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Assessing the Impact of Domestic Solid Fuel Burning on Ambient Air Quality in Ireland

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ENVIRONMENTAL PROTECTION AGENCY

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- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Radiological Protection
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA Research Programme 2014–2020

Assessment of Particulate Air Pollution and Polycyclic Aromatic Hydrocarbons Associated with Solid Fuel Usage in Four Towns in Ireland

(2010-AQ-MS-1)

EPA Research Report

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by

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Executive Summary

The European Union (EU) Clean Air for Europe (CAFE) Directive (EU, 2008) set specific limit and target values for air quality that were designed to protect human health and the natural environment in the EU. The World Health Organization (WHO) issued guideline values that are generally more stringent than the EU limit values and are based on protecting human health. This study addressed some of the knowledge gaps that existed as a consequence of the absence of continuous air quality monitoring in some towns in Ireland by determining the air quality in four such towns.

Measurements of particulate air pollution were undertaken at four representative monitoring locations, in Navan, Letterkenny, Tralee and Killarney during 2011–2012. These were chosen as they did not have continuous air quality monitoring. Other selection criteria included similar population sizes, the availability or otherwise of natural gas and the presence or absence of a smoky coal ban.

Particulate air pollution can be measured in a number of different ways. The parameters measured in this study were Black Smoke (BS), particulate matter (PM) less than 2.5 µm in diameter ($PM_{2.5}$) and PM less than 10 µm in diameter (PM_{10}). These were selected as they are associated with residential solid fuel burning. Monitoring was conducted during 2011–2012, encompassing both the "heating season" and the "non-heating season". In addition, a chemical analysis of the PM was undertaken for the presence of selected polycyclic aromatic hydrocarbons (PAHs), as these are specified within the EU legislation. Local weather conditions and local residential fuel usage were also considered in the analysis. Data from the monitoring locations were analysed both separately and collectively and also compared with data from the established continuous monitoring sites in Dublin. At no time during the monitoring did any of the measured pollution parameters exceed their respective EU air quality limits. However, Letterkenny and Tralee were both above the lower WHO guideline values for $PM_{2.5}$ and close to the EU limit values for $PM_{2.5}$. Both were also close to the WHO guideline values for PM_{10}. Levels of PAHs in Letterkenny were at the EU limit value.

The statistical analysis of the data shows that the PAH levels are most strongly associated with the BS measurements. The BS system is particularly sensitive to the measurement of bituminous or "smoky" coal and diesel smoke emissions, which suggests that "smoky" coal and diesel are the major sources of the measured PAHs. This is also supported by the fact that the elevated pollution levels were detected only during the heating season, suggesting that space heating, particularly from "smoky" coal and other solid fuel usage, is the main driver of the elevated pollution levels.

Findings

1. We conclude that particulate air quality in some of the locations monitored in this study is of concern, and this raises the question of whether or not similar locations with no continuous monitoring data may have similar issues in relation to particulate air quality.
2. While at no time during the monitoring were any of the existing EU particulate air quality limits exceeded, this is not grounds for complacency.
3. Considering the four locations where monitoring was undertaken, the highest pollution levels were observed during the "heating season" in those locations that had the highest combined percentages of residential oil and coal heating

Recommendations

1. Future particulate air quality policy in Ireland should be considered in the context of the evolving understanding of the health implications of air pollution levels.
2. A combination of indicative monitoring (including selective chemical analysis) and modelling should be developed to supplement the current national monitoring regime.
3. An assessment of the continued effectiveness of the bituminous coal ban should be carried out and, if deemed necessary, the possible introduction of a national prohibition on the usage of bituminous coal should be considered.

1 Air Pollution in Ireland

Air pollution is known to cause adverse health effects and also to damage the environment in which we live. This specific project is concerned with what we call particulate air pollution, namely tiny particles that are present in the air. There is an extensive research literature relating to the adverse health effects associated with exposure to these particles. The main sources of such particles are normally the combustion of fuels, be it coal, oil, turf, etc., whether they be from industry, motor vehicles or residential heating. There are also some natural sources of these particulates, such as volcanoes and sea spray.

Throughout the 1980s Dublin experienced severe air pollution events, and was frequently in breach of European Union (EU) air quality guidelines. When the government subsequently introduced legislation to ban the marketing, sale and distribution of smoky coal in Dublin [Air Pollution Act, 1987; Statutory Instrument (SI) 123 1990], it proved very effective at reducing air pollution levels (Clancy et al., 2002). The ban was then extended in a stepwise manner to cover Cork city in 1995, (Air Pollution Act, 1987, SI 403 1994); Arklow, Drogheda, Dundalk, Limerick and Wexford on 1 October 1998 (Air Pollution Act, 1987, SI 118 1998); and Celbridge, Galway city, Leixlip, Naas and Waterford city on 1 October 2000 (Air Pollution Act, 1987, SI 72, 2000). In all of these places significant improvements were subsequently observed in the air quality, (Goodman et al., 2009), suggesting that residential smoky coal burning was a major contributor to the local air pollution. The ban was further extended to cover Bray, Kilkenny city, Sligo town and Tralee in 2003 (Air Pollution Act, 1987, SI 541, 2003) and Athlone, Carlow, Clonmel and Ennis in 2011 (Air Pollution Act, 1987, SI 270, 2011). After completion of this study, there were further changes, with the ban being extended from 1 May 2013 to cover Greystones, Letterkenny, Mullingar, Navan, Newbridge, Portlaoise and Wicklow town (Air Pollution Act, 1987, SI 326, 2012). Apart from including these additional towns, the 2012 legislation also extended the boundaries of many of the earlier bans to take account of the expansion of the various towns and cities. In addition, the 2012 legislation also made it an offence to burn smoky coal.

This project commenced in 2011, and by then all the cities and most of the major towns with populations in excess of 15,000 people in Ireland had a ban in place that prohibited the marketing, sale and distribution of smoky coal in those centres. However, there were a number of towns where no ban existed, and where there was no continuous monitoring of particulate air pollution. This project was designed to investigate the particulate air pollution levels in Navan, Letterkenny, Tralee and Killarney. The selection of the towns was based on the following criteria: population size; presence/absence of a natural gas supply; and/or a smoky coal ban.

The project work involved measuring the particulate air pollution, that is, particulate matter (PM) less than 10 µm in diameter (PM_{10}), $PM_{2.5}$ and Black Smoke (BS), at these centres for a full year (6 months for PM_{10} and $PM_{2.5}$), and also conducting a chemical analysis of the filter samples with the intention of identifying the main sources of the pollution at each location. Details are provided in section 4 of the full report available online.

This project was a collaboration between Dublin City Council (DCC), the Health Service Executive (HSE) and the Dublin Institute of Technology (DIT). There was external advice from colleagues at the Harvard School of Public Health. Monitoring and some of the analytical work was conducted by DCC staff. The HSE staff at each of the four monitoring locations facilitated the selection and provision of the monitoring sites within those towns, and they checked and monitored the equipment and loaded and unloaded the sample filters. The chemical analysis of the filters was undertaken by DIT, together with the overall management of the project. The project could not have been undertaken without this collaborative approach.

2 Background to the Study

2.1 Introduction

The project was developed to address the requirements of the Environmental Protection Agency (EPA) 2010 research call to measure particulate air pollution and associated polycyclic aromatic hydrocarbons (PAHs) in some towns in order to assess the impact of residential solid fuel use on ambient air quality in Ireland. The project was also structured to inform policy in Ireland in relation to the Clean Air for Europe (CAFE) Directive (EU, 2008).The main solid fuel used in residential dwellings in Ireland is coal, and all coal products account for 8% of all residential fuel (CSO, 2011).

Four towns of similar population size were selected for this study, namely Tralee (smoky coal ban and no natural gas supply), Killarney and Letterkenny (no smoky coal ban and no gas supply) and Navan (no smoky coal ban but with a natural gas supply). These four centres cover all the potential scenarios of coal usage (or ban) and the availability/non-availability of the less polluting energy source of natural gas. As part of the data analysis, data from these centres were compared with each other and also with data from monitoring sites in Dublin over the same timeframe.

2.2 Health Effects of Air Pollution

It has been known for centuries that air pollution can be harmful to health (Brimblecombe, 1987). Brimblecombe notes that Jonathan Swift recorded that doctors in Dublin advised their ill patients to move to the suburbs away from the “foul air of the city”. Another interesting aspect to Brimblecombe’s book is that a significant amount of the pollution events he refers to were due to coal burning, and he discusses policies introduced to reduce coal usage from the 15th century to the 19th century.

However, it was really only in the 20th century that our knowledge and understanding of air pollution developed. A number of well-documented cases of severe air pollution were shown to be associated with significant increases in mortality: Donora in Pennsylvania (Snyder, 1994); London in 1952 (HMSO, 1954); and Dublin in 1982 (Kelly and Clancy, 1984). In the London episode of 1952, over 4000 excess deaths were recorded over the 2-week period during which the air pollution occurred (HMSO, 1954). However, a 2001 report suggests that the excess death toll was about 12,000 (Bell and Davis, 2001).

The events mentioned above all relate to very severe air pollution episodes. The question arises whether or not adverse effects of air pollution can be detected at low levels of air pollution. From the 1980s onwards, various studies around the world have added to our knowledge in this respect. The Harvard Six Cities Study (Dockery et al., 1993) was a publication that brought the issue of air pollution and heath straight into the public eye. That study showed that people living in the city with the highest air pollution had the shortest life expectancy, and that those in the least polluted city had the longest life expectancy. The big issue, however, was that air pollution in all of those cities was within the US Environmental Protection Agency (US EPA) air quality guidelines in force at that time. The results from multi-city studies in Europe, such as the APHEA project (Katsouyanni et al., 1996) and the NNMAPS study in the USA (Samet et al., 2000; Dominici et al., 2007), show that adverse health effects are still detectable at low levels of particulate air pollution, and that there is no safe “threshold”. The adverse health effects of PM includes the causation or aggravation of cardiovascular and lung diseases, heart attacks, effects on the central nervous system and cancer, and the outcome of all of these may be premature death (EEA, 2012).

In recognition of the adverse health effects of ambient airborne pollution, the US EPA project and the European Commission initially set air quality guidelines in the 1970s. These guidelines have been continually revised, and both the limit values and the pollutants specified have changed over time. The current EU legislation (EU, 2008) requires Member States to conduct measurements of various pollutants in larger urban centres (populations > 250,000) and in all zones within their jurisdiction.

However, for the purposes of this project, we have concentrated our monitoring on a subset of those parameters, namely PM_{10}, $PM_{2.5}$ and PAHs.

2.3 Air Pollution Monitoring and Associated Interventions

Traditionally, particulate air pollution was measured using a technique known as the “Black Smoke” (BS) method (British Standard 1747 and Commission of the European Communities 1980) (British Standards Institute, 1969), which measured the “blackness” of a filter caused by the pollution on that filter following the drawing of ambient air through the filter at a specified flow rate for a given period of time. This particular technique had been designed to monitor air pollution from coal burning. McFarland et al. (1982) showed that this technique samples particles that have an aerodynamic diameter less than 4.4 μm. The EPA report on air quality in Ireland for the year 2011 (EPA, 2012) reported the measurement of both PM_{10} and BS in Ireland. In respect of the BS measurements, it can be seen that most of these measurements were made in large urban areas, where a smoky coal ban was already in place. Routine PM_{10} monitoring is conducted within all Air Quality Assessment Zones in Ireland in compliance with the legislative requirements. Additional PM monitoring is conducted within Zone A by DCC and reported by the EPA. Given the geographical size and the population of rural Ireland that falls into Zone D, an argument could be made for additional monitoring within this large diverse zone.

For example, monitoring conducted by the EPA using their mobile laboratory in 2006–2007 indicated elevated levels of PM_{10} in Ennis. The 2008 EPA report concluded that these elevated levels were due to residential fuel emissions (EPA, 2009). Subsequently, Ennis was included in the 2011 extension of the smoky coal ban. This highlighted the need to gather data for parts of the country not covered by the existing networks. This is where the monitoring undertaken within this project serves to fill some of these gaps.

Although we know that mortality increases when air pollution increases, there are fewer examples of what happens when air pollution is reduced. There was some evidence of a health benefit when fuel mixtures were legislated for in Hong Kong (Hedley et al., 2002), and during an employee strike at an industrial facility in the USA, where the respiratory health of children improved (Pope, 1989; Friedman et al., 2001; Lee et al., 2007; Pope et al., 2007). Each of these documented large-scale air pollution reductions has been associated with a beneficial public health effect. This includes reductions in total and/or cause-specific mortality rates (Hedley et al, 2002; Pope et al, 2007), bronchitis prevalence (Heinrich et al., 2000), childhood hospital admissions for respiratory disease (Pope, 1989), asthma acute care events (Friedman et al., 2001) and childhood asthma hospital admissions (Lee, 2007). Henschel et al. (2012) recently published a review of such interventions, whether planned or not, and showed that in almost all cases the improved air quality was associated with reduced morbidity or mortality. Although not specifically related to ambient outdoor pollution, Goodman et al. (2009) showed that similar consistent results were observed following workplace smoking bans.

An important scientific publication in this area relates to the Dublin coal ban (Clancy et al., 2002), which reported on both the reduction in pollution associated with the ban and the sustained reduction in mortality. Following the success of the Dublin coal ban, further local coal bans were introduced in Ireland. These “coal bans” proved successful at reducing air pollution in all centres where they were implemented (Goodman et al., 2009; EPA, 2010).

However, for the bans implemented in 2003 (Bray, Kilkenny, Sligo and Tralee), there are no suitable pre- and post-ban data to evaluate formally the success of such bans.

Recent studies have shown that removing small particles from indoor air (smoking bans) can improve the health of the general population (Goodman et al., 2007, 2009). Pope and Dockery (2006) in their review of the evidence suggest that fine particles ($PM_{2.5}$), which are normally derived from combustion processes, are those most associated with adverse health effects.

2.4 Justification for the Project in Relation to National and International Research

Previous studies by the EPA (see EPA 2012, 2013, 2014) indicated that there was a lack of knowledge as regards the air pollution levels in some Irish towns. This study undertook to monitor at four such towns with the

aim of filling in some of this knowledge gap. In addition, the study also serves to inform with respect to compliance with EU legislation.

2.4.1 CAFE Directive and 4th Daughter Directive requirements

Key aspects of the CAFE Directive are as follows:

- Member States must conduct detailed measurements of fine PM at rural background locations in order to understand better the impact of this pollutant and to develop appropriate policies.
- In relation to fine PM:
  - Fine PM ($PM_{2.5}$) is responsible for significant negative impacts on human health. Furthermore, there is as yet no identifiable threshold below which $PM_{2.5}$ would not pose a risk. As such, this pollutant should not be regulated in the same way as other air pollutants. The approach should aim for a general reduction of concentrations in the urban background to ensure that large sections of the population benefit from improved air quality. However, to ensure a minimum degree of health protection everywhere, that approach should be combined with a limit value, which is to be preceded in the first stage by a target value. Under the CAFE Directive the limit value is set to be reduced to 25 ug/m^3 from 1 January 2015. Each Member State is also required to apply the following assessments to air quality;
  - Member States shall assess ambient air quality with respect to the listed pollutants in all their zones and agglomerations, where "zone" shall mean part of the territory of a Member State, as delimited by that Member State for the purposes of air quality assessment and management; "agglomeration" shall mean a zone that is a conurbation with a population in excess of 250,000 inhabitants or, where the population is 250,000 inhabitants or less, with a given population density per km^2 to be established by the Member State;
  - Directive 2004/107/EC (EC 2004) gives target values for a number of metals and PAHs in ambient air. Benzo[*a*]pyrene [B(a)P] is seen as a marker compound for PAHs and has been assigned a target value of 1 ng/m^3 for ambient air.

2.5 Project Objectives

The key project objectives and targets were to:

- conduct a review of the impact of residential solid fuel usage on air quality in Ireland, with particular emphasis on coal usage;
- undertake the measurement of ambient PM in four towns over a 12-month period, measuring PM_{10}, $PM_{2.5}$ and BS;
- undertake analysis of the PAHs present on the particulate filters, with particular emphasis on B(a)P levels;
- produce a final report, synthesis report and summary findings on the impact of residential solid fuel usage on air quality.

2.6 Sources of Particulate Air Pollution

Particulate pollution falls into two main categories: natural and anthropogenic. In general, there is not much we can do in relation to the natural sources, which are events such as volcanoes and forest fires and elements such as sea salt and dust, for example Saharan dust.

This study is more concerned with the anthropogenic sources, which are mainly combustion emissions from heating sources (such as coal, oil, peat and wood burning), motor vehicle emissions, industrial sources and electricity generation, and illegal ("back yard") burning.

In this project, our primary concern is particulate pollution (BS, $PM_{2.5}$ and PM_{10}) from residential heating systems. We would expect most of the signal to be contained in the BS and in $PM_{2.5}$ if the sources are combustion. PM_{10}, or more specifically the coarse fraction that is between PM_{10} and $PM_{2.5}$, is more representative of particles from mechanical processes (COMEAP, 1995). A major source of BS in Ireland is open fires in dwelling houses (EPA, 2011)

2.7 Meteorological Conditions

Meteorological conditions have a significant role in relation to air quality. Windy conditions generally serve to disperse and dilute the pollutants, whereas calm weather can facilitate a build-up of air pollution. The weather can also be responsible for bringing air pollution emitted in other countries to Ireland. The role of meteorological conditions is considered in the data analysis in this study, particularly wind speed and direction; see the full online report for details.

3 Particulate Monitoring Methodology

3.1 Pollutants Measured

We monitored PM_{10}, $PM_{2.5}$ and BS at the four chosen monitoring locations. An additional feature of this study is that it also incorporates some chemical analysis of the PM_{10} and $PM_{2.5}$ samples, which, although not completely conclusive, assists in the identification of the likely sources of the pollution.

Monitoring at the chosen locations was conducted for the heating season, October–March inclusive, and the non-heating season, April–September inclusive. BS monitoring was conducted for an entire year at each location; however, owing to budgetary/equipment constraints, it was possible to monitor PM_{10} and $PM_{2.5}$ for only 6 months at each location. These 6 months were strategically planned to ensure that a portion of both the heating and non-heating season was captured at each location. The monitoring results from the project locations are compared with the monitoring results from Dublin city over the same period.

Seven US EPA PAHs were chosen for analysis, all of which are suspected carcinogens and known products of fossil fuel combustion. This is further discussed in the full report available online.

3.2 Sampling Methodology

The sampling methodology that was employed at all sites for BS was British Standard 1747 (BS 1747) for BS. The introduction of the ban on the sale of bituminous fuel in 1990 was primarily based on the results of monitoring BS in urban areas using BS 1747. This allows for an effective comparison between historic data for those urban centres where a ban on bituminous solid fuel has already been introduced and the urban centres within this study. An added advantage of the BS 1747 system was that it was specifically designed to assess pollution caused by bituminous coal. Although BS 1747 is no longer one of the reference methods for the purposes of determining compliance with the CAFE Directive (EU, 2008), the EPA has encouraged all local authorities to retain BS monitoring networks if possible.

Dichotomous Partisol samplers (Thermo Scientific) were used for PM_{10} and $PM_{2.5}$ monitoring, with monitoring at each of the four sites for 3 months of the heating season and 3 months of the non-heating season. PAHs were extracted from sample filters and analysed by high-performance liquid chromotagraphy with fluorescence detection.

3.2.1 Site selection criteria

The criteria used for developing a monitoring site are defined in the Air Quality Standards Regulations 2011. In order to ensure compliance with these criteria, a checklist was developed to assist staff when on site (see Appendix 3 of the main report).

The availability of HSE Environmental Health Officers (EHOs) on site or close by to undertake filter changes was a significant factor. For all sites, consideration of possible pollutant sources and industry emissions were taken into account (details in full report available online). The environmental sections of the local authorities in each of the four towns were consulted in relation to the presence or otherwise of any significant sources of localised particulate pollution.

3.3 Navan (No Restriction on the Sale of Bituminous Fuel and Connected to the Irish Natural Gas Network)

3.3.1 Monitoring site location

Navan is a town located in County Meath, approximately 30 miles north of Dublin city. The town sits at an elevation of 42 m.

The site at which monitoring was conducted was located at Our Lady's Hospital in the town (co-ordinates X686528, Y767584). Our Lady's Hospital is a roadside monitoring location. It sits above the natural valley formed by the Boyne River, which flows through Navan. The site is in a largely residential area, with some office/warehouse buildings and a football field adjacent to it. It is located to the west of the North Eastern Ambulance

Services premises on hospital grounds among the outbuildings. The BS monitoring location was at first-floor level, on the left-hand façade of the building as one looks at it from the R161, approximately 10 m from the R161, and approximately 100 m from the junction of the R161 and Commons Road. The PM sampler was located adjacent to a single-storey building, approximately 25 m from the nearest roadway, the R161, and 100 m from the junction of the R161 and Commons Road. Approximately 250 m west of the site is the N51. There are no obvious sources of large-scale PM or BS pollution in the immediate vicinity of the site. This particular site was selected because it allowed unrestricted access by HSE EHOs and because it complied with the site selection criteria (see Appendix 3 of the main report).

3.3.2 Background information

The population of Navan is 28,586 according to the 2011 Census (CSO, 2012). Natural gas is available in Navan, as it forms part of the national gas supply network. During the period when air quality monitoring was being undertaken there was no restriction on the sale of bituminous coal in the Navan region.

Table 3.1 shows the fuels used for space heating according to the 2011 Census.

3.3.3 Monitoring dates

BS was monitored in Navan from 7 February 2011 until 1 May 2012.

PM_{10} and $PM_{2.5}$ were monitored from 19 January 2012 until 4 July 2012.

3.4 Letterkenny (No Restriction on the Sale of Bituminous Fuel and Not on the Irish Natural Gas Network)

3.4.1 Site location

Letterkenny is a town located in County Donegal and sits at an elevation of 52 m. The monitoring site chosen is a HSE-owned building on Slieve Sneacht Road. The site was chosen because it was previously the site of a BS and sulphur dioxide monitoring programme by the HSE and it complied with the requirements set out in the site selection checklist. Slieve Sneacht Road is a quiet residential estate. There are no major industries nearby. During the monitoring period there was no restriction on the sale of bituminous fuel in the Letterkenny area. Letterkenny is not on the Irish natural gas network.

3.4.2 Background information

The population of the town of Letterkenny is 15,387 according to the 2011 Census (CSO, 2012), and the fuels used for space heating are shown in Table 3.2.

Table 3.1. Main fuel used for space heating in Navan in 2011 (number and percentage of households) (CSO, 2012)

No central heating	Oil central heating	Gas central heating	Electric heating	Coal	Peat	LPG	Wood	Other	Not stated
53 (0.5%)	2877 (30%)	5821 (60%)	548 (6%)	286 (3%)	18 (0.2%)	34 (0.4%)	22 (0.2%)	19 (0.2%)	68 (0.7%)

LPG, liquid petroleum gas.

Table 3.2. Main fuel used for space heating in Letterkenny in 2011 (number and percentage of households) (CSO, 2012)

No central heating	Oil central heating	Gas central heating	Electric heating	Coal	Peat	LPG	Wood	Other	Not stated
51 (1%)	4539 (77%)	237 (4%)	268 (5%)	613 (10%)	29 (0.5%)	61 (1%)	19 (0.3%)	16 (0.3%)	77 (1%)

LPG, liquid petroleum gas.

3.4.3 Monitoring dates

BS was monitored in Letterkenny from 16 February 2011 until 1 May 2012.

PM_{10} and $PM_{2.5}$ were monitored from 7 August 2011 until 17 January 2012 and from 12 July 2012 until 28 July 2012.

3.5 Tralee (A Restriction on the Sale of Bituminous Fuel in Place and Not on the Irish Natural Gas Network)

3.5.1 Site location

Tralee is the largest town in County Kerry, located on the northern side of the Dingle peninsula, approximately 2.5 km from the coast. The monitoring was conducted in two HSE properties, located in a residential area west of Tralee town centre. The sites were chosen because of their ease of access for HSE staff and compliance with the site selection criteria detailed. BS monitoring was conducted in Caherina House, Strand Street (co-ordinates x482863, y614375), at ground-floor level, with the inlet located at a height of approximately 2 m above ground level. Particulates were monitored in the rear garden of the adjacent Caherina House Day Hospital on Spa Road (co-ordinates x482817, y614387). There was a boiler house located approximately 10 m from the PM sampler. The boiler was oil fired, with the flue dispersing at approximately 2.5 m above ground level. The boiler only operated Monday–Friday between the hours of 08.00 and 17.00. The monitoring locations are immediately adjacent to each other. There were no obvious single sources of large-scale PM or BS pollution present in the immediate vicinity of the monitoring location.

3.5.2 Background information

Tralee has a population of 23,693 according the 2011 Census (CSO, 2012). There is a ban on the sale of bituminous fuel in Tralee, which was introduced in 2003. Natural gas is currently not available in County Kerry.

Table 3.3 shows the fuels used for space heating in Tralee according to the 2011 Census data.

3.5.3 Monitoring dates

BS was monitored in Tralee between 24 March 2011 and 9 May 2012.

PM_{10} and $PM_{2.5}$ were monitored between 12 January 2012 and 1 August 2012.

3.6 Killarney (No Restriction on the Sale of Bituminous Fuel and Not on the Irish Natural Gas Network)

3.6.1 Site location

Killarney is a town in County Kerry located north-east of Killarney National Park, and is central to tourism around the Ring of Kerry. It is approximately 28 km to Tralee via the N22. The monitoring was conducted in Killarney Health Centre on St Anne's Road, which forms part of the N71 national route through Killarney town. The site was chosen because of ease of access for HSE staff and compliance with the site selection criteria detailed in Appendix 3 (see the full report online). The health centre is located north-east of the town centre in a largely residential area. It sits in an elevated position above the town centre. The particulate monitor was located externally in the rear yard of the property at ground level.

3.6.2 Background information

Killarney has a population of 14,219 according to the 2011 Census (CSO, 2012) but the population can double in the summer months at the height of the tourist season. Natural gas is currently not available in County Kerry. During the monitoring period, there was

Table 3.3. Main fuel used for space heating in Tralee in 2011 (number and percentage of households) (CSO, 2012)

No central heating	Oil central heating	Gas central heating	Electric heating	Coal	Peat	LPG	Wood	Other	Not stated
242 (3%)	4758 (59%)	218 (3%)	1655 (20%)	867 (11%)	89 (1%)	72 (1%)	78 (1%)	28 (0.4%)	115 (1.4%)

LPG, liquid petroleum gas.

Table 3.4. Main fuel used for space heating in Killarney in 2011 (number and percentage of households) (CSO, 2012)

No central heating	Oil central heating	Gas central heating	Electric heating	Coal	Peat	LPG	Wood	Other	Not stated
78 (2%)	2707 (65%)	85 (2%)	817 (20%)	305 (7%)	33 (1%)	47 (1%)	34 (1%)	15 (0.4%)	47 (1%)

LPG, liquid petroleum gas.

no restriction placed on the sale of bituminous fuel in Killarney. The fuels used for space heating in Killarney, according to the 2011 Census data, are shown in Table 3.4.

3.6.3 Monitoring dates

BS was monitored from 24 March 2011 until 9 May 2012.

PM_{10} and $PM_{2.5}$ were monitored from 7 August 2011 until 8 January 2012 and from 3 August 2012 until 26 August 2012.

4 Monitoring Results

4.1 Limit and Guideline Values for Particulate Air Pollution

Traditionally, air pollution data are presented with mean, median and maximum concentrations of the various pollutants being reported for the monitoring period under consideration. In the case of the EU limit values and the WHO guideline vales for PM, which are presented in Table 4.1, both the annual and daily averages are included.

Table 4.2 shows the limit and guide values that applied to BS monitoring under EU Directive 80/779/EEC. However, BS monitoring has not been mandatory in Ireland since 2005, when EU Directive 80/779/EEC was revoked. As such, there are no enforceable limits currently in place regarding permissible levels of BS pollution. These are provided here for information purposes, and no limits were exceeded at any point during this study.

4.2 Particulate Pollution Results

Tables 4.3–4.5 present a summary of the data collected during this study at each of the monitoring locations.

Table 4.1. EU Limit values and WHO guideline values for particulate matter

EU PM_{10} Limit values	Averaging period	Limit value
24-hour limit value for the protection of human health	24 hours	50 mg/m³ not to be exceeded more than 35 times in a calendar year
Annual limit value for the protection of human health	Calendar year	40 mg/m³
EU $PM_{2.5}$ Limit values	**Averaging period**	**Limit value**
Annual limit value for the protection of human health	Calendar year	25 mg/m³
WHO Guideline values PM_{10}	**Averaging period**	**Guideline values**
For the protection of human health	24 hours	50 mg/m³
For the protection of human health	Calendar year	20 mg/m³
WHO Guideline values $PM_{2.5}$	**Averaging period**	**Guideline values**
For the protection of human health	24 hours	25 mg/m³
For the protection of human health	Calendar year	10 mg/m³

Table 4.2. Limit and guide values for Black Smoke monitoring under EU Directive 80/779/EEC

	Reference period	Value
Limit value	1 year (median of daily values)	80 mg/m³
	Winter (median of daily values)	130 mg/m³
	98th centile of daily mean	250 mg/m³
Guide value	24-hour mean	100–150 mg/m³
	1-year mean	40–60 mg/m³

Table 4.3. Particulates summary – entire monitoring period

Parameter	Location					
BS (daily)	*Navan*	*Letterkenny*	*Killarney*	*Tralee*	*Coleraine Street Dublin*	*Crumlin Dublin*
Mean (µg/m³)	5	12	3	5	No data	5
Median (µg/m³)	3	12	2	3		5
Maximum (µg/m³)	34	32	21	25		25
Day count	442	439	383	413		314
$PM_{2.5}$ (daily)						
Mean (µg/m³)	10	14	5	14	9	No data
Median (µg/m³)	7	12	4	11	7	
Maximum (µg/m³)	47	62	53	50	51	
Day count	143	211	211	160	397	
PM_{10} (daily)						
Mean (µg/m³)	12	17	10	19	No data	No data
Median (µg/m³)	10	15	8	17		
Maximum (µg/m³)	62	68	67	53		
Day count	133	210	211	160		

Table 4.4. Particulates summary – heating season

Parameter	Location					
BS (daily)	*Navan*	*Letterkenny*	*Killarney*	*Tralee*	*Coleraine Street Dublin*	*Crumlin Dublin*
Mean (µg/m³)	7	16	4	7	No data	7
Median (µg/m³)	6	15	3	5		5
Maximum (µg/m³)	34	32	21	25		25
Day count	228	226	190	191		132
$PM_{2.5}$ (daily)						
Mean (µg/m³)	13	21	8	20	12	No data
Median (µg/m³)	10	18	5	19	8	
Maximum (µg/m³)	47	62	53	50	51	
Day count	70	109	100	78	158	
PM_{10} (daily)						
Mean (µg/m³)	16	26	13	26	No data	No data
Median (µg/m³)	13	23	10	25		
Maximum (µg/m³)	62	68	67	53		
Day count	60	108	100	78		

Table 4.5. Particulates summary – non-heating season

Parameter	Location					
BS (daily)	*Navan*	*Letterkenny*	*Killarney*	*Tralee*	*Coleraine Street Dublin*	*Crumlin Dublin*
Mean (µg/m³)	3	8	2	3	No data	4
Median (µg/m³)	2	6	1	2		3
Maximum (µg/m³)	23	23	7	14		12
Day Count	214	213	193	222		182
$PM_{2.5}$ (daily)						
Mean (µg/m³)	7	6	3	8	7	No data
Median (µg/m³)	7	5	2	7	6	
Maximum (µg/m³)	21	20	19	22	40	
Day count	73	102	111	82	239	
PM_{10} (daily)						
Mean (µg/m³)	9	9	7	13	No data	No data
Median (µg/m³)	8	8	7	13		
Maximum (µg/m³)	31	30	26	29		
Day count	73	102	111	82		

4.3 Polycyclic Aromatic Hydrocarbon Results

Detailed information on the measurement methods, calibration and control are provided in the main report, and a summary of the results from the PAH analysis are provided here. The EU (EU, 2008) specifies limit values for PAHs; however, normally B(a)P is specified and is used to represent all PAHs (see Table 4.6).

Table 4.7 gives the mean, median and maximum daily values for each PAH from the PM_{10} fraction ($PM_{2.5}$ + coarse fraction) for heating and non-heating seasons. The highest values for all PAHs were found in the Letterkenny samples, followed by Tralee, Navan and Killarney in descending order.

Table 4.8 gives the mean PAH values based on all the samples analysed for each town. The average values for B(a)P in Letterkenny exceed 1 ng/m³ (n = 156), although the method of rounding the data as per the CAFE Directive gives a value of 1 ng/m³ for Letterkenny, which is at the EU limit. The PAH values in all of the other towns were well below this value.

4.4 Discussion of Particulate Pollution Results

Although there is some spatial variation in the air quality in Ireland, from a European perspective, the overall air quality is good. We have shown that overall air quality with respect to PM is good in the selected towns. This can be demonstrated with reference to the EU legal limit values presented in Table 4.1, which show compliance with these limits. We have, however, also shown that particulate pollution levels in these towns, especially in Letterkenny and Tralee, are noticeably worse than data for Dublin city over the same periods. Based on the

Table 4.6. Benzo[*a*]pyrene limit values

EU B(a)P Limit values	Averaging period	Limit value
Annual average limit value for the protection of human health	Annual average	1 ng/m³

Table 4.7. Comparison of individual polycyclic aromatic hydrocarbons and seasonal data for all towns

Town	Season	Parameter	PAH concentration (ng/m^3) for PM_{10} fraction ($PM_{2.5}$ + coarse fraction)					
			B(a)P	B(a)Anth	Chrys	B(b)Fl	B(k)Fl	Dibenz
Letterkenny	Heating	*n*	86	86	86	82	82	86
		Mean	1.49	0.73	0.57	1.52	0.67	0.66
		Median	1.45	0.61	0.49	1.47	0.60	43.00
		Max.	3.14	2.45	1.55	3.89	1.99	3.48
	Non-heating	*n*	62	61	62	62	61	61
		Mean	0.62	0.17	0.11	0.54	0.22	0.29
		Median	0.48	0.14	0.00	0.32	0.21	0.04
		Max.	1.81	0.95	0.68	4.18	1.29	1.85
Tralee	Heating	*n*	54	54	54	54	54	54
		Mean	0.82	0.85	0.23	1.16	0.32	0.28
		Median	0.82	0.73	0.21	0.84	0.30	0.16
		Max.	2.19	3.69	0.67	3.26	1.06	1.34
	Non-heating	*n*	68	68	68	68	68	68
		Mean	0.19	0.16	0.04	0.26	0.07	0.10
		Median	0.00	0.00	0.06	0.00	0.00	0.00
		Max.	0.80	0.88	0.17	1.28	0.46	0.58
Navan	Heating	*n*	64	64	64	64	64	64
		Mean	0.32	0.30	0.09	0.37	0.12	0.10
		Median	0.12	0.00	0.00	0.00	0.00	0.00
		Max.	1.93	2.97	0.60	3.80	0.99	1.48
	Non-heating	*n*	64	64	64	64	64	64
		Mean	0.15	0.06	0.04	0.04	0.02	0.02
		Median	0.00	0.00	0.00	0.00	0.00	0.00
		Max.	3.26	0.92	0.69	1.37	0.60	0.46
Killarney	Heating	*n*	66	67	60	60	64	67
		Mean	0.17	0.29	0.09	0.27	0.20	0.04
		Median	0.00	0.00	0.00	0.00	0.00	0.00
		Max.	1.46	2.72	1.00	1.95	1.95	1.04
	Non-heating	*n*	60	60	60	55	57	60
		Mean	0.05	0.08	0.11	0.24	0.19	0.01
		Median	0.00	0.00	0.00	0.00	0.00	0.00
		Max.	0.51	0.63	1.04	1.95	2.47	0.14

B(a)Anth, Benz[*a*]anthracene; B(a)P, benzo[*a*]pyrene; B(b)Fl, Benzo[*b*]fluoranthene; B(k)Fl, Benzo[*k*]fluoranthene; Chrys, Chrysene; Dibenz, Dibenz[*a*,*h*]anthracene; max., maximum.

Table 4.8. Overall mean polycyclic aromatic hydrocarbon values for the entire monitoring period ($PM_{2.5}$ + coarse fraction)

Town	Mean PAH (concentration in ng/m³)					
	B(a)P	B(a)Anth	Chrys	B(b)Fl	B(k)Fl	Dibenz
Letterkenny	1.13	0.50	0.38	1.10	0.48	0.51
Tralee	0.47	0.46	0.12	0.66	0.18	0.18
Navan	0.23	0.18	0.06	0.21	0.07	0.06
Killarney	0.11	0.19	0.10	0.26	0.20	0.02

B(a)Anth, Benz[*a*]anthracene; B(a)P, benzo[*a*]pyrene; B(b)Fl, Benzo[*b*]fluoranthene; B(k)Fl, Benzo[*k*]fluoranthene; Chrys, Chrysene; Dibenz, Dibenz[*a*,*h*]anthracene.

particulate pollution monitoring presented for the limited monitoring sites, it seems a reasonable inference that particulate air quality in Tralee and Letterkenny is worse than it is in Dublin, which is a major urban centre. The fact that traffic densities are significantly higher in Dublin than in any of the towns involved in this study clearly indicates that traffic is not the main driver of the higher particulate pollution levels in these towns, and that other local sources are to blame. Also the fact that higher levels are seen in the “heating season” would support the hypothesis that space heating is the main driver of the particulate pollution levels in some of these towns.

The whole rationale for improving air quality is improving human health. If we can improve air quality by reducing pollution, human health improves, and the cost to the health service is reduced, through both less illness and increased life expectancy. The challenge in Ireland is to ensure good air quality in all urban and rural areas.

The latest research (Samoli, 2005; Dominici et al., 2007; Kobach Bolling et al., 2009) shows that there is no safe threshold, so the lower we can make the particulate pollution levels the better. The WHO (2012) advises that, even where air quality is good, and where it is within the EU guidelines, attempts should still continue to reduce levels, as there is no safe threshold. This is also echoed in the CAFE Directive (EU, 2008). In addition, WHO has also categorised air pollution from coal burning as a carcinogen (IARC, 2013). They state “given the technological challenges in burning coal cleanly in homes (including removal of toxins such as arsenic), policy on household fuel use should aim for the complete substitution of coal with cleaner fuel”.

We recommend that, where possible, monitoring be continued in these towns, and in the other towns covered by the 2012 legislation (SI 326 2012) that extended the ban on smoky coal, to gauge the effectiveness of the new legislation.

4.5 Discussion of Polycyclic Aromatic Hydrocarbon Results

Comparing sites with each other, a clear distinction is seen based on (i) mean PAH values (Tables 4.7 and 4.8), and (ii) patterns of PAH distribution during the heating and non-heating seasons. Clearly, Letterkenny has the highest levels of PAH in each of the seasons, with an overall mean B(a)P of 1.13 ng/m³, which is significantly higher than all the other sites. Although the overall mean values for Tralee are well below the annual EU target value, values for B(a)P during the heating season are relatively high. Navan and Killarney have low overall values of PAH, although occasionally elevated levels were seen for both. The results for PAH found in $PM_{2.5}$ filters correlate well with those for particulate levels.

Although Navan and Tralee have similar populations, they have significantly different fuel usage profiles, with natural gas heating in Navan at 60% and Tralee heavily dependent on oil heating (59%) and coal (11%). This is reflected in the relative levels of PAH in each town, indicating that oil and coal combustion are a major source of these pollutants.

Letterkenny and Killarney have similar populations, and neither town had a smoky coal ban during the monitoring period (note: the smoky coal ban was since extended in 2013 to cover Letterkenny). Letterkenny has a higher reliance on oil and coal heating (87% combined) than Killarney (72% combined). There is a significant difference in the PAH levels recorded for

each town, with the overall mean B(a)P for Letterkenny being approximately seven times higher than that for Killarney. As discussed previously, local factors such as geography, wind speed and direction, etc., can have major influences on measured particulate and hence PAH levels. Notwithstanding this, the fact still remains that the residents of Letterkenny may be exposed to far higher levels of PAH than their counterparts in Killarney.

4.6 Source Apportionment

Although traffic will make some contribution to the overall PAH levels, the distinct seasonal variations are indicative of other combustion sources such as solid fuel or oil used for home heating. As Killarney is a major tourist centre and experiences significant increases in traffic volumes during the summer period, this might be expected to have an impact on non-heating season results. Some spiking of PAH levels was seen in August data from Killarney, but, interestingly, very little B(a)P was found during this period. No likely industrial sources of PAH were identified at any of the towns monitored, ruling out industrial pollution as a source of PAHs.

From the data gathered it is not possible to attribute PAH production to any specific sources, but seasonal variation strongly indicates that a major source of PAHs is the combustion of oil and solid fuel for home heating purposes.

5 Overall Discussion

5.1 Introduction

This section provides an overview and discussion of the main findings of this study and combines the findings from the different parts of the work.

5.2 Particulate Matter

For all of the measured parameters, the levels measured during the heating season were between two and four times higher than those for the non-heating season at each location. Also, as would be expected, levels were higher when wind speeds were lower. Where comparable PM data were available, the levels measured at all four sites were consistent with EPA data for 2011–2012 (EPA, 2012). Overall annual levels were quite low, with the notable exception of Letterkenny, where the annual average was more than double that of any of the other centres in this study, and the Letterkenny levels were similar to the highest values reported by the EPA for 2011. EU limit values were not exceeded for any measured air quality parameters at any of the monitoring sites during this study

A strong seasonal component was observed for both $PM_{2.5}$ and BS. A limitation of this study is that because of time and equipment constraints, data for both $PM_{2.5}$ and PM_{10} were available for only 6 months at each monitoring location. Both Letterkenny and Tralee exceeded the WHO air quality guideline values for $PM_{2.5}$, while Navan was close to the limits. Only Killarney scored well on all criteria.

5.3 Polycyclic Aromatic Hydrocarbon Data

PAHs are released during combustion, particularly from the burning of solid fuels such as coal and wood, incomplete combustion of automobile fuels and residential "back yard" burning. The PAHs are normally adsorbed onto the particles that are emitted during the combustion, namely the $PM_{2.5}$ and the BS particles. PAHs are considered to be hazardous to human health and so both the WHO and the EU have set guideline and target values, respectively, for PAHs. In this study, particular attention was given to B(a)P, as it is traditionally used to represent all PAHs.

The results show that Letterkenny, with an average value of 1 ng/m^3, was at the EU target value and exceeded the WHO guideline value for B(a)P. The other three towns were within these criteria. When these data are compared with EPA data for 2011 (EPA, 2012), it is seen that Letterkenny is higher than any other site included in this report.

5.4 Source Apportionment

One aspect of this study was to provide some indication of what the main contributors to air pollution are in the various centres included in the study. Although it was not possible to "fingerprint" conclusively the sources of pollution, the study does provide some indication of the main sources of the pollution.

B(a)P is formed primarily from combustion processes. However, in the current study, natural and industrial sources can be assumed to be negligible. Thus, it is reasonable to assume that the comparatively high levels detected in Letterkenny are from combustion processes involving solid fuel (coal, wood and peat), which are known to emit significantly more B(a)P than the other main fuel, oil (petroleum and diesel). The higher levels detected in the heating season would indicate that it is most likely to be space heating that is acting as the major contributor rather than road vehicles. This would also be supported by the low levels of B(a)P detected in both Navan (this study) and Dublin (EPA, 2012), where there is a high usage of natural gas for space heating.

In addition, the association observed in this study between B(a)P and BS at all centres strongly suggests that the sources of BS, most notably coal burning and the use of diesel fuel, are the major contributors to the observed B(a)P levels in all centres. Although the data cannot conclusively verify that coal burning and the use of diesel fuel for space heating are the sole contributors to the observed pollution levels, there is sufficient evidence presented to show that these fuels make a major

contribution to the BS and $PM_{2.5}$ levels, and also to the concentrations of PAHs.

5.5 Health Considerations and Limit Values

The interest in particulate air pollution is twofold: firstly, for the effect these pollutants have on the environment itself, and, secondly, for the effect they have on human health. In relation to human health, at present, both the EU and WHO have guidelines for PM and PAHs in the environment.

The EU limit values are enshrined in legislation (EU, 2008) to protect human health and the environment, and they are used for reporting to the EU for compliance purposes. The WHO guideline values are of the order of 50% lower than the EU limit values. The WHO values have been used for comparative purposes in this report.

It has also been highlighted earlier in this report (section 2.2) that there is no evidence of a threshold or safe level of particulate air pollution (Samoli, 2005; Dominici et al., 2007; Kobach Bolling et al., 2009), and therefore from a health perspective it is recommended that the WHO guidelines be used to evaluate air quality, with the view that there is no safe level, and that efforts should be made to keep levels as low as can be reasonably achieved. However, despite all the efforts that might be made to reduce pollution levels, especially by addressing local sources, there is still the possibility that one might experience pollution transported from further afield, such as neighbouring countries/regions. This is what is often referred to as "trans-boundary air pollution", and to address this, international agreements and collaboration are needed. Thankfully, in the Irish context, the prevailing winds provide a degree of protection.

5.6 Overall Findings

The findings from this study of particulate air pollution levels in four towns in Ireland, namely Killarney, Letterkenny, Navan and Tralee, during 2011–2012 have shown that particulate pollution levels in some of these towns were higher than might have been anticipated. Higher levels were observed during the heating season in all centres, suggesting that space heating is a significant contributor to the higher levels. Another key factor here is that, when compared with Dublin, which has higher traffic densities, the observed particulate air pollution levels in the four towns cannot be attributed solely to traffic. In fact, the PAH analysis, in conjunction with the BS data, suggests that space heating, in the form of coal and other solid fuel usage, is the largest contributor to the observed pollution levels.

Over the study period it was found that two towns, namely Tralee and Letterkenny, were above the WHO guidelines for $PM_{2.5}$, while Letterkenny was also at the EU target value of 1 ng/m^3 for B(a)P. No EU legislative limit values were exceeded at any site.

The study has indicated that space heating from solid fuels is the most likely contributor to the observed pollution levels, and the results clearly indicate that consideration of a national smoky coal ban is needed.

6 Conclusions and Recommendations

6.1 Conclusions

1. We conclude that particulate air quality in some of the locations monitored in this study is of concern, and raises the question of whether similar locations with no continuous monitoring data may have similar issues in relation to particulate air quality. The particulate pollution levels measured in some of these locations are significantly worse than those in Dublin city. This is consistent with other findings that particulate pollution levels, as measured in some smaller Irish towns, are significantly higher than in the large urban centres.

2. At no time during the monitoring were any of the existing EU particulate air quality limits exceeded. However, the growing body of evidence, coupled with recent EU initiatives relating to the health effects associated with both the quantity and the chemical composition of particulate air pollutants, would suggest that this is not grounds for complacency, and further investigation is merited.

3. Both Tralee and Letterkenny at 14 µg/m^3 for $PM_{2.5}$ are within the annual EU limit value of 25 µg/m^3. However, if one only considers the heating season data, they are approaching the limit values.

4. When the PAH analysis is considered, Letterkenny is seen to be at the EU target values for B(a)P.

5. Letterkenny and Tralee exceed the annual WHO $PM_{2.5}$ particulate air quality guideline. Navan is at the guideline value. Only Killarney is well within this guideline.

6. Letterkenny and Tralee also approach, but do not exceed, the WHO guideline values for PM_{10} during the heating season.

7. Considering the four locations where monitoring was undertaken, the highest pollution levels were observed in those that had the highest combined percentages of residential oil and coal heating.

8. We observed higher pollution levels from October 2011 to March 2012 (i.e. the heating season), suggesting that residential heating is contributing to the higher pollution levels.

9. Although Ireland complies with its CAFE Directive requirements for monitoring, the fact that continuous routine monitoring is not conducted in many towns in Ireland means that there is a knowledge gap regarding what levels are to be found in those towns. As it is not feasible to carry out continuous monitoring in every town in the country, it would be prudent to consider alternative approaches such as indicative monitoring or developing national- and sub-national-level emission inventories and air quality models.

10. This study raises the question of whether the successes already achieved in improving air quality to date, arising from the banning of smoky coal in specified urban centres, can be sustained or replicated on a national basis.

6.2 Recommendations

Based on the conclusions of this report, we recommend the following:

1. Future particulate air quality policy in Ireland is considered in the context of the evolving understanding of the health implications of air pollution levels. In this regard the more stringent WHO guideline values rather than the current minimum legal requirements of EU limit values should be considered.

2. The feasibility of extending continuous particulate air quality monitoring in Ireland should be considered.

3. If it is not viable to carry out continuous monitoring using EU/CEN approved methodologies, some level of indicative monitoring should be carried out to determine if further in-depth monitoring is required.

4. The production of appropriate national and regional air emissions inventories and air quality models should be progressed as a matter of priority to support existing and future air quality monitoring and control strategies.

5. Selective chemical analysis should be undertaken to determine the source apportionment of particulates in a selection or subset of available particulate filters routinely collected as part of the national air quality monitoring programme.

6. An assessment to determine the continued effectiveness or otherwise of the extended bituminous ("smoky") coal ban legislation on air quality should be carried out using a combination of continuous and discontinuous monitoring.

7. In the event that the "town by town" approach in point 6 is shown to be ineffective, the possible introduction of a national prohibition on the usage of bituminous coal should be considered.

8. In view of the renewed interest at EU level in monitoring black carbon and/or BS, it would be prudent to earmark resources for such monitoring in the coming years.

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Abbreviations

B(a)Anth	Benz[*a*]anthracene
B(a)P	Benzo[*a*]pyrene
B(b)Fl	Benzo[*b*]fluoranthene
B(k)Fl	Benzo[*k*]fluoranthene
CAFE	Clean Air for Europe
BS	Black Smoke
Chrys	Chrysene
Dibenz	Dibenz[*a*,*h*]anthracene
DCC	Dublin City Council
DIT	Dublin Institute of Technology
EHO	Environmental Health Officer
EPA	Environmental Protection Agency (Ireland)
HSE	Health Service Executive
PAH	Polycyclic aromatic hydrocarbons
PM	Particulate matter
SI	Statutory Instrument
US EPS	United States Environmental Protection Agency
WHO	World Health Organization

Glossary

B(a)P	Benzo[*a*]pyrene is a polycyclic aromatic hydrocarbon (PAH) that is a by-product of incomplete combustion or burning of organic (carbon-containing) items, for example cigarettes, petrol, oil, coal, wood, etc.
Bituminous coal	Bituminous coal or black coal is a relatively soft coal containing a tar-like substance called bitumen.
Black Smoke method	This is a method that was developed to measure smoke particles in the air. The system sucked air through a filter and then measured the "blackness" of the filters. This value was then converted using a formula to get a concentration of particles in the air. It measured particles of approximately 4.5 μm.
Guideline values	These refer to concentrations of specified pollutants, which are set as a guide normally for the protection of human health and/or the environment; however, they have no legal standing.
Heating season	When reporting air pollution data it is quite common to present data for the heating and the "non-heating" season; for Ireland the heating season is defined as October–March inclusive.
Limit values	These refer to concentrations of specified pollutants that should not be exceeded. In Europe the EU set limit values for both particulate matter (PM) and PAHs in the air.
Non-heating season	The non-heating season in Ireland is defined as April–September inclusive.
PAHs	Polycyclic aromatic hydrocarbons often are by-products of petroleum processing or combustion. Many of these compounds are highly carcinogenic at relatively low levels. Although they are relatively insoluble in water, their highly hazardous nature merits their positioning in potable waters and wastewaters. There are many different PAHs and so they are not listed here. Traditionally, B(a)P is measured and presented to represent all PAHs.
Particulate matter	PM is a complex mixture consisting of varying combinations of dry solid fragments, solid cores with liquid coatings and small droplets of liquid. These tiny particles vary greatly in shape, size and chemical composition and can be made up of many different materials such as metals, soot, soil and dust. PM may also contain sulphate particles. PM may be divided into many size fractions, measured in μm (1 μm is one-millionth of a metre). Typically, there are two size classes of particles: particles up to 10 μm (PM_{10}) and particles up to 2.5 μm in size ($PM_{2.5}$). $PM_{2.5}$ particles are a subset of PM_{10}.
PM_{10}	This is PM or particles present in the air. They behave like a sphere 10 μm in diameter (10 millionths of a metre). They are of interest, as particles of this size have been shown to penetrate human lungs during breathing and can be associated with adverse health effects
$PM_{2.5}$	These particles are a subset of PM_{10}, and they are the smaller particles. Quite often these are produced by combustion processes. They have been shown to enter human lungs, and some may also enter the bloodstream via the lungs.

PM coarse fraction	This relates to the difference between $PM_{2.5}$ and PM_{10}, namely the larger particles from 2.5 µm up to 10 µm. Such particles are often produced by mechanical action such as tyre wear on roads, etc.
Smoky coal	This is another name used to describe bituminous coal.
Target value	Target values are used in some EU Directives and are set out in the same way as limit values. They are to be attained where possible by taking all necessary measures that do not entail disproportionate costs.

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú

- Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola (m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- an diantalmhaíocht (m.sh. muca, éanlaith);
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe (OGM);
- foinsí radaíochta ianúcháin (m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha);
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce

- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil (m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí).

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn

Taighde agus Forbairt Comhshaoil

- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta

- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn (m.sh. mórphleananna forbartha).

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas

- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol (m.sh. Timpeall an Tí, léarscáileanna radóin).
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta

- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí.
Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Measúnú Comhshaoil
- An Oifig um Cosaint Raideolaíoch
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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Assessing the Impact of Domestic Solid Fuel Burning on Ambient Air Quality in Ireland

Authors: Patrick Goodman, Martin Fitzpatrick, Barry Foley, Michelle McNally, Tracey Healy, Sarah Middleton, Peter Brien & Doug Dockery

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Identifying Pressures

Ireland like all other countries faces the challenge of ensuring a high standard of air quality. Air pollution is associated with increased deaths and illness, even in developed countries. There is no safe level of air pollution. Thus the challenge is to keep air pollution levels as low as can be reasonably achieved. The EU set limit values for air pollutants, and Ireland is within the EU limits. The WHO set more stringent guideline values for the protection of human health, and Ireland approaches some of those values at times.

It is now over 25 years since the 'smoky' coal ban was introduced in Dublin. The ban was effective at reducing emissions and delivered a significant reduction in excess winter mortality and compliance with the then standards. Following the success in Dublin, the ban was subsequently implemented in other cities and towns across the country in the intervening years. The EPA, in its 2012 State of the Environment Report, concluded that the ban on bituminous 'smoky' coal has had a positive effect on limiting particulate matter emissions from home heating and should be extended to all urban areas.

Informing Policy

This study evaluated air quality in four towns in Ireland, where continuous monitoring is not routinely undertaken. Comparisons were undertaken with respect to the main types of fuel used for space heating, and whether there was a "smoky coal ban" in existence or not.

Particulate air quality in some of the locations monitored was of concern, and raises the question of whether similar locations may have similar issues. The particulate pollution levels measured in some of these locations were significantly worse than those in Dublin city.

The highest pollution levels were observed in those towns that had the highest combined percentages of residential oil and coal heating. We observed higher pollution levels from October 2011 to March 2012 (i.e. the heating season), suggesting that residential heating is contributing to the higher pollution levels.

Developing Solutions

It is recommended that there is further scope to improve air quality in some of our smaller towns.
It is also recommended that future particulate air quality policy in Ireland is considered in the context of the evolving understanding of the health implications of air pollution levels. In this regard it is recommended that the more stringent WHO guideline values rather than the current minimum legal requirements of EU limit values be considered.
The feasibility of extending continuous particulate air quality monitoring should be considered. If it is not viable, indicative monitoring should be carried out to determine if further in-depth monitoring is required. The production of appropriate national and regional air emissions inventories and air quality models should be progressed as a matter of priority to support existing and future air quality monitoring and control strategies.

Comhshaol, Pobal agus Rialtas Áitiúil
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