CAN HISTORIC AIR QUALITY DATA BE USED TO MODEL INDIVIDUAL LONG-TERM EXPOSURE TO AIR POLLUTION.

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ABSTRACT

Historic air quality data lacks spatial and temporal coverage together with information on the nature of the pollutants sampled. This paper presents the results of two studies, the first using co-located modern and historic particulate monitors and the second historic land-use information. It concludes that there is the potential to use historic air quality data to show both across and within community variation in exposure, providing reference is made to a range of other historic information available.

INTRODUCTION.

The effects of airborne particulate matter on health have been widely reported (Pettinen, et al. 2000) and epidemiological research carried out over the past decade has concluded that there is an increase in short-term deaths associated with an increase in PM_{10} (Pope, 2002). However, many of the reported studies have concentrated on the short term effects of air pollution on health (Brunekreef & Holgate, 2002) with fewer studies attempting to evaluate the longer terms effects of exposure to elevated concentrations of air pollution. Exposure studies investigating the effects of air pollution on lung development in persons now reporting with respiratory problems are also lacking (Pope, 2002). The lack of these studies may be due, in part, to a lack of available information on the concentrations of ambient air pollutants, to which individuals may have been exposed during their early developmental years. However, within the UK there is a vast amount of historical air quality information (Chow, 1995). The data does however lack both spatial and temporal completeness and different monitoring techniques have been used. Historically airborne particles have been collected using deposit gauges (1920-1950) and black smoke monitors (1940 onwards), both of which may measure a different size range of particles to modern PM_{10} monitors (QUARG, 1996). The sites used for monitoring have not been consistent over the entire time span for which results are available and for some areas there may be a total lack of monitored data.

In order to determine the suitability of historic data sets for the development of exposure profiles and determine if alternative data sets can be used to improve spatial and temporal coverage, this paper will present the results of two studies. In the first study, co-located modern & historic particulate monitors have been operated at two sites in the UK. The first is a kerbside site in the City of Sunderland where the major source of particulate matter is vehicle emissions and the second is a rural site in Northumberland, where black smoke from coal fires is still the major source of air pollution. The results presented will detail the nature of the airborne particulate matter sampled by: deposit gauge; black smoke monitor; Partisol 2025(a gravimetric technique, comparable to the EU reference method for airborne PM_{10}); OSIRIS (ex Turnkey Instruments) a real time monitor for PM_{10}, operated at the rural site, and a Tapered Element Oscillating Microbalance (TEOM), operated at the City of Sunderland site. The potential for relating this information to emission data will be reviewed.

The second set of results presented will evaluate historic monitored data for the City of Sunderland as compared to potential sources of pollution in the proximity of the monitors, at the time they were present at the sites. Black smoke monitors were developed and used to monitor black smoke pollution associated with coal burning, however, much of the particulate matter sampled may not have been measured by the reflectance technique used (QUARG, 1996). Therefore should the monitors have been sited near to industry, they may not give an accurate representation of the particulate matter to which individuals in these areas were exposed. Interpretation of the monitored data in terms of pollution sources will give an indication of the suitability of this data for use.

2.1 METHODS.

2.1 MONITORING PROJECT

Monitoring has been carried out using a Partisol 2025 air sampler manufactured by Rupprecht & Pataschnick. Black smoke has been monitored according to the requirements of BS1747 Part 2. Smoke in a sample of air is passed through a filter and the darkness of the stain produced is measured by reflectometer. The measurement obtained is then converted into mass units $\mu g\ m^{-3}$ using a standard calibration curve (BS1747:part 2 1991). The deposit gauge operated complied with BS1747- Part 1. The design of the gauge is such that atmospheric impurities that are deposited by their own weight or with the assistance of rainfall are collected. The deposit gauge was left at the site for a period of one calendar month with results being reported as weight of deposit/unit area/unit time after separation by washing with distilled water through filters of size: 63 microns, 11 microns, 2.5 microns and 0.2 microns. At the rural site a real time measure of airborne particles (PM_{10}) was obtained from an Osiris monitor operated by Tynedale Council. This techniques relies on the light scattering properties of airborne particles. At the site in Sunderland a real time measure of PM_{10} was obtained using a tapered element oscillating microbalance TEOM series 1400 operating at 50^0C. Monitoring was carried out in Sunderland in July 2002 and in Hayden Bridge from November 2003 until March 2004.

2.2 HISTORIC DATA PROJECT.

Data on air pollutant concentrations has been obtained from paper records for the period 1947-1962 from reports to the Scientific and Industrial Research Council whilst information from 1962 onwards has been obtained from the UK government web site (URL 1). Information on pollutant sources has been extracted from historic land-use maps. Information on historical uses of land in all regions is available from Landmark ™ maps, for the years 1856,1921,1936, 1950’s and 1960’s. These maps provide information on potential sources of pollution. Details on the industrial processes and potential pollutants associated with these processes have been obtained from historic process guidance notes and also from contaminated land industry profiles (DOE, 1995). This paper will review the monitored data with respect to one time frame however information is available to cover the whole of the time periods required for the development of profiles.

3.0 RESULTS.

3.1 MONITORING RESULTS

The results for airborne particulate matter as sampled by PM_{10} and BS monitors can be found in Figure 1 (Hayden Bridge) and Figure 2 (Sunderland). The BS filters have been measured by reflectance and the results converted into mass units using the British Standard calibration curve (QUARG, 1996). Whilst the validity of the calibration curve will be dependent on the particulate composition (QUARG,1996), in this initial study the conversion from reflectance to mass has been applied.

At the Hayden Bridge site the highest mass of particulate matter is measured by the PM_{10} monitors whilst at the Sunderland site the results are variable. For some time periods the mass as measured by the BS monitor is equivalent (3/7/02 – 10/07/02) whilst on other occasions the greatest mass is measured by the PM_{10} monitors (13/07/02 – 19/07/02). At kerbside sites particulate pollution is dominated by vehicle generated exhaust (QUARG, 1996) and this carbonaceous material is likely to be measured by all three monitors. However, on occasions the particulate matter sampled at the Sunderland site can comprise a range of inorganic particles such as sea salt, nitrate and sulphate (Bulpitt, 2004) and these particles will not be measured by the BS monitor. This could explain the difference between the results obtained for the three monitors. The Hayden Bridge site is in a rural setting and here the PM_{10} monitors may be recording a range of inorganic particulate matter such as wind blown dusts, again particulate matter that would not be recorded by the BS monitor.

The results for airborne particulate matter as sampled by deposit gauge can be found in Table 1. Deposit gauges are still routinely used for analysis of nuisance dusts by local authority regulators. Historically deposit gauges were the first technique used for measurement of airborne particulate matter. This information is therefore needed in exposure studies, in order to give information on lifetime exposure, for individuals now reporting with respiratory problems

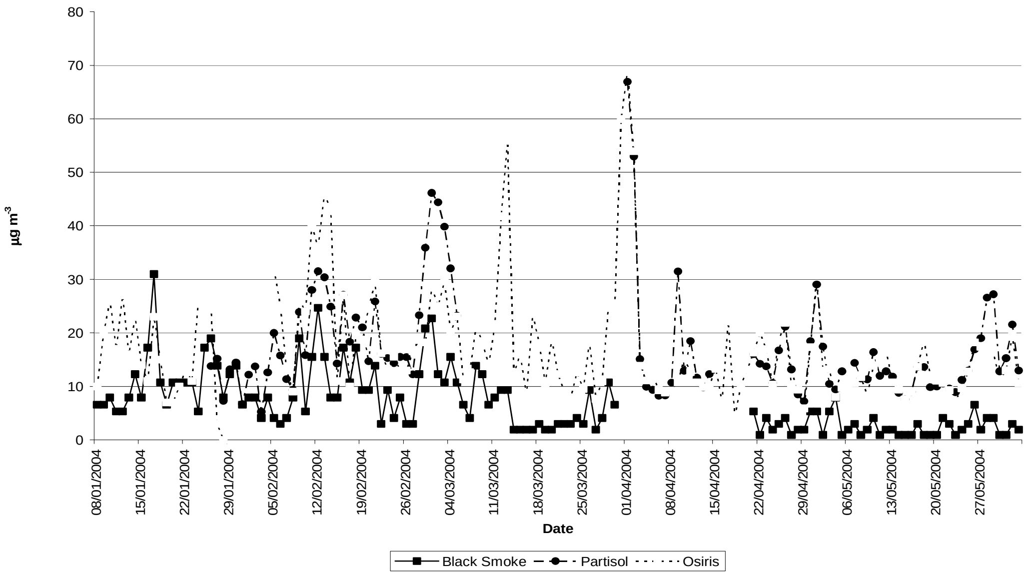

Figure 1: Monitoring Results from Hayden Bridge, November 2003 – March 2004.

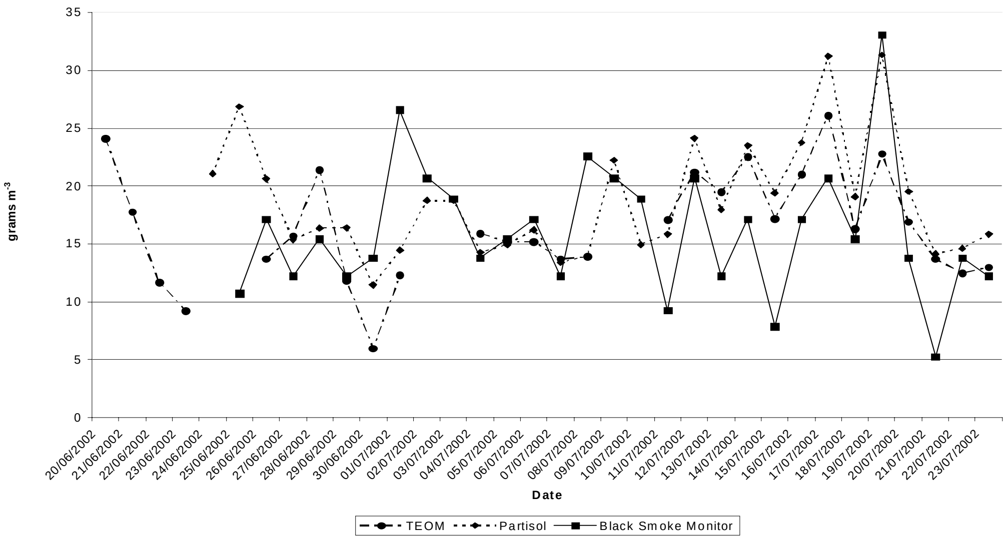

Figure 2: Monitoring Results from Trimdon Street July 2002.

The mass of total deposited particles was greatest at Hayden Bridge as was the mass of PM_{10}. During these time periods the mean daily values for PM_{10} were 16 $\mu g\ m^{-3}$ in Sunderland and 29 $\mu g\ m^{-3}$ in Hayden Bridge. Both monitored PM_{10} and deposited particles being greater, at the times of sampling, at the Hayden Bridge site.

Deposition Rate $\mu g\ m^{-2}\ d^{-1}$	Hayden Bridge Sept.2003-Feb 2004	Sunderland July 2002
>63 µicrons	7.7	5.8
<63 but>11 µicrons	2.5	4.6
<11 but>2.5 µicrons	0.5	0.2
<2.5 but>0.2 µicrons	5.0	-

Table 1: Deposit Gauge Results for Hayden Bridge & Sunderland.

Particles deposited from the atmosphere are likely to be greater than 10 microns in size and outside the range of particles inhaled (QUARG, 1996). However, if the historic deposit gauge data reflects the differences in relative pollution climates across and within communities, it would be possible to use it to indicate areas of relatively poor air quality, for epidemiological studies. The limited results from this study would suggest that this might be possible.

The next step in this project is to collate information on the sources of pollution at the two sites. This will be carried out using fuel use data at the Hayden Bridge site and traffic counts and emission data at the Sunderland site. This information can then be used to relate monitored BS to sources. Information on historical sources, such as numbers of houses, can then be used to infer pollution levels for areas and times where monitoring has not been carried out.

4.2 DATA INTERPRETATION PROJECT.

Air pollution data from two sites has been investigated. At site 1 the monitor is surrounded by housing whereas at site 2 the major sources of pollution are industrial. The major industries at site 2 are: clay, brick & tile manufacture; natural & man-made textiles; transport & cargo handling; railways & timber treatment.

Using both prescribed process notes and the contaminated land industry profiles it is possible to develop an overview of the potential pollutants associated with these industries. However, it should be remembered that the aim is get an insight into the potential pollutants. It will not be possible to determine accurate emissions profiles as information on the quantities of pollutants emitted will not be available. The information can however be used to develop a system of rankings for industry in terms of the potential for the particles generated to have an effect upon respiratory health.

Process	Potential Pollutants	Associated Processes
Bricks & Clay	VOC’s, Fluoride	Energy Generation
Textiles	Inorganic dusts	Energy generation
Dockyards	Coal dusts	Coke& gas production
Timber Treatment	VOC’s, pesticides	
Railways	Combustion particles	Track maintenance

Table 2: Potential Pollutants Associated with Industrial Processes at Site 2.

Table 3 shows that BS concentrations are greater at both sites in the winter (November) with the pollution being slightly higher at the domestic site. In the summer (August) BS pollution is much reduced with concentrations being slightly greater at the industrial site. Further work is needed to review a range of sites and monitored data to determine the relationship between BS and both domestic and industrial emissions. This information can then be linked to the information gained in the co-located monitoring project, in order to estimate pollutant levels in areas where monitoring has not occurred. However, it is likely that a scoring system will have to be developed for industrial emissions as Table 2 shows that some of the particulates emitted may not have been measured by BS monitors.

Site	August	November
1- Domestic	47.2	270.4
2 - Industrial	66.0	248.5

Table 4 Mean BS μg m^{-3} at Sites 1& 2 in Sunderland in August & November 1962.

5.0 CONCLUSIONS

The UK has a wide range of historic monitored air quality data that could be used to develop exposure profiles for use in epidemiological studies. However it lacks spatial and temporal coverage. The initial results for the two studies presented here indicate that it may be possible to improve upon the spatial and temporal coverage for the data in two ways. Firstly by developing pollution indices for industrial sources and secondly by investigating the current and historic relationships between monitored data and emission sources across a range of pollution climates.

6.0 REFERENCES.

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