Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Air Pollution
in Northern Ireland 2016

Ricardo Energy & Environment

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Report Highlights

This is the fifteenth 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 Agriculture, Environment and Rural Affairs (DAERA). 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 2016. 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 2016.

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 2016, including exceedances of air quality objectives.

Section 4 covers two important aspects of Northern Ireland's air quality: firstly, how air pollution has changed over time, and secondly, how it currently varies spatially across the region. Section 5 focuses on air pollution from agriculture. Finally, Section 6 provides information on the measures and initiatives being undertaken to help protect and improve the quality of the air in our region. Details of where to find more information are given on the back cover.

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.

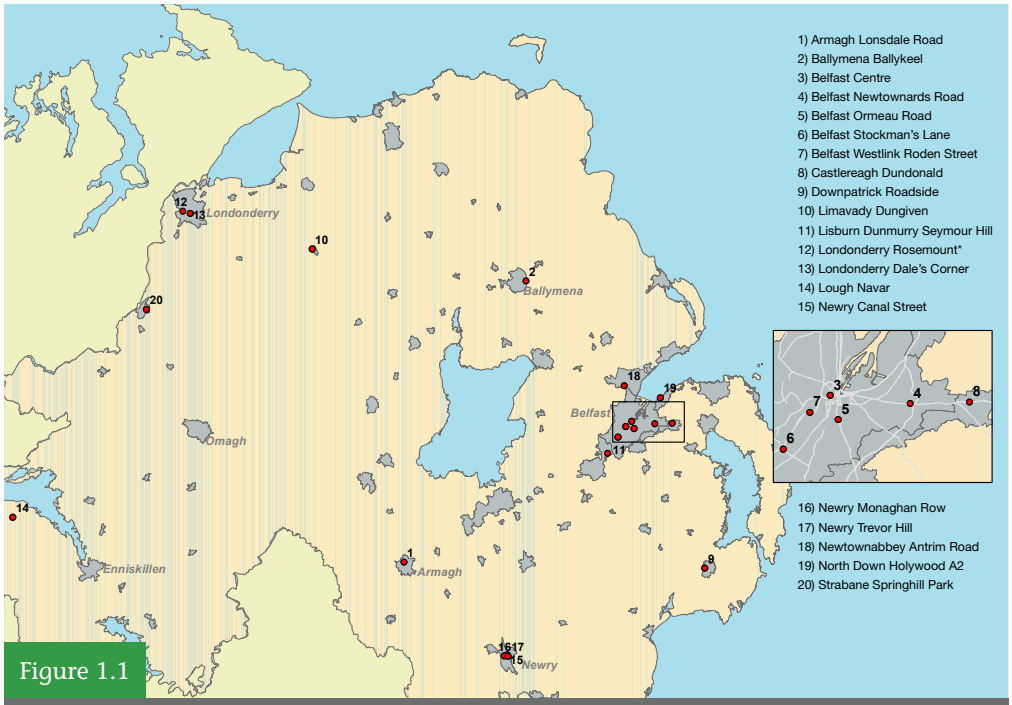

Figure 1.1

Locations of Automatic Air Quality Monitoring Sites in Northern Ireland, 2016

* Londonderry Rosemount replaced Londonderry Brooke Park in early 2016

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Legislation and Policy

The management of air quality in Northern Ireland is currently 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 Directives 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. In June 2016, the UK voted to leave the European Union and in March 2017 the UK Government began the formal process of doing so. In response to this, DAERA has established a Brexit Division to identify and review all relevant Northern Ireland agricultural and environmental legislation.

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 DAERA to inform the public about air quality in the region, particularly with regard to warning the public when information and alert thresholds are exceeded.

Also, a target to improve air quality exists in the Northern Ireland Executive's Programme for Government.

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.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1.

In late 2016, DAERA commenced work on delivering a long term air quality strategy for Northern Ireland, which will include reviewing all current air quality policy.

Photo: Cliffs near Portrush in Northern Ireland

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 the 11 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 (along with relevant authorities), to develop an Action Plan addressing the problem.

There are currently 24 AQMAs in Northern Ireland, as shown in Table 2.1. Nine councils have AQMAs: of these, five have AQMAs for NO_2 only, and four have AQMAs for PM_{10} and NO_2 (either separately or together). There are no AQMAs in place for any other pollutants. 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 October 2017)

District Council	No. of AQMAs	Pollutants	Sources
Antrim and Newtownabbey	1	NO_2	Road traffic
Ards and North Down	0	–	–
Armagh, Banbridge and Craigavon	2	NO_2	Road traffic
Belfast City	4	NO_2 (3), NO_2 and PM_{10} (1)	Road traffic
Causeway Coast and Glens	1	NO_2	Road traffic
Derry City and Strabane	8	NO_2 (5), PM_{10} (3)	Road traffic, Domestic emissions
Fermanagh and Omagh	0	–	–
Lisburn City and Castlereagh	1	NO_2	Road traffic
Mid and East Antrim	2	NO_2 (1), PM_{10} (1)	Road traffic, Domestic emissions
Mid Ulster	3	NO_2	Road traffic
Newry, Mourne and Down	2	NO_2 (1), PM_{10} (1)	Road traffic, Domestic emissions

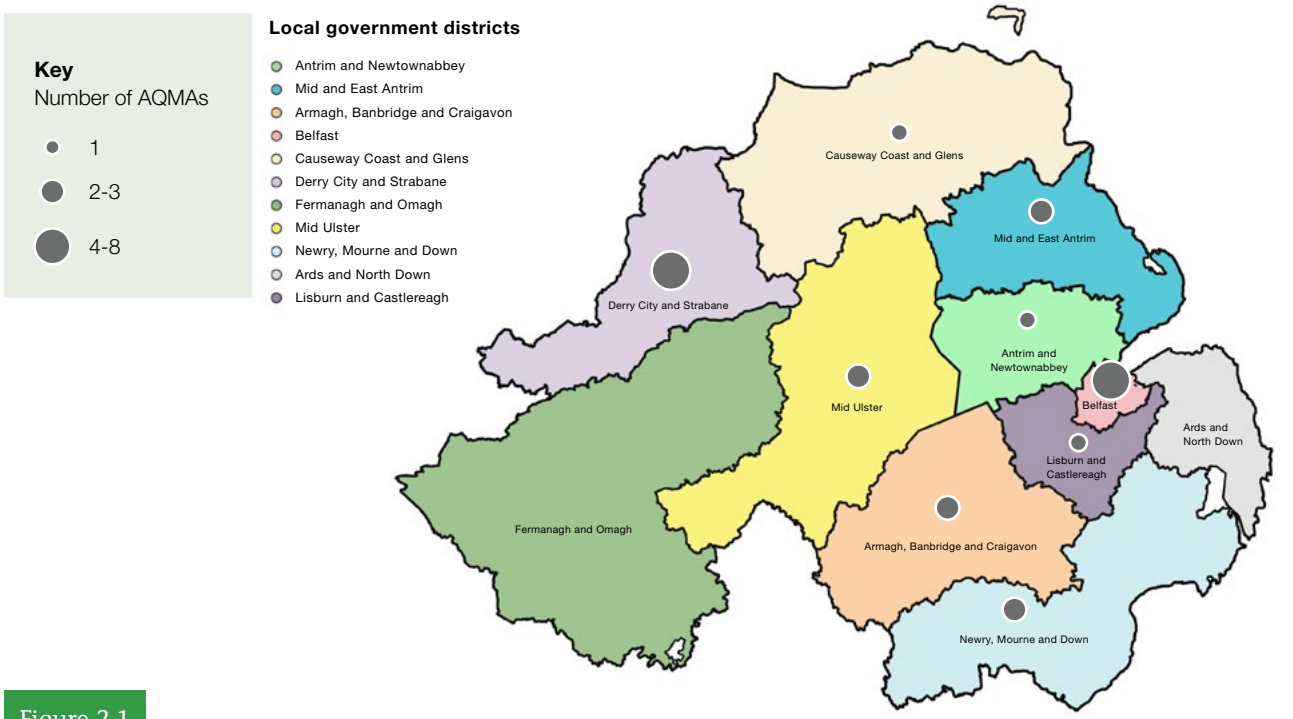


Figure 2.1

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

3

Monitoring Results for 2016

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 2016:

- 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 (PAHs).

There were 21 automatic air quality monitoring stations that operated for part or all of 2016 in Northern Ireland (including Londonderry Brooke Park, Newry Monaghan Row and Newry Trevor Hill which closed part way through the year). Each was 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 are communicated rapidly to the public via the website www.airqualityni.co.uk. Public warnings are issued when levels approach or reach 'high' levels as defined by the Daily Air Quality Index (see https://uk-air.defra.gov.uk/air-pollution/daqi for an explanation of this Index).

Six of the automatic monitoring sites (Armagh Lonsdale Road, Ballymena Ballykeel, Belfast Centre, Belfast Stockman's Lane, Londonderry Rosemount – which replaced Londonderry Brooke Park in March 2016 - and Lough Navar) were part of the UK's national monitoring network, and were used to assess compliance with the Air Quality Directive.

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

In addition, several 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 The Volatile Correction Model

Three of Northern Ireland's 13 PM_{10} monitoring sites used the Tapered Element Oscillating Microbalance (TEOM) to measure PM_{10} during 2016. 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 European 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}: there is at present no requirement to correct TEOM measurements of $PM_{2.5}$, and in any case all of Northern Ireland's $PM_{2.5}$ monitoring sites use the FDMS analyser.

3.3 Key Results for 2016

This section summarises key monitoring results from 2016, 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.

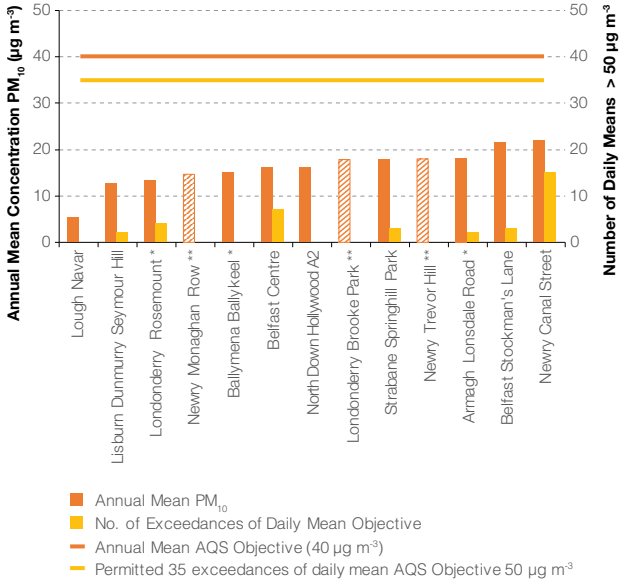
Carbon monoxide was monitored using an automatic instrument at one site – Belfast Centre. The results were well within the EU limit value and AQS objective for this pollutant, and have been for many years.

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 2016, 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 Heavy Metals Network. The results for 2016 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 six automatic sites during part or all of 2016 (counting both Londonderry Brooke Park and its replacement, Londonderry Rosemount). 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 13 locations in 2016 (including Londonderry Brooke Park which closed early in the year, its replacement Londonderry Rosemount, also Newry Monaghan Row and Newry Trevor Hill which closed during the year). Figure 3.1 shows the annual mean PM_{10} concentrations (shown by the darker coloured bars, against the left axis), and the number of exceedances of the daily mean limit value and objective (shown by the lighter coloured bars, against the right axis). Three of these sites (Newry Canal Street, North Down Holywood A2 and Lisburn Dunmurry Seymour Hill) used the TEOM instrument, so data from these 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 value and objective of 40 µg m^{-3} for annual mean PM_{10}, and no sites exceeded the daily mean limit value and objective of 50 µg m^{-3} on more than the maximum permitted 35 occasions during the year (after VCM correction if applicable).



* Asterisk indicates sites with < 85% data capture, ** two asterisks indicate sites with < 50% data capture. The latter shown with striped rather than solid shading.

Figure 3.1

Annual Mean PM_{10} Concentrations and Exceedances of Daily Objective, 2016

Particulate matter – $PM_{2.5}$. Fine particulate matter as $PM_{2.5}$ was monitored (using the FDMS analyser) at Belfast Centre throughout 2016, and at Londonderry Rosemount from 23rd March 2016. Both sites reported annual mean $PM_{2.5}$ concentrations well below the EU Stage 1 limit value of 25 µg m^{-3} (which had to be met by 1st Jan 2015). Levels were also below the EU Stage 2 limit value (20 µg m^{-3} to be achieved by 1st Jan 2020).

Nitrogen dioxide was monitored using automatic analysers at 15 sites during 2016. Figure 3.2 shows the annual mean NO_2 concentrations (shown by the darker coloured bars, against the left axis), and the number of exceedances of the hourly mean objective (shown by the lighter coloured bars, against the right axis). This figure presents all sites, including two with very low data capture: Londonderry Brooke Park (which closed early in 2016) and

Limavady Dungiven. The annual means for these sites are shown by striped rather than solid shading.

Four sites exceeded the AQS objective for annual mean NO_2 concentration (40 µg m^{-3}). These were as follows: Belfast Stockman's Lane (50 µg m^{-3}), Downpatrick Roadside (44 µg m^{-3}), Limavady Dungiven (44 µg m^{-3}) and Newtownabbey Antrim Road (41 µg m^{-3}). However, it should be noted that Limavady Dungiven had only 14% data capture – insufficient for a valid annual mean. All four of the above are traffic-related sites beside major or busy roads.

No sites exceeded the hourly mean limit value of 200 µg m^{-3} on more than the permitted 18 occasions. Where data capture is less than 85%, exceedance of the hourly mean objective is judged on whether the 99.8th percentile of hourly values has exceeded 200 µg m^{-3} rather than the number of hourly means above the objective. This was not the case for any sites.

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 2016 and previous years has been identified as non-compliant with the EU Directive limit value for annual mean NO_2 (also 40 µg m^{-3}). None of the other sites that exceeded the AQS objective for this pollutant are used for compliance monitoring.

Ozone was monitored at Belfast Centre, Londonderry Brooke Park (subsequently at its replacement Londonderry Rosemount), 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 2016 (Figure 3.3), although all three sites had at least one exceedance day during 2016.

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 (for example, there were none in 2014). The reasons for this relate to how

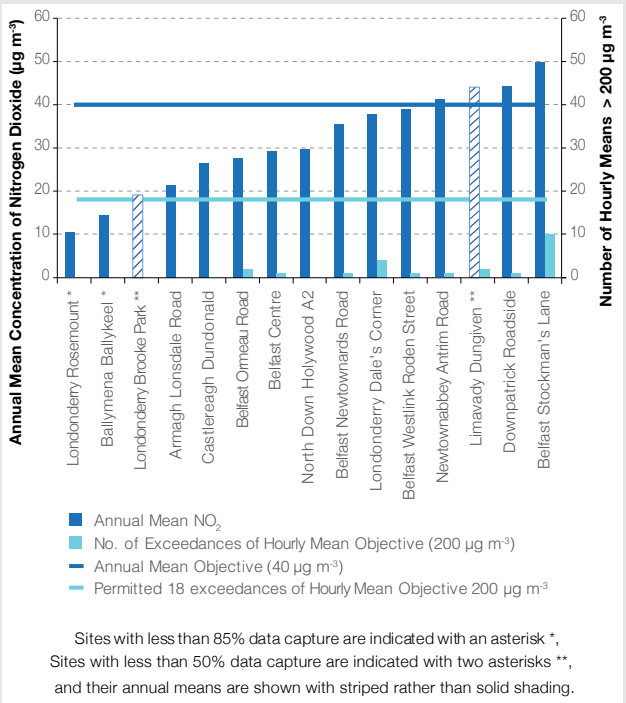


Figure 3.2

Annual Mean NO_2 Concentrations and Exceedances of Hourly Objective, 2016

ozone is formed: it is a 'secondary' pollutant – that is, it is formed by reactions involving other pollutants, 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 global 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 much of the ozone measured in a particular area may have been generated elsewhere, and so it is more difficult to reduce concentrations by local action.

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

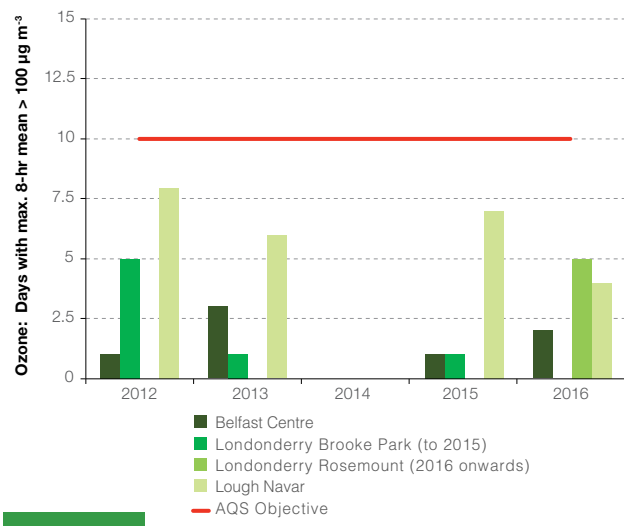


Figure 3.3

Ozone: Days with Maximum 8-hour mean > 100 µg m^{-3} for Five Years 2012-2016

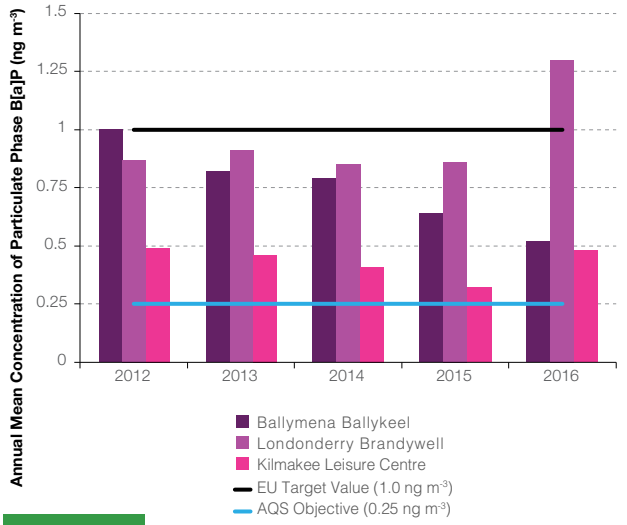


Figure 3.4

Annual Mean Concentrations of Benzo[a]pyrene for Five Years 2012-2016

Polycyclic aromatic hydrocarbons (PAHs) were monitored at three sites in 2016; Ballymena Ballykeel, Londonderry Brandywell and Kilmakee Leisure Centre in Dunmurry. All are part of the UK PAH Monitoring 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 3.4 shows the annual mean concentrations at these three sites over the past five years. Londonderry Brandywell exceeded the EU target value of 1 ng m^{-3} for annual mean B[a]P concentration, which was to be met by 31st Dec 2012. This is the first year since 2010 in which it has exceeded this objective, and follows three years in which no sites in Northern Ireland exceeded. The other two sites were compliant. All three sites continue to exceed the more stringent AQS annual mean objective of 0.25 ng m^{-3} for this PAH species, which was to have been achieved by 31st Dec 2010.

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, three monitoring sites with sufficient data for a valid annual mean did not meet the limit values and objectives for nitrogen dioxide in 2016; Belfast Stockman's Lane, Newtownabbey Antrim Road and Downpatrick Roadside. All are traffic-related sites. One site, Belfast Stockman's Lane, was used for assessment of 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 non-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, local and meteorological factors. This pollutant can therefore vary considerably from year to year. Although no sites exceeded the AQS objective in 2016, O_3 exceedances remain a possibility in future. The most recent year in which any monitoring sites in Northern Ireland exceeded the AQS objective for ozone was 2011.

Following three consecutive years without an exceedance of the EU target value for benzo[a]pyrene in Northern Ireland, in 2016 Londonderry Brandywell exceeded. All three sites continue to exceed the more stringent AQS objective.

4

Spatial Variation and Changes Over Time

This section looks at two aspects of Northern Ireland's air quality:

(i) spatial distribution of the various pollutants – that is, where the highest and lowest pollutant concentrations were in 2016,

(ii) changes over time.

4.1 Spatial Variation in Air Pollutant Concentrations

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 background pollutant concentrations across Northern Ireland for 2016.

Figure 4.1 shows modelled annual mean PM_{10} concentrations. Highest concentrations occur in the Lagan Valley, in the area around Belfast and Dunmurry. Like all pollutants, ambient concentrations of PM_{10} can vary from year to year; the area with concentrations greater than 8 µg m^{-3} is larger compared with the 2015 map, though still lower than in 2014. (See previous years' reports.) However, annual mean background concentrations throughout the region were well below the AQS objective of 40 µg m^{-3}, as Northern Ireland's monitoring also showed.

Figure 4.2 shows corresponding annual mean $PM_{2.5}$ concentrations. These are lower than PM_{10} as would be expected. Most of rural Northern Ireland has annual mean background concentrations below 6 µg m^{-3}, though in Belfast and other cities the annual mean background concentrations can reach 9 µg m^{-3} or more. However, annual mean $PM_{2.5}$ concentrations throughout Northern Ireland are well below the EU Stage 2 limit value of 20 µg m^{-3}.

Figure 4.3 shows modelled annual mean NO_2 concentrations at background locations - i.e. at least 10m away from major roads. These are all well below the AQS objective even in central Belfast. The routes of some of Northern Ireland's major roads can be seen (as the presence of a major road in a grid square raises its average NO_2 concentration). Average concentrations outside of Belfast and the Lagan Valley are mostly below 10 µg m^{-3} even if there is a road in the grid square.

For traffic-related pollutants, roadside concentrations, 4 m from the kerb, are also modelled. Figure 4.4 shows modelled annual mean NO_2 concentrations alongside major roads in the Belfast area. As in previous years, exceedances of the AQS objective (annual mean concentrations above 40 µg m^{-3}) are predicted along some road links in and around the city, including some city centre streets, part of the A12 (Westlink), and parts of the A2 and A55. (There are some differences between the model's predictions and actual measurements; Belfast Westlink Roden Street did not record an exceedance in 2016, but Belfast Stockmans Lane did).

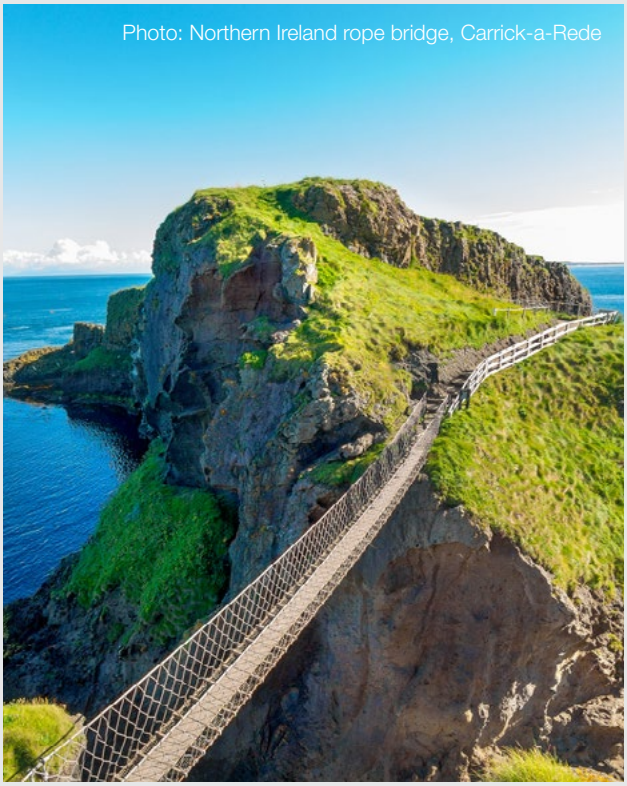


Photo: Northern Ireland rope bridge, Carrick-a-Rede

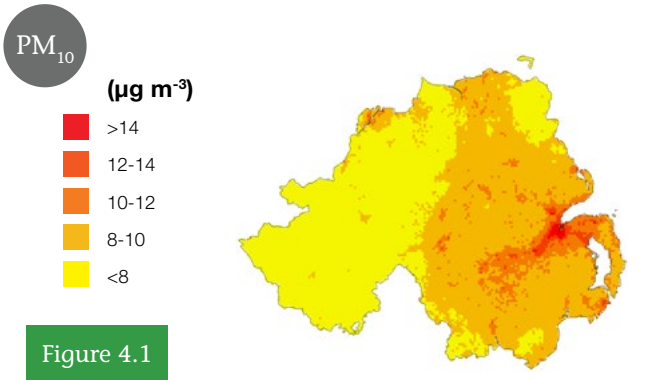


Figure 4.1

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

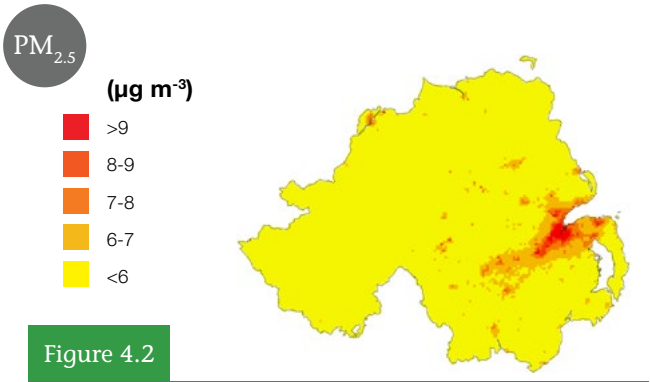


Figure 4.2

Estimated annual mean background $PM_{2.5}$, µg m^{-3}

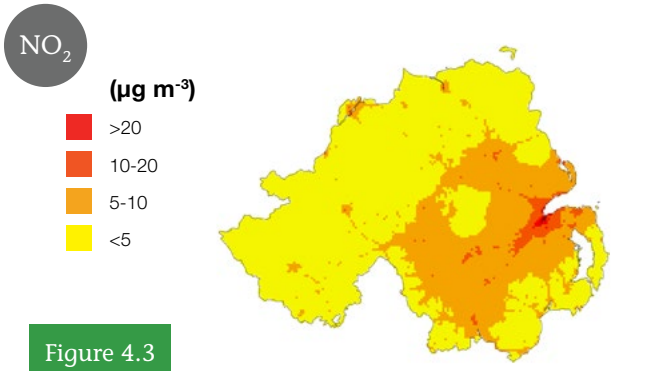


Figure 4.3

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

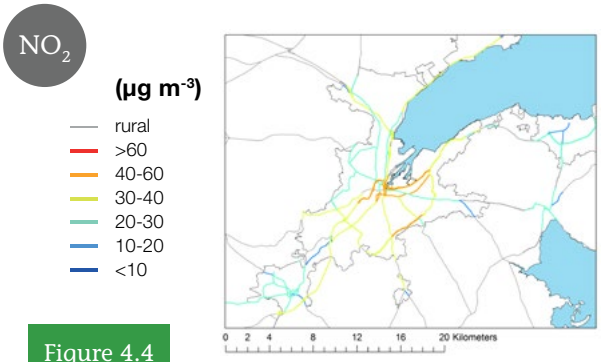


Figure 4.4

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

Photo: Northern Ireland, Ulster coast

4.2 Changes Over Time

This part of the report looks at how air quality in Northern Ireland has changed over recent years. Previous recent reports in this series have focussed on trends shown by groups of long-running monitoring sites. This year's report uses a different approach; it investigates trends in a different parameter: the Population Weighted Annual Mean.

Like the maps in Section 4.1, the Population Weighted Annual Mean is based on modelled pollutant concentrations. Northern Ireland is divided into a grid of 1 km x 1 km squares: for each grid square, the annual mean concentration is modelled for each pollutant of interest (for example, NO_2). The annual mean NO_2 concentrations for all the grid squares are then averaged, but with a weighting factor applied, based on the population of the grid square. So densely populated grid squares make a proportionately bigger contribution to the weighted mean, than do those with few residents. This gives the Population Weighted Mean (PWM).

Below, we investigate how the PWM for NO_2, PM_{10} and $PM_{2.5}$ in Northern Ireland have changed since 2009.

4.2.1 Nitrogen Dioxide

Figure 4.5 shows a time series graph of Northern Ireland's PWM for NO_2, from 2009 to 2016. This shows a small general decrease over the eight year period (illustrated by the linear regression line): on average, the PWM for NO_2 has decreased by 0.18 µg m^{-3} per year over this period. However, there is not a consistent year-on-year decrease: this graph also shows that the PWM has increased in some years, compared to the previous year's value. In particular, the PWM for 2016 is the highest since 2012.

Also shown in the same graph (in a lighter colour) is the NO_2 PWM for the whole of the UK, for comparison. The PWM for the whole UK is typically 7-9 µg m^{-3} higher than that for Northern Ireland alone; it shows a pattern that is similar in some respects, including a slight rise in 2016 compared to the previous year.

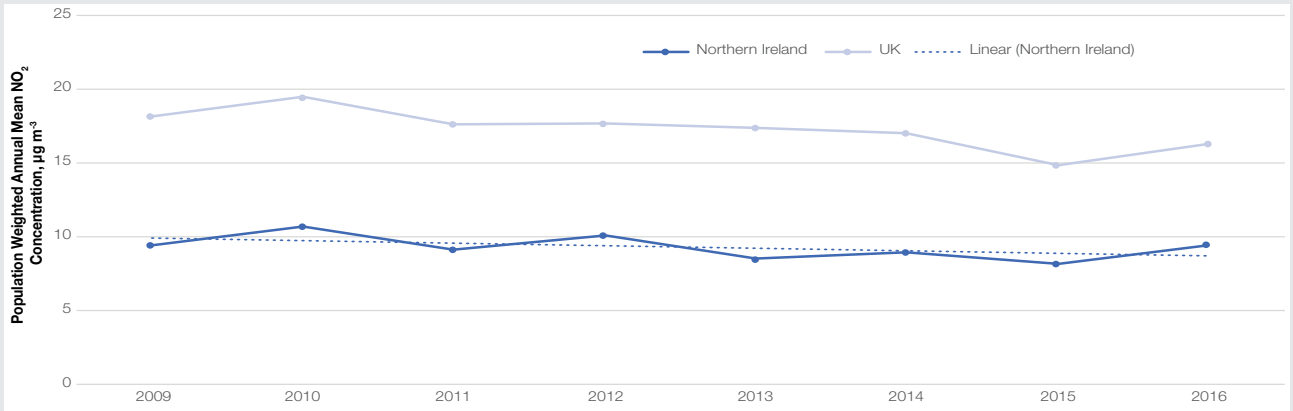


Figure 4.5

Population Weighted Mean NO_2, 2009 – 2016, µg m^{-3}

4.2.2 PM_{10} Particulate Matter

Figure 4.6 shows a time series graph of Northern Ireland's PWM for PM_{10}, from 2009 to 2016. This also shows some decrease over the eight year period, though again there is variation from year to year. On average, the PWM for PM_{10} in Northern Ireland has decreased by 0.28 µg m^{-3} per year, though the biggest decrease was between 2014 and 2015. Like NO_2, PM_{10} appears to have been higher in 2016 than in 2015.

Figure 4.6 also shows the PM_{10} PWM for the whole of the UK (in a lighter colour). The UK PWM is typically 3-4 µg m^{-3} higher than that for Northern Ireland alone, but shows a similar pattern including the 'upturn' in 2016.

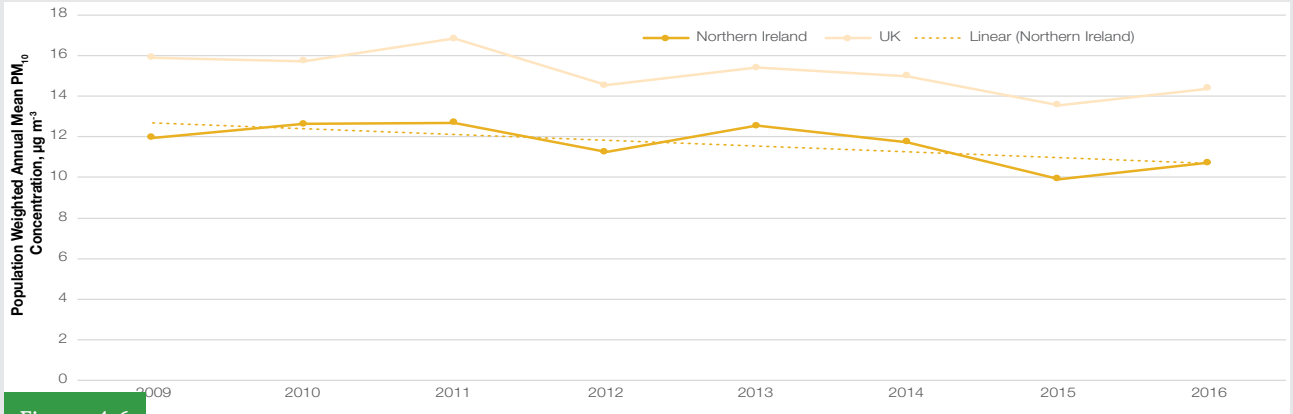


Figure 4.6

Population Weighted Mean PM_{10}, 2009 – 2016, µg m^{-3}

4.2.3 $PM_{2.5}$ Particulate Matter

Figure 4.7 shows a time series graph of Northern Ireland's PWM for $PM_{2.5}$, from 2009 to 2016. This graph indicates that between 2009 and 2013, the PWM for $PM_{2.5}$ increased overall. This was followed by a decrease, and in 2015 the PWM appears to have reached its lowest level since 2009. However, as for NO_2 and PM_{10} there is a slight upturn in 2016. Figure 4.7 also shows the $PM_{2.5}$ PWM for the whole of the UK (in a lighter colour): the UK PWM is typically 2-3 µg m^{-3} higher than that for Northern Ireland alone, but follows a very similar pattern.

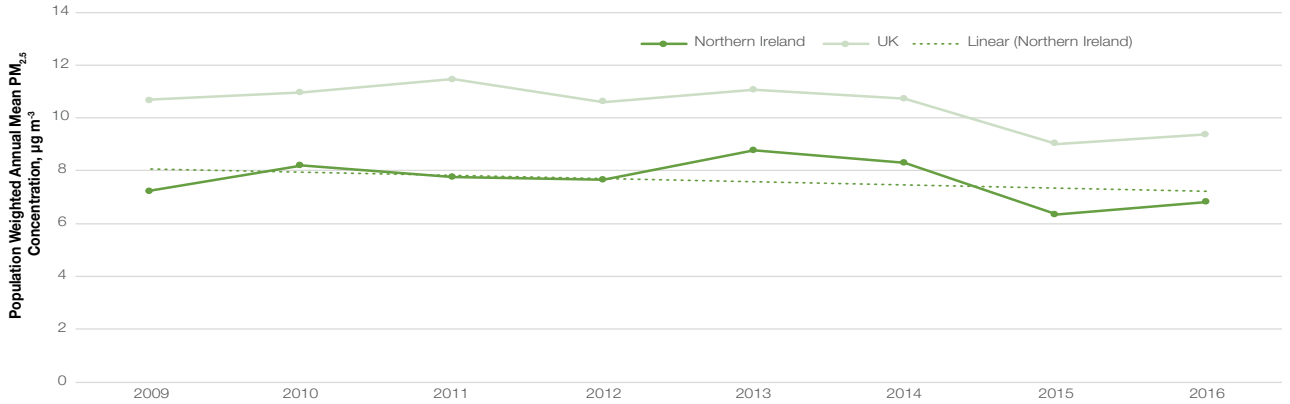


Figure 4.7

Population Weighted Mean $PM_{2.5}$, 2009 – 2016, µg m^{-3}

Photo: Carnlough Harbour, County Antrim

5

Air Pollution from Agriculture

5.1 Agriculture in Northern Ireland

Relative to the UK as a whole, agriculture is a more important industry in Northern Ireland, employing 2.5% of total civil employment, compared with 1.1% across the UK[2]. Agriculture in Northern Ireland is dominated by livestock farming with a higher proportion of total agricultural activity being devoted to cattle, pig and poultry farming than in the UK as a whole (Figure 5.1). Most of the agricultural area in Northern Ireland is grassland; arable or horticultural crops occupy just 4.7% of the farmed area.

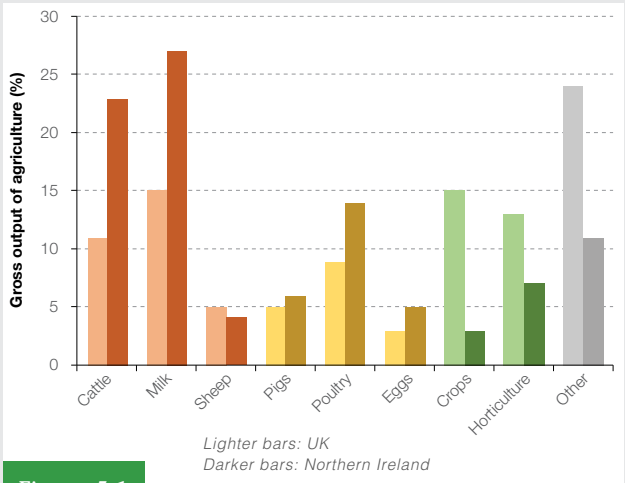


Figure 5.1

Gross output of agriculture in the UK[2] and in Northern Ireland[3], for 2015.

5.2 Air Pollutants from Agriculture in Northern Ireland

The most important emissions from agricultural activity with respect to air quality are:

- Ammonia (NH_3)
- Particulate matter (PM)
- Volatile organic compounds (VOCs)
- Oxides of nitrogen (NO_x)

Agricultural activity also emits greenhouse gases, including nitrous oxide (N_2O) from soil and manures, methane (CH_4) from livestock and manures, and carbon dioxide (CO_2) from fuel combustion and from oxidation of carbon stored in soil. According to data from the Northern Ireland Greenhouse Gas Inventory, agriculture accounted for 3.6% of Northern Ireland's CO_2 emissions, and 28.6% of its total greenhouse gas emissions in 2015[4]. However, here we focus on pollutants affecting air quality.

5.2.1 Ammonia

The greatest effect of agriculture on air quality in Northern Ireland results from emission of ammonia (NH_3). Agricultural activities emit 91% of NH_3 emissions in Northern Ireland[5]. Ammonia is emitted when livestock excreta or manures are exposed to the atmosphere in livestock housing, in storage, during and following application to land, and from manures deposited to pasture during grazing. Ammonia is also emitted following application to land of some manufactured fertilisers, and from crop residues and silage.

Estimates of NH_3 emissions in Northern Ireland[6] show that around 49% of agricultural emissions are from livestock manure management, (38% from dairy and non-dairy cattle, 5% from pigs and 5% from poultry), 34% from animal manure applied to soils, 10% from excreta deposited by grazing animals, and 7% from use of inorganic nitrogen fertilisers. In Northern Ireland, the proportion of NH_3 emissions from livestock manures is greater than in England because livestock farming, especially grazed livestock, dominates agricultural production in Northern Ireland (Figure 5.1).

In 2015, Northern Ireland's NH_3 emissions constituted 12% of the UK total[5], reflecting the relative importance of the agriculture industry here.

[2] Statistical Review of Northern Ireland Agriculture 2016. Department of Agriculture, Environment and Rural Affairs. https://www.daera-ni.gov.uk/publications/statisticsal-review-ni-agriculture-2007-onward Accessed 15 September 2017.

[3] Statistical Review of Northern Ireland Agriculture 2015. Department of Agriculture, Environment and Rural Affairs. https://www.daera-ni.gov.uk/publications/statisticsal-review-ni-agriculture-2007-onward Accessed 15 September 2017.

[4] Calculated using data from the Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2015, http://naei.beis.gov.uk/reports/reports?report_id=932 Accessed 21 September 2017.

[5] Air Quality Pollutant Inventories for England, Scotland, Wales, and Northern Ireland: 1990-2015 (2017). https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1710060932_DA_Air_Quality_Pollutant_Inventories_1990-2015_v01-01.pdf Accessed 30 October 2017.

[6] Data from http://naei.beis.gov.uk/reports/reports?report_id=895 Accessed 30 October 2017.

Emissions of NH_3 from within livestock buildings increase with the total ammoniacal nitrogen (TAN) content of the manure, temperature, ventilation rate, surface area fouled by manure, and the pH of the manure. Ammonia emissions can be mitigated by measures such as reducing the nitrogen intake in feed, managing temperature and ventilation of livestock housing, and by removing slurry to covered stores as soon as possible.

Low-emission spreading methods, such as direct soil injection of manure, emit much less NH_3 than the use of 'splash plate' systems that fling slurry from the back of a tanker. To effectively reduce emission of NH_3 from manure management, a chain of measures is needed: NH_3 that is contained during housing or storage could be released at the spreading stage, if low-emission spreading is not used. Other means of reducing NH_3 emissions are to filter air removed from livestock buildings, and use additives to acidify the manure.

Following emission to the air, NH_3 is either deposited to the ground, usually to soil and vegetation, or reacts with acidic pollutants to form fine particles. These may be deposited, or alternatively persist in the atmosphere, where they can cause adverse human health impacts.

The deposition to soil has implications for greenhouse gas (GHG) emissions because deposition of NH_3 leads to emission from soil of the greenhouse gas N_2O. Deposition of NH_3 to soil, vegetation and water is important because it acts as a nitrogen fertiliser, increasing growth of plants; this has negative implications for the species composition of terrestrial and aquatic ecosystems, affecting biodiversity and species balance of sensitive and protected habitats such as bogland in Northern Ireland.

5.2.2 Particulate Air Pollution

Particulate matter (PM) emissions occur directly from farming activities, also from the reaction of NH_3 with acidic pollutants, such as nitrogen and sulphur oxides produced from combustion processes, to form fine particulate matter.

Direct emissions of PM_{10} are predominantly from poultry and pig farming, with a smaller contribution from arable farming. Livestock housing with solid manure management systems emit more PM than buildings with a slurry management system, because loose and relatively dry bedding materials (e.g. straw) release particles when disturbed. Emissions of PM from livestock buildings are influenced by the type of bedding, factors that influence animal activity (e.g. age), feeding systems, manure management systems, and building design. Animal activity causes less PM emission if the litter is moist, and the air leaving buildings can also be filtered to control PM emissions.

5.2.3 Other Pollutants

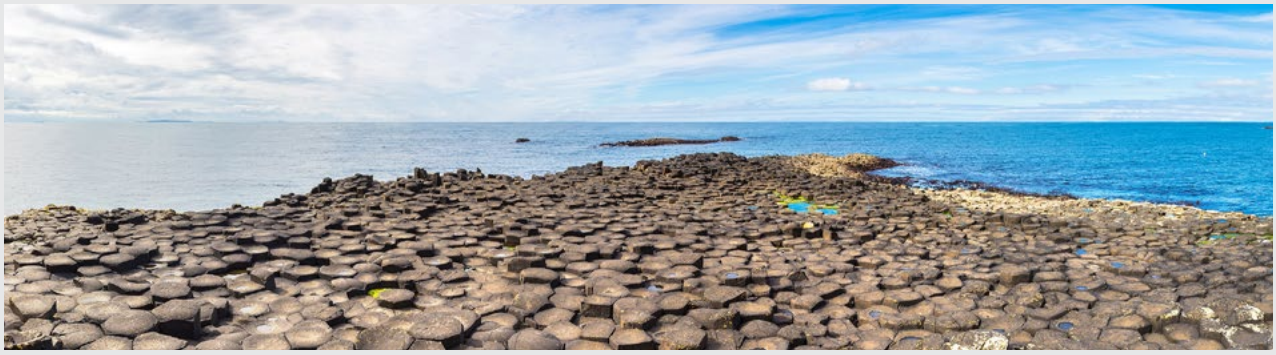
A wide range of carbon-containing chemical compounds, known as volatile organic compounds (VOCs) or non-methane volatile organic compounds (NMVOCs), can be emitted from crops and from livestock farming. Examples include ethanol, isopropanol, hexane and acetic acid. NMVOCs have a role in the formation of ozone (O_3) in the lower atmosphere. There is large uncertainty about the size of NMVOC emissions from crops and livestock, but emissions from crops are estimated to be small relative to emissions from trees.

Nitric oxide (NO) and nitrogen dioxide (NO_2), referred to together as NO_X, are emitted from soils, crops and animal manures; NO reacts in the air to form NO_2.

Estimates of NO emissions from soils and crops are very uncertain, but are estimated to contribute between 4% and 8% of total European emissions. Nitric oxide may be released from soils following nitrogen fertiliser application and by mineralisation of organic matter. Very few data are available on emissions of NO from manures during housing and storage. However, as emissions of NO_X from combustion sources are decreasing (due to better control), so NO_X emissions from agriculture are expected to receive more attention as they become a greater proportion of the total.

6

Measures and Initiatives



Northern Ireland continues to seek to understand and improve its air quality. This section highlights some of the measures and initiatives taking place in Northern Ireland, which are expected to deliver improvements in air quality. For some of these measures, reducing air pollution is the main objective. Others may be primarily aimed at – for example - reducing traffic congestion, investing in cleaner fuels or promoting active travel; but with improved air quality as a likely co-benefit.

Northern Ireland's Regional Development Strategy 2035 includes specific Regional Guidance to ***"Reduce our carbon footprint and facilitate mitigation and adaptation to climate change whilst improving air quality."*** (RG9, at https://www.planningni.gov.uk/index/policy/rds2035.pdf). This acknowledges the need for; investment in the energy production and distribution infrastructure to facilitate increased use of renewable sources, reducing the need for car use, improving the energy efficiency and adaptability of buildings and development of strong linkages between policies for managing air pollution and policies for managing climate change.

The Belfast Rapid Transit (https://www.infrastructure-ni.gov.uk/articles/belfast-rapid-transit-background) will provide a fast, frequent, accessible and reliable transport service for Belfast. The first phase, beginning operation in 2018, will link East Belfast, West Belfast and the Titanic Quarter via the city centre. Its articulated vehicles each carry 100 people, potentially saving an estimated 83 car journeys, and use hybrid diesel/electric technologies for lower emissions.

Active School Travel in Northern Ireland: Sustrans (a charity promoting cycling and walking) is being funded by the Department for Infrastructure and the Public Health Agency to deliver the Active School Travel Programme across Northern Ireland. Sustrans is providing a planned programme of activities and support at over 280 schools. The aim of this programme is to provide schools with the skills and knowledge to get more children walking, cycling and scooting as their main mode of transport to school. At participating schools, the percentage of children travelling actively to school increased from 40% to 55% between September 2013 and June 2016. More information about Active School Travel in Northern Ireland can be found at https://www.sustrans.org.uk/NIschools.

CHIPS Project in East Belfast: the Europe-wide CHIPS project (Cycle Highways Innovation for Smarter People Transport and Spatial Planning) seeks to promote cycling and facilities for cyclists. Over the next three years, Belfast will be collaborating with cities in the Netherlands, Belgium, Germany and the Republic of Ireland. Sustrans is working with CHIPS, and last year carried out a survey of cyclists using the Comber Greenway in East Belfast to identify the barriers preventing people commuting by bicycle. The results, published in January 2017, showed that in Belfast the biggest barriers were concerns about heavy traffic and erratic drivers (https://www.sustrans.org.uk/news/health-main-motivator-take-cycling).

Strategic Plan for Greenways in Northern Ireland: recognising the importance of active and sustainable travel such as cycling, Northern Ireland now has a Strategic Plan for Greenways. This sets out a framework to help Northern Ireland's District Councils draw up their own projects and seek funding, to investigate, plan and implement greenways – traffic-free routes for cyclists, walkers and wheelchair users - across the region (https://www.infrastructure-ni.gov.uk/publications/strategic-plan-greenways-northern-ireland-screening-form).

Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Ricardo Energy & Environment

This report has been produced by Ricardo Energy & Environment on behalf of the Department of Agriculture, Environment and Rural Affairs

Its main authors are Alison Loader, Dr Jeremy Wiltshire and Andrew Kent; pollution maps by Joe Richardson.

ISBN: 978-1-84807-815-4

Printed on 100% recycled paper

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.

DAERA's website at https://www.daera-ni.gov.uk/ provides links to information on a range of environmental issues including biodiversity, waste and pollution. DAERA's 'Protect the Environment' web page at https://www.daera-ni.gov.uk/topics/protect-environment covers air quality, climate change and local environmental issues including noise.

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.