveness of many medical interventions had not been properly evaluated.[69] [70]

Evidence based medicine has placed Cochrane's agenda firmly in the general medical and public domain. It acknowledges that lack of professional consensus about evidence of effectiveness exists for many clinical scenarios and that extensive variation in clinical practice occurs. However, though patients benefit from proven interventions – and are less likely to be subjected to treatments whose benefit has not been properly evaluated – the driving force behind evidence based medicine has undoubtedly been economic.

Now well into Relman's 'era of accountability'[71] policy makers want to know what actually works, and evidence based medicine provides the framework necessary to limit spending and enhance efficiency. As well as the journals, workshops, and research programmes, the UK Government has set up and funded centres of excellence in Reviews and Dissemination at York, Health Technology Assessment at Southampton, and centres for evidence based pharmacotherapy, nursing, medicine, mental health and dentistry. Politicians have placed 'clinical

effectiveness' and the related 'clinical governance' at the forefront of current health policy.[72 73 74]

Limitations of evidence based medicine

With the above outline in mind it is now possible to look at some of the philosophical and ethical limitations of evidence based medicine. The aim is not to describe each in detail, but instead to illustrate the implications and constraints posed by each for air pollution epidemiology.

Hierarchy of evidence

Within evidence based medicine there exists an ordering of scientific research studies. To satisfy the advocates of evidence based medicine a health care intervention needs substantial research proof of its effectiveness, normally repeated in a variety of settings and conditions.

The research study design at the top of the hierarchy is the randomised controlled trial (RCT), perceived as the design most likely to deliver objective, value-free, evidence, through its random allocation of patients to treatment (or placebo) groups. The RCT has been labelled the 'gold standard' of research studies.

Next in the hierarchy comes observational research studies – cohort studies[vii] or case-control studies[viii] – then cross-sectional (or prevalence) studies, and lastly cross-sectional aggregate data studies. Variations on this hierarchy exist, some

[vii] A cohort study follows a group, or cohort, of individuals, and compares the incidence of disease in those members of the cohort exposed to a risk factor with the incidence in those unexposed. Cohort studies are usually time and resource intensive. They are observational since no specific intervention is applied.

[viii] A case-control study finds individuals with a disease (the cases) and compares their exposure to a risk factor with a comparison group of individuals who do not have the disease (the controls). Case-control studies are usually quicker and cheaper than cohort studies, and are also observational.

lists adding qualitative research or peer opinion towards the bottom of the list. For instance, the United States Preventive Services Taskforce rates the value of evidence from RCTs as "grade I", non-RCTs as "grade II" and from opinions of respected authorities as "grade III".[75] The idea, however, remains the same, and most orderings are basically variations on the hierarchy illustrated in Figure 4.1 (p160).

For air pollution epidemiology, the most striking aspect of this list is the place occupied by time-series studies close to the bottom of the hierarchy, meaning they fall into the category of studies valued least by scientific consensus. Time-series studies are a particular kind of cross-sectional study, so-named because data is collected repeatedly over a specified time period. But, crucially, the data is aggregated. It is data collected at the (aggregated) population level, and *not* the individual level. So, for example, in the time-series studies discussed earlier in the chapter, air pollution exposure levels are those measured in a certain region, and there is a level of presumption that individuals are actually exposed to those levels. In reality, of course, some individuals may be working outdoors by the roadside while others stay at home. Statistical methods can help by adjusting, for example, for population density and mobility patterns, but the fact remains that atmospheric pollutant levels are a substitute for more accurate measures of individual exposure.

The same issue exists for the outcome measures. Mortality and hospital admission rates are aggregated at the population level. This means that time-series studies correlate population level exposures with population level outcomes, with no way of being sure that those individuals actually exposed to high pollutant levels are those either dying or being admitted to hospital. These studies have also been called ecological studies,[ix] supposedly to reflect their population level and environmental bent. This is an inappropriate label since the studies share little

[ix] They are also sometimes referred to as correlational studies, as they correlate aggregated data at the population level.

with ecology.[76] But it is also an unfortunate label, as it has associated ecology with 'ecological fallacy', a phrase now commonly, and pejoratively, used to indicate the dangers of drawing inappropriate conclusions about individuals from population-based studies.

> "In fact, they may be among the most difficult study designs from which to obtain valid results pertaining to individual level risks for disease. Mainly this is because we cannot be sure that the individuals who are exposed are the same ones who contract the disease. The cross-sectional aggregate data reflect only an aggregated level of exposure and disease for the group (e.g. averages), whereas a very different relationship may exist between individual exposure and disease. For this reason, we cannot necessarily extrapolate results of cross-sectional aggregate data studies directly to individual risks (i.e., the ecologic fallacy)."[77]

It is because cross-sectional aggregated data studies – such as time-series analyses – do not measure exposures and outcomes on individuals that they are considered the studies of least scientific value, and so placed at the bottom of the hierarchy. The results they provide, the evidence they yield, is continually open to the most obvious, toughest, criticism, and so can be most readily rejected by policy-makers.

And it is here that an important distinction must be made. Rejection because of scientific methodological concerns is one thing, but difficulties in accepting the evidence from time-series studies is shaped by the very nature of contemporary medicine and medical research. As discussed in the previous section, the dominant model in western medicine and epidemiology remains biomedical, centred on the individual, focused on risk factors close to the individual, and geared towards individual level interventions. Research study designs have been determined by this thinking, those favoured being those orientated around individuals and objectivity. And the current drive towards evidence based medicine and clinical effectiveness firmly reinforces the biomedical model, perpetuates the valuing of the individual above communities, and thereby diminishes the importance of the natural environment and human connectedness with it.

The epidemiological research obsession with these downstream, proximate, factors has been coined 'prisoners of the proximate'.[78] While epidemiology stays confined to this cell, time-series and other similar environmental health related studies will remain of low significance because they do not fit into the dominant research paradigm. The challenge is to break free from the shackles, as captured by a chapter in a 2001 book *Ecological Integrity* which addresses the usefulness of epidemiology to determine the links between human health, environmental concerns and ecological integrity:

> "In contrast to this seemingly despondent view of the place of aggregate-type studies in the world currently driven by individual risk factor epidemiology, others have begun searching for a more holistic role for epidemiology to truly address public health concerns."[79]

The positivist nature of evidence based medicine

Defining firm evidence and deciding what constitutes firm evidence is not a straightforward matter, and the narrow paradigm within which scientific medicine operates is responsible for some of the conceptual confusion that lies at the heart of the effectiveness debate. The problem starts with trying to agree on what is exactly meant by firm or reliable evidence.

This seems initially straightforward and most scientists would accept a definition which included the idea of 'weight of objective proof, about which consensus has been reached in the scientific community'.[80] In the earlier parts of the twentieth century the logical positivists argued that the development of knowledge is essentially the accumulation of meaningful statements about the world (either logical propositions or statements based on empirical observation) and that progress in science is dependent on the increasing accumulation of such statements and the development of theories based on them.[81]

By the 1930s, in a seminal work, Ludwig Fleck argued that every scientific concept and theory (including his own ideas on the development of the

Wasserman reaction as a test for syphilis) is culturally conditioned. Fleck advocated a sociological approach to epistemology, focusing on the nature of scientific inquiry itself, rather than its logical structure. He argued that scientific disciplines develop in stages, and that long accepted sets of beliefs (later termed paradigms) are overturned only after intellectual and practical crisis.[82] In the mid-1960s Thomas Kuhn found further evidence of paradigms in science. The existence of such long transitional stages led Kuhn to question the notion that universal standards of rationality guide scientists in their investigations.[83]

Today it is widely (though not universally) accepted that we should not assume the existence of trans-historical or cross-cultural standards by which we can judge the value of scientific knowledge. In other words we should not assume that scientific inquiry is attainably objective. If this is the case then obtaining firm evidence, if defined by scientists as necessarily objective, may not be possible. In *Contingency, Irony and Solidarity* the philosopher Richard Rorty argues that science is just one language among many, each with different ways of describing the world:

> "... since truth is a property of sentences, since sentences are dependent for their existence upon vocabularies, and since vocabularies are made by human beings, so are truths ..."

Rorty is an epistemological relativist (the idea that knowledge claims are relative to their conceptual framework), and for him the notion of an undisputed fact is problematic, as he continues:

> "... the world does not provide us with any criterion of choice between alternative metaphors, that we can only compare languages or metaphors with one another, not with something beyond language called 'fact'."[84]

Of particular relevance to this section is that, if one accepts difficulties with the existence of objective fact, then a simple definition of firm evidence is equally problematic, and the same problems naturally extend to evidence based medicine and clinical effectiveness.[85]

The corollary is that research methods that see the world differently and search for different kinds of evidence are denigrated rather than being understood as alternative metaphors. Qualitative research in particular, but also theoretic evidence, expert evidence, and ethics-based evidence are either found at the bottom of the hierarchy, or not considered to be part of the hierarchy at all.[86 87 88 89]

So, the effect for air pollution epidemiology is something akin to a double-whammy. Within the hierarchy of scientific evidence it finds itself low down, and its position is further compromised by the impact of evidence based medicine on entrenching the perspective that the foundations of scientific medical practice are attainably objective.

Air pollution epidemiology as middle ground

Bringing together the different strands so far debated in this section, it could be argued that air pollution epidemiology represents a sort of contemporary theoretical middle ground. As described earlier in this chapter, historical developments in the latter half of the twentieth century reveal a rising pre-occupation with technological and methodological precision in epidemiology, alongside an escalating search for associations between exposures and health parameters. Endeavours have remained largely underpinned by a biomedical model of (individual) health, focusing more on proximate risk factors, and less on what goes on inside the black box compared with associations found outside it.

However, time-series studies in air pollution epidemiology do, in some respects, represent a challenge to prevailing views. They embrace a commitment to more distal, or upstream, environmental determinants of wellbeing. And they investigate populations rather than individuals, often over time-periods of sufficient length to capture a more complete picture of community experience.

Further, in the context of the lofty status afforded to evidence based medicine, air pollution epidemiology has managed to hold its own despite the apparent lowly status of aggregated data studies. Despite the evidence provided by such studies being positioned near the bottom of the hierarchy of scientific importance, policy-makers and the public do appear to take the findings of such investigations seriously. Although not providing as dramatic an alternative to scientism as is offered by Rorty's relativism, air pollution epidemiology does begin to ask questions about the relative validity of scientific truths.

Yet such change has been countered by containment within certain boundaries. In order to be taken (at least moderately) seriously by the scientific community, air pollution epidemiology has needed to stress methodological rigour, for instance through emphasis on control for apparent confounding factors. This, as discussed earlier, detaches the population under study from its social and historical context, so placing air pollution epidemiology back into the scientific paradigm that it partly challenges. And the focus on smaller and smaller pollutants within time-series studies has shown commitment within air pollution epidemiology to a reductionistic model of health, and the positivist scientific enterprise of which this is part.

So air pollution epidemiology might be seen as an example of a middle way, challenging the absolute scientific basis of public health, yet embracing it too. The difficulty of this position is further illustrated by looking at evidence based public health policy, and the ethical foundations of this in the positivist doctrine of utilitarianism.

Evidence based policy: ethical and political issues

There is a strong political component to the notion of quantifiability, which relates to the issues of what *can* be readily quantified, and what policy-makers actually *want* to have quantified information on. At their core both evidence based

medicine and evidence based policy are primarily directed at cost containment, which is understandable in the area of healthcare provision, where costs escalate with ever-increasing demand and expensive new technologies. But the values embedded within the politically and economically driven search for evidence should not be masked by the apparent objectivity of information on effectiveness. As Kerridge states, the concept of evidence underpinning allocation of resources may be seductive, and the desire for simplicity understandable, but only certain kinds of interventions are amenable to RCTs, the gold standard of research:

> "Allocating resources on the basis of evidence may therefore involve implicit value judgements, and it may only be a short step from the notion that a therapy is "without substantial evidence" to it being thought to be "without substantial value". " [90]

Certain areas of medicine are suited to RCTs, mainly the specialities, and especially those with high costs, often from new technologies. Activities "likely to receive serious research attention are ones that result in large unit costs, with substantial short-term effect, and a limited number of well-defined alternatives."[91] Meanwhile, general practice and primary care are less amenable because of points raised earlier; and palliative care and health care of the elderly are areas where research is traditionally difficult to do for unrelated reasons including, for instance, problems obtaining informed consent.

So political commitments are evident in evidence based medicine, through the areas in which specific kinds of evidence can be carried out, and the values implicit in prioritising apparent objectivity and de-prioritising alternative conceptual frameworks. As Dickenson and Ashcroft postulate:

> "... it should also be noted that the state has a great interest in the success of the EBM [evidence based medicine] programme, as a mechanism for providing an objective basis for cost control, and for defining standards of practice, which on the one hand protect the state and its employees against negligence actions, but on the other hand provide a scientific (rather than a policy or authority) based method for keeping clinicians to a clear, planned line."[92]

Rudolf Klein, the policy analyst, is even more forthright in condemning evidence based medicine as "an attempt to assert the hegemony of a particular type of evidence". He argues that it privileges certain types of evidence [science], notably RCTs, over other kinds of knowledge or understanding, and privileges certain skills over others (e.g. statistics, epidemiology). Evidence based medicine promises a "spring-clean of existing clinical practice", introduces a brake on new interventions and technologies and offers the mirage "of solving all health care funding problems by eliminating unnecessary, unproven and ineffective care."[93]

While evidence based medicine emphasises the place of research evidence in clinical practice, it is only a short step – or extension – to seeing how the same factors, problems and conceptual flaws apply to evidence based policy-making. The most obvious example may be allocation of healthcare resources, but the extension has more subtle and deep-rooted effects. And these effects are most stark for health promotion policies, fiscal policies, and – most relevantly for this chapter – environmental and transport policies.

Research in these areas is hard to do, not scientifically merited, politically difficult, and often fails to inform policy, let alone result in policy change. Substantial improvements to air pollution levels and environmental quality are only likely to come about from dramatic shifts in the way evidence is perceived, the environment is valued, changed political priorities and, perhaps most fundamentally, from radical policies.

Historical developments in public health in England and Wales: separation from 'the environment'

Having explored developments in epidemiological theory and also evidence base medicine, it is now important to look at how air pollution epidemiology and the QRA fit in to developments in the public health profession and public health

practice – in particular, the changing capacity for public health to engage in environmental issues.

Public health in proximity to environmental issues

As discussed in the first case study the huge influx of people to cities in the eighteenth and nineteenth centuries, accompanied by changing working practices and conditions, brought new and worrying health problems. Infectious diseases spread easily in areas where people lived in close proximity and dreadful sanitary conditions, and the environment of factories and industries heralded occupational diseases and accidents on an unprecedented scale, and special threats to child health and development. Vaccination against smallpox, which was very common at that time, was the only statutory measure enforced upon local authorities, but cholera epidemics were a similarly huge concern.

These anxieties, accompanied by the need to have a healthy workforce in an era of expanding Empire, engendered a search for possible solutions. Two linked debates informed this search. The first was about infectious disease causation, whether miasma or contagion was aetiologically responsible. The second debate was about morality, in particular the moral nature of the poor. Darwinian ideas were being extended to the social domain substantiating the idea, among some, that those less fit be allowed to be selected out in the interests of the moral advance of the nation. This both supported allowing those morally inferior – such as the poor – to either languish or be weeded out through eugenic policies, and also justified aggressive imperialist action towards other nations and cultures.

But, whatever the reason for the behaviour of the poor towards hygiene, infectious diseases did not respect boundaries and the workforce needed to stay healthy. Believing that health improvement lay beyond the scope of the medical profession early 'pioneers' such as Edwin Chadwick advocated sanitary reform as the key in the mid-nineteenth century. Importantly these lawyers and engineers, despite

coming up against influential individuals and companies (such as the water authorities), were not promoting ideas in conflict with political will, but rather the opposite. This, as will be returned to later in this section, contrasts with the more contemporary position of public health practitioners taking on environmental issues.

Removal of environmental filth and improvements to sanitation would check the progress of infectious diseases, but the government soon felt that the medical profession should both determine how this could be achieved, as well as monitor the nation's health. The position of Medical Officer of Health (MOH) was created to advise and monitor locally, and John Simon (who had been one of the initial metropolitan MOsH) became the first adviser to, and planner for, central government. And, as appointment of MOsH became mandatory – to metropolitan sanitary districts in 1855 and to provincial districts in England and Wales in 1875 – a State medical service had essentially been established.[94]

As the last quarter of the nineteenth century progressed, although no speciality existed as such, public health consolidated itself. In 1871 a postgraduate certificate was developed, which later became the Diploma in Public Health (DPH), first in Trinity College Dublin, then Edinburgh and Cambridge. By 1876 Oxford and London had a certificate in Preventive Medicine and Public Health.

Although DPH courses varied a little depending on university the essential components were, and remained long-term, a combination of classroom and practical work. While the former consisted of lectures and study time, later accompanied by laboratory work, the latter involved a period of experiential training alongside an existing MOH, a method mirroring that practised in clinical medicine. Environmental issues were integral to learning. Both meteorology and climatology were required parts of the initial DPH curricula, receiving great emphasis, and stayed there for some decades.[95]

Those training to be, and taking up posts of MOsH, were a mixture of experienced doctors and others going into the speciality soon after completing their medical training: some worked full-time and some part-time. Early on, the position of MOH carried gravitas, as well as political weight and power, and attracted high calibre physicians hoping it would boost their private practice and status. But, although a public health specialist qualification was made compulsory for metropolitan districts in 1891, by the end of the century the status of the MOH had declined. Those taking up posts tended to be either general practitioners wanting – or needing – to supplement their private income, or those attracted by the lure of a steady, albeit unremarkable, income from local government.[96] Despite this, naturally, there were some drawn by a passion for the job.[x]

At the turn of the century MOsH were well-established positions in local authorities. Working alongside sanitary inspectors, engineers, and those responsible for housing and town planning, they monitored the health of their local communities (including notification of infectious diseases from 1899), oversaw the health dimensions of local developments, were involved in industrial and occupational matters, and acted as advocates for health improvement, such as through reduction in smoke pollution. And, despite significant changes to the direction and nature of public health over the coming periods, these essential components of the public health doctor remit – enabled by the location and working relations of the MOH – remained present and active until the 1970s.

As the twentieth century dawned what did shift, however, was the emphasis in public health towards preventive medicine. Once the germ theory of disease was largely accepted, awareness grew of the importance of personal and social habits in the spread of infectious diseases. In tandem with this, concern mounted about national efficiency and the nation's health.

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[x] General practitioners operated on a fee-for-service basis, and there was competition for patients and income. MOsH were salaried by local government although, in time, salaries were found to vary between locations, sometimes dramatically. Security was not such a draw, as tenure of appointment did not occur for some time.

In response to these developments environmentalists demanded wider preventive services. While eugenicists unsuccessfully countered these calls,[xi] services were set up to advise, inform, improve, and monitor the health of groups in need, especially the young who were seen as both the nation's future and also the starkest recipients of the detrimental health effects of poor hygiene. So welfare programmes for pregnant and post-natal mothers, infants and schoolchildren were established, as well as midwives and health visitors, the latter operating as hygiene instructors in early years rather than a resource for new mothers as today.[97]

These services, later alongside community health centres and social work, created teams based in public health departments, under the leadership of MOsH, that oversaw the health of the local community. But the traditional responsibilities of the MOH, and hence public health, for environmental health and as 'community watchdog' remained, as these officers were still best placed, and most suitably trained, to monitor and act accordingly. And strong allegiances existed between MOsH and, say, town planners, for instance in the creation of integrated municipal management systems to ensure health efficiency.[94]

The tasks and duties placed on the MOH and his department at this time were numerous and wide-ranging, but it was a good time for public health. When Lloyd George introduced the National Insurance Act in 1911, the numbers able to use municipal hospitals, then under the administration of MOsH increased, as did the status of these hospitals (in comparison with the ailing voluntary hospitals), so further adding to the responsibilities of the MOH and the good feeling within the profession. The inter-war period has been labelled by some commentators as the 'golden era' of public health.[97]

[xi] Some preventive services could be supported by eugenicists, e.g. family planning.

There is therefore an apparent paradox, created from the seemingly conflicting notions that public health both lost status after about 1900, and that the 1920s and 1930s were a special, and good, time for the profession. This can be squared as follows. The loss of status was related to the change of direction away from surveillance and towards community health: individual prevention involving mainly mothers and children. Part of the loss was that this was seen to be primarily women's work, and this resonates through the lowly position that community health still occupies today. On the other hand, however, management of the constantly expanding state medical service reached its maximum extent during the period 1929 to 1948 when the Poor Law medical services were incorporated into public health. This made the MOsH very powerful but at the same time had negative professional connotations if public health is conceived to be principally about surveillance of health rather than management of medical care.

In 1946 the National Health Act described a new health service that would become operational two years later. Planning, however, had been going on before and during the second world war, and MOsH had envisaged a three-tiered service with themselves in the coveted position of central co-ordinators and administrators. But government plans dashed all hopes of being at the heart of the new system and, instead, public health was placed at the periphery and disempowered. Bevan, along with most politicians and doctors at the time, equated improvements in medical care with improvements in health, a fallacy unmasked a few decades later but still widely ascribed to today;[7] preventive medicine was relatively unimportant. The new service was orientated around State hospitals, which replaced existing municipal and voluntary hospitals, with teaching hospitals dominating the system. General practitioners would act as the gateway to the new establishments.[98]

Public health was marginalised. It remained outside the NHS, based in local authorities, with its functions substantially reduced and its status severely compromised. And for some of the community clinical services it had to compete

with general practice. MOsH and their public health departments were pressured from both within and without the medical profession, and morale fell. It could be argued[99] that, despite a brief resurgence in the early 1970s, it is a position from which public health has never fully recovered:

> "Just as the public health doctor was not able successfully to justify his continued work in personal prevention, so he failed to make a good case for the medical administration of welfare work. Thus MOsH increasingly found themselves accused of failure in respect to the delivery of effective community care, and squeezed between the twin pressures of general practice from without and social work from within."[100]

Regardless, however, of the enthusiasm or mental state of its practitioners, public health remained – and continues to remain – a vital function. Responsibility for environmental health, among other important functions, stayed with public health departments in their local authority base. MOsH still held and built empires in their departments, although the prestige of these may have declined.

But, as Jane Lewis has importantly pointed out, public health lacked a philosophy.[101] In the 1950s and 1960s an opportunity arose to fill that void. Social medicine, as mentioned earlier in this chapter, offered the possibility to both bring together service and academic workers in public health, and to provide a theoretical framework through which a unified speciality could develop. But social medicine meant different things to different people at different times. Originally conceived as a socio-biology of health and disease, early proponents of social medicine postulated a new type of doctor, who searched to understand her patients – their health and disease – in the context of their communities, their environment, and their personal and social histories. Medical training needed to be revamped to create a new breed of clinicians, who practised whole-person medicine, a holistic endeavour combining clinical and preventive medicine and underpinned by a framework of social ecology.[102 103]

Academics, however, moved social medicine in a different direction. They conceptualised it, not so much as scientific humanism, but as a positivist

intellectual enterprise to explain the social basis of illness in populations. Founded on scientific rationalism and epidemiology, social medicine would describe how health and disease in societies was produced, including social, environmental and biological determinants. Early proponents were caught in an ideological difficulty as they also largely held that medical care would solve health problems once it was available universally. But by the 1960s and 1970s this was challenged, both by McKeown's thesis that many of the health improvements in the late nineteenth and early twentieth centuries were due to improvements in sanitation and living conditions rather than the effects of medicine, and also with the introduction of qualitative methods into social medicine.[7]

The rifts, both within social medicine itself, and between its academic proponents and service-based public health practitioners, could not be reconciled. And, when major reorganisations of the NHS and public health were planned and implemented in the early 1970s, social medicine was side-lined. It did not, however, die and, as Dorothy Porter has highlighted,[104] social medicine has had something of a revival recently with new university departments in Bristol and Birmingham, reflecting both a resurgence of interest and also the philosophical leanings of individuals.

Public health separated from environmental issues

At the end of the 1960s public health was at yet another cross-roads, but this juncture was to be highly significant for environmental health. Escalating costs of health care delivery and new medical technologies, accompanied by a realisation that demand for healthcare services was ever-increasing, prompted the governments of many countries to think of ways to contain costs.[xii] In the early

[xii] When the NHS was set up, many believed that the need for health care could be fairly met by an improved system, and with efficiency gains. In the following decades, however, there was a growing understanding of the difference between demand and need for health care, and an appreciation that there were always opportunities for additional health gain, albeit at perpetually rising marginal cost.

1970s the UK government planned a major reorganisation of the NHS which, eventually, saw the creation of area health authorities (coterminous with local government units responsible for social services) with 14 regional health authorities responsible for planning, and 205 District Management Teams below. Managerial negotiations would go on between health authorities and hospitals as to the level, nature, and of course cost, of provision of services. But who would arbitrate or broker the arrangements?[98]

Public health doctors, it was felt, might be in the best position to do this. As members of the medical profession they spoke the same language as their clinical colleagues, and enhanced training in administration, management and organisation of health services would serve them well. And a further carrot was dangled, one that would improve their standing within the profession, that of speciality status. Following negotiations between various public health professional groups and the General Medical Council, a new faculty was set up in 1972 under the auspices of the Royal College of Physicians – the Faculty of Community Medicine (FCM).[xiii]

Alongside the FCM a new medical speciality was created, that of community medicine, with a training and examination process (Membership of the Faculty of Community Medicine) paralleling the clinical specialities. This step was appealing to some public health doctors who felt their credibility would be boosted, and a new identity formed; others, however, were resentful or took early retirement. It was anticipated, nevertheless, that community physicians would be the medical professionals of community health, monitoring the health of their local communities, assessing the need for healthcare, evaluating services, and acting as important administrators. In fact, the honeymoon period was short-lived

[xiii] There had been discussion about an umbrella Faculty being multi-disciplinary, housing public health workers from different backgrounds, but it was felt this would not be allowed under the Royal College of Physicians, so the 'doctors-only' option was preferred.

and within a few years community medicine was confused and demoralised. Although there is insufficient scope to discuss that further here, Lewis surmises:

> "... little thought was given to the way in which community medicine would be practised in the new NHS and community physicians experienced considerable tension in reconciling first their responsibility for the management of health services with that of analysing health problems and, second, their formal accountability to the NHS bureaucracy with their ethical accountability to their communities."[105]

What is most relevant, however, is that public health – now as community medicine – moved out of local authorities and into the NHS. And local authorities, pushed to one side in the reorganisations, were left with the vital health related areas such as environmental health and community care. The position of MOH had been abolished, and existing public health doctors became community physicians/medical officers at a variety of levels. Occasional posts may have remained outside the NHS, but essentially public health split with local government, and newly qualified community physicians would be predominantly based in public health departments in NHS health authorities.[106]

And with this move, public health doctors and their departments became irrevocably separated from their colleagues working on matters of environmental health, sanitation, and local planning and development. Working contacts may have been retained for a while, but inevitably over time relationships disintegrated, the decline accelerated by the new workloads of public health departments as well as the different geographical boundaries within which the two authorities operated: it is difficult to co-ordinate activities when the district community of the health authority is defined differently to that of the corresponding local authority.

In 1982 another NHS reorganisation abolished the area tier, further polarising community medicine (now uncertain as to whether prime responsibility lay with management of health services, or analysis of health problems and needs), although the 1988 inquiry into the state of public health by Sir Donald Acheson[107]

bolstered morale within the speciality as well as resulting in a name change to public health medicine.[xiv]

Crucially, however, the divide forged by the 1974 reorganisation has never been bridged. While those in local authorities have reinforced their training and backgrounds – as environmental health officers (EHOs, previously sanitary officers), town planners and public health engineers (a sub-speciality of civil engineering) – these skills have become harder for public health workers to tap in to.[103] Although the QRA project illustrated that cross-organisational working is not impossible, it is only very recently, with the very latest restructuring of the health service (and public health), that the prospects of collaborative working have really improved. This is discussed further in the conclusions of the thesis.

Conclusions

This case study has been used to illustrate developments in the contemporary relationship between air (as air pollution), epidemiology and public health, and also to demonstrate what this reveals about current ways of thinking in public health. The quantitative risk assessment (QRA) described, and the epidemiological research designs contained within it, show that air has been further reduced to its constituent components, and polluted air is perceived as these parts, separated from the population but whose impact on the health of a community can be calculated.

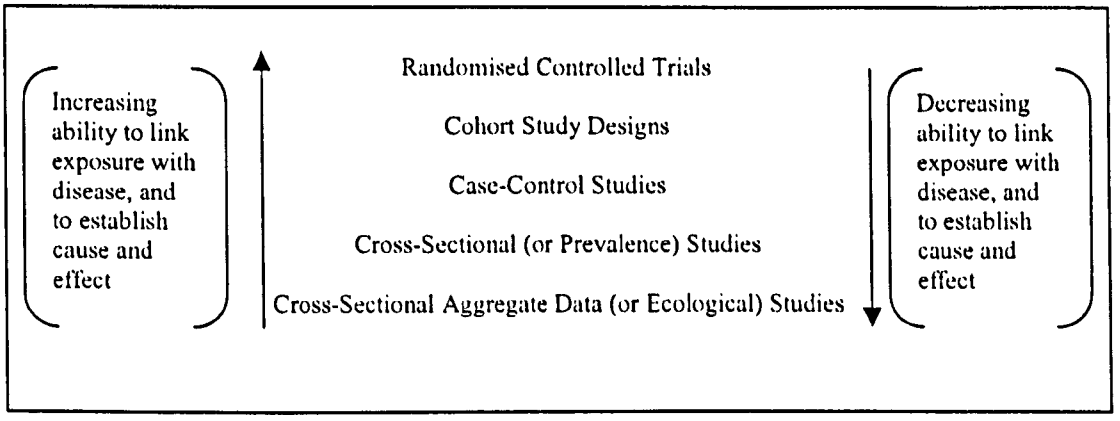
But the QRA is constrained by both its science, and the philosophical and policy dimensions that shape its science. As a research scientific process the QRA has methodological flaws, but the epidemiological framework that determines those flaws is itself confined. There are deep-rooted philosophical issues that both limit

[xiv] A 2003 vote resulted in a further change to the Faculty of Public Health (FPH).

and dictate current epidemiological thinking, such as problems with causality and the lack of coherent epidemiological theory. And the policy initiatives that promote certain notions of evidence and effectiveness are ethically contestable, so compounding the problem. Epidemiology and public health used to go hand-in-hand, but their paths have diverged.

At a practical level, the possibility of valuable local public health work on air pollution and other environmental issues is limited. Fragmented developments in public health have driven apart relationships with those working in environmental health. What we are left with is rather shallow environmentalism, theoretically problematic and practically restricted.

Figure 4.1 The hierarchical nature of epidemiological studies ranked by ability to establish cause and effect



Source: Soskolne CL, Sieswerda LE, and H Morgan Scott. Epidemiologic methods for assessing the health impact of diminishing ecological integrity. In: Pimentel D, Westra L, Noss RF eds. *Ecological integrity: integrating environment, conservation, and health*. Washington: Island Press, 2000: 264.

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CHAPTER 5

CASE STUDY 4: CLIMATE CHANGE, ETHICS AND NEW MORAL HORIZONS IN PUBLIC HEALTH

Overview of case study 4

This fourth historical case study of the relationship between air and public health explores the approach to dealing with climate change. The case study begins with a description of the scientific basis of global warming and climate change. The approach to dealing with climate change is then used as an instrument to probe utilitarianism as the moral foundation of public health. This historical case study (history of medicine and public health, history of science, history of philosophy) again has strong inter-disciplinary components: basic science (of climate change) and philosophy (moral philosophy, political philosophy, and environmental philosophy). Primary and secondary data sources were used, as described in chapter one, and inter-disciplinary connections are examined.

Introduction

In the approach taken to dealing with climate change, the debate about air has provided the opportunity to rethink the relationship between mankind and nature, and the moral dimensions of public health theory and practice. Often referred to synonymously as greenhouse warming, climate change presents an instance of the health effects of western lifestyles being borne by those at a distance in time and place. Unlike, say, passive smoking, those affected by climate change have little or no connection with the perpetrators, yet are left with the consequences. And this raises fundamental questions about the geographical, temporal and moral

boundaries of public (health) responsibilities, as well as the place of utilitarianism in public health theory.

Using the approach taken in dealing with climate change as the study area of this case, the case study is structured as follows. First there is an overview of the science of climate change and its effects on human health. Next, these health dimensions are used as a basis to challenge utilitarianism as the moral foundation of public health. Other possible moral frameworks for public health are put forward. First, John Rawls's theory of social justice is presented, followed by an exploration of how this has been used in the climate change debate. Second, it is argued that environmental ethics could provide a framework for public health, and environmental ethicists have used the climate change debate to argue their case. Environmental ethics, in common with the perspectives of Ludwig Wittgenstein and also virtue ethics, highlights serious concerns about the overall direction of modern western moral philosophy. These concerns have historical roots that connect to other developments in the history of science, medicine, and political philosophy.

Climate change: science and health

Climate change is one of a number of large-scale anthropogenic processes often collectively labelled global environmental change (GEC). Other processes under this umbrella include ozone depletion, acid rain, deforestation, and loss of biodiversity. Although no precise definition of GEC exists, the term encompasses detrimental environmental effects consequent to activities accompanying human development, most of which are relatively recent in terms of the history of the planet. The processes are often inter-locked, and inevitably have ramifications for human health.

As mentioned earlier climate change is often referred to inter-changeably as greenhouse warming, the greenhouse effect, or even global warming. To

differentiate, the greenhouse effect describes the bio-geo-atmospheric process, greenhouse and global warming refer to the resultant heating, and climate change depicts the meteorological consequences which include changes in temperature.

The greenhouse effect is a highly complex, incompletely understood, process that involves the geology and biology of the earth, as well as the oceans, the atmosphere and the sun. But the basic effect is a natural one. It is human activities that have distorted the natural effect. The scientific details are not relevant to this thesis, so the basic science will only be sketched.

In 1937 the term greenhouse effect was used "to describe how atmospheric gases stabilise the earth's temperature by allowing the passage of visible and UV [ultraviolet] radiation from the sun, which warms the earth's surface, but block the escape to space of reflected infrared radiation."[1]

This early proposition is not that dissimilar to what is understood of the process today. The earth's atmosphere freely admits short-wave solar radiation from the sun, including visible light. Most of this incoming radiation is absorbed by the Earth's surface, and warms it. Some solar radiation is reflected off the Earth's surface back to space, but some longer-wave infra-red radiation is trapped by the atmosphere – predominantly the troposphere[i]. This heat retention, or 'radiative forcing', causes the natural greenhouse effect.

The troposphere of this planet is composed of approximately 78% nitrogen, 21% oxygen and 1% of the following: argon, traces of carbon dioxide, water vapour and methane, ammonia, hydrogen and other minor gases. It is these latter gases – making up just the 1% – that are naturally occurring greenhouse gases, each

[i] The earth's atmosphere extends approximately 100 kilometres from the earth's surface. It is comprised of the 10km troposphere closest to the earth, which contains 90% of the mass of the atmosphere; then the stratosphere band between 10 and 50 kilometres, which is less dense and contains the ozone 'layer'; and finally the mesosphere.

absorbing a particular wavelength of infra-red radiation, so trapping energy in the lower atmosphere and creating a heat blanket. The greater the concentration of greenhouse gases, the thicker the blanket. So, while the natural effect keeps the Earth around its life-promoting moderate temperature, man-made contributions to the greenhouse gases are likely to disturb this balance and heat up the atmosphere.[2]

Of most relevance to this case study is that an estimated massive 10,000 Gt of 'ancient' carbon is locked away in sedimentary limestone deposits and, crucially, in fossil fuels. The combustion by humans of these fossil fuels creates more carbon dioxide, water vapour and nitrous oxide (oxides of carbon, hydrogen and water), transforming the natural greenhouse effect into an unnatural one.

There are three other main anthropogenic greenhouse gases, methane and the entirely synthetic chlorofluorocarbons 11 and 12 (CFC-11 and CFC-12), but carbon dioxide is the most significant because of its stability. With an atmospheric lifetime of up to 200 years, if *all* carbon dioxide emissions stopped today, global temperatures would continue to rise until about 2025, and most temperature excess would still be present in the year 2100.[2]

Emissions of various greenhouse gases into the atmosphere have increased substantially since about 1800, and dramatically since 1950, essentially as the product of industrialisation. Seventy-five per cent of anthropogenic carbon dioxide comes from combustion of fossil fuels, especially coal, an increasing amount from motor vehicles, and the remainder largely from rainforest burning. Methane is mainly derived from irrigated agriculture, cows, mines, gas pipelines and rubbish tips. And, nitrous oxide comes from fossil fuel combustion and fertilisers

Historically, there has been approximately a 100-fold increase in global energy use since 1800 and the same multiple in annual rate of carbon dioxide production. As a result, atmospheric carbon dioxide concentrations have gone up by a third,

half of that increase since the 1950s. Between 1800 and 1988, developed countries have been responsible for about 83.8% of industrial carbon dioxide emissions, 67.8% of total carbon dioxide emissions, and 66.9% of total combined carbon dioxide and methane (of which the United States contributes 33.2, 29.7, and 29.2%). In comparison, developing countries have been responsible for 16.2, 32.2, and 33.1 % respectively.[3]

However, though developed countries are responsible for over four-fifths of historic carbon dioxide (in other words the total carbon dioxide now in the atmosphere), developing countries *currently* contribute 32% of annual global carbon dioxide emissions, expected to increase to around 44% by 2010.[4] This is, of course, to do with industrialisation in many rapidly developing countries, for instance China.

According to most experts the increase in greenhouse gases in the atmosphere has resulted in a rise in surface temperature of the Earth. In 1988 the United Nations (UN) Environment Programme and the World Meteorological Organization established a multi-disciplinary body of over 300 scientists to advise governments, called the Intergovernmental Panel on Climate Change (IPCC). A 1990 report by the IPCC suggested that average global temperatures had risen by 0.3-0.6° C over the past 100 years.[5] Eleven years on, the 2001 IPCC report concludes that global average surface temperatures have increased by 0.6° C +/- 0.6° C over the twentieth century, and are projected to rise by 1.4. to 5.8° C by 2100.[6]

Consequences to human health

The consequences to human health of a rise in temperature and associated climatic changes are diverse, and most conveniently grouped into direct and indirect effects.[7] Most of these health effects are predictions based on new research techniques, such as scenario-based computed modelling. The direct effects result

from increased exposure to thermal extremes – changed mortality and morbidity from heatwaves and severe cold. Increased heatwaves, exacerbated by increased humidity and urban air pollution, impact greatest on the elderly, the sick and those without access to air-conditioning. Heat can also be connected with domestic violence, civil disturbances and riots. Other direct effects are mediated through destabilised ocean and air currents leading to extreme weather events such as floods, storms, cyclones, hurricanes and bushfires with their associated deaths, injuries, psychological disorders, and infectious diseases.[2]

Indirect effects stem from disturbances to complex ecological systems. Changes in the ranges and activity of vectors and infective parasites – through altered rainfall and temperature – will affect the geographical range and incidence of associated diseases such as malaria, dengue fever, trypanosomiasis, and the viral encephalitides. Altered local ecology will impact on water-borne and food-borne infective agents – compounded by floods and damage to public health infrastructures – causing increased incidence of gastro-intestinal and other infectious disease.[8 9]

Changed food productivity, especially crops, will result in malnutrition, hunger, impaired child development and growth, with increased morbidity and mortality. Tropical and sub-tropical countries will be worst affected as the "poor and economically underdeveloped populations ... would be unable to offset agricultural yields by trade."[10] Despite the expected increased productivity in temperate countries, there will be an estimated additional 40-300 million hungry people attributable to climate change by 2060, against a background total of about 600 million. Decreased water availability is expected for many populations in water-scarce regions, especially the sub-tropics.[6]

The IPCC anticipates a globally averaged sea-level rise of 0.09 to 0.88m by the end of this century with associated rise in population displacement, damage to infrastructure, psychological morbidity, and problems with disposal of sewage and waste. Half the world's population lives within 60km of the sea, and rising

waters would particularly affect those living near coasts, on small islands, and those with limited material resources. A 50cm rise would double the number experiencing flooding annually, currently about 46 million. Many fish populations will be put at risk from the sea-level and temperature rises rendering habitat unsuitable, and land-use changes are creating obstacles to migration.[6]

As has been mentioned, the poorest countries are likely to be most heavily affected by the health effects of climate change, as they lack the resources to adapt accordingly. The story, however, is somewhat different in the United Kingdom (UK). Warmer winters will be associated with less cold-related deaths: the UK currently has the highest seasonal excess mortality in Europe at 60-80,000, expected to decline to about 20,000 cold-related deaths in 2050. Warmer, and probably drier, summers, will increase heat-related deaths and hospital admissions but by a much smaller dimension, although an extra 10,000 cases of food poisoning could occur annually. More outdoor activity in the warmer weather may result in an additional 5000 cases of skin cancer and 2000 extra cataracts by 2050. In the same time frame indigenous malaria may have become re-established in the UK but probably only associated with the less threatening *Plasmodium vivax*. Sea-level rise and increased frequency of winter storms and gales will make flooding of low-lying coastal areas more likely. Most air pollutant levels are expected to decrease.[11 12]

Climate change and public health philosophy

From the perspective of public health philosophy, what is fascinating about climate change is that it throws open three new aetiological dimensions to population health and disease. First, the causes of greenhouse warming, and the resultant climate change and its health effects are anthropogenic. Excluding 'lifestyle' diseases – which an individual predisposes him- or herself to through

personal activity[ii] – there are plenty of examples of illnesses created by human activity, such as occupational cancers or the passive smoking example mentioned earlier. But in these situations only the populations that create the environmental hazard experience the consequences.

What is different about climate change is that certain communities (and the individuals within them), through their adopted activities, will affect the health of other communities that may well not have taken up such activities. And this opens up interesting, hitherto unexplored questions about personal responsibility, and also about the relationship between public responsibility and how this is expressed through policies such as those concerning public health. In other words, how do such responsibilities fit into the public health philosophy and practice of the perpetrating communities?

Second, the health effects of climate change are, to a substantial degree, likely to impact at a large geographical distance from their source. Aside from the equity issues relating to the *differential* impact and ability to mitigate or adapt accordingly – which are looked at later in this case study – it is difficult to think of any other example[iii] in which the activities of one community could so connectedly affect the health of a population afar. War is perhaps the closest parallel. Related to this point, the third new aetiological dimension that climate change throws up is that the health impacts of current (and past) activities will likely be the burden of generations to come. Once again, it is difficult to recall any similar example in the history of public health. So the question arises again of how do these spatial and chronological dimensions fit into the public health philosophy and practice of the perpetrating communities?

In some ways this brings us back to the third case study, in which it was argued that western epidemiology and public health lack a coherent theoretical

[ii] Personal choice, however, such as the ability to stop smoking, may be affected by factors such as employment status and social support, both of which are linked to deprivation.
[iii] Apart from economic activity, which is of course related to human lifestyles.

philosophy. But a different tack will be taken here, which looks more directly at the ethical foundations of public health. Like much public policy, public health is informed heavily by one moral theory, utilitarianism. Yet utilitarianism is problematic, and seems out of touch with the world's current problems. As a guide for both personal and public morality, traditional utilitarianism appears anachronistic. Indeed, the roots of all the new dimensions of health effects of climate change outlined above, can be traced to the deficiencies of utilitarian theory.

So the next section looks specifically at utilitarianism, its moral limitations and the relevance of these to climate change and public health philosophy. After that, the first major challenging moral framework for public health is considered, one based on John Rawls's vision of social justice.

Utilitarianism, climate change and public health

Utilitarianism falls into the consequentialist class of moral theories, in which the rightness or wrongness of an action, or rule, is determined by the consequences of that action or rule. Ethical egoism is also a consequentialist moral theory, but one in which only consequences to the self are deemed morally relevant. There is, however, far more to utilitarianism than the common parlance reference to the ends justifying the means. The other main class of moral theories comprises deontological theories,[iv] in which inherent characteristics of actions are of moral relevance, rather than an action's consequences. These are duty-based theories and include Kantianism, religious philosophies and the ethics of natural law.

Despite relentless ongoing criticism utilitarianism has proved a remarkably tenacious moral theory, the corner-stone to liberal democracy, and both its persistence in and significance to western political philosophy inevitably tie

[iv] This supposition is challenged later in the chapter.

utilitarianism to ethical issues in public health. Utilitarianism became applied politically in the eighteenth century, and is most famously associated with Jeremy Bentham (1748-1832) and, a little later, John Stuart Mill (1806-1873). But utilitarianism had antecedents, and the main tenets of the theory were laid down earlier by philosophers such as John Locke (1632-1704) and David Hume (1711-1776). Much of what Bentham and Mill had to say was not particularly new.

Bentham was a lawyer and was most interested in the relevance of his ideas to legislature. This element connected him strongly to one of his followers, Edwin Chadwick, because of a shared belief in improving the lot of those worst off through reform. But Bentham's concept of equality was strikingly at odds with that of certain successors, such as Marx and Engels, who provided a very different explanation for the historical processes determining how inequalities arose, and what should be done to redress them. To Bentham, equality formed the basis of a calculus[v] in which each individual counted the same, and was the corner-stone of his utilitarianism.[13]

Bentham's theory was founded on two linked principles, the principle of association and the principle of utility. The principle of association was a deterministic account of linked mental occurrences, akin to the modern 'conditioned reflex' but without the physiology. The principle of utility, or the greatest-happiness principle is, however, what Bentham is best known for, and rests on the premise that what is good is pleasure, and what is bad is pain. Bentham came to this position through the belief, articulated in his 1789 *Introduction to the Principles of Morals and Legislation*, that human beings are subject to, and slaves to, two poles of sensation:

> "Nature has placed mankind under the governance of two sovereign masters, pain and pleasure ... They govern us in all we do, in all we say, in all we think: every effort we can make to throw off our subjection will serve but to demonstrate and confirm it. In words a man may pretend to

[v] The calculus referred to a calculation, rather than the modern understanding as a particular method in mathematics.

> abjure their empire, but in reality he will remain subject to it all the while."[14]

Extraordinarily, Bentham came up with 58 synonyms for pleasure, all denoting the same sensation, and famously remarked that "Quantity of pleasure being equal, pushpin is as good as poetry". From this perspective on human psychology Bentham took the leap of designating happiness as the moral goal, and his principle of utility "approves or disapproves of every action whatsoever, according to the tendency which it appears to ... augment or diminish the happiness of the party whose interest is in question; or what is the same thing in other words, to promote or to oppose that happiness".[15]

Extrapolated from the individual to the larger, social domain, the principle of utility states that "the greatest happiness of all those whose interest is in question ... [is] ... the only right and proper and universally desirable end of human conduct."[14] So, one set of affairs is better than another if there is a greater balance of pleasure over pain, or a smaller balance of pain over pleasure. Empiricism was thus brought firmly into the foreground, as the right action could – in theory at least – be determined by summing up individual experiences of these two sensations. This process of quantification was Bentham's 'felicific' calculus,[vi] in which the 'audience' to be considered was all those affected by the action, each counting equally. Animals were not excluded from the calculus, as Bentham believed "The question is not, Can they *reason*? Nor Can they *talk* but, *Can they suffer*?"

In his 1863 book *Utilitarianism* John Stuart Mill, like Bentham, extended moral consideration to the whole of sentient creation but, differently, made qualitative distinctions between pleasures. Mill felt that "pleasures of the intellect, of the feeling and imagination, and of the moral sentiments" had higher value than those of mere sensation, so contrasting his non-hedonic, or 'ideal', utilitarianism with

[vi] Also known as the optimific, or hedonic, calculus.

Bentham's hedonic version.[16] Mill felt it better to be a dissatisfied Socrates than a satisfied fool. But, in general respects, Mill was in accord with Bentham:

> "The creed which accepts as the foundation of morals, Utility or the Greatest Happiness Principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the worst of happiness. By happiness is intended pleasure and the absence of pain; by unhappiness, pain, and the privation of pleasure."[17]

Although critiques of modern utilitarianism, and their relevance to public health, will be looked at a little later, it is necessary to point out here a serious problem with the theory's early forms. That is, utilitarianism as depicted by both Bentham and Mill, makes an erroneous conceptual leap of inferring from what "is" in the world to what "ought" to be. This move from description of fact to moral prescription has been coined the 'naturalistic fallacy'.[18]

Bertrand Russell is straightforwardly damning:

> "John Stuart Mill, in his Utilitarianism, offers an argument which is so fallacious that it is hard to understand how he can have thought it valid. He says: Pleasure is the only thing desired; therefore pleasure is the only thing desirable. He argues that the only things visible are things seen ... and similarly the only things desirable are things desired. He does not notice that a thing is 'visible' if it can be seen, but 'desirable' if it ought to be desired. Thus desirable is a word presupposing an ethical theory; we cannot infer what is desirable from what is desired."[19]

With this basic mistaken leap in mind, it is perhaps surprising that utilitarianism has endured. Yet few would demur that utilitarianism strongly underpins much of contemporary moral and political thinking and action. Good national policies are judged to be those that increase overall wealth, the modern euphemism for the greatest happiness, and good public health policies are judged to be those that demonstrably improve population health. These two examples, however, also capture one way in which utilitarian beliefs have changed with time: the separation of the private and the public.

For the early followers, there was no division. Utilitarianism, as a moral theory, provided a guide to both personal behaviour and also to public decision-making. But today it is quite acceptable – and perhaps even the norm – for individuals to draw on various ethical ideas to inform their private behaviour, while expecting governments, public bodies and institutions to essentially act for the common good. And while those private ethical ideas tend to have their roots in duty-based theories or, for some, religious beliefs, the notion of the common good is undeniably utilitarian. This is the moral pluralism of contemporary western, largely secular societies.

That is not to say that individuals in such societies do not seek to improve their own happiness, in fact quite the opposite. But the pursuit of happiness is removed from moral consideration, and has become something closer to a 'taken-for-granted', a lifelong endeavour shaped by society, unquestionably accepted and followed. And the inevitably elusive chase finds happiness disguised as, *inter alia*, healthism, obsession with risk aversion, and consumerism.[20 21] Not surprisingly, therefore, faced with the significant lifestyle changes that would be required to offset climate change and its global health effects, most individuals do not really want to sacrifice or undermine pursuit of their own happiness-oriented goals, despite superficial environmental soundings to the contrary.

Picking up on this the philosopher Alisdair MacIntyre has put the blame for today's moral ambivalence squarely on the shoulders of utilitarianism, and the selfishness it has engendered. He argues that "the individualism of modern society and the increasingly rapid and disruptive rate of social change brings about a situation in which for increasing numbers there is no over-all shape to the moral life but only a set of apparently arbitrary principles inherited from a variety of sources." In such circumstances, he continues, "the need for a public criterion for use in settling moral and evaluative disagreements and conflicts becomes even more urgent and ever more difficult to meet". He suggests that the utilitarian criterion, which appears to embody the liberal ideal of happiness, is apparently without rivals, "and the fact that the concept of happiness which it embodies is so

amorphous and so adaptable makes it not less but more welcome to those who look for a court of appeal on evaluative questions which they can be assured will decide in their own favour."[22]

Further, MacIntyre holds the early utilitarians directly responsible for today's woes, and emphatically questions the price to be paid:

> "But it is necessary to emphasize that the utilitarian advocacy of the criterion of public happiness is not only a mistake. That it seems so obviously the criterion to be considered in certain areas of life is something we owe to Bentham and Mill.
>
> The concept of happiness is, however, morally dangerous in another way; for we are by now well aware of the malleability of human beings, of the fact that they can be conditioned in a variety of ways into the acceptance of, and satisfaction with, almost anything. That men are happy with their lot never entails that their lot is what it ought to be. For the question can always be raised of how great the price is that is being paid for the happiness."[23]

This now brings us back to the ways in which utilitarianism has changed from its early forms. In the private sphere happiness has become morally detached, confusingly and ambiguously entangled with the ethos of western self-centredness. But in the public sphere utilitarian theory has developed. As theorists began to recognise that summation of happiness was, not only practically difficult, but also an insufficient and incomplete reflection of human goals and needs, alternatives were sought, through for instance using preferences, interests or welfare.[24]

It is now appropriate – with a broad picture of utilitarianism in mind – to look at criticisms of utilitarian philosophy, and how these relate to climate change and public health.

Critiques of utilitarianism, and relevance to climate change

The first criticism is that utilitarianism, in its classical or present economic form, necessitates the enumeration and summation of utilities in some shape or form. And utilitarianism then uses the results of this process as the moral basis to guide actions or policies. In its classical form an obvious difficulty was how to quantify happiness, along with the problem outlined earlier of whether happiness is an appropriate moral goal in the first place. Preference- and welfare-based utilitarianism circumvent the latter issue, but do not get around the issue of quantification.

In fact, modern versions of utilitarianism do precisely the opposite. They are reliant, perhaps more than ever, on empirically obtained information as the basis for acting. They place, metaphorically, all the moral eggs in the basket of a positivist conception of science. In a classic contemporary book containing essays for and against utilitarianism, the philosopher Bernard Williams describes contemptibly the appeal of utilitarianism in that it picks up "little of the world's moral luggage", preferring instead to place huge demands on information because "even insuperable technical difficulty is preferable to moral unclarity, no doubt because it is less alarming."[25]

This moral side-step may be economically and politically advantageous, in the short term at least, but it (or perhaps because it) raises almost insuperable problems for climate change. There may be a general consensus now on the scientific proof that climate change is actually happening, as outlined earlier in the chapter, but there is no agreement about what should be done about it.[26 27]

And the same problem exists for assessing the health impacts of climate change. They are based on, at best, plausible predictions using models and methods (including expert judgement and inference) developed because of the newness of the topic and the lack of alternatives. But utilitarian calculations prefer concrete facts to ranges and possibilities. This provides an easy escape-route for policy-makers, but also reflects the compounded difficulties of comparing or trading utilities in the climate change debate. With both health and monetary impacts

fraught with empirical impracticabilities, weighing up options and alternatives is extremely hard.

More subtly, it raises the important point that some elements are more amenable to scientific enquiry and analysis than others. The environment, for example, is excluded from investigation. After all, how do you place a utility function on the value individuals may, or may not, place on retaining a beautiful area of wilderness, or an unpolluted atmosphere? This will be returned to later in the chapter, but it is clearly easier to calculate the economic costs of climate change and the mitigation strategies to prevent it, than to reliably quantify the health impacts or environmental utilities, so creating a bias in areas of consideration; and this does not even touch the question of how to compare different utilities. This is a fundamental issue recognised by MacIntyre:

> "For to exercise utilitarian methods on things which at least seem to respond to them is not merely to provide a benefit in some areas which one cannot provide in all. It is, at least very often, to provide those things with prestige, to give them an unjustifiably large role in the decision, and to dismiss to a greater distance those things which do not respond to the same methods. Just as in the natural sciences, scientific questions get asked in those areas where experimental techniques exist for answering them, so in the very different matter of political and social decision weight will be put on those considerations which respected intellectual techniques can seem, or at least promise, to handle."[28]

The second criticism of utilitarianism, and its framing of climate change policies, relates to proximity. As has been described, classical and modern versions of utilitarianism involve quantification and summation of individual utilities, whether happiness, preferences or interests. But who should be included in the arithmetic? Bentham and Mill predicated that the pleasures and pain of all affected by the action, the audience, should be considered, including – to a lesser degree – non-human animals.

Although circumstances in the nineteenth and twentieth centuries were more contained than today by the technological allowances of the time, the same

concentration on individuals (the audience members) close in space and time applies to both eras. This is because, once again, the utilitarian calculus favours consideration of that over which there is greater certainty. The philosopher Robert Goodin highlights that utilitarians may want to include the utilities of all those affected by an action in any given calculation, but in practice it is unlikely:

> "... utilitarians can go on to say, perfectly properly, that as a purely pragmatic matter their calculations will often lead us to show some apparent favouritism toward those near and dear to us. It is easier to know what people nearby need, and how best we can help; ... Those are purely contingent, pragmatic considerations, to be sure. In the ideal world, they may be absent. But in the real world, they are powerfully present."[29]

This creates special problems for policies relating to climate change. At the national level, and at the local level within countries, policies usually take into account their effects on individuals contained by their boundaries. Climate change would appear to open up the borders by demanding that those from afar are considered too. But it is hard at present to know how to incorporate such requirements, and it remains difficult to believe that such tough decisions will be made by politicians with national, party, and their own interests at heart. The limited concessions to date in the high profile international climate change meetings affirm the somewhat bleak outlook, as is discussed later in this case study.

Similarly, public health policies within, say a health district in England or Wales, would need to take heed of their distant impacts. As recent authors in the global bioethics literature have put forward, western hospitals are heavy producers of greenhouse gas emissions and should be making every effort to substantially reduce these so as to avoid the irony of a health care system in one country adding to the health care problems of another.[30] Yet it is difficult to envisage the dramatic changes needed, and token efforts are likely instead. This is because at the heart of that very problem lies the unrealistic notion of health that is a central feature of western living, and the corresponding reliance that has developed on health care services. Also, cause-effect relationships may often appear stretched. For

example, few Londoners would be happy about the closure of an intensive care unit in central London, on the grounds of reducing greenhouse emissions to avert flooding in Bangladesh. But more straightforward examples in public health illustrate the proximate utilitarian spirit. Speed bumps, for instance, are hugely popular because they reduce traffic accidents locally, but they also increase greenhouse gas emissions from motor vehicles.

So far, the focus of this second criticism has related to geographical proximity. But utilitarianism also has a temporal bias. The utilitarian philosopher JJC Smart argues that it is impossible to envisage the total future situation because it stretches to infinity.[31] According to Smart it is unnecessary in practice to consider very distant consequences, as these in the end approximate rapidly to zero like the furthermost ripples on a pond after a stone has been dropped into it. He defends this presentism:

> "The necessity for the 'ripples in the pond' postulate comes from the fact that usually we do not know whether remote consequences will be good or bad. Therefore we cannot know what to do unless we can assume that remote consequences can be left out of the account."[32]

This issue is particularly acute for climate change, and policies related to it, as the environmental, financial, and health impacts will not only occur in the future, but in the distant future. Economists have a general way of dealing with this phenomenon called 'discounting', an analytical tool to compare economic effects that occur at different points in time.[vii] But there are different discount rates available and "the choice of discount rate is of crucial technical importance for analyses of climate change policy, because the time horizon is extremely long, and mitigation costs tend to come much earlier than the benefits of avoiding damages."[33]

[vii] The basic premise behind discounting is that a million pounds to me now is of more value than a million pounds in a year's time.

There has been extensive, unresolved debate about discounting in assessment of climate change policies, a debate which reminds us that facts alone cannot provide moral judgements. The latest IPCC publication emphasises that uncertainty regarding the discount rate "relates not to calculation of its effects, which is mathematically precise, but to a value judgement about the appropriateness of the present generation valuing services for future generations."[34] Environmental philosophers have pointed out that any form of discounting devalues the environment, and the benefits it holds for future generations.

The final criticism of utilitarianism relates to equity. The summation and averaging of utilitarian calculations insufficiently recognises the importance of how utilities are distributed within the population under consideration. Whether the utility is health or wealth, there is no difference between a population in which a small number have a lot of (good) health and the remainder have poor health, and a population in which everyone is reasonably healthy. And this does not sit comfortably with our common-sense morality, as Williams states:

> "In this light, utilitarianism does emerge as absurdly primitive, and it is much too late in the day to be told that questions of equitable or inequitable distribution do not matter because utilitarianism has no satisfactory way of making them matter. On the criterion of maximising average utility, there is nothing to choose between any two states of society which involve the same number of people sharing in the same aggregate amount of utility, even if one of them is relatively evenly distributed, while in the other a very small number have a very good deal of it; and it is just silly to say that in fact there is nothing to choose here."[35]

So, if climate change illustrates that utilitarianism is a limited moral determinant of public health policies, an alternative is needed. And here, recent developments in the climate change debate suggest an alternative might be emerging.

Other moral frameworks for public health 1

Social justice and climate change

There is a huge literature on justice stretching back as far as the Greeks. Aristotle, for instance, in the *Nicomachean Ethics* considers just actions, and likens the characteristic of being just to the other 'excellences' – or virtues of character. For Aristotle justice is a mean, injustice represents the extremes, and the just man[viii] recognises how to determine an individual's appropriate share. Justice is "that by which the just man is said to do by choice what is just and to be one who will distribute either between himself and another or between two others ... so as to give what is proportionately fair."[36] Aristotle's perception of justice, and some of its problems, are returned to later in the chapter.

In contemporary times social justice has come to embody aspects of the last part of Aristotle's definition, fairness and proportionality. In contrast with legal and retributive justice, social justice is about the distribution of society's benefits and burdens and the socio-political mechanisms that enable such distribution to occur. This distinction of degree is exemplified in the debate about healthcare provision.[37] [38] Despite extensive ethical and philosophical discussion about fair allocation (or rationing) of healthcare resources and services, in practice economic analyses have dominated decision-making, and it is questionable how much the debate has actually influenced the institutions and processes that determine decisions at national and local levels. Only recently has research begun to look more closely at these issues.[39]

As illustrated in this fourth case study, the approach taken in dealing with climate change has certainly extended the boundaries of moral debate in areas of public, and public health, policy-making. Because the causes and effects of climate

[viii] I am using man here, rather than person, to represent Aristotle's depiction, which focused predominantly on men.

change are differentially distributed, the reasonableness of basing decisions purely on utilitarian economic thinking has been questioned. Climate change has pushed to the forefront, and into the public realm, issues that appeal directly, and instinctively to people's common sense morality. It simply does not seem fair that islanders in the south Pacific should lose their homes because of two centuries of industrialisation in the west, and the profligate lifestyles this development has engendered. And it simply does not seem fair that the next generation of children in coastal Peru might suffer cholera and dysentery for the same weather-related reasons.

As a result there has been a flurry of academic work looking at equity considerations in the climate change debate. But before outlining what this work has explored, it is necessary to consider what frameworks could be used. One way of determining how to distribute the costs of climate change mitigation and adaptation policies would be *not* to try to 'falsely' distribute such costs at all, but to allow the market to decide. But libertarian, or market utilitarian, approaches would likely lead to rich countries not valuing, or not wanting to pay, for such policies, and poor countries being unable to afford them. Unless there was some kind of catastrophic threat from climate change, poor countries might well be left to simply deal with the consequences.

An alternative framework would be contractarian, also sometimes called administrative utilitarian. In this approach, the limits of using total sum or average utility as a sufficient determinant of policy are acknowledged, and efforts are made to incorporate additional dimensions to economic calculations to allow for more informed, and apparently fairer, distribution. These have figured strongly in the debate and will be returned to, but criticisms can still be levelled at inherent deficiencies in valuing human health, the environment, communities at a distance and future generations.

The third framework has been intensely advocated as egalitarian, and has drawn heavily on the concept of social justice. In fact, one person's theory has been

stressed within this dimension of the debate, John Rawls, whose name can be found scattered among the articles, discussion papers, and policy-related documents on equity issues in climate change. But Rawls is also emphasised by those working on the contractarian approach mentioned above, so, before examining how Rawls's ideas have been applied, it is necessary to look at the theory itself.

* * *

Rawls's *A Theory of Justice*[40] was first published in 1971 and 30 years on the impact remains remarkable. And despite criticisms, revisions and reprints, arguably no rival theory of justice has contested its pole position, or lasted so well. And yet, most public health workers today would probably never have heard of it, a reflection that will be considered in the recommendations section of the thesis.

Rawls thinks of justice as fairness. He starts from the premise that utilitarianism is an inadequate, inappropriate, and ultimately unjust moral or politico-economic tool for making distributive decisions in society. For Rawls justice *denies* that "the loss of freedom for some is made right by a greater good shared by others." And justice does *not* allow "that the sacrifices imposed on a few are outweighed by the larger sum of advantages enjoyed by many."[41] Instead Rawls defines justice as "a characteristic set of principles for assigning basic rights and duties and for determining what they take to be the proper distribution of the benefits and burdens of social cooperation."[42]

Rawls makes two other key assertions. Firstly he argues that people's perceptions of entitlement – and so too of justice or fairness – are inevitably shaped by their own backgrounds, interests and social organisations. While Rawls accepts that human beings naturally have certain interests – for instance striving for basic primary goals – most interests are not of this nature and any agreed notion of justice needs to be reached before the undue influence of unnatural interests.

Secondly, he predicates that any social advantages obtained through chance – by birthright or natural endowment – are essentially unfair.

Putting these together Rawls sets out to establish the principles of justice for the basic structure of society that would be agreed by individuals in an 'original' (or abstract pre-existence) state. Taking the form of a social contract these principles are those that "free and rational persons concerned to further their own interests would accept in an initial position of equality as defining the fundamental terms of their association."[43] This initial, or 'original', position corresponds to the state of nature in the traditional theory of the social contract. Rawls purports that the "original position is ... the appropriate initial status quo, and the fundamental agreements reached in it are fair." This, he continues, "explains the propriety of the name "justice as fairness": it conveys the idea that the principles of justice are agreed to in an initial situation that is fair."[44]

So Rawls sets up this original position and makes procedural justice the basis of his theory: the procedure is the contract, or the principles of justice, that would be determined by those sitting in the hypothetical position. Rawls now recognises the importance of nullifying "the effects of special contingencies which put men at odds and tempt them to exploit social and natural circumstances to their own advantage." This he does by situating parties making the contract, and in the original position, behind 'a veil of ignorance' so that they "do not know how the various alternatives will affect their own particular case and they are obliged to evaluate principles solely on the basis of general considerations."[45]

Behind this veil "no one knows his place in society, his class position or social status; nor does he know his fortune in the distribution of natural assets and abilities, his intelligence and strength, ... his conception of the good, the particulars of his rational life, or even the special features of his psychology such as his aversion to risk or liability to optimism or pessimism."[45] Of special significance to the climate change debate, Rawls also highlights the moral relevance of the environment and of future generations:

> "The persons in the original position have no information as to which generation they belong. These broader restrictions on knowledge are appropriate in part because questions of social justice arise between generations as well as within them, for example, the question of the ... conservation of natural resources and the environment of nature ... They must choose principles the consequences of which they are prepared to live with whatever generation they turn out to belong to."[45]

So parties in the original position have facts concealed from them by the veil of ignorance. They do not know where they will fall in society, what ordinal levels of wealth and income they will receive, what opportunities will befall them by virtue of their social positions. They do not know what their lot will be. From this position Rawls argues that parties would agree to two principles of justice and, by extension, these are the principles that society should strive to promote and maintain. The two principles are:

1. Each person is to have an equal right to the most extensive scheme of basic liberties compatible with a similar scheme of liberties for others.
2. Social and economic inequalities are to be arranged so that they are both (a) reasonably expected to be to everyone's advantage, and (b) attached to positions and offices open to all.[46]

The first principle sets out generally that all social values – liberty and opportunities, income and wealth, and the social bases of self-respect – are to be distributed equally. These Rawls calls primary social goods, assets that every rational human being is presumed to want, but the attainment of which is unduly, and unfairly, influenced by historical and social fortune. In contrast Rawls labels individual talents and abilities, such as intelligence and vigour, as primary *natural* goods, the differential distribution of which is an acceptable aspect of the human condition. He acknowledges that these goods or characteristics are influenced by social structure but claims they are less directly under its control. Interestingly Rawls also brackets health as a natural good, a perhaps contentious point given

the recent growing understanding of the relationship between income and health. This is touched on later in the section on inequalities in health.

Rawls is not concerned with challenging the allocation of natural goods, but justice requires fair distribution of social goods. So the second principle, named the difference principle, attempts to rebalance the arbitrary effects of the natural lottery, and gives weight to considerations he describes under the principle of redress:

> "This is the principle that undeserved inequalities call for redress; and since inequalities of birth and natural endowment are undeserved, these inequalities are to be somehow compensated for. Thus the principle holds that in order to treat all persons equally, to provide genuine equality of opportunity, society must give more attention to those with fewer native assets and to those born into the less favourable social positions. The idea is to redress the bias of contingencies in the direction of equality."[47]

Rawls describes the two principles as providing together the 'maximin' (*maximum minimorum*) solution to problems of social justice. Any putative policy, and alternatives, will have a range of outcomes which may differentially impact on those well off and those less well off. The maximin rule ranks alternatives by their worst possible outcome and advises adopting the option, the worst outcome of which is superior to the outcome of the others. The worst outcome refers to the impact of the policy on those worst off, and the goal is to maximally improve their situation.[48]

Rawls elaborates that the best arrangement possible, a perfectly just scheme, is when the expectations (or lot) of the least advantaged are maximised, and no change in those better off can improve the situation of the worst off. But society is constantly changing, equilibrium is not fixed, so a just arrangement (but not the perfectly just arrangement) is that in which any increase in the expectations (or lot) of the more advantaged would increase that of the least advantaged. Any improvement in the welfare of the more fortunate must contribute to the welfare of the less fortunate. But the perfectly just state has not been reached, and only

exists when the lot of the worst off has been maximised and any improvement to the better off would not improve the lot of the worst off.

Rawls adds a vital caveat, which is often under-emphasised. The situation described above could guide policies that widened existing inequalities, in say wealth, so long as the poorest had some, however tiny, gain. A policy that lead to the richest 10% earning an extra £1 million could be acceptable if the poorest resultantly earned an additional penny. Of course it would have to be ranked and considered against competing policy options, but nevertheless would be theoretically possible. So Rawls qualifies the conditions and stresses that a scheme is unjust when the lot or expectations of the advantaged are 'excessive' and a decrease in their situation would improve that of the least favoured.[49]

Fairness issues in the climate change debate

Armed with the basics of Rawls's theory of justice, it is possible now to return to the climate change debate. The starting-point for the distributive concerns in climate change are three related questions: who is responsible for the problem; who will suffer (most) from the problem, and how; and who will bear the costs of abatement? The four fairness issues in climate change policy that correspond to these questions have been expressed as follows:[50 51]

1. What is a fair allocation of the costs of preventing the global warming that is still avoidable?
2. What is a fair allocation of the costs of coping with the social consequences of the global warming that will not, in fact, be avoided?
3. What background allocation of wealth would allow international bargaining (about the first two points) to be a fair process?
4. What is a fair allocation of greenhouse gases over the long-term and during transition to the long-term allocation?

In trying to address the fairness issues in climate change, debate has actually focused on an administrative utilitarian (or contractarian) approach, drawing in, to a degree, some Rawlsian ideas of social justice. The IPCC, for example, distinguishes two categories of equity as significant to climate change analyses: procedural equity and consequentialist equity. The former is largely about making policy, focusing on the criteria and methods for implementing fair procedures for design of, and participation in, the decision-making processes, as well as respect for legal rights. It is about inclusion, fairness and openness at all stages in the policy-making processes and corresponds to item four on the list on the previous page.

Consequentialist equity, in contrast, corresponds to items in the earlier list, and is about the outcomes of climate change (and policies addressing climate change): justice and fairness in respect of the *impacts* of climate change, and justice and fairness in respect of *abatement*, in other words the distribution of burdens and allocation of benefits associated with reducing greenhouse gas emissions and managing climate change. Consequentialist equity has been further divided into *intra*generational equity (although actions by individuals in contributing to greenhouse gas emissions may affect anyone, impacts reflect vulnerability and are borne differentially by social groups or countries depending on their geography, economic development and so forth) and *inter*generational equity (costs of abatement may be borne now but benefits may not be realised well into the future). Consequentialist equity takes on board the widely flouted 'precautionary principle', which dictates that when there is serious doubt about likely environmental impacts and consequences, decisions should be made that err on the side of safety.[52]

The IPCC has postulated there are several traditions in attempting these calculations, some of which have an egalitarian base. But the traditions are, in the main, about how the cake is divided rather than how the cake is made, perceived or valued: 'parity' of burdens and benefits (equal distribution to all claimants, 'egalitarian'); 'proportionality' of burdens and benefits (distribution in proportion

to contribution of claimants); priority (according to greatest need, emphasises basic needs and minimum level of wellbeing); classical utilitarianism (maximising total utility); and Rawlsian distributive justice (described as equal distribution unless unequal distribution operates to benefit the least advantaged). The IPCC sometimes appears to consider Rawls central:

> " A basic needs approach ... involves allowing countries the right to emit the minimum levels of greenhouse gases needed to meet the *basic needs* of their citizens, defined as the minimum consumption levels needed to support full participation in society, and then requiring countries to buy (or pay taxes on) the rights to emission levels above these ... This approach can be related to Rawlsian philosophy."[53]

Such efforts to introduce elements of fairness, however, need to be considered against the backdrop of the domination of the economic *weltanschaung* in which they are placed, and indeed calculated. Early on, economic models – collectively termed Integrated Assessment Models (IAMs) – were developed to allow detailed analysis of greenhouse gases (full cycle of anthropogenic gases, concentrations of gases in the atmosphere), resultant climate change, impacts on society and economy (economic losses as the 'damage function'), and the costs of slowing climate change ('cost function'). The belief was that, through "creating the same metric for cost and benefit assessments, IAMs [could] be used to develop economically efficient policies".[54]

But limited attention is paid in such models to equity concerns and, despite more creative recent inclusions, to some the debate over climate change policies represents the discomforting conceptual imperialism of economics. As Harvey stresses , "some sort of hegemonic economistic-engineering discourse has come to prevail which ... has the effect of making us 'puppets of the institutional and imaginary worlds we inhabit'... by commodifying everything and subjecting almost all transactions ... to the singular logic of commercial profitability and the cost-benefit calculus."[55]

Economic analyses such as IAMs have embedded within their methodology a picture of human manipulation of the natural world, and the natural world seen largely in terms of monetary value. As well as the deep-seated flaws in representing the world in such a way, such analyses also misrepresent that which people actually value:

> "Many valuable goods escape the net of the national income accounts and might affect the calculations of the economic effects of climate change ... Among the areas of importance are human health, biological diversity, amenity values of everyday life and leisure, and environmental quality. Some people will place a high moral, aesthetic or environmental value on preventing climate change, but I know of no serious estimates of what people are willing to pay to stop greenhouse warming."[56]

Yet despite acute criticisms of this kind, the range of criteria brought into the calculations do indicate efforts to address concerns about global social justice within the climate change debate. Linnerooth-Bayer suggests Rawls has been instrumental, postulating that "moral reciprocity in the veil of ignorance forces individuals to treat others as they would want to be treated themselves, making responsibility to fellow humans an intricate functional property of Rawls's justice scheme."[57] But this inflated assertion perhaps misses the reality. There may have been a shift in social conscience, if not in practical policy outcomes, with Rawls a useful resource to draw on. But this has remained predominantly within an economic framework (and all the limitations embedded within that) built on administrative utilitarian thinking.

Climate change and climate justice

The intellectual and theoretical developments described in the previous section have been mirrored in two parallel, connected sets of processes in the climate change debate: developments in international policy around managing climate change; and growth in the campaigning efforts of pressure groups. There is not scope here to look at how international policy developments have captured

Rawls's ideas, although I have described these in *Air, the Environment and Public Health*.[58] Instead, climate justice will be explored here.

In parallel to policy developments and negotiations (and sometimes providing evidence for them) there has been a groundswell in 'independent' think tanks, non-profit making organisations, and other new bodies established to press for fair and generally more aggressive policy targets relating to climate change. A number of these have expressed their opinions and activities in terms of global justice, and their mix of conscience-driven academics and pressure-group campaigners has provided both the intellectual base and the energy needed to drive activities forward. There is the feel of a throwback to the lobbying efforts of the first half of the twentieth century to clean the skies of air pollution, as described in the second case study.

The Global Commons Institute (GCI), for instance, was set up in 1990 in London, and has been encouraging awareness of its solution to climate change called *Contraction and Convergence*. Put forward as the suggested international framework for the arrest of greenhouse gas emissions *Contraction and Convergence* argues that economic growth can continue at current ('business as usual') rates only provided large efficiency gains are made and nearly all energy comes from renewable sources.[59] [60]

Another group, the cleverly named US-based EcoEquity, is committed to advancing equal rights to global commons resources, in particular the principle mentioned earlier of equal per capita rights to the atmosphere. Lamenting both US rejection of the Kyoto Protocol and also the Byrd-Hagel resolution,[ix] EcoEquity argues that fairness "cannot and will not mean that the rich go on as before", and that a climate treaty will have to embody a "fairness that is acceptable in China as

[ix] A campaign prior to the Kyoto negotiations of 1997 led to 95 US senators demanding developing countries also take on firm reduction commitments, so challenging the UNFCC principle that developed countries take the lead in reducing emissions.

well as the United States." EcoEquity hopes to deepen and clarify the meaning of climate justice through drawing together academics and non-government organisations into the global justice movement: "What will we be doing?" poses the EcoEquity website, then answers, "Working to bring the many threads now being spun around climate justice together into a stronger web, one that can support a broader political strategy."[61]

There are other individual groups or organizations,[62] but a powerful coalition of groups – including CorpWatch, Friends of the Earth International, OilWatch Africa and the World Rainforest Movement – gathered as the 'International Climate Justice Network' at the final preparatory negotiations for the Earth Summit in Bali in June 2002. The coalition developed a set of principles aimed at 'putting a human face' on climate change. The 'Bali Principles of Climate Justice' first list (as a series of 'Whereas') the nature of the problem (caused primarily by the rich; felt disproportionately by small island states, coastal peoples, women, the poor and others; violating human rights) then state 27 core principles of the international movement for Climate Justice. These include, as numbered by the network:

1. Affirming the sacredness of Mother earth, ecological unity and the interdependence of all species, Climate Justice insists that communities have the right to be free from climate change, its related impacts and other forms of ecological destruction.

8. ... Climate Justice protects the rights of victims of climate change and associated injustices to receive full compensation, restoration, and reparation for loss of land, livelihood and other damages.

26. Climate Justice requires that we, as individuals and communities, make ... choices to consume as little of Mother Earth's resources ... and make the conscious decision to challenge and reprioritize our lifestyles, re-thinking our ethics with relation to the environment and Mother Earth.[63]

Within the context of this case study - the approach taken to dealing with climate change – these principles illustrate that Rawls's social justice has provided an alternative moral framework to utilitarianism for public health. The climate change debate has spawned a range of academic, policy and pressure group writings reflecting ideas articulated by John Rawls. Connected to this, the climate change debate has also become an arena for expression and discussion of the perceived reasons for many of the world's ills: the impact of industrialisation and of modern western lifestyles, global poverty, and the conceptual imperialism of economics.[64 65 66]

The approach to dealing with climate change is not the only public health-related area in which Rawls's ideas have been invoked. The subject of inequalities in health has also drawn on Rawls, as I have discussed elsewhere.[58] However, within this case study it is now important to look at how the approach to dealing with climate change has thrown up another possible moral framework for public health.

Other moral frameworks for public health 2

Environmental ethics and public health

Separation and disconnection: science, nature and political philosophy

The origins of today's environmental problems, and the relevance of this to public health, can be traced through the inter-connected paths of progress in medicine, science and political philosophy over the past few hundred years. It is necessary to outline these developments in order to understand the place of environmental ethics.

Prior to the seventeenth century western medicine still drew strongly on Greek ideas and beliefs, even though practical aspects had changed somewhat. Disease

was understood as bodily imbalance, or disturbance of the equilibrium, interpreted by physicians through symptoms and signs. Treatment was geared towards re-orientation of balance, both within the individual and with nature, and remedies used were of natural origin.

In the seventeenth century, Cartesian dualism split mind from matter and, in so doing, began the separation of facts from values.[67] In the centuries to follow Descartes, huge strides were made in understanding the facts about the way the world works, both the physical world that surrounds us and also the matter that makes up our own bodies. Mechanistic philosophy pictured the world as a machine, with explanations needed for the mechanisms hidden behind the phenomena that we see or otherwise come to observe. Mechanisms have causes and effects and, however complex these may be, they can be broken down to simpler mechanisms as a means to understanding the larger processes better – and what slowly emerged was the belief that mechanisms could be explained through objective scientific truths. In this way, Cartesianism paved the way for the development of what we think of now as modern medicine, based on the physical sciences.[68]

Making the distinction between mind and matter, however, not only corresponded with creating demarcations between values and facts, but it also altered the way in which we think about those values and facts themselves. The search for the objective has meant reducing, and then further reducing, complex natural relationships to far simpler ones. And in an effort to make the complex more simple and more amenable to scientific investigation, relationships change. Smaller concepts, simplified systems, linear relationships, more direct connections, all can seem to become more important than that from which they came. Believing that the world can be split and explained in such a manner entails commitment to a way of seeing the world that is value-laden in itself, a commitment at minimum to the reductionist vision.[69]

The reductionist vision embodied within Cartesian philosophy marked a change in how we understand the world, and the values we place on different aspects of that world. In attempting to explain scientifically how we function, we see ourselves as individual entities disconnected from the natural world. The disconnection from other people and nature later shifted beliefs about social organisation and the place of citizens within society.[70]

But the natural world, it would seem, does not really exist in isolation, or disconnection, and modern thought – even scientific – seems to suggest we are much more connected than we realised. The Greeks were aware of this, in their understanding of the importance of balance and harmony to human health, both for the individual and in relation to the natural world. The political philosophy of Plato and Aristotle mirrored this perspective in picturing the social organisation of the Greek city-state as an organism, different elements working together for the good, or just, functioning of the whole. And within this framework fitted the individual pursuit of a virtuous life.[71]

In the centuries of Hobbes and Locke, however, this outlook changed dramatically. The development of mechanistic philosophy and progression of science somewhat removed humans from the natural environment, which itself was mechanistically objectified. The era of individualism had begun, with justification of self-interested behaviour and an emphasis on individual and private rights. Personal morality no longer had a special relationship to the State, whose role became that of partner in a dispassionate arrangement that primarily provides an environment suitable for promotion of the individual.[72] Mary Midgley captures this well:

> "Since the Renaissance, this kind of contraction has in any case been happening in political philosophy in the West. Political thinkers of the Enlightenment systematically shrank morality by making it essentially a civic affair – a matter of mutual bargaining between prudent citizens within a limited society. Contract thinking sought to abolish the idea of duties towards anyone or anything outside that society ... But this move had unintended side-effects. It now makes it quite hard for us to make

> sense of our responsibility towards humans outside our own society, and almost impossible to explain our responsibilities towards non-human nature."[73]

The seventeenth-century philosopher John Locke's emphasis on individual rights and property rights illustrate how the era also proclaimed mankind's dominion over nature. The natural environment was articulated in inert, demarcated terms, largely devoid of value, and humans would be morally justified in manipulating it however necessary to further legitimate personal interests. This tied in with ownership, rather than stewardship, of nature, and began to set in stone an image of the natural environment – detached and there for human needs – which has only relatively recently been challenged by environmentalists. [74]

In fact, despite some romantic inclinations, this image of nature was reinforced during the eighteenth and nineteenth centuries as utilitarian political philosophy took hold.[75] As discussed earlier in this case study, utilitarianism has (indirectly) reinforced moral justification for individual pursuit of that which gives pleasure, with maximising human happiness as the overall goal. Manipulating nature to meet these ends has ethical validation, and modern welfare economics – the corner-stone of liberal democracies – is grounded in these ideals. Yet utilitarianism focuses proximally, both in terms of the 'audience' within its calculation (failure to include impacts on those at a distance) and with regard to time – the difficulty of incorporating the needs and desires of future generations. And there is little or no accounting for the intrinsic worth of nature.

As shown in the first case study, utilitarianism emerged politically at a time of corresponding changes in science, medicine and biology. The connection of human health with nature through miasmatic theories of disease was gradually replaced at the end of the nineteenth century by bacteriological explanations, which catalysed the reductionism of medical science. And at that time Darwin and his colleagues were providing a vision of nature that placed self-interested behaviour at its very core, the driver for change, integrally related to adaptation to, and manipulation of, the environment. Not only did this vision reinforce utilitarian

thinking, it also provided a basis for ideas of hierarchies of human social organisation, and justification of social Darwinism.[76]

Brought together, developments over the last 400 years or so have – in secular western living at least – disconnected mankind from nature through a mixture of mechanistic philosophical understanding, scientific and medical reductionism, validation of self-interested behaviour and utilitarian-based political philosophy. Individuals have simultaneously become seen as disconnected from other individuals, flitting around as distinct particles within some form of social apparatus, separated from others and the natural world, with purpose, values and goals narrowly defined. Midgley again captures this well:

> "It is the *social atomism that lies at the heart of individualism* – the idea that human beings are essentially separate items who only come together for contingent reasons of convenience [author's italics]. This is the idea expressed by saying that the state is a logical construction out of its members, or that really there is no such thing as society. A social contract based on calculations of self-interest is then supposed to account for the strange fact that such things as human societies do actually exist."[77]

These developments have clearly impacted on how public health has progressed. There has, however, been a recent counter-vision, in the form of environmental ethics, which has provided a different way of understanding the world. A look at environmental ethics, and its relevance to this chapter's case study, will enable a synthesis of the implications for public health theory and practice.

Environmental ethics

Although environmental ethics has blossomed as an academic activity over the last two decades, its main tenets can be traced back to earlier this century. And, though these fundamentals have been subject to considerable theoretical and philosophical debate, they have also become inescapably linked to socio-political ideologies and movements.[78]

It is difficult to place the various philosophical perspectives on the environment into a bag labelled 'environmental ethics', as they differ in many important aspects, but what they share is a fundamental questioning of the value, or values, ascribed to nature. Yet even here there are different approaches, or ways in, to examining this core. One such approach, a sort of starting point in environmental ethics, is to distinguish between anthropocentric (human-centred) and non-anthropocentric ethics. This is seen as a good place to begin because an oft shared belief in environmental ethics is that the roots of today's environmental problems lie in the moral favouritism given to human interests, this in itself linked to developments in science and political philosophy discussed in the previous section. The moral favouritism, the anthropocentric ethical framework, is then disapproved of in different ways, and for different reasons.

In trying to summarily address what an environmental ethic is, Robert Elliot captures this overview, and presents five sub-divisions. The first, 'human-centred ethics', has modern utilitarianism as an exemplar, in which facts are needed to calculate the happiness yielded by options, but only humans are treated as morally considerable i.e. are included in the calculus. An 'animal-centred ethic' treats individual animals as morally considerable, but may allow ranking to account for different interests and capacities. Treating equal interests equally and unequal ones unequally, for example, would accommodate human ranking above animals based on a different capacity for rational autonomous action. A 'life-centred ethic', on the other hand, counts *all* living things as morally considerable, not just humans or non-human animals. However, while some would ascribe equal moral considerability to all life, such as the 'biotic egalitarianism' of Norwegian philosopher Arne Naess, others allow differentiation, for instance by complexity. This may favour, for example, the biosphere over humans, and leads to a special kind of life-centred ethic termed 'ecological holism', which grants moral considerability to wholes, such as large ecosystems or the biosphere: individuals or species are only important in relation to these wholes. The final environmental

ethic, called 'rights for rocks' by Elliot, extends moral considerability to all as an 'everything ethic'.[79]

Underlying these divisions, or different perspectives, is the justification for any kind of environmental ethic, which is the question of what makes something worthy of moral considerability – worthy of consideration when judging the morality of action.[80] Humans are morally considerable because they have interests that can be promoted or harmed, based on their human capacities – for rational thought and action, and sentience. However, not only is sentience shared by some animals (which could extend moral consideration to them), but moral considerability could lie elsewhere, in some other intrinsically valuable property, for instance complexity or even beauty. This in turn would shift moral considerability to non-sentient animals, plants,[x] ecosystems or the wilderness, and could include non-living[xi] entities.

The different perspectives within environmental ethics lie within a spectrum, which stretches from humans to animals, plants, all living and non-living things, incorporating different concepts of what matters morally. Des Jardins, for example. divides the spectrum up a little differently, but it still incorporates the same elements. His grouping are: biocentric ethics, which is centred around (all) life and has correlative duties;[xii] ecological ethics, which focuses on ecological communities and embraces ethical holism; the 'land ethic', articulated first by Aldo Leopold in 1949, which embraces living things, ecosystems and the land;[81] 'deep ecology', especially that of Naess, which emphasises the deep roots of environmental crises, the radical cure needed (personal and cultural transformation) and forcibly expresses its distinction from shallow anthropocentric environmentalism; and social ecology and ecofeminism, which

[x] The difference between having interests and goals has been stressed by philosophers. A plant may grow towards light or a tree may wither and die, but neither the plant nor the tree, arguably, has attitudes towards these happenings.

[xi] The distinction between living and non-living is often neither biologically or philosophically clear. For instance, a rock may be considered non-living or inert, but what about soil?

[xii] These are non-maleficience (to any organism), non-interference, fidelity (to not betray or deceive wild animals) and restitutive justice (to restore balance if harm done).

explore how social structures serve the interests and power of certain groups, reflected in and reinforced by domination over nature.[82]

However the continuum within environmental ethics is separated out academically or theoretically, a common thread is the difficulty, or failure, to ascribe 'inherent' value to non-human nature, whether that be other animals, vegetation or alternative concepts of what might exist. The anthropocentric nature of western ethics gives, at best, 'instrumental' value to anything non-human; in other words wombats, wild flowers and the wilderness are of value only by way of serving human interests – as pets, for rambling, or as potential new medicines. This has arisen because of entwined developments in science, medicine, and moral and political philosophy that have already been described. It may be fair to reflect that dominion over beasts was heralded back in Aristotelian times, but the contemporary situation is rather different in terms of the success and value placed on liberal individualism, materialism, and the socio-political structures enshrining these ideologies. The present situation is also vastly different in terms of the depth of environmental crises affecting the planet, of which greenhouse warming is just one example. The Australian philosopher Peter Singer, despite holding sentience alone as morally considerable, is sure of the seriousness of the problem, and the extent of change needed:

> "Now we face a new threat to our survival. The proliferation of human beings, coupled with the by-products of economic growth, is just as capable as the old threats of wiping out our society – and every other society as well. No ethic has yet developed to cope with this threat. Some ethical principles we do have are exactly the opposite of what we need. The problem is that ... ethical principles change slowly and the time we have left to develop a new environmental ethic is short. Such an ethic would regard every action that is harmful to the environment as ethically dubious, and those that are unnecessarily harmful as plainly wrong."[83]

Singer then outlines his environmental ethic as including consideration of all sentient creatures now and well into the future, aesthetic appreciation of wild places and nature, rejection of materialistic ideals, promotion of frugality and reassessment of extravagance. He espouses these further, and in more detail, in his

popular classic *How are we to live? Ethics in an age of self-interest.*[84] For Singer, and many others, the connection between environmental ethics and environmental activism (or environmentalism) is strong.

Environmental ethics, environmental justice, climate change and public health

Through the 1990s ideas and values articulated within environmental ethics have spawned developments in two related directions, global ethics and environmental justice. Global ethics, and a spin-off global bioethics, are both broadly concerned with relationships between current western values, damage to the natural environment (often in global terms, for instance around acid rain or loss of biodiversity), and impacts on human health. The latter with its 'bio' prefix pays special attention to the place of the health care system in the same debates.

Alongside has been the emergence of environmental justice. With a broad agenda, this field of academic debate and social activism has been concerned with many of the same areas as global ethics, but with special attention to fairness of distribution of environmental burdens and benefits, as well as just treatment of individuals in respect of environmental matters. Issues of interest range from unfair distribution of the causes of ozone depletion and its unequal health impacts to local matters such as unequal access to green spaces; and of course there is overlap in the climate change area with climate justice. The environmental justice movement embodies is a mixture of environmentalism, environmental ethics or philosophy, together with concern for local community health and global public health. In the main, however, it is not about the health of the environment *per se* (its intrinsic worth), but the health of the environment in relation to human use and its impact on human health – its instrumental value.

It is now more apparent how this chapter's case study fits in. It is now widely accepted that climate change has arisen due to man-made pollution accompanying industrialisation and modern western development. The sequelae of climate

change will impact on the health of the planet, and of humans, now but especially in the future. The causes and consequences of climate change are unequally, and unfairly, distributed. Calls for 'climate justice' have been increasing in reaction to these inequities, as well as due to slowness of progress in policy around mitigation and adaptation.

What this case study highlights, however, is an accumulation of malcontent around western living, western values, care of the environment and global poverty – along with displeasure with policy-makers' efforts to address these. Climate change captures the dissatisfaction of environmentalists and environmental ethicists with the way the planet and its natural resources (which include air) are treated, and is often used as an example or case-study in books and journals of these disciplines.

Climate change, however, still pushes forward anthropocentric views of nature, through its emphasis on the impact on humans. In this sense it is strange to find it in the environmental activist's toolkit, but it is there because it is a powerful example of what happens when nature is inappropriately valued. It is there because it can progress an important agenda, and because it represents growing disillusionment with the way things are.

But changing the way things are has proven hard, as stumbling climate change policy has shown, because the roots of our current problems lie very deep, and have become ingrained in western lifestyles. To have purchase, attempts to seriously tackle problems such as climate change need simultaneously to address the roots that have bred liberal individualism, dominant utilitarian-based political philosophy, materialism and social atomism.

For environmental work within public health, similar arguments apply. As a sub-section of public health, 'environmental health' has always been concerned with the impact that the environment has on human health – not surprising given that 'public health' by name attends to the health of human communities. Not only,

however, is the environment here considered as an instrument, a means, to human well-being, but environmental health largely encompasses man-made damage to the environment and the subsequent effects on humans: contamination of the land with hazardous chemicals; landfill sites; factory products; unwanted effluents into water supplies; and of course air pollution as addressed in the third case study.

More recently, through a combination of attention to inequalities in health and general environmentalism, there has been growing attention to so-called environmental injustices, whether these be global matters such as climate change or more local concerns such as residents in deprived areas living disproportionately close to industrial pollutants. These are important and valuable advances, but in Naess' language they reflect shallow environmentalism, touching only the surface of the problem, and unlikely to yield substantial results. Deep environmentalism, in contrast, requires commitment to radical cures such as significant personal and cultural change.

So far the climate change debate would concur with this. Without addressing the deep roots of the current environmental crisis, without valuing the environment for its inherent worth, real progress in protecting the environment – and indirectly human health – may be hard to achieve. Therein lies the challenge for public health theory and practice – to embrace environmental ethics, as well as social justice, as underpinning moral frameworks.

Conclusions

This final case study has looked at the relationship between air and public health in the context of the approach taken in dealing with climate change, and has explored what this represents and tells us about current and future prospects for public health.

While climate change is a global problem, it is also a global public health problem as the health consequences are severe, and are likely to impact differentially on poorer countries with their limited abilities to cope or adapt. The case study has illustrated some of the deficiencies of utilitarianism as a moral framework for public health.

Within the climate change debate there has been a distinct focus – academically and in policy – on the unfair, or inequitable, distribution, of the causes and consequences of greenhouse warming. This has both involved and spawned an activist movement, which one could collectively call climate justice, involving a combination of intellectual work, debate, websites, and advocacy. The climate justice movement reflects a general growing interest in health inequalities, and health inequities, which have drawn significantly on John Rawls's ideas about justice and fairness. Social justice provides an alternative moral framework for public health.

Not only, however, does climate change reflect interest in health inequities but it also embraces contemporary concerns about the plight of the environment. The activist component of climate justice is an extension of the environmentalism of the 1960s and 1970s, which has been accompanied by emergence of the field of environmental ethics. However, while commitment to reducing inequities is laudable, as is commitment to improving the environment, environmental ethics reminds that the roots of current environmental ideas lie deep. Several hundred years of separation in western thought of mind from matter, subject from object, values from facts, has resulted in the dominance of scientific reductionism over holism, and the devaluing of nature. Connected developments in moral and political philosophy have ingrained utilitarianism and liberal individualism, justifying self-interested behaviour and leading to social atomism. The depth of the problem means meaningful solutions need to be radical.

For public health, the environment has predominantly been of instrumental interest, as it relates to concern with the human health consequences of

environmental damage. While environmental matters such as chemical hazards and even outdoor air pollution are undeniably important, they really only attend to the superficial end of the spectrum, representing shallow environmentalism. For the future of the public's health a more substantial change in attitudes is required, and the discipline of public health needs to embrace the ideals of environmental ethics.

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CONCLUSIONS

This thesis has aimed to explore historically (and thereby increase our understanding of) the relationship between air and public health, and to use analysis of the theme of air and public health as a vehicle to critically examine generic problems in contemporary public health theory and practice, and how these problems relate to current environmental issues.

As was presented in the introduction, this thesis has adopted Sweeney's helpful five-stage framework (p19) for undertaking a piece of historical research:

i) identification of a researchable phenomenon;
ii) forming research questions and hypotheses, and identification of a theoretical framework;
iii) systematic location of source materials;
iv) analysis/evaluation of evidence and information, forming generalisations and conclusions; and
v) writing the report, involving description and interpretation of findings.[1]

In the introduction there was a description of the first stage – the personal journey of the candidate, and evolution of the thesis idea into a researchable phenomenon (p15-18). In chapter one the methods used in the thesis were put forward, beginning with presentation of the research questions that the thesis would aim to address (Sweeney's second stage, p22-23). These research questions will be returned to shortly when bringing together the main findings of the thesis.

Other aspects of the methods used were presented in some detail in the first chapter, for instance location of source materials, and it is not necessary to return to these here. There was also discussion in chapter one of the theoretical framework of the thesis, and how analysis, evaluation and interpretation of the

evidence occurred in an ongoing manner as the research progressed. The analysis and interpretation has been presented accordingly within the main thesis chapters.

In this final chapter it is most appropriate to further interpret and bring together the main findings of the thesis, and to examine what conclusions can be drawn and what challenges remain. In order to do this the chapter is divided into three main sections. First, the limitations and benefits of the methods used are discussed, including reference to an important debate about the relationship between historical progress and historical research Next, the main findings and conclusions of the thesis are brought together, with reference to the research questions posed. Finally, future challenges are presented.

Limitations and benefits of the methods used

As described in chapter one, this has primarily been a thesis in the history of medicine, using historical case studies. There are four historical case studies, each around the theme of air and public health, together making a case series. Each case study has also had inter-disciplinary components built into the historical research, integrating methods and techniques from different academic disciplines, notably philosophy (moral philosophy, political philosophy), health policy and science (epidemiology). Incorporation of other disciplinary techniques has become an accepted part of academic historical research.[2 3]

The case study may have had clinical origins, but has been adopted largely as a qualitative research instrument over recent years, firstly within sociological studies and later within historical research. There is no agreed definition of what a case study constitutes, and this thesis has taken a flexible approach to defining the nature and parameters of the case study. Each case study in this thesis is around the relationship between air and public health, with a different framework and definition provided for each.[4]

There are difficulties and advantages around using a case study approach. Important difficulties lie in defining the case study, and in knowing what conclusions can reasonably be drawn from such a methodological approach. At the beginning of each chapter in this thesis a definition of the case study, and its parameters, has been provided, to aid clarity and guide the work. However, it could be argued that this inevitably involves selection and may introduce bias. For instance, in the first case study the perspectives of only some Greek philosophers are provided; and, in a broader sense, the case studies that constitute the series have been self-selected.[5] These issues have presented real challenges for the project, and can be countered by the need to be expansive because of aims of the thesis and the nature of the research questions,[6 7] and efforts have been made within each chapter to comprehensively cover relevant areas of that case study.

Another criticism of historical and other qualitative research is that it is difficult to generalise from the findings of, say, any particular case study or even from a case series. Such accusations have receded in more recent times with a better understanding of the foundations and goals of qualitative research. Where quantitative science aims to simplify and reduce, historical and other qualitative research aims to explore the complexities of the human and social worlds.[8] Inferences are made from the findings of such research that inform our understanding of social connections, interactions and developments.[9]

Challenges are also posed by bringing other methods into historical research: in this thesis the case studies inter-disciplinary elements.[10] Each research discipline, whether history or epidemiology, has its own methodological limitations, so an inter-disciplinary approach would appear to add a further layer of methodological difficulties. These real challenges have been embraced in the thesis, through efforts at methodological rigour within each discipline that has been adopted, whether gathering historical material, analysing epidemiological data, or applying moral philosophical theories.

There are, however, significant and important benefits of bringing inter-disciplinary elements into historical research.[11] The social world is not demarcated along the lines of academic disciplines, and understanding developments within the social world, such as developments in public health, can be enriched through effective blending of disciplinary methods and approaches. This does not replace the need for , or value of, uni-disciplinary research, but complements it.[12]

Historical progress and historical research

It is important at this point to note that there has been a significant academic debate, of relevance to this thesis, about the relationship between historical progress and historical research.[13]

This debate relates in particular to applied historical research, that is research that pertains to have practical application. For instance, in history of medicine this might be a piece of research that aims to inform or influence current, or new, health policy. This contrasts with more classical historical research, that intends to generate new knowledge by helping better understand the past.

Applied historical research has been criticised, to some degree, by virtue of the way it views historical progress. The traditional way of viewing historical progress employs a 'processual' mode, meaning understanding historical change in terms of sequential development (from past through to present). This, literally, sees historical progress as a process, and research employing this mode allows for understanding the uniqueness of different historical stages or periods.[14]

An alternative way of viewing historical progress employs the 'analogical' mode. Research employing this mode might compare a topic (such as the nursing profession in past and present examples) in different historical periods, arguing by analogy and applying the findings to current policies. To classical historians this

approach has sometimes been seen as more controversial, as it risks negating the gulf between past and present, the intervening periods between the analogies.[2]

Contemporary applied history, however, especially around health and health policy, has increasingly rejected these dichotomous positions, and argued the strength of open-mindedness. It is possible to employ the analogical mode without losing the depth of the past, and contrasts in time can bear fruitful illumination on current issues. It is also possible to combine modes, thereby opening up debates and broadening discussions.[15]

In this thesis, both modes have been employed. There is a processual tone to the chronological connections between the case studies, producing one case series. But there is also some reasoning by analogy, as findings in the case studies are compared with each other, and the overall conclusions build on such analyses.

Main findings and conclusions

As mentioned in chapter one, within each case study there has been integrated ongoing analysis, with conclusions described at the end of the chapter. In this section of this chapter the main findings of each case study, and the case series as a whole, are brought together, along with the conclusions that can be drawn from them. These synthesised findings and conclusions are presented with regard to the four main research questions (p22-23) that were described in chapter one:

- What is our understanding of the historical relationship between air and public health?
- How has the relationship between air and public health changed over time?
- What does this relationship tell us about developments in professional public health, in particular in England and Wales?

- What does the relationship between air and public health tell us about problems in contemporary public health theory and practice, and how these problems relate to current environmental issues?

The *first case study* (chapter two) charted changes in the relationship between air and health from ancient civilisations to the bacteriological era at the end of the nineteenth century. In Egyptian medical thought, air had a special, supernatural place as the creator and sustainer of life, not dissimilar to the life-force *qi* in Chinese medicine, or early Judeo-Christian vitalism, in which the breath of life lay in air, imbued with the Spirit of God.

Greek medicine attempted to remove religious elements and provide the first rational medical theory; but supernatural ideas remained, as the concept of pneuma connected air with the soul in the *Hippocratic Corpus*, and also later in the works of Plato and Aristotle. As well as an emphasis on empirical observation, Greek medicine was, however, naturalistic, understanding mankind as part of nature, and illness as a natural phenomenon. Balance within the body, and between the body and the natural environment maintained health, and imbalance resulted in disease. Air was part of the natural environment, and epidemics were felt to be carried by polluted air, or miasma. But air was also internalised, connected in this capacity with specific illnesses, such as the sacred disease, now known as epilepsy.

The connectivity between air and health in Greek medicine embodied a holistic relationship both within the human body, and between humans and the natural environment. This relationship between air and health continued with Roman medicine, and through to the Enlightenment. By that time, however, air was at the centre of a debate about the causation of infectious diseases. A spectrum of beliefs about disease causation existed, incorporating at one end the idea that poor sanitary conditions created polluted air, miasma, that was responsible for epidemic outbreaks; and, at the other end, minute particles, contagion, were held to be the cause – or a combination of the two explanations was invoked. The

terms miasma and contagion were used unpredictably, sometimes to answer different questions, but air was the medium of disease in both.

This debate about disease causation was framed by a wider debate through the nineteenth century, about the role of the environment in shaping biological and social evolution. Professional public health emerged in the middle of that century with an emphasis on improving the insanitary environmental conditions of the poor. The context was the need for a healthy workforce at a time of economic expansion, but to some the immoral poor were responsible for their adverse living conditions, and assistance would run counter to moral progress.

As scientific rationalism began to underpin medicine, the relationship between air and health lost the spiritualism and holism of earlier epochs. Air became equated with polluted air, first as miasma, then more visibly as smoke pollution. As discussed in the *second case study* (chapter three), naturalism also disappeared from the conception that was developing, of man-made polluted air and its effects on human health. Industrialisation in the cities led to increasing output of smoke from factories, and also from domestic coal fires. The atmosphere darkened, and air in relation to public health corresponded with the adverse effects of the smoke-filled skies on human wellbeing: deaths, respiratory illnesses such as pneumonia and tuberculosis, and psychological effects of the gloom.

As air became reduced to the polluting component of smoke, the statistical search for associations between smoke pollution and mortality or morbidity began. This was repeatedly demonstrated through the early twentieth century but, despite the evidence, and in the face of a growing anti-smoke campaign, policy to reduce smoke levels failed to deliver. The developing public health profession, and Medical Officers of Health in particular, worked with campaigners and with communities, advocating improvements to environmental and atmospheric conditions.

The great smog of 1952 was possibly the straw that broke the camel's back, in terms of leading to change in policy. The severity of that episode, along with public concern and mounting pressure from campaigners, led to a significant legislative event, the Clean Air Act. But this Act was a watered down version of the Beaver committee's recommendations, in particular the Act's failure to cover domestic smoke pollution. And the fall in smoke production that was to ensue over the following decades probably had more to do with falling prices of alternative fuels, as well as a growing emphasis through the 1960s on personal responsibility for matters relating to health – the encouragement of householders to make the change.

The period between the world wars has been referred to as the heyday for the (medical) public health profession, with authority and control at their highest. The profession, however, lost influence over significant medical services with formation of the National Health Service (NHS) in 1948, and its powers were further diminished by the removal of control over sanitary officers and social workers. As public health moved into health authorities, connections with local authorities (where environmental health officers would be located) were attenuated, as was the ability of the profession to engage substantially in matters of environmental health.

Public health may have been bolstered in terms of status in the 1970s through formation of the Faculty of Community Medicine, and through recognition as a medical speciality, but the costs included increased managerial responsibilities over provision of health services, and marginalisation of those not medically qualified. For public health, improving population health became dominated by improving health services, with less emphasis on social determinants and the environment.

During the second half of the twentieth century, the relationship between air and public health continued to centre around polluted air and its effects on human health. But, as described in the *third case study* (chapter four), polluted air was

gradually reduced to its constituent components. First smoke and sulphur dioxide, then oxides of nitrogen, ozone, and particulate matter: particulates have been further divided by diameter, with differential health impacts associated with different diameter particles. The epidemiological search for associations between components of polluted air, and mortality or morbidity, has been extensive over the past two decades.

As the quantitative risk assessment case study illustrated, this reductionistic orientation has been driven by technological and methodological advances – in measurement of pollutants, measurement of health effects, and in data handling and statistical analysis. But the case study also brought out some of the constraints of modern epidemiology: the limitations of 'black box' thinking and the focus on proximate risk factors; the dominance of evidence based medicine and evidence based policy, and the limitations of their positivist nature; the lowly status of cross-sectional studies within hierarchies of what counts as evidence; and the lack of theoretical development around population health.

The *fourth case study* (chapter five), the approach taken in dealing with climate change, represents the final conception of air and public health, and completes the case series. Industrialisation and western lifestyles have led to a warming of the atmosphere, which has resulted in meteorological changes including a rise in average temperature, more extremes of temperatures, and increased incidence of events such as heatwaves and floods. These climatic changes will have a variety of adverse health effects, direct and indirect, although there may be some health benefits. The negative health effects, and the ability to adapt or mitigate against them, are likely to be unequally borne by rich and poor communities and countries.

This last case study raises important questions about the philosophical foundations of public health, and the links between these foundations and other developments in the history of science and moral philosophy. Utilitarianism has traditionally been the foundation of public health practice. But climate change illustrates the

limitations of utilitarian thinking: the focus on proximate impacts (many health effects will occur at a distance from the emitters of greenhouse gases); the presentism (many health effects will occur well into the future); the reliance on empirical data; and the difficulties of taking sufficient account of equity (fair sharing of the burdens of climate change).

First espoused by John Rawls, social justice has emerged as an alternative to utilitarianism, arguing for more equitable distribution of societal burdens and benefits.[16] It remains, however, a contractarian approach, and has been thrust into the climate change debate to press for fairer mechanisms of dealing with the costs (and other burdens) of the damage from greenhouse warming. Extensive academic work around equity issues has informed the climate change policy debate, buttressed by the climate justice movement with its environmentalism and activist component.

However, as is argued in chapter five, social justice is not the only alternative to utilitarianism as a moral framework for public health, and environmental ethics provides another dimension. As is described in the case study, historical developments in moral philosophy are linked to developments in political philosophy and the history of science, and understanding how we value the environment today needs bringing these together to see the bigger picture. The Cartesian separation of mind from matter, value from fact, has impacted in different, but connected ways. In scientific medicine the body, stripped from the environment and earlier holistic conceptions, has become a material entity within which disease may occur. Progressive reductionism has demarcated the body into separate sections, corresponding to different specialities.[i]

In political philosophy, the concern of the Greeks for the well-being of the whole (the city-state), and how this meshed with individual flourishing, has been largely lost – within western capitalism at least. The brutal world of Thomas Hobbes

[i] Parallel reductionistic tendencies have occurred in epidemiology, as discussed in chapter four.

oriented morality around a social contract needed for self-protection and, together with Locke's attention to ownership rights, heralded the individualism that is now the cornerstone of modern liberalism.[17]

Importantly, any way of seeing the world entails a belief about that which should be valued, a moral component. The way we think about our material selves is connected to how we think about our duties to other humans, animals, and the natural world. The accepted emphasis on the individual, and his or her rights, has shifted duties towards others to the responsibility of the state. At the same time, manipulation of the natural environment has become understood as fundamental to individual and utilitarian aims. But reducing nature to an instrument for human needs has dramatically changed the way we see the natural world. [18]

Environmental ethicists would argue that this slow shift, from perceiving the natural environment as having inherent value to having instrumental value (to human needs), is at the core of the current environmental crisis. But the roots of the problem lie deep, and resolution will require considerable effort, and radical reform.

The climate change debate illustrates how most current efforts at environmental improvement really just scratch the surface. And the case study also identifies that public health has adopted a largely instrumental stance towards the environment. For the sake of the health of the environment, and the health of those affected by the environment, it may be advisable for public health to embrace environmental philosophy, and adopt an environmental ethic that accepts the inherent value of the natural environment.

It should be noted here that, while the final case study has indicated that social justice and environmental ethics provide the real alternatives to utilitarianism as moral frameworks for public health, there are other possibilities. In particular, interest in the importance of virtue ethics has been growing,[19 20 21 22 23] as well as the perspectives of the most renowned modern philosopher, Ludwig

Wittgenstein.[24 25] However, there is insufficient scope to explore these here, and I have done so elsewhere.[26]

* * *

Taken in totality it is apparent how the four case studies have addressed the research questions posed. Although the case studies differ qualitatively from one another, presentation of the findings as a series (in the previous section) illustrates how the historical relationship between air and health has changed over time – from a more spiritual and holistic relationship, through the emphasis on smoke pollution and policy, to the epidemiological focus and finally the broader compass of climate change.

In parallel, the sequence of case studies has shown how the relationship between air and public health has progressed historically. Air had a very close relationship with understanding of disease around the period when professional public health emerged in Britain, and public health efforts were important to smoke pollution policy. In more recent times, however, the relationship has separated, both conceptually with the impartiality required of a scientific discipline such as air epidemiology, and also in practice as public health professionals find it harder to engage with environmental matters.

Seeing developments in public health in England and Wales in the context of the case series helps understand the roots of some of the difficulties encountered today. The deficiencies of the theoretical underpinnings – scientific and philosophical – of modern public health are evident, and it is apparent how these deficiencies impact on tackling local environmental issues as well as global concerns such as climate change.

Connections and challenges ahead

Finally, it is important to think about other connections between the case studies, and how these may relate to challenges for the future. There are two types of connections that warrant touching on here.

The first broad connection between the case studies is the issue of complexity. Historical research of the kind adopted in this thesis is valuable to public health because it allows a form of bigger picture examination of a particular subject. Within each case study the complexity of the subject matter emerges (and complexity has been a theme for each), yet using the different disciplines – while remaining within a historical framework – allows one to see the subject matter from differing perspectives. Then, looking at the case series in entirety provides an even broader overview.

The value of seeing the bigger picture,[27 28] together with the importance of complexity and multi-disciplinarity, presents a challenge ahead for public health. It is understandable and appropriate that the scientific basis of public health is taught, but it is imperative that history, ethics and philosophy[29] play a more prominent part in public health education, training,[30 31] and practice.[32 33] In the UK at present, the educational syllabus for the theoretical component of the public health professional examination suggests that there is still some way to go (Table 6.1, p228). In a similar vein, it is also vital that history, ethics and philosophy are central to the development of public health theory, which to date has been limited.[34 35 36 37]

The second broad connection between the four case studies relates to the pivotal place of the environment within public health, and ethical issues pertaining to this. The natural environment used to have a more integrated place in understanding and improving individual and community health. This has been largely lost, and considerations of environmental ethicists would indicate that it should be more prominent. But re-positioning needs to go further than tokenistic shallow environmentalism.[38] Climate change has starkly illustrated the need for deeper environmental perspectives, and has also laid bare some of the limitations of

current ethical and theoretical thinking in public health. But, most significantly, it has also presented the world with the biggest challenge ever to global public health and to global governance.[39 40]

Table 6.1 Part A MFPH Syllabus – knowledge tested (at March 2007)[ii]

1. Research methods (epidemiology, statistics, needs assessment, health economics, qualitative methods)
2. Disease causation and prevention, and health promotion (specific diseases and their epidemiology, screening, genetics, health and social behaviour, environment, communicable diseases, principles and practice of health promotion)
3. Health information
4. Medical sociology, social policy and health economics (includes some aspects of equality, equity and social justice)
5. Organisation and management of health care

[ii] This table has been drawn from the website of the Faculty of Public Health (UK). www.fph.org.uk/exams/part_1/knowledge_testing.asp (accessed 9 March 2007).

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Appendix: additional information on methods

This appendix provides supplementary information, largely pertaining to the methods used in the conduct of the research and to the preparation of the thesis. The details in this appendix augment the methods described in Chapter 1, but draw on the same references – hence no additional references are provided here. A Gantt chart of key milestones is provided as an aid to describing the course of the thesis.

Overall points on methods

This thesis has robustly followed accepted methods in academic history, as captured in Sweeney's 'Five stages in historical research' that are described in Chapter 1. I first gained methodological instruction in social historical methods during my MPhil degree in History and Philosophy of Science at Cambridge University. For this thesis there was academic supervision in historical methods (Dr David Greaves; advisory role of Prof. Virginia Berridge) and academic supervision in public health and ethics (Professor John Porter, Professor Tony McMichael). Further details below are divided according to Sweeney's five stages.

Stage 1 - Identification of a researchable phenomenon

This stage is discussed in the Introduction, with an explanation of the broad development of the thesis and a description of the importance of the enthusiasm of the researcher and the need for familiarity with the subject matter. This thesis also has important connections with clinical practice, which is encouraged within the MD regulations. In particular, such connections include the candidate's experience of the current challenges of meaningfully engaging in environmental matters in public health practice.

Stage 2 - Forming research questions and hypotheses, and identification of a theoretical framework

It is important to note that the bedrock of historical research is its empirical nature and inductive direction, rather than theory. Historical research is scientific with its emphasis on empiricism, objectivity, and rigour, although of course it does not adopt experimental scientific methods. Impartiality and rigour were applied consistently in this thesis to data collection and analysis, as is discussed further in this Appendix.

The research questions are clearly defined in Chapter 1, alongside a discussion of the relationship between periodisation in academic history and the framing of the case studies. In historical research case studies are not used in the same way as in sociological research, just like interviews in historical research (oral history) are not used for the same purposes as in social science.

Academic historians describe the need to be theoretically eclectic and to use a theoretical approach relevant to the research questions. Historians stress the need to 'get above' different theories, because the delineation of theories relates to the demarcation of different disciplines (which have separated for various reasons serving various interests), and the world out there is not artificially demarcated along such lines. This is especially relevant to the macro-historical approach taken in this MD, which combines primary material and secondary literature as relevant to current theory and practice of public health. This thesis has avoided the less practically-relevant and more esoteric micro-historical approach.

The methods, and theoretical framework, in this thesis are those of social history, which embodies understanding how social factors, such as economics, politics and religion, shape historical change (in medicine / public health). Sub-categories of social history do exist, such as Marxist history or feminist history (the latter, say, would endeavour to understand historical change in the context of the oppression of women), but a broad social historical approach is adopted in this thesis. Examples of the social historical approach include: examination in the first case study of how economic factors in the nineteenth century allowed an understanding of the place of miasma in infectious disease causation, within a broader debate about the role of the

environment in directing animal and social evolutionary change; and exploration in the second case study of how political and economic factors dictated the lack of substantial developments in smoke pollution policy and legislation between 1850 and 1956.

In relation to undertaking social historical research the closest theoretical analogy is probably 'grounded theory', with its iterative process of gathering data to generate a theory (or theoretical ideas), and then going back to data to check if the theory upholds. New data may result in changes to the theory, and further iteration, until a final position is achieved.

This thesis also has a progressive inter-disciplinary component, with the incorporation of ethics, and this is discussed in some detail in Chapter 1.

Stage 3 - Systematic location of source materials

For each case study a systematic approach/plan was used to identify historical material, but the approach differed between case studies. For instance, in the second case study there was extensive material to review, which began with literature searches and guidance from supervisors, and developed through further tracking of referenced citations, snowballing, as well as hand searching and exploration of specific resource centres. Appraisal of historical material ended when it was felt that no new data was being generated. In the third case study, the approach was similarly systematic and methodological, but there is less material available on philosophy of epidemiology and the history of public health, so it was clearer when to be able to stop reviewing the material. The plan for identification and review of material for each case study was agreed and discussed regularly with supervisors.

Historical research is empirically rooted, so gathering and appraisal of evidence ends when it is felt that no new data/ideas are forthcoming. Inevitably this involves a degree of judgement as searching could prove endless, but academic historians would argue that such judgement occurs in other related disciplines, such as social science and anthropology. The types of data sources that were used are described in Chapter

1, and predominantly these were primary sources (original documents, publications, legislation, policy documents, newspapers, pressure group publications and secondary sources (articles/books written on those subjects). It was deemed not relevant or possible to use archival sources (e.g. original research notes), given the nature and scope of the thesis.

There is a description in Chapter 1 (p31-32) of some of the resources used, but an expanded description includes: other libraries (also Cambridge University library and Cambridge History of Medicine and History and Philosophy of Science library, LSHTM, UCL); electronic and paper sources for journals (many-fold); institutions and organisations (e.g. Faculty of Public Health, Royal College of Physicians, NSCA); websites (activist groups, environmentalist groups), and web-resources (e.g. History and Policy website).

In this MD there has been substantial use of diverse materials. For example in the first part of the first case study primary sources included Greek philosophers (Hippocrates, Aristotle, Plato), and secondary sources included historical accounts/commentaries on these and other sources (Galen, ancient civilisations). In the second part primary sources included Chadwick's Report, original legislative Acts, Darwin's books, Spencer's books, and original research publications (BMJ pieces), and secondary sources included historical books (Hamlin, Porter, Darwin books), academic articles (History and Philosophy of Science journals and academic history journals such as J Hist Biol, and J Hist Behav Sci).

In the second case study primary sources were Government legislative Acts pertaining to smoke pollution (all Bills and Acts), government policy papers and reports, local policies and laws (e.g. local regulations on smokeless zones), local reports (e.g. of local sanitary inspectors), publications from campaign groups (e.g. NSAS), press material (newspapers), and magazines (e.g. Readers Digest). Secondary sources were published academic articles (medical journals, history journals, meteorology journals, NSAC journal, WHO reports, history textbooks).

In the third case study primary sources were epidemiological data, policy documents on environment and health, original research publications (air pollution,

epidemiological), and secondary sources were some of the extensive journal publications (epidemiological commentaries, philosophy of science articles), and textbooks (history of public health, philosophy, pressure group/advocacy, WHO documents). Corroborating this case study also involved drawing on current personal experience working in public health.

Stage 4 – Analysis / evaluation of evidence and information, forming generalisations and conclusions

In social historical research narrative (accurate descriptive account of the past) and analysis (placing those accounts in social, political or economic contexts) go on in combination – as they do in the chapters of this thesis. Analysis is a fluid, ongoing process in historical research, and there is no distinct point where it starts or ends. Historians talk about using the material flexibly.

In this thesis (for each case study in turn) evidence was marshalled, and progressive assessment was made of such evidence, resulting in a coherent discourse. An interpretive/analytical approach was employed in the analysis, looking for correspondence and patterns, synthesising themes and concepts. The closest analogies in social science are thematic analysis and grounded theory, the latter of which was described earlier.

Throughout data gathering and analysis the verification of authenticity ('external criticism' cross-checks the validity of different sources and 'internal criticism' checks the credibility of a particular source) is an important part of the historical research process. Such verification ensures rigour and enhances the accuracy of the narrative. In this thesis there was constant, and repeated, verification of authenticity, especially around particular key areas. Examples include: verification of the reported differences between the Beaver Report, the Clean Air Bill and the Clean Air Act (different sources reported differences for different purposes, requiring my verification of all original documentation and production of Table 2.2 on p113); verification and clarity about chronological developments in coal/smoke use and production (different sources used different metrics, resulting in some confusion – I distilled and

synthesised reports from different sources to aid clarity into Table 2.3 on p114); and, in the fourth case study, numerous references are made in the climate change debate to approaches adopting Rawlsian social justice. The authenticity of such claims could only be tested by reference to Rawls's original work, which was presented.

It is important in historical research to create a critical synthesis across (sometimes conflicting) accounts. Use of diverse sources is an essential part of this process, and exploration for conflicting or corroborating accounts is key. However, the goal is not to establish the absolute 'validity' of accounts, but to note differences as part of the research process. Historians, like sociologists of knowledge, would argue there is no such thing as 'facts', and all apparent facts are contingent upon the framework within which they are constructed. The MD is limited to 60,000 words, so this has meant synthesis of materials down to manageable amounts. I have elided from the evidence obtained and drawn generalisations/conclusions in the writing. One example of critical synthesis is in case study two, in which different accounts of the problem of smoke pollution are presented – these varied between political interests, medical opinion on health effects, and accounts by campaigners and pressure groups.

Stage 5 - Writing the report, involving description and interpretation of findings

Data gathering and analysis were undertaken in an iterative process in this thesis, as described earlier. When data gathering and analysis ceased, interpretation and writing up of the findings began. Each case study was written up in turn as a coherent narrative, through building up and clearly articulating the arguments. The chronological nature of the case studies aided the development of the thesis as a whole. Conclusions were drawn and that chapter was written up at the end. A whole process of review and revision then followed, including extensive discussion with supervisors (for instance around interpretation and credibility of the findings), eventually resulting in the final thesis.

Key milestones in development and progression of the MD

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Background preparation	X General background reading	X MFPHM Part 2 submission									
Stage 1 - Identification of a researchable phenomenon	X	X	X								
Stage 2 - Forming research questions and hypotheses, and identification of a theoretical framework			X	X							
Stage 3 - Systematic location of source materials			X Case studies 1, 2	X Case studies 2, 3	X Case studies 2, 3, 4	X Case studies 3, 4					
Stage 4 – Analysis / evaluation of evidence and information, forming generalisations and conclusions						X	X	X	X		
Stage 5 - Writing the report, involving description and interpretation of findings							X	X	X	X	
Revision and Review of thesis										X	
Submission of MD thesis										X	
MD Viva											X