Department of the
Environment
www.doeni.gov.uk

Air Pollution
in Northern Ireland 2014

RICARDO
Ricardo
Energy & Environment

1

Report Highlights

This is the thirteenth in a series of annual reports on air quality in Northern Ireland. It is produced by Ricardo Energy & Environment, on behalf of the Department of the Environment. This report aims to provide the citizens of Northern Ireland, and the wider air quality community, with user-friendly information on local air quality monitoring. It contains the key results of that monitoring from throughout the region during 2014. Figure 1.1 shows the locations of all the automatic air quality monitoring sites in Northern Ireland that were in operation during part or all of 2014.

Section 2 of this report outlines the air quality legislation and policy applicable to Northern Ireland, including the Local Air Quality Management process by which district councils manage air quality at a local level. **Section 3** summarises the monitoring carried out in Northern Ireland and presents an overview of the data from 2014, including exceedances of air quality objectives.

As in previous reports, **Section 4** deals with how air pollution in Northern Ireland has changed over time, and **Section 5** covers spatial patterns in pollution. **Section 6** is used to report on topics of special interest; this year it focuses on the impact of air quality on health. Finally, **Section 7** provides information on how each one of us can help protect and improve the quality of the air in our region, and where to find more information.

Air quality in Northern Ireland has improved substantially in recent decades. In particular, concentrations of sulphur dioxide, a pollutant associated with coal and oil combustion, have declined significantly over the past twenty years. However some pollutants in some parts of Northern Ireland continue to exceed air quality objectives. A continued effort to reduce air pollution is therefore important, together with monitoring to assess progress and to provide sound, science-based input into policy development.

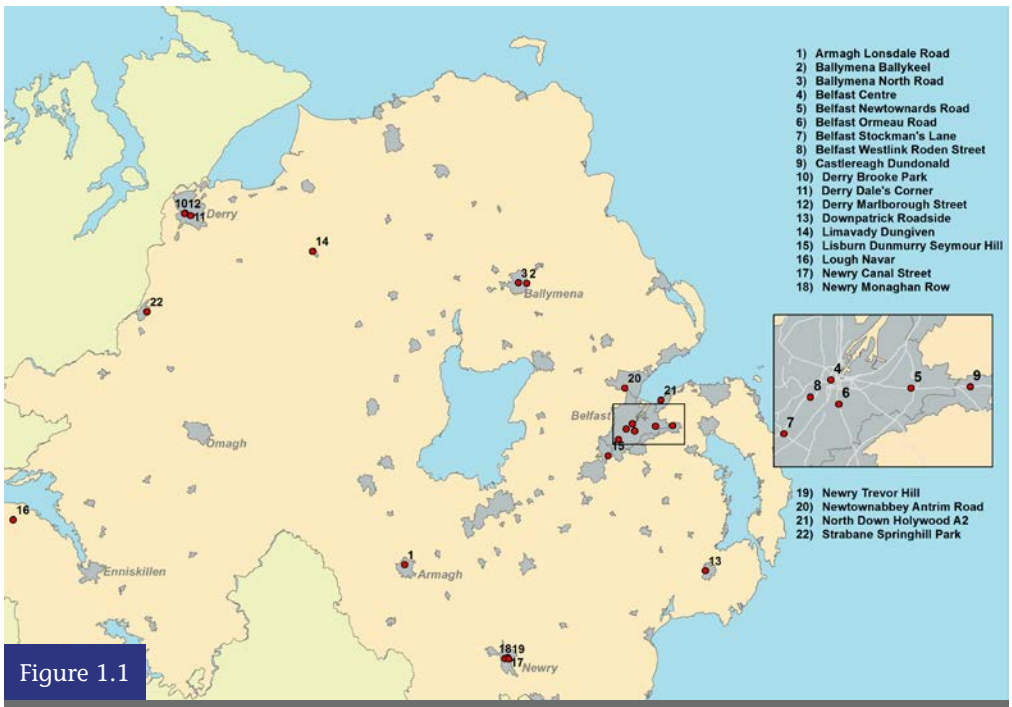


Figure 1.1

Locations of Automatic Air Quality Monitoring Sites in Northern Ireland, 2014

2

Legislation and Policy

The management of air quality in Northern Ireland is based on the requirements of European Union (EU) Air Quality Directives, and on the UK Air Quality Strategy. These requirements are incorporated (or 'transposed') into Northern Ireland's own legislation by statutory measures, forming the basis of a strong framework for managing air quality.

2.1 The European Union

Much of Northern Ireland's air quality legislation has its roots within the Air Quality Directives which apply to all Member States of the European Union:

- Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the Air Quality Directive), which relates to sulphur dioxide, oxides of nitrogen, particulate matter, lead, carbon monoxide, benzene and ozone in ambient air; and
- Directive 2004/107/EC (the Fourth Daughter Directive) relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons (PAH) in ambient air.

These are incorporated into Northern Ireland's national law by the Air Quality Standards Regulations (Northern Ireland), of which the most recent revision was in 2010.

2.2 The Air Quality Standards Regulations (Northern Ireland) 2010

These Regulations transpose the provisions of the above Directives into Northern Ireland's own legislation. As well as the EU limit values and non-mandatory target values for ambient concentrations of pollutants, the Regulations set out requirements for ambient air quality monitoring, including the number of monitoring sites required, siting criteria and acceptable methodology. They also identify the duties of Northern Ireland's Government Departments in relation to achieving limit and target values. It is the responsibility of Department of the Environment to inform the public about air quality in the region, particularly with regard to warning the public when information and alert thresholds are exceeded.

2.3 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, first published in 1997 and updated in 2007, provides a comprehensive framework for tackling air pollution. It was established on the basis of strong scientific evidence and a science-based understanding of the effects of air pollutants on health and the environment.

The Strategy sets objectives to be met within the UK for a suite of pollutants. The scientific basis, the objectives set and provisions contained within the Strategy are closely associated with the corresponding standards set within European Air Quality Directives, as listed above. The Strategy's provisions for some pollutants differ from those in the Directives with these differences relating to scientific evidence and expert opinion that is specific to the UK situation. However, all the Air Quality Strategy objectives are at least as stringent as the corresponding limit values in the Air Quality Directive or 4th Daughter Directive.

The full Air Quality Strategy and its technical annexes are available online and can be downloaded from www.defra.gov.uk/environment/quality/air/air-quality/approach.

Photo: Northern coast of County Antrim

2.4 Local Air Quality Management

Local Air Quality Management (LAQM) provides the framework under the Environment Order (NI) 2002 within which air quality is managed by district councils in Northern Ireland. LAQM requires district councils to review and assess a range of air pollutants against the objectives set by the Air Quality Strategy, using a range of monitoring, modelling, observations and corresponding analyses. For locations where objectives are not expected to be met by the relevant target date, district councils are required to declare an Air Quality Management Area (AQMA), and to develop an Action Plan addressing the problem.

Early in 2015, there were substantial changes to Northern Ireland's district councils. Several of the former 26 district councils merged, and some boundaries were changed, to form 11 new larger districts. Although the old district councils were still in existence during 2014, the information in this section has been based on the current (new) districts, to avoid confusion.

There are at present 26 AQMAs in Northern Ireland. Table 2.1 shows details of these, and which of the current districts they are now in. Eight districts have AQMAs for NO_2. Of these, four also have AQMAs for PM_{10} (either on its own or together with NO_2). There are no AQMAs in place for SO_2. Table 2.1 and Figure 2.1 show the locations of these AQMAs, and which pollutants they address.

Table 2.1 Air Quality Management Areas in Northern Ireland (as of September 2015)

District Council	No. of AQMAs	Pollutants	Sources
Antrim and Newtownabbey	3	NO_2 (1), PM_{10} (2)	Road traffic, domestic emissions
Belfast	4	NO_2 (3), NO_2 and PM_{10} (1)	Road traffic
Lisburn and Castlereagh	1	NO_2	Road traffic
Causeway Coast and Glens	1	NO_2 (1)	Road traffic
Armagh, Banbridge and Craigavon	4	NO_2 (4)	Road traffic
Newry, Mourne and Down	2	NO_2 (1), PM_{10} (1)	Road traffic, domestic emissions
Derry and Strabane	6	NO_2 (3), PM_{10} (3)	Road traffic, domestic emissions
Mid Ulster	5	NO_2 (5)	Road traffic

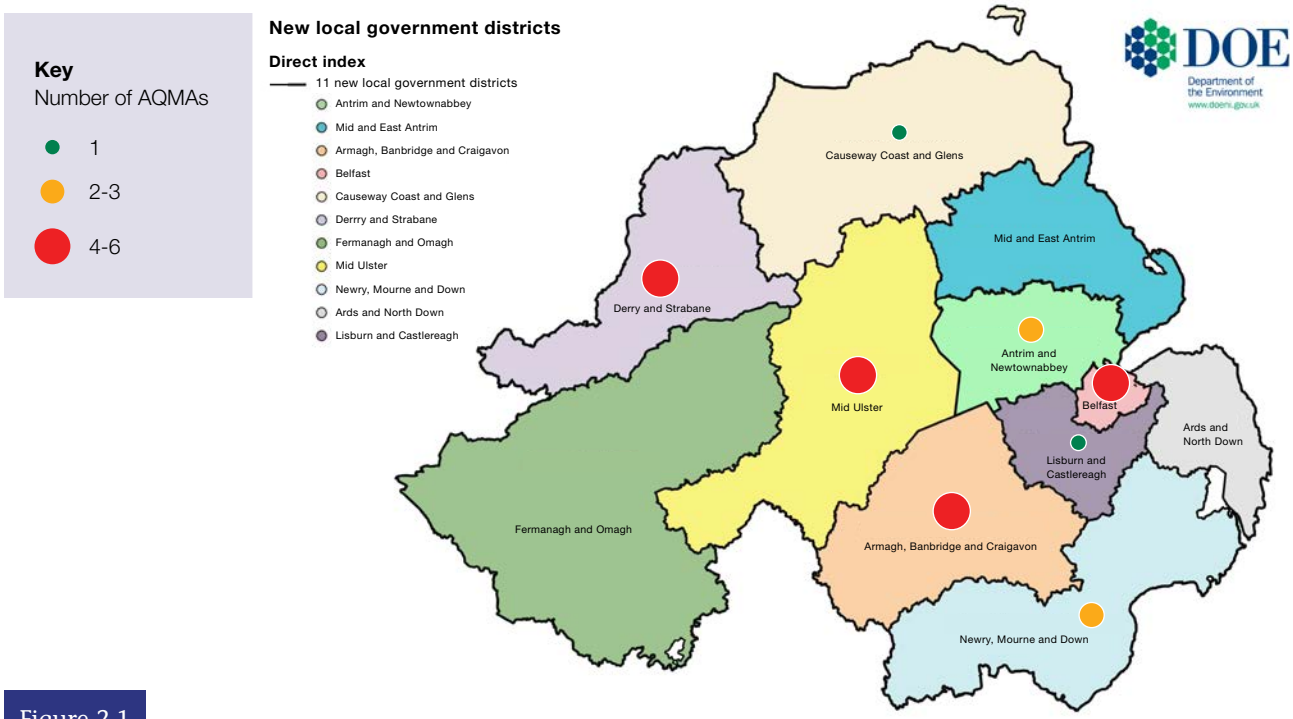


Figure 2.1

Air Quality Management Areas in Northern Ireland (source: DoENI)

3

Monitoring Results for 2014

3.1 Monitoring in Northern Ireland

A wide range of air quality monitoring is carried out in Northern Ireland. Some monitoring sites are run as part of UK-wide monitoring networks; others are operated by district councils in order to meet local objectives.

The Air Quality Directive requires Member States to be divided into 'zones' for reporting purposes. Northern Ireland comprises two reporting zones – the 'Belfast Metropolitan Urban Area' agglomeration (the conurbation of Belfast), and the 'Northern Ireland' zone (the rest of the region). The Directive then specifies how many monitoring sites (or 'stations') are needed in each zone (based on its size and population). Only sites which meet the stringent siting criteria of the Directive may be used for reporting to the European Commission. The Directive siting criteria are different from those used for LAQM: for example, sites located close to major road junctions are used in LAQM, but must not be used for Directive compliance monitoring purposes. There are also different criteria regarding relevant public exposure.

The following pollutants were monitored in Northern Ireland during 2014:

- Carbon monoxide (CO);
- Oxides of nitrogen (NO_x), comprising nitric oxide (NO) and nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Particles (as PM_{10}, $PM_{2.5}$, and black carbon);
- Ozone (O_3);
- Benzene;
- Polluting elements – including lead, arsenic, cadmium, nickel and mercury; and
- Polycyclic Aromatic Hydrocarbons (PAH).

During 2014 there were 22 automatic air quality monitoring stations in Northern Ireland, each equipped with continuous monitoring equipment for one or more of the pollutants for which automatic methods are used: CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$ and O_3. These sites (shown previously in Figure 1.1) provide hourly information on a wide range of pollutants. Data from the continuous monitoring sites is communicated rapidly to the public via the website www.airqualityni.gov.uk. Public warnings are issued when levels approach or reach 'high' levels as defined by the Daily Air Quality Index.

Six of the automatic monitoring sites (Belfast Centre, Belfast Stockman's Lane, Derry Brooke Park, Armagh Lonsdale Road, Ballymena Ballykeel and Lough Navar) are part of the UK's national monitoring network, and are used to assess compliance with the Air Quality Directive. Belfast Stockman's Lane is the latest addition, having been 'affiliated' into the national network in 2014.

Non-automatic monitoring techniques are used for benzene, metallic pollutants, black carbon and PAH. Some of these measurements are used to assess compliance with the Air Quality Directive and Fourth Daughter Directive.

In addition, many district councils use diffusion tubes for indicative monitoring of NO_2. These low-cost, single-use samplers absorb the pollutant directly from the air and need no power supply. They measure average concentrations over a specified sampling period (typically one month), and provide a useful and economical supplement to automatic monitoring.

3.2 King's College London Volatile Correction Model

Two of Northern Ireland's 12 PM_{10} monitoring sites use the Tapered Element Oscillating Microbalance (TEOM) to measure PM_{10}. The relatively high operating temperature of the TEOM (necessary to prevent condensation on the filter) can result in the loss of volatile components of the particulate matter sampled, causing under-estimation of the PM_{10} concentration. It is, however, possible to correct for this using the Volatile Correction Model (VCM) developed by King's College, London. The VCM uses data from Filter Dynamic Measurement Systems (FDMS) PM_{10} analysers in the region, which measure both the volatile and non-volatile

fractions, to calculate an appropriate correction based on the location of the instrument and the period of the measurements. The resulting corrected measurements have been demonstrated as equivalent to the gravimetric reference method. To access the model and for more information, visit www.volatile-correction-model.info. The TEOM PM_{10} data presented in this report have been corrected to gravimetric equivalent using the VCM. This issue only arises for PM_{10} as there is at present no requirement to correct TEOM measurements of $PM_{2.5}$, and in any case all three of Northern Ireland's $PM_{2.5}$ monitoring sites use the FDMS analyser.

3.3 Key Results for 2014

This section summarises key monitoring results from 2014, including compliance with EU limit values and the corresponding Air Quality Strategy (AQS) objectives. Further information is provided on the Northern Ireland Air website at www.airqualityni.co.uk.

Carbon monoxide was monitored using an automatic instrument at one site – Belfast Centre. The results were well within the EU limit value and AQS objective for this pollutant, and have been for many years.

Benzene was monitored at one site, Belfast Centre, which met the annual mean EU limit value and AQS objective (for the running annual mean) in 2014, as it has for many years.

Metallic and other polluting elements – including lead, arsenic, cadmium and nickel – were monitored using non-automatic techniques at Belfast Centre, as part of the Urban Metals Network. The results for 2014 were within the annual mean EU limit value and AQS objective for lead, and within the EU annual mean target values for arsenic, cadmium and nickel.

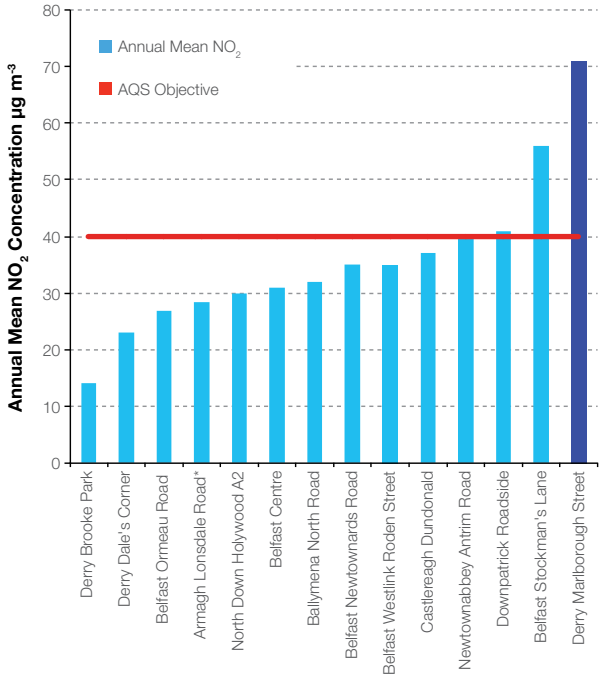
Sulphur dioxide was monitored at five automatic sites. All sites met the EU limit values for SO_2 (1-hour and 24-hour mean), and the AQS objective for the 15-minute mean.

Particulate matter – PM_{10}. Particulate matter as PM_{10} was monitored at 12 locations in 2014. Two of these sites (Newry Canal Street and North Down Holywood A2) used the TEOM instrument, so data from these two sites have been corrected to gravimetric equivalent using the King's College Volatile Correction Model as explained in Section 3.2. All sites met the limit values and objectives for PM_{10} (after VCM correction where applicable).

Particulate matter – $PM_{2.5}$. Fine particulate matter as $PM_{2.5}$ was monitored (using the FDMS analyser) at Belfast Centre, Derry Brooke Park and Lisburn Dunmurry Seymour Hill during 2014. Belfast Centre and Derry Brooke Park measured annual mean $PM_{2.5}$ concentrations well below the EU target value for 2010 of 25 µg m^{-3}. These two sites have therefore also already achieved the Stage 1 limit value, which is also 25 µg m^{-3}, and must be met by 1st Jan 2015. Levels were also below the Stage 2 limit value (20 µg m^{-3} to be achieved by 1st Jan 2020). Lisburn Dunmurry Seymour Hill achieved 69% data capture, which is less than the 75% data capture required for a representative annual mean; however, the available data indicate that this site will have no difficulty in meeting the limit values for $PM_{2.5}$.

Nitrogen dioxide was monitored using automatic analysers at 17 sites during 2014 (three of these sites had data capture below 50% and have not been included in Figure 3.1). Three urban traffic-related sites exceeded the AQS objective for annual mean NO_2 concentration (40 µg m^{-3}). These sites were: Downpatrick Roadside, Belfast Stockman's Lane, and Derry Marlborough Street (Figure 3.1).

Of these three sites only Belfast Stockman's Lane is affiliated into the national network which is used for monitoring compliance with the Air Quality Directive. This site falls within the Belfast Metropolitan Urban Area reporting zone, which in previous years has been identified as not compliant with the EU Directive limit value for annual mean NO_2 (also 40 µg m^{-3}), on the basis of modelled data.



Sites which exceeded the AQS objective for hourly mean NO_2 on > 18 occasions, or for which data capture was < 90% and the 99.8th %ile of hourly means was > 200 µg m^{-3}, are shaded dark blue. *Asterisk indicates sites greater than 50% and less than 75% data capture in 2014 (Armagh Lonsdale Road)

Figure 3.1

Annual Mean NO_2 Concentrations 2014

One site also recorded more than the permitted 18 exceedances of the hourly mean AQS objective for NO_2 (200 µg m^{-3}); this was Derry Marlborough Street (which also exceeded the annual mean objective).

Ozone was monitored at Belfast Centre, Derry Brooke Park and the rural Lough Navar site. No sites exceeded the EU target value for human health of 120 µg m^{-3} (for the maximum daily 8-hour mean) on more than the permitted 25 days, or the more stringent AQS objective of 100 µg m^{-3} on more than the permitted 10 days in 2014 (Figure 3.2). There were no exceedance days for any of these three sites for the whole of 2014.

Unlike some other pollutants, levels of ozone (O_3) in Northern Ireland do not appear to be decreasing, but remain variable from year to year. Ozone exceedances happen in some years but not others. The reasons for this relate to how ozone is formed: it is a 'secondary' pollutant – that is, it is formed by reactions involving other pollutant gases, in the presence of sunlight, and over several hours. This means that the number of ozone exceedances in any given year depends substantially on weather conditions. There is also evidence that the 'hemispheric background' concentration of O_3 has increased since the 1950s due to the contribution from human activities.[1] O_3 exceedances therefore remain possible in future.

Ozone is also a 'transboundary' pollutant: once formed it may persist for several days and be transported over long distances. This means that district councils have little control over ozone levels in their area.

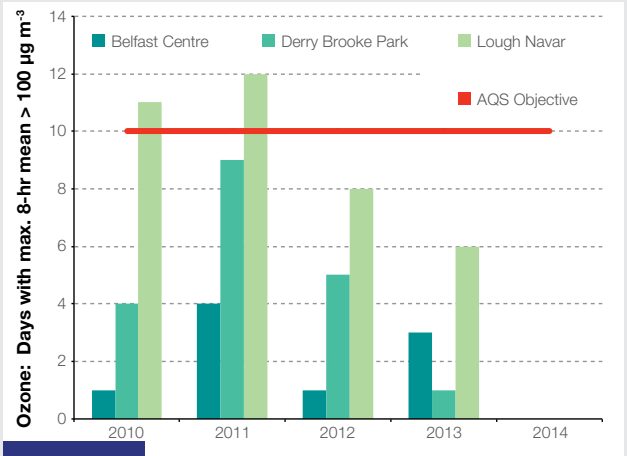


Figure 3.2

Ozone: Days with Maximum 8-hour mean > 100 µg m^{-3}, for Five Years 2010-2014

Polycyclic aromatic hydrocarbons (PAH) were monitored at three sites in 2014; Ballymena Ballykeel, Derry Brandywell and Kilmakee Leisure Centre in Dunmurry. All are part of the UK PAH Network. The network measures a range of PAH compounds, but one species in particular, benzo[a]pyrene (B[a]P), is used as a 'marker' for PAH compounds and is the subject of an AQS objective and EU target value. Fig 3.3 shows the annual mean concentrations at these three sites over the past five years. This graph also shows data from the old Dunmurry High School site which closed in 2012. All three sites exceeded the AQS annual mean objective of 0.25 ng m^{-3} for this PAH species, which was to have been achieved by 31st Dec 2010; however, none exceeded the EU target value of 1 ng m^{-3} for annual mean B[a]P concentration, to be met by 31st Dec 2012. Unlike EU limit values, EU target values are non-mandatory; however, Member States must show that they are taking all necessary and reasonable measures towards achieving target values.

The reasons for the high PAH concentrations in some areas were explored in a 2012 report by NPL[2], the organisation responsible for operating the UK PAH Network. In Northern Ireland PAHs are believed to arise primarily from household combustion of solid fuel, in particular 'smoky' coal. Particularly high levels of PAH were seen in 2010 due to very cold winter weather. The cold weather is believed to have led to an increase in domestic solid fuel burning, coupled with meteorological conditions that did not allow air pollutants to disperse effectively.

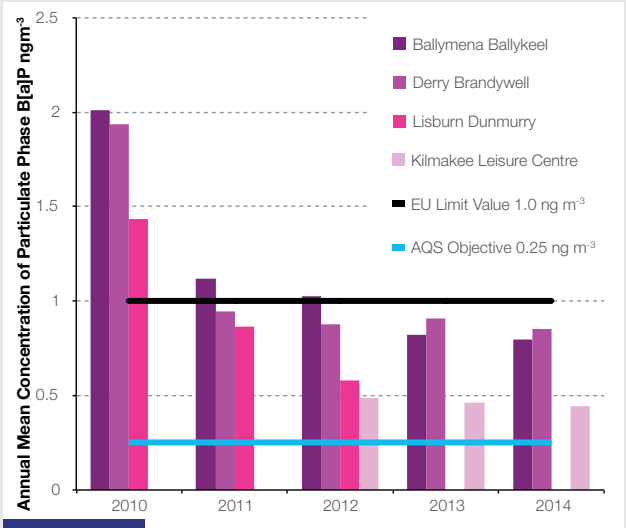


Figure 3.3

Annual mean concentrations of benzo[a]pyrene, for Five Years 2010 - 2014

[1] See the APIS webpage 'Ozone' at http://www.apis.ac.uk/overview/pollutants/overview_O3.htm

[2] DM Butterfield, RJC Brown 2012 'Polycyclic Aromatic Hydrocarbons in Northern Ireland. NPL Report Number AS66. Available online at http://uk-air.defra.gov.uk/reports/cat05/1203080854_pah_in_ni_report_final_published_version_v2.pdf

In 2013 and 2014 a project was carried out to monitor PAH in Armagh with the aim of assessing whether other urban areas in Northern Ireland were experiencing the same concentrations of PAH as found at the three existing monitoring sites. Figure 3.4 shows that levels of PAH found at Armagh were consistent with those at the other three PAH monitoring sites. High levels of PAH in urban areas are believed to arise primarily from residential combustion of solid fuel and this can be seen in the higher levels which are monitored during the colder winter months.

3.4 Summary

EU limit values, target values and corresponding AQS objectives, have been met by the due dates for the following pollutants in Northern Ireland –

- Particulate matter as PM_{10} and $PM_{2.5}$
- Carbon monoxide
- Benzene
- Sulphur dioxide
- The elements lead, arsenic, cadmium and nickel.

However, a small number of sites close to busy roads in urban areas did not meet the limit values and objectives for nitrogen dioxide in 2014. Of these sites only Belfast Stockman's Lane was used for assessment of compliance with the Air Quality Directive in 2014. This site falls within the Belfast Metropolitan Urban Area reporting zone, which in previous years has been identified as not compliant with the EU Directive limit value for annual mean NO_2 (40 µg m^{-3}), on the basis of modelled data. Belfast Urban Area is not alone in this respect: many parts of the UK, and other Member States of Europe, have reported similar exceedances.

Ozone concentrations are affected by both long-range and local factors. Although no sites exceeded the AQS objective in 2014, O_3 exceedances, like those which occurred in 2010 and in 2011, remain a possibility in future.

Benzo[a]pyrene concentrations at all three of Northern Ireland's PAH Network sites met the non-mandatory EU target value in 2014. However, all three sites continue to exceed the AQS objective for 2010 as they have in previous years.

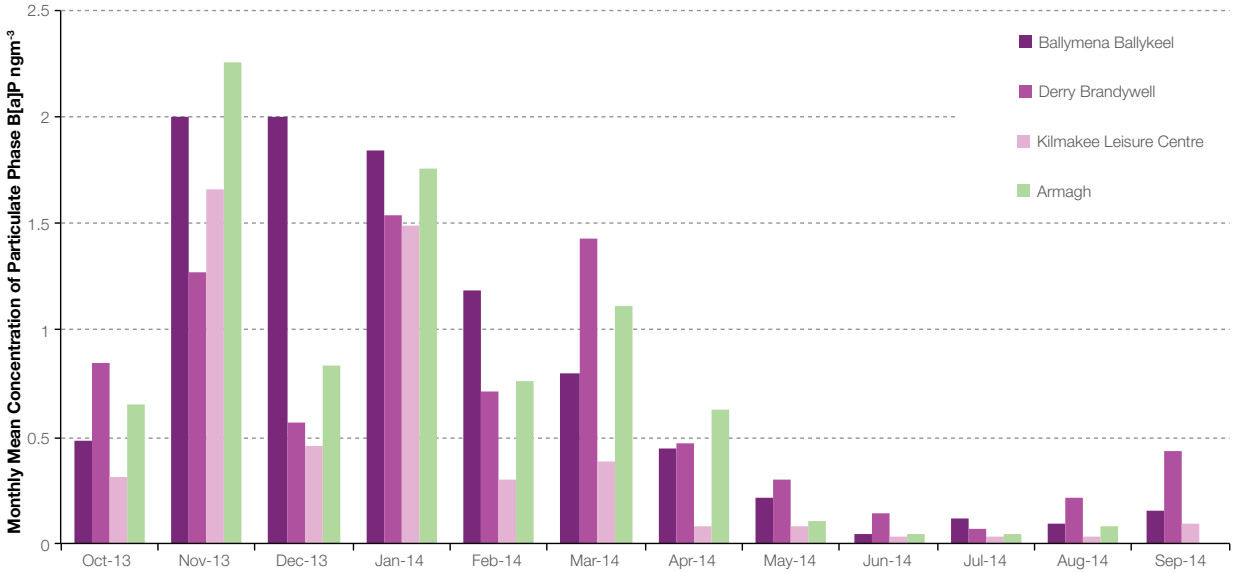


Figure 3.4

Monthly mean concentrations of benzo[a]pyrene, Oct 2013 – Sep 2014

4

Changes Over Time

This section looks at how air quality in Northern Ireland has changed in recent years. In this year's report, the focus is on NO_2, as this pollutant is responsible for most of the exceedances of AQS objectives that occur in Northern Ireland. This year's report concentrates on roadside monitoring sites that have reported exceedances of the annual mean AQS objective for NO_2 in recent years, and how measured concentrations are changing. The period covered here is 2008 to 2014.

As in last year's report, this section will focus on a subset of long-running sites. This is a robust approach that avoids the effects of changes in network size and composition. The sites selected are:

- Newtownabbey Antrim Road;
- Belfast Stockman's Lane;
- Belfast Newtownards Road;
- Belfast Ormeau Road; and
- Newry Trevor Hill.

Derry Marlborough Street, Limavady Dungiven, and Downpatrick Roadside have not been included despite having reported exceedances in recent years. This is because they have been in operation for less than five years and therefore are unable to show long term trends.

Trend analysis has been carried out using Openair: a free, open-source software package of tools for analysis of air pollution data. Openair was developed by King's College London with the University of Leeds. For more information on this package please see www.openair-project.org/Default.aspx. Here, the Openair 'TheilSen' tool, based on the Theil-Sen statistical method, has been used to determine trends in pollutant concentrations over several years. The trend analysis is based on monthly mean pollutant concentrations, calculated here from hourly mean data. Openair includes an option to 'de-seasonalise' the data – i.e. to make statistical modifications the plotted data to remove the influence of seasonal cycles, thus providing a clearer indication of the overall trend over the relevant time. The 'de-seasonalise' option has been used here, where appropriate. When this option is used Openair also fills any gaps in the dataset by a linear interpolation method.

The Openair Theil-Sen trend graphs show the trend as a solid red line, with its 95% confidence intervals as dotted red lines. The trend is given at the top of the graph in green, with confidence intervals shown in square brackets. The trend is given as units (i.e. µg m^{-3}) per year, over the period shown. This may be followed by a symbol, with '+' indicating that the trend is statistically significant at the 0.1 level, '*' indicating significance at the 0.05 level, '**' indicating significance at the 0.01 level, and '***' indicating significance at the 0.001 level.

Trend plots have also been prepared for other pollutants: sulphur dioxide, particulate matter, ozone and total oxides of nitrogen. These are presented and discussed on the 'Trend' pages of the Northern Ireland Air website, at www.airqualityni.co.uk/reports.php?n_action=trend as there is not sufficient space to include them in this short report.

4.1 Newtownabbey Antrim Road

The Newtownabbey Antrim Road monitor is situated on a busy road within the Borough Council's Elmfield AQMA, declared in 2010. An Air Quality Action Plan has been in place since that time, containing a large number of measures including developing a Green Travel Plan, a programme of vehicle testing and the provision of information on the Council website to encourage change in travel behaviour.

Photo: Carrick a Rede Rope Bridge, County Antrim

Figure 4.1 shows a de-seasonalised trend plot for NO_2 at Newtownabbey Antrim Road. This site has been in operation since 2008.

There is a downward trend in NO_2 concentration at this site, statistically significant at the 0.001 level. It should be noted that in January 2010 the monitoring station was moved back from the road, such that the distance from the inlet to the kerb increased from 1m to 3m. Although the Borough Council reported a decrease following this change, it does not account for the long-term decrease in NO_2 concentration apparent from early 2009. The annual mean has not exceeded the limit value since 2012. However, it remains close to the limit value and so further reductions in NO_2 levels are desirable.

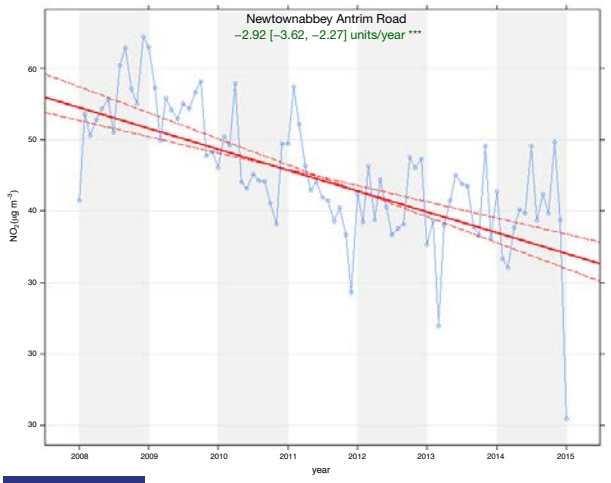


Figure 4.1

De-seasonalised Trend Plot for NO_2 at Newtownabbey Antrim Road, 2008 - 2014

4.2 Belfast Stockman's Lane

This monitoring site, which has operated since 2006, is located in an AQMA that extends along a long stretch of the M1/ Westlink corridor. Belfast City Council's Action Plan contains a wide range of measures, many of which are aimed at improving public transport and encouraging its use. These will have required significant investment and time to implement.

Figure 4.2 shows a de-seasonalised trend plot for NO_2 at Belfast Stockman's Lane from 2008 to 2014. Throughout this time it has consistently measured annual mean NO_2 concentrations well above the annual mean AQS objective and limit value of 40 µg m^{-3}.

There is a downward trend in NO_2 concentration at this site, statistically significant at the 0.001 level. It appears, however, that most of the reduction in NO_2 concentration has occurred in the past three to four years. If the apparent downward trend continues, the annual mean AQS and EU Objective could be met at this site in future years. Meteorological and other factors such as traffic flow and other nearby sources will inevitably influence whether this proves to be the case.

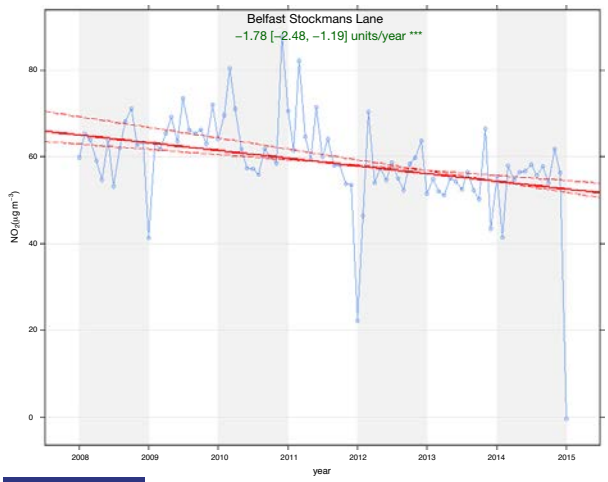


Figure 4.2

De-seasonalised Trend Plot for NO_2 at Belfast Stockman's Lane, 2008 - 2014

4.3 Belfast Newtownards Road

This monitoring site is located beside the busy Upper Newtownards Road, and is in one of Belfast City Council's AQMAs. Figure 4.3 shows a de-seasonalised trend plot for NO_2 measured at this site, from 2008 to 2014. Although there is an overall highly significant downward trend, most of the decrease appears to have happened after 2010. In this respect the pattern is similar to that observed for Belfast Stockman's Lane. Statistics from the Northern Ireland Air website confirm that annual mean concentrations (in µg m^{-3}) were consistently

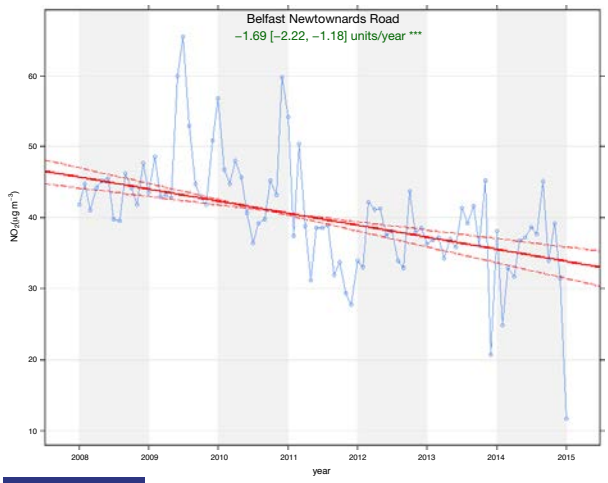


Figure 4.3

De-seasonalised Trend Plot for NO_2 at Belfast Newtownards Road, 2008 - 2014

in the mid-40s. In 2011, however, there appears to have been a substantial decrease. From that year onwards the AQS Objective has been met at this site.

4.4 Belfast Ormeau Road

This monitoring site is also beside a busy road and within one of Belfast City Council's AQMAs. Figure 4.4 shows a de-seasonalised trend plot for NO_2 measured at this site, from 2008 to 2014. The pattern at this site is unusual; there is little change in NO_2 concentration over the period from 2008 to 2011, but this is followed by a large increase at the beginning of 2012. Belfast City Council's 2013 Progress Report (available for download from the Northern Ireland Air District Council Reports page at www.airqualityni.co.uk/reports.php?n_action=dc_report) highlights this increase, and explains that, *"It is considered that this sharp increase may be attributed to more congestion in the area resulting from the introduction of bus corridors and changes in traffic signalling to facilitate the introduction of Belfast on the Move. It is anticipated that this congestion will be short term until Belfast on the Move and the Rapid Transit System are fully operational"*. The Council will continue to monitor at the site. Data now show that NO_2 concentrations have returned to their pre-2012 levels and annual means are now well below the limit value.

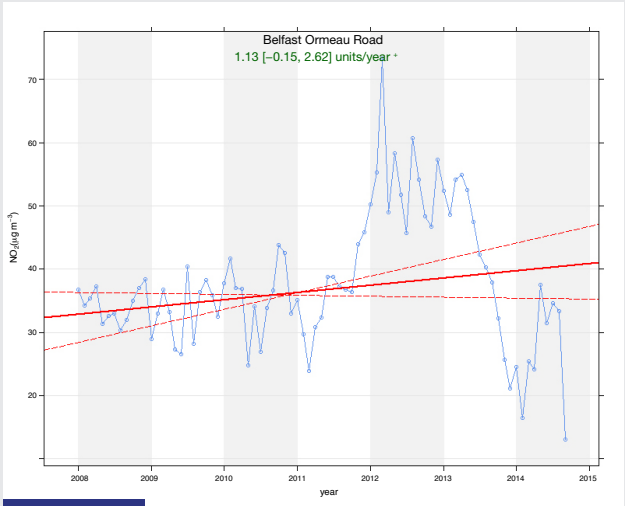


Figure 4.4

De-seasonalised Trend Plot for NO_2 at Belfast Ormeau Road, 2008 - 2014

4.5 Newry Trevor Hill

Figure 4.5 shows a de-seasonalised trend plot for NO_2 as measured at Newry Trevor Hill, a site at a junction of two major roads in Newry. Concentrations of NO_2 at this site are very variable, and there is no significant increasing or decreasing trend. Therefore further exceedances of the AQS Objective remain likely in future years.

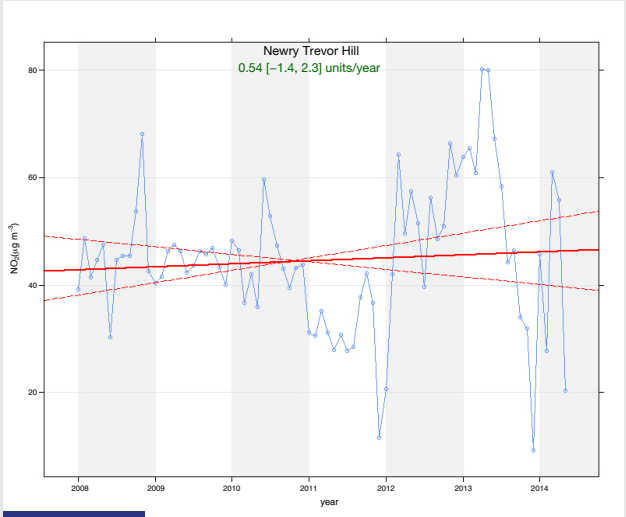


Figure 4.5

De-seasonalised Trend Plot for NO_2 at Newry Trevor Hill, 2008 - 2014

4.6 Summary

The five monitoring sites discussed in this section have all been in operation for at least five years and have measured exceedances of the AQS Objective for annual mean NO_2 concentration during this time.

Both Newtownabbey Antrim Road and Belfast Newtownards Road datasets show downward trends in NO_2 concentration, although Newtownabbey Antrim Road remains close to the limit value, with an annual hourly mean of 40 µg m^{-3} for 2014. Belfast Stockman's Lane, too, has recorded a decrease in NO_2 concentration, although levels here are higher and it is likely to be several years before the AQS Objective and EU limit value is met.

The recent increase in NO_2 at Belfast Ormeau Road was due to local traffic changes during 2012, but as expected this was short-term and NO_2 levels returned to their pre-2012 levels once the works were completed. Annual means are now well below the limit value.

Overall, the graphs from the Belfast sites show that the long-term roadside NO_2 concentrations in the city are mostly decreasing, although at different rates in the monitored areas.

The exception is the Newry Trevor Hill site, which has measured annual mean NO_2 concentrations above 40 µg m^{-3} in several recent years, and has not shown a clear trend either upward or downward. It is therefore difficult to predict when compliance with the AQS Objective might be achieved here.

5

Maps of Air Quality

Measurements from air quality monitoring sites in Northern Ireland have been combined with pollutant emissions estimates from the UK's National Atmospheric Emissions Inventory (NAEI) to produce detailed modelled maps – at 1 km resolution – of average or peak background pollutant concentrations across Northern Ireland for 2014.

Figure 5.1 shows modelled annual mean PM_{10} concentrations. Highest concentrations occur in the Lagan Valley, in the area around Belfast and Dunmurry. Despite this, annual mean background concentrations throughout the region are well below the AQS objective.

Figure 5.2 shows corresponding annual mean benzo[a] pyrene (B[a]P) concentrations. Highest concentrations occur around Derry. However the annual mean background concentrations throughout the region are below the AQS objective (1 ng m^{-3}).

Figure 5.3 shows modelled annual mean NO_2 concentrations at background locations - i.e. at least 10 m away from major roads. These are all well below the AQS objective even in central Belfast. Although this map shows background concentrations, the contribution of vehicle emissions can still be seen, with the network of major roads connecting Northern Ireland's cities clearly visible in Figure 5.3. The roads are visible because the presence of a major road in a grid square raises the average NO_2 concentration in that grid square.

For traffic-related pollutants, roadside concentrations, 4 m from the kerb, are also modelled. Figure 5.4 shows modelled annual mean NO_2 concentrations alongside major roads in the Belfast area. Exceedances of the AQS objective are predicted along numerous road links, including some city centre streets, the A12 (Westlink), and stretches of the A2 towards Holywood. This is generally consistent with monitoring results. The exception is the A2: the North Down Holywood A2 monitoring site did not record an exceedance in 2014 despite the model's predictions – possibly because of its coastal location.

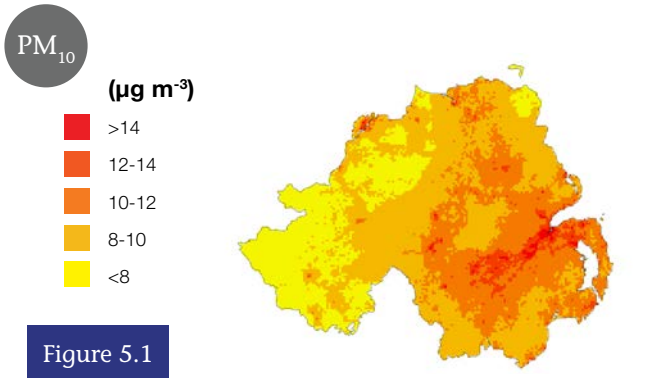


Figure 5.1

Estimated annual mean background PM_{10}, µg m^{-3}

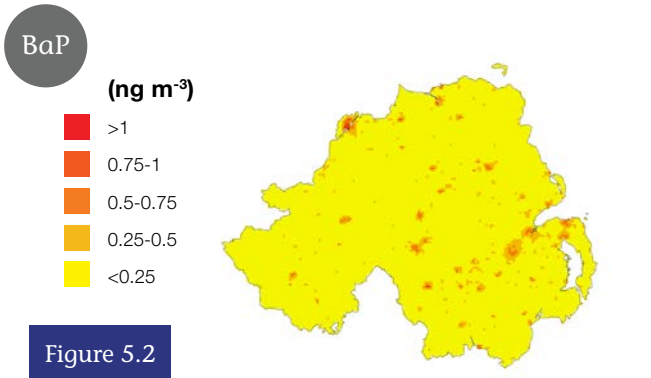


Figure 5.2

Estimated annual mean background BaP ng m^{-3}

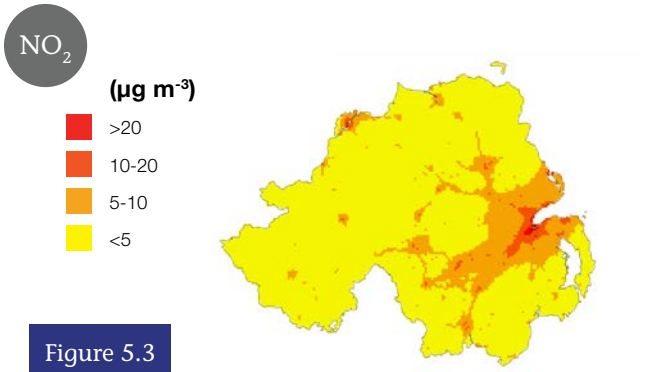


Figure 5.3

Estimated annual mean background NO_2, µg m^{-3}

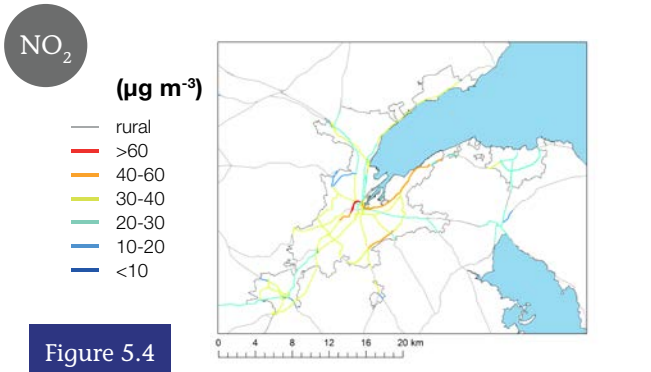


Figure 5.4

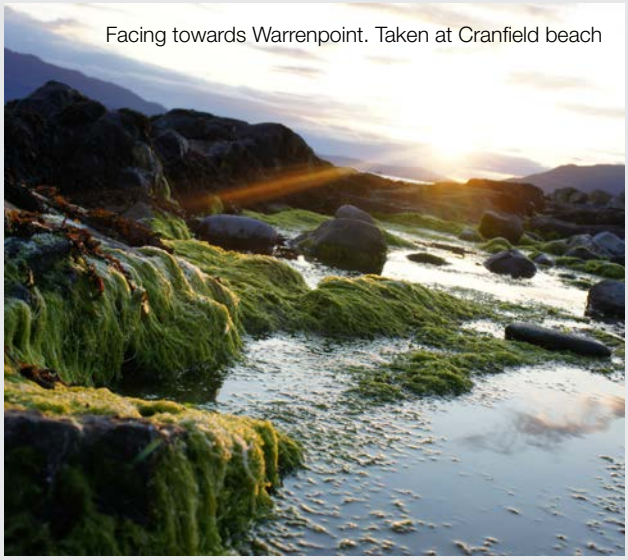
Estimated annual mean roadside NO_2, µg m^{-3} in the Belfast area

6

Health Effects of Air Pollution

It is well known that air pollution can affect human health. In this section we outline the health effects of some of the pollutants that commonly impact on our outdoor air quality.

Particulate Matter: the particles that pollute our air are made up of many different substances – for example soot from car exhausts or chimneys, wind-blown dust and soil, sea salt, and chemical compounds such as sulphates and nitrates formed in the atmosphere[3]. When inhaled, coarser particles – those greater than around 10 microns across – are mostly trapped in our noses and throats, and do not reach our lungs. However smaller particles (those that fall into the PM_{10} and $PM_{2.5}$ size fractions) are small enough to be inhaled into our lungs[4]. There, they can cause a range of health problems: many scientific studies have now found strong links between ambient PM_{10} or $PM_{2.5}$ concentrations, and health outcomes such as mortality and hospital admission. On a day-to-day basis, people with existing heart or lung conditions may find their symptoms are worse when particulate pollution is elevated. Long-term exposure to particulate pollution has been found to increase the risk of developing cardiovascular and respiratory diseases[5,6].



Facing towards Warrenpoint. Taken at Cranfield beach

Ozone: in the stratosphere, ozone (O_3) occurs naturally, forming the 'ozone layer' that protects life on Earth from the sun's harmful ultraviolet radiation. As we saw in Section 3, however, O_3 can also be formed near ground level from chemical reactions involving other so-called 'precursor' compounds, in the presence of sunlight. At ground level O_3 is a problem. It is harmful to plants and ecosystems and also affects human health, causing irritation of the eyes, nose, airways and lungs. A recent study by the Committee on the Medical Effects of Air Pollutants (COMEAP)[7] found that, for each 10 µg m^{-3} increase in daily maximum 8-hour running mean O_3 concentration, the risk of death, by any cause, went up by 0.34%, the risk of hospital admission for respiratory problems went up by 0.75%, and the risk of hospital admission for cardiovascular (heart and circulatory) problems went up by 0.11%. No 'safe' level (below which no health effects occur) has been identified for O_3.

Nitrogen Dioxide (NO_2): according to the National Atmospheric Emissions Inventory (see http://naei.defra.gov.uk/overview/pollutants?pollutant_id=6), road vehicles are now the largest single source of nitrogen oxides, accounting for almost a third of the UK's emissions. Members of the public are most likely to be exposed to high NO_2 concentrations when they are close to busy urban roads.

[3] Defra 'What are the Causes of Air Pollution' [online]. Available at http://uk-air.defra.gov.uk/assets/documents/What_are_the_causes_of_Air_Pollution.pdf (Accessed 08 Oct 2015).

[4] World Health Organization (2005) 'Air quality guidelines. Global update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide' pp218-219 (ISBN 92 890 2192 6). [online] Available at http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf?ua=1 (Accessed 08 Oct 2015).

[5] World Health Organization (2005) 'Air quality guidelines. Global update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide' pp218-219 (ISBN 92 890 2192 6). [online] Available at http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf?ua=1 (Accessed 08 Oct 2015).

[6] WHO (updated 2014) 'Ambient (outdoor) air pollution and health- Factsheet No 313' [online]. Available at http://www.who.int/mediacentre/factsheets/fs313/en/ (Accessed 02 Oct 2015).

[7] COMEAP (2015) 'Quantification of Mortality and Hospital Emissions Associated with Ground Level Ozone' [online]. Available at https://www.gov.uk/government/publications/comeap-quantification-of-mortality-and-hospital-admissions-associated-with-ground-level-ozone (Accessed 02 Oct 2015).

Like O_3, NO_2 is a respiratory irritant. According to the World Health Organization[4], short-term exposure to concentrations greater than 200 µg m^{-3} can cause 'significant inflammation of the airways'. (This value is the 1-hour air quality objective for NO_2). Long-term exposure is linked with increases in symptoms of bronchitis in asthmatic children, and NO_2 concentrations currently measured in Europe's cities have been linked with reduced lung function growth[4]. As well as affecting human health, NO_2 contributes to the formation of nitrate particles (a component of PM_{10} and $PM_{2.5}$), and of O_3.

Sulphur Dioxide (SO_2): formed from the combustion of fuels containing sulphur (such as some coals and oils). Like NO_2 and O_3, SO_2 is an irritant. The sharp, eye-watering smell of coal smoke is partly due to SO_2. High concentrations of this pollutant, for even short periods, can cause coughing, mucus secretion, and a worsening of symptoms for people with existing breathing problems such as asthma.

Carbon Monoxide (CO): this is produced when fuels containing carbon are burnt without enough oxygen to turn all of the carbon to carbon dioxide (CO_2). The main source of CO in the outdoor air is vehicle exhaust emissions. CO has no taste, smell or irritant effect, but is very dangerous. When inhaled, CO reduces the blood's ability to carry oxygen around the body. Outdoor concentrations of CO rarely reach harmful levels. People are most likely to be exposed to harmful, or even deadly, levels of CO indoors, due to emissions from a faulty or inadequately ventilated boiler or heating appliance. CO is also one of the many harmful constituents of cigarette smoke.

How Might Air Pollution Affect Me?

Many people are unsure about how everyday levels of air pollution might affect them or their family. The information below is taken from DHSSPS's advice on *'Air pollution and health'*, and more information can be found at www.nidirect.gov.uk/air-pollution-and-health.

From time to time, weather conditions can lead to a build up of air pollutants associated with emissions from transport and the burning of fuel. These raised levels of air pollution can affect health.

In winter, cold, still conditions can lead to an increased level of pollutants at ground level. In summer, hot weather without much wind can also lead to raised concentrations of pollutants (particularly O_3).

While most people will not be affected by short term peaks in air pollution, some people – particularly vulnerable groups such as those with existing heart or lung conditions – may experience increased symptoms.

If you think you may be affected by air pollution levels, you should consider modifying your treatment as you usually do when symptoms increase, and consult your doctor if this is not effective.

You may also wish to reduce the time you spend outdoors or avoid busy, congested streets.

If you have noticed in the past that your breathing is affected during cold, calm conditions or on hot, sunny days, you should avoid strenuous outdoor activity on those days and ensure that you have access to your usual medication, such as asthma inhalers.

Children with asthma should be able to take part in games in the usual way, although they may need to increase their use of reliever medicines before participating. There is no need for them to stay away from school.

If you suffer from a heart condition and notice a change in your symptoms you should seek medical advice as you normally would.

Air Pollution Alerts Text Service

You can receive high air pollution alerts free to your mobile phone to let you know when air pollution levels are high. Subscribe to the 'Air Aware' service by texting AIR to 67300 to receive these alerts.

Text messages to the service will be charged at your normal standard rate and alerts are received free of charge.

7

What Can I Do To Help?

It takes energy to produce food, treat our drinking water, manufacture the things we use, heat our homes and workplaces, and transport us to the places we need to go. Most of this energy comes from the burning of fuels – producing CO_2, which contributes to climate change, and usually some air pollutants, such as NO_X and PM_{10}.

Therefore, the choices we make about how we travel, how we heat our homes, and the things we buy and use can all help to make a difference to air quality. If we can use less energy, and avoid wasting it, this will avoid releasing unnecessary pollution into the air. It will also save us money.

Here are some things to do:

Make sure your home is well insulated and the boiler well maintained. In most UK homes the central heating system accounts for the highest percentage of energy used[8]. Under the **Warm Homes Scheme** you may be able to receive energy advice and help to make sure your home is well insulated. Check out the Warm Homes website at www.nidirect.gov.uk/affordable-warmth-grant-scheme to see if you qualify.

- Stay warm but don't overheat your home. 21 °C is comfortable for most people.
- If you are a landlord, ensure that the homes you let are properly insulated so that your tenants do not have to waste energy to keep warm.
- Avoid wasting food – it takes energy to produce. There is plenty of useful advice on the **Love Food Hate Waste** website, at http://ni.lovefoodhatewaste.com.
- Try to drive less. Walk or cycle if possible, or use public transport – especially for short journeys. The NIDirect **Travelwise Northern Ireland** website provides advice and information on more sustainable transport options including walking, cycling, car sharing and public transport, and this is provided for commuters, schools and employers. Travelwise Northern Ireland will help you to understand the health and environmental benefits and cost savings of cycling. For example, by visiting the website at www.nidirect.gov.uk/index/information-and-services/travel-transport-and-roads/travelwiseni.htm, you can:
  - Compare the costs of cycling with those of using a car;
  - Estimate the calories you can burn;
  - Learn about important safety skills for cyclists;
  - Plan your bike journey using interactive route maps; and
  - Find out about the Cycle to Work scheme, a financial initiative that allows employees to take out a tax exempt loan to purchase a bicycle.

Lots more energy saving advice can be found on the **NI Direct 'Environment and Greener Living'** webpages at www.nidirect.gov.uk/index/information-and-services/environment-and-greener-living.htm.

Where to Find Out More on Air Quality:

The Northern Ireland Air Quality Website at www.airqualityni.co.uk provides information covering all aspects of air pollution in Northern Ireland.

The DoENI website at www.doeni.gov.uk provides information on a range of environmental issues including air quality, waste and climate change.

National and local air quality forecasts are available from:

- The Air Pollution Recorded Helpline on freephone 0800 556677;
- The Defra UK Air Information Resource (UK-AIR) at http://uk-air.defra.gov.uk
- The Northern Ireland Air Quality website www.airqualityni.co.uk

For information on air quality issues in your local area please contact the Environmental Health Department of your district council.

[8] nidirect "Central Heating" [online].
Available at www.nidirect.gov.uk/index/information-and-services/environment-and-greener-living/energy-wise/central-heating.htm. (Accessed 28 Oct 2015))

Department of the
Environment
www.doeni.gov.uk

Ricardo
Energy & Environment

This report has been produced by Ricardo Energy & Environment on behalf of the Department of the Environment

Its main authors are Jenny Thomas and Alison Loader, section 6 by DoENI and maps by Shaun Brace.

ISBN: 978-1-907053-97-9

Printed on 100% recycled paper