The Scottish Government

Air Pollution in Scotland 2012

RICARDO-AEA

1

Introduction

This brochure has been produced on behalf of the Scottish Government, and is the sixth in an annual series. It aims to provide a summary of the air quality monitoring and associated work carried out by and on behalf of the Scottish Government and local authorities during 2012.

Section 2 of this brochure reviews the air quality legislation and policy applicable to Scotland. **Section 3** summarises the air quality monitoring carried out in Scotland, and presents an overview of the provisional data from 2012, including exceedances of air quality objectives. **Section 4** deals with trends in air pollution in Scotland, and **Section 5** covers spatial patterns of pollution. **Section 6** provides information on the recent update of the openair tool on the website to include modelled meteorological data and the enhanced Local Site Operator Training programme. Finally, **Section 7** provides more information on the "Know & Respond" air alert service and links to sources of information.

A more detailed Annual Report on the Scottish Air Quality Database Project will also be available on the Air Quality in Scotland website (at http://www.scottishairquality.co.uk) in May 2013.

Since the initial development of the database in 2006, the database has grown year on year. The total number of automatic air quality monitoring sites in the Scottish Air Quality Database during 2012 was 90. The increase in the number of monitoring sites included in the Scottish Air Quality database since 2006 and locations of these sites are shown in Figure 1-1a and 1-1b. While air quality in most of Scotland is generally good, levels of some pollutants still exceed air quality objectives, particularly in urban areas. Continued effort to reduce air pollution is therefore vital, together with careful monitoring to assess progress.

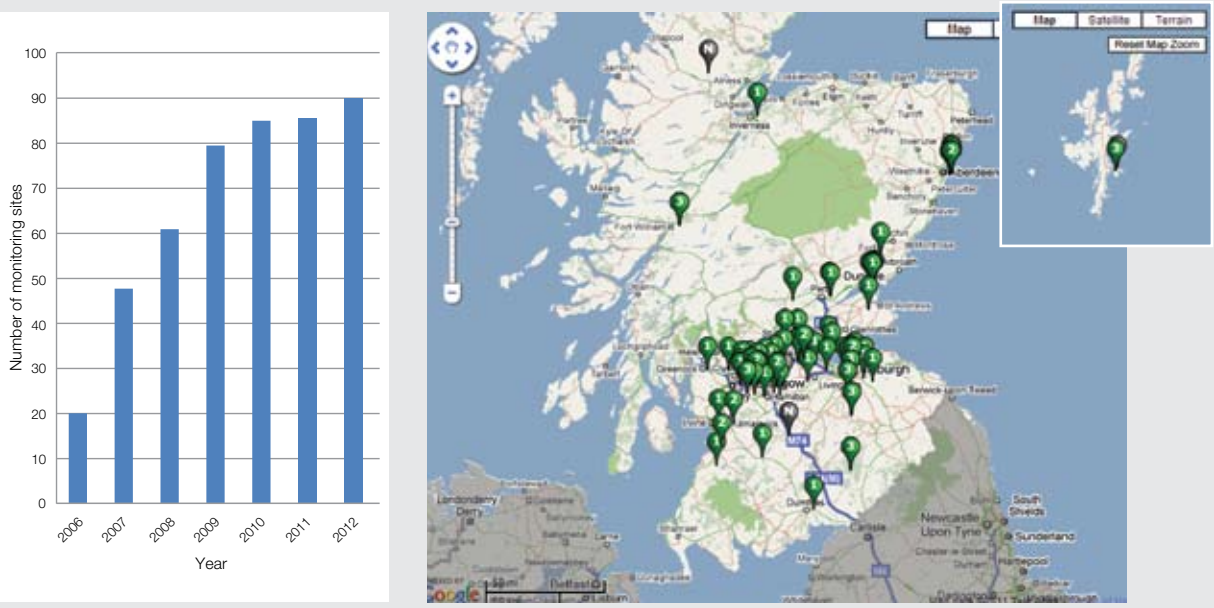


Figure 1.1a

Growth in the number of monitoring sites included in the SAQD since 2006, and Figure 1-1b Locations of Automatic Air Quality Monitoring Sites in Scotland (courtesy of GoogleTM).

2

Legislation and Policy

The management of air quality is based on a series of statutory measures and policy programmes originating from Europe, the UK and within Scotland. Together, these form the basis of a strong framework for managing air quality.

2.1 European Union Legislation

Much of the foundation of Scotland's air quality management has its roots within the Air Quality Directives adopted by all Member States of the European Union:

- The European Union's Directive 2008/50/EC on Ambient Air Quality and Cleaner Air For Europe (the Air Quality Directive); and
- Directive 2004/107/EC (the Fourth Daughter Directive) relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.

The Scottish Government has duly transposed these Directives into Scotland's national law. A substantial review of the EU's air quality policy, including the Air Quality Directive, is under way and scheduled for completion in 2013. In addition, consultations on the Local Air Quality Management Review and Assessment Process and the Clean Air Act are also scheduled to take place during 2013.

2.2 The Air Quality Strategy

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (first published in 1997 and revised in 2000 and 2007), establishes a UK wide strategy for tackling air pollution. It is based on strong scientific evidence and a science-based understanding of the effects of air pollutants on health and the environment.

The Air Quality Strategy (AQS) sets objectives for a series of pollutants to be met within the UK. The scientific basis, the objectives set and provisions contained within the Strategy are closely associated with the corresponding limit values set by European Air Quality Directives, as described above. The Strategy's provisions for some pollutants differ from those in the Directives: these differences relate to scientific evidence and expert opinion that is specific to the UK situation. However, all the AQS objectives are at least as stringent as the corresponding limit values applicable within the European Union. For some pollutants (such as PM_{10}), Scotland has adopted more stringent objectives than the rest of the UK.

The full revised AQS and its extended series of associated technical annexes can be seen at: http://www.scotland.gov.uk/Topics/Environment/waste-and-pollution/Pollution-1/16215/6116.

2.3 Local Air Quality Management

Local Air Quality Management (LAQM) provides the framework within which air quality is managed by local authorities in Scotland. LAQM requires local authorities to review and assess a range of air pollutants against the AQS objectives, using a range of monitoring, modelling, observations and corresponding analyses. For locations where objectives are not met by the specified date, local authorities are required to:

- Declare an Air Quality Management Area (AQMA), and
- Assess and identify the reasons for the problem and develop an Air Quality Action Plan to help address the problem.

The Scottish Government Policy Guidance and Technical Guidance on LAQM are available online, from http://www.scottishairquality.co.uk/reports.php?n_action=guidance.

At the time of writing, 13 of Scotland's 32 local authorities have declared AQMAs. Since last year's edition, several changes have been made to the AQMAs that have been declared. These changes include the first two AQMAs to be revoked in Scotland – the Harthill AQMA, North Lanarkshire which was officially revoked in April 2012, and Falkirk Council's Town Centre AQMA for exceedance of the hourly NO_2 objective which was revoked on the 31st of January 2013. In addition, the hourly mean objective for NO_2 has been added to Dundee City Council's AQMA, whilst Falkirk Council have amended the wider Town Centre AQMA for Falkirk Town Centre to include the annual mean and daily PM_{10} objectives. As of February 2013 there were 28 AQMAs in Scotland, and a summary is presented in Table 2.1. All Authorities with AQMAs have either prepared, or are currently preparing Air Quality Action Plan(s) for their AQMAs.

Table 2.1 Air Quality Management Areas in Scotland

Council	Pollutant	Source	Date Declared	AQMAs
Aberdeen	NO_2 & PM_{10}	Roads	July 2006, December 2008	3
Dundee City	NO_2 & PM_{10}	Roads	July 2006	1
East Dunbartonshire	NO_2 & PM_{10}	Roads	December 2005 December 2010	2
Edinburgh	NO_2	Roads	December 2000, 2006 and March 2009	3
Falkirk	SO_2 (1), NO_2 (2), PM_{10} (2)	Industry and Roads	November 2005, March 2010 August 2011	4
Fife	NO_2 & PM_{10} (1) NO_2 (1)	Roads	October 2008 November2011	2
Glasgow City	NO_2 & PM_{10} (1) NO_2 (2)	Roads	January 2002, July 2007	3
Midlothian	PM_{10}	Domestic	April 2008	1
North Lanarkshire	PM_{10}	Roads	December 2005 and July 2011	5
Perth & Kinross	NO_2 & PM_{10}	Roads	May 2006	1
Renfrewshire	NO_2	Roads	September 2005	1
South Lanarkshire	PM_{10}	Roads	November 2008	1
West Lothian	PM_{10}	Roads	March 2011	1

3

Networks and Data

3.1 Monitoring in Scotland

A wide range of air quality monitoring is carried out in Scotland. Some monitoring sites are run as part of UK-wide monitoring networks; others are operated by local authorities for LAQM purposes. The following AQS pollutants were monitored in Scotland during 2012:

- Benzene
- 1,3-butadiene
- Carbon monoxide (CO)
- Lead
- Oxides of nitrogen (NO_x), comprising nitric oxide (NO) and nitrogen dioxide (NO_2)
- Particles (as PM_{10}, $PM_{2.5}$ and black carbon)
- Sulphur dioxide (SO_2)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Ozone (O_3)

Figure 3.1

East Dunbartonshire Milngavie

The locations of automatic monitoring sites are shown in Figure 1-1b. These provide high-resolution hourly information on a wide range of pollutants. Data from national network monitoring sites are updated hourly in near-real time on the Scottish Air Quality Database; whilst data from local authority operated monitoring sites are updated either hourly or daily, depending on the station configuration. A typical automatic monitoring site, East Dunbartonshire Milngavie, is shown in Figure 3-1.

Scotland's automatic monitoring is supplemented by non-automatic monitoring techniques, for example the pumped-tube samplers used to monitor benzene, the high-volume samplers used to measure PAH, and the non-automatic techniques used to monitor metals including lead

3.2 King's College Volatile Correction Model

Many monitoring sites use the Tapered Element Oscillating Microbalance (TEOM) to measure PM_{10}. The relatively high operating temperature of this instrument (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.

However, it is 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 equivalent. To access the model and for more information, visit www.volatile-correction-model.info.

The VCM correction of PM_{10} data in this brochure is based on FDMS data from sites in the national Automatic Urban and Rural Network (AURN): at the time of writing (March 2013), the last three months' data remain provisional pending full ratification at the end of March. It is therefore possible that there could be some changes to the VCM-corrected data, once the ratification process is complete.

3.3 Key Results for 2010

This section provides a summary of results from both automatic and non-automatic monitoring in Scotland in 2012 including compliance with AQS objectives. Further information is provided on the Scottish Air Quality website at www.scottishairquality.co.uk. This will be supplemented by further information and data to be published in the full Annual Report later this year. The automatic data for 2012 summarised here are not yet fully ratified; there may therefore be subsequent changes to the data which may affect the results presented here.

Benzene

This hydrocarbon is a constituent of vehicle exhaust emissions. Benzene was monitored using a non-automatic pumped-tube sampler at two sites (Glasgow Kerbside and Grangemouth), as part of the UK Non-Automatic Hydrocarbon Network. Both sites had annual mean concentrations below the AQS objective for the running annual mean.

1,3-Butadiene

1,3-butadiene is also a constituent of vehicle exhaust. This pollutant was monitored at one rural site, Auchencorth Moss in Midlothian, as part of the UK Automatic Hydrocarbon Network. The 2012 annual mean has indicated that the AQS objective is met.

Carbon Monoxide

Carbon monoxide (CO) is a product of incomplete combustion, with vehicle exhaust emissions being an important source. It was monitored at five sites in Scotland in 2012; Edinburgh St Leonards, Glasgow Centre, Glasgow Byres Road, Glasgow Anderston and North Lanarkshire Croy. Outdoor concentrations of CO were well within the AQS objective, as they have been for many years.

Lead

This toxic metallic pollutant is emitted from some industrial processes (although emissions are now strictly controlled). Lead is monitored at two non-automatic sites in Scotland: the full dataset for 2012 is not yet available, but previous years' data from both sites have established that ambient concentrations are well within the AQS objective, so no exceedances are expected.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is emitted from most combustion processes, including power generation, domestic heating and vehicle engines. This pollutant was monitored at 79 automatic sites in Scotland during 2012. Thirteen of these achieved less than the 75% data capture generally considered necessary to calculate a representative annual mean, either because of instrument faults, or because the site started up or closed down part way through the year.

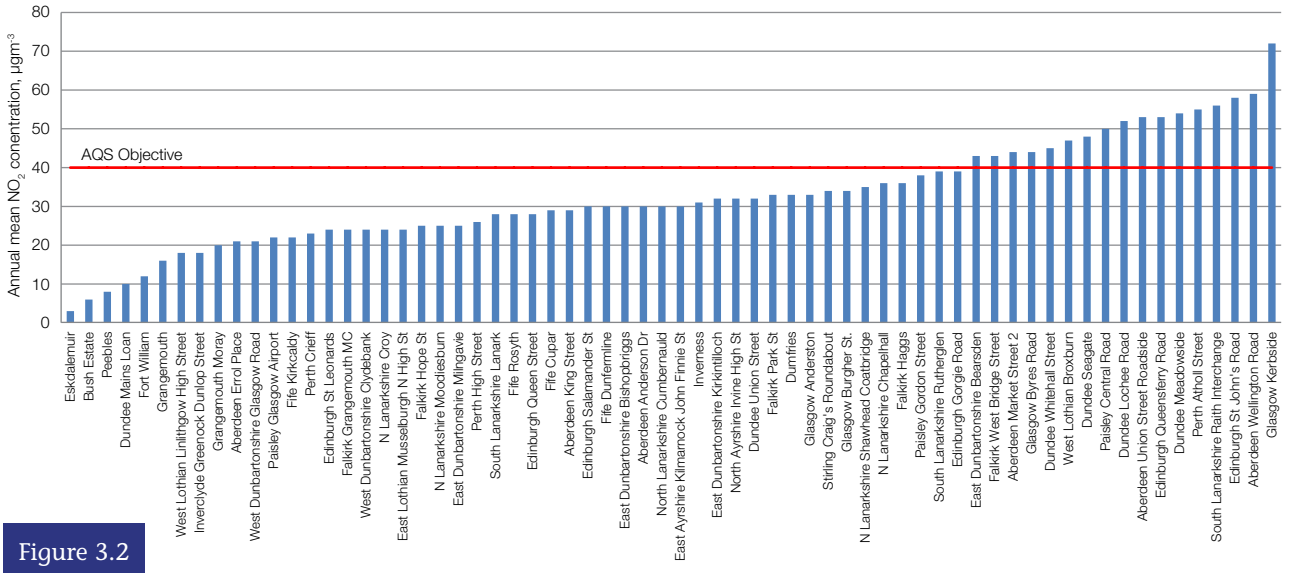


Figure 3.2

Annual Mean NO_2 concentrations (minimum 75% data capture for inclusion)

Sulphur Dioxide

Sulphur dioxide (SO_2) is emitted when fuels containing small amounts of sulphur (such as oil and coal) are burned. This pollutant was monitored at 13 sites in 2012. Three of these (Falkirk Grangemouth MC, Grangemouth and Grangemouth Moray) recorded more than the permitted 35 exceedances of the AQS objective for the 15-minute mean (266 µg m^{-3}) during 2012. This is illustrated in Figure 3-3. All other sites in Scotland met this AQS objective, and those applying to the 1-hour and 24-hour mean.

Particulate Matter as PM_{10}

Particulate matter arises from many sources. It can be directly emitted from combustion processes, or formed from chemical reactions involving other pollutants. Natural sources, e.g. wind-blown dust and sea salt, also contribute. PM_{10} (particulate matter of size 10 microns or less) was monitored at 77 Scottish sites in 2012. No sites exceeded the UK AQS objective of 40 µg m^{-3} for the annual mean. However, Scotland has adopted a more stringent annual mean objective of 18 µg m^{-3}. This objective was exceeded at 12 sites in 2012 (based on VCM-corrected data where TEOMs were used). Three of these annual means were based on less than 75% data capture.

The UK AQS objective for the 24-hour mean PM_{10} concentration is 50 µg m^{-3}, not to be exceeded on more than 35 days per calendar year. All sites in Scotland met this objective. The more stringent Scottish objective requires the daily mean PM_{10} concentration not to exceed 50 µg m^{-3} on more than seven days per year. Seven sites recorded more than the seven permitted exceedances (Figure 3-4).

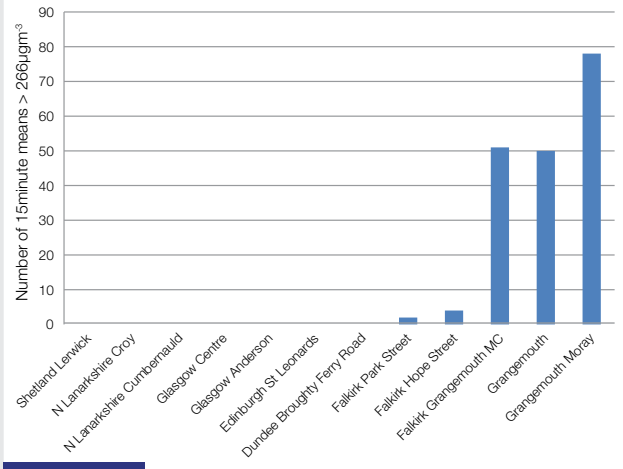


Figure 3.3

Exceedances of 15-min AQS objective for SO_2

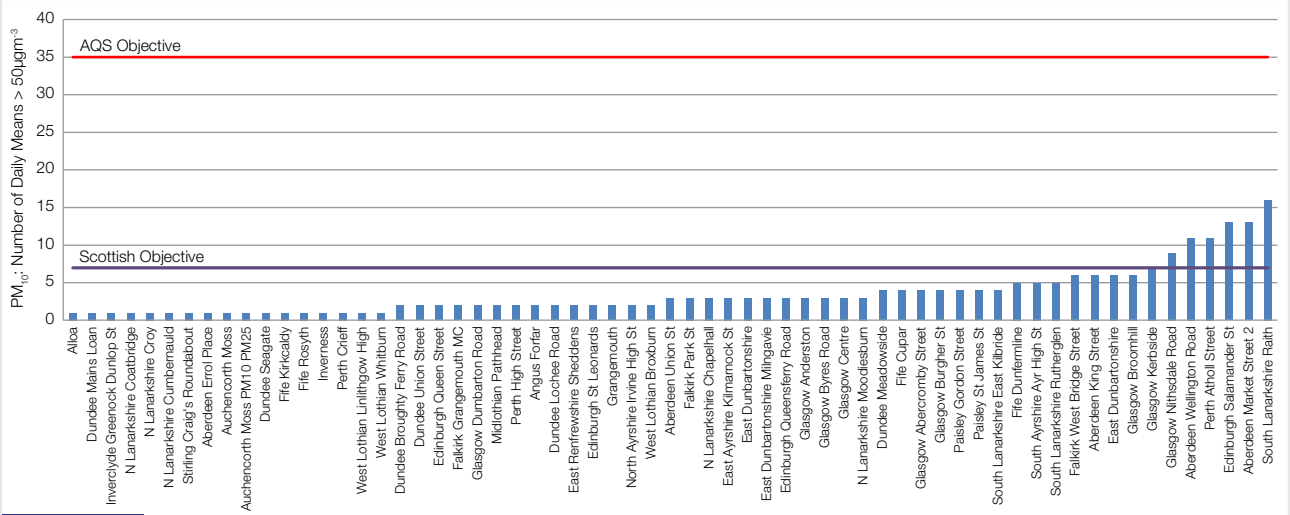


Figure 3.4

Exceedances of Daily Mean Objectives for PM10 (Graph shows only sites with at least one exceedance of the Scottish objective).

Particulate Matter as PM2.5

The finer particulate fraction $PM_{2.5}$ was monitored at seven sites in Scotland during 2012. The Scottish AQS objective of 12 µg m^{-3} was exceeded at one of these sites: Glasgow Kerbside.

Only the sites in urban background areas are used for monitoring under the EU Air Quality Directive. The Directive sets an exposure reduction target for $PM_{2.5}$, based on the Average Exposure Indicator (AEI). This statistic is the three calendar year running annual mean, averaged over all urban background measurement stations. The "baseline" period is the three years 2010-2012. The reduction required by 2020 depends on the "baseline" AEI. Over the "baseline" period, the mean PM2.5 concentration at Scotland's urban background sites was 8 µg m^{-3}. Based on this value (which remains provisional until the 2012 dataset is finalised) it is likely that the reduction required in Scotland by 2020 will be 10%. For more information on the Air Quality Directive's provisions regarding $PM_{2.5}$, please see the 2009 report in this series .

Polycyclic Aromatic Hydrocarbons

This group of pollutants (referred to as PAHs) is monitored at four sites in Scotland. The full 2012 dataset is not yet available and will be reported in the full Annual Report later this year. In 2011, one site (Kinlochleven) exceeded the AQS objective for benzo (a) pyrene.

Ozone

Ozone is a secondary pollutant – formed by reactions involving other pollutant gases, in the presence of sunlight, and over several hours. Once formed, it may persist for several days and be transported over long distances. This makes it difficult to control by local action. Ozone is monitored at 11 sites in Scotland: of these, one (Strath Vaich) exceeded the AQS objective of 100 µg m^{-3} on more than the permitted ten days in 2012. This site is in a rural and remote area, which often have the highest ozone concentrations.

The AQS objective for ozone is currently not included in regulations, in recognition of the fact that it is transboundary in nature, and that local authorities have very little control over ozone concentrations in their areas.

3.4 Summary

Provisional results from Scotland's network of air quality monitoring stations in 2012 show that measured concentrations of benzene and carbon monoxide continue to meet the applicable AQS objectives.

However, some pollutants at some sites did not meet the AQS objectives. Three sites in industrial areas such as Grangemouth failed to meet the objective for 15-minute mean SO_2. The objective for ozone – which is difficult for local authorities to control – was exceeded at one rural site. The pollutants for which exceedances were most widespread were NO_2 and PM_{10}. These pollutants are associated with vehicle emissions, and exceedances were particularly prevalent close to busy roads.

[1]Scottish Government "Air Pollution in Scotland 2009" [online]. Available at http://www.scottishairquality.co.uk/documents/reports2/281100426_Scottish_Newsletter_2009-vFF4_screenopt.pdf. [Accessed 29 Feb 2012].

4

Air Quality Trends

This section summarises how air quality in Scotland has changed in recent years. This brochure focuses on one type of pollutant – suspended particulate matter. Trends in other pollutants of concern in Scotland (such as oxides of nitrogen, and ozone) will be dealt with in the main report, to be produced later this year.

Automatic monitoring of particulate matter as PM10 has been routinely carried out in Scotland since 1996, when the Glasgow Centre monitoring site began measuring this pollutant. However, until 2000 there were relatively few automatic monitoring sites: the number of air quality monitoring sites in the Scottish Air Quality database has grown significantly since then. This increase in the number of monitoring sites has improved our understanding of Scotland's pollution climate. However, it potentially complicates the investigation of trends in air quality. If this investigation is based on all available data, the apparent changes we see in the dataset may not reflect real changes in Scotland's air quality, but rather be due to the changes in the number of sites (and their distribution). Therefore, in reports in this series from 2010 onwards, investigation of trends has been based on subsets of long-running sites. This should lead to a more robust assessment. It is usually considered that at least five consecutive years' data are required from a monitoring site, in order to assess long-term trends.

This pollutant is of great interest because:

- Scotland has adopted a more stringent annual mean PM_{10} objective (18 μgm^{-3}) than the objective of 40 μgm^{-3} adopted in the rest of the UK.
- Scientists do not believe that there is actually a safe level of this pollutant in terms of human health effects.

Many of Scotland's monitoring sites use the Tapered Element Oscillating Microbalance (TEOM) to monitor PM_{10}. The relatively high operating temperature of this instrument (necessary to prevent condensation on the filter) can result in the evaporation of volatile components of the particulate matter sampled, causing under-estimation of the PM_{10} concentration.

However, it is possible to correct for this. In years up to and including 2008 the convention was to apply a factor of 1.3 to the data, and the data presented here for those years have been adjusted in this way. TEOM data from 2009 onwards has been adjusted for possible loss of the volatile component using the King's College Volatile Correction Model (VCM). At the time of writing (March 2013), VCM correction has not yet been carried out for the 2012 dataset: however, this will be done, prior to the writing of the main annual report later in the year. Meanwhile, as an interim measure, the TEOM data from 2012 have been corrected using the old correction factor of 1.3.

The trend plots shown here were produced using Openair. The trend analyses presented here are based on the Theil-Sen statistical method, applied to monthly mean pollutant concentrations: at least 75% data capture is required for the monthly mean to be included. Openair includes an option to 'de-seasonalise' the data (i.e. statistically modify 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.

PM_{10} at Urban Background Sites

A smoothed trend plot of de-seasonalised monthly mean PM_{10} concentrations at the longest-running Scottish urban background site, Glasgow Centre, is shown in Figure 4.1. This shows a general decrease between 1996 (when the site began monitoring PM_{10}) until its closure in 2012. Measurements in the winters of 2009-10 and 2010-11 are thought to have been influenced by emissions from a diesel generator placed near the monitoring site during a Christmas Market. Peaks at these times are clearly visible on the chart, though they appear to be superimposed on a general increase through the years 2005-2009 which has subsequently reversed.

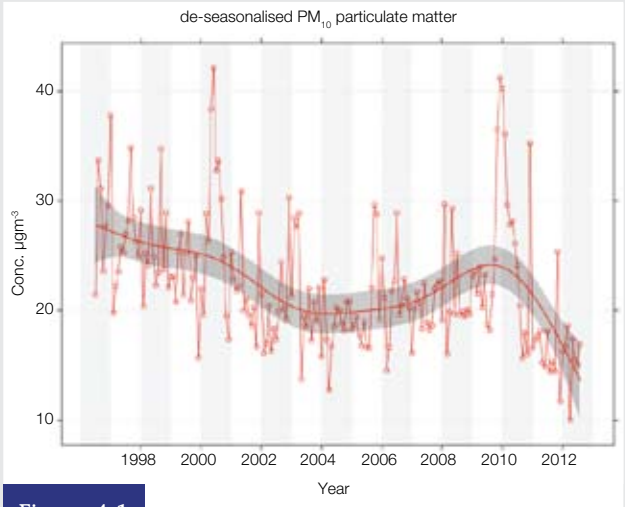


Figure 4.1

Smoothed Trend Plot of PM10 Concentration at Glasgow Centre, 1996 – 2012

Four urban non-roadside sites in Scotland have been in operation since 2003 or earlier. These are Aberdeen Errol Place (TEOM, converted to FDMS in 2009), Edinburgh St Leonards (FDMS since 2007), Glasgow Centre (FDMS since the end of 2008) and Grangemouth (FDMS since 2009). Figure 4.2 shows trends in de-seasonalised monthly mean PM_{10} at this subset of long-running sites. Three of the four sites show a significant negative trend (most negative for Aberdeen Errol Place).

Seven PM_{10} sites have been in operation from 2006 to 2012: the above four sites plus Glasgow Anderston, Dundee Mains Loan and West Lothian Whitburn. Trends in de-seasonalised monthly mean PM_{10} for six of these are shown in Figure 4.3: (the exception being Glasgow Centre, because of the generator emissions affecting winter results in recent years). All six sites show downward trends in PM_{10} between 2006 and 2012, significant in some cases at the 0.001 level.

The average PM10 concentration for all urban background sites in 2011 was 14 μgm^{-3}: this is well within the Scottish AQS Objective of 18 μgm^{-3}. All the individual non-roadside sites met this objective.

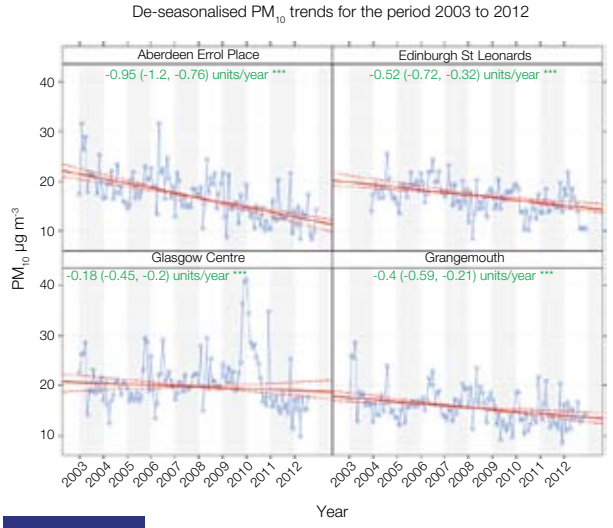


Figure 4.2

Trends in PM_{10} Concentration at Long-Running Scottish Urban Background Sites, 2003 – 2012

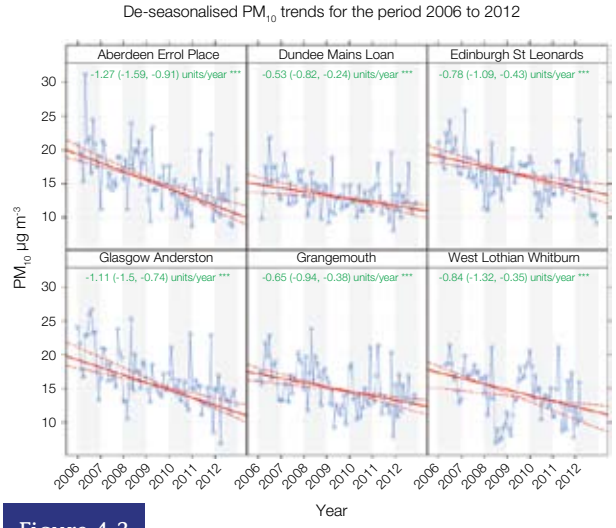


Figure 4.3

Trends in PM_{10} Concentration at Long-Running Scottish Urban Background Sites, 2006 – 2012

PM_{10} at Traffic-Related Urban Sites

By far the longest-running traffic-related PM_{10} monitoring site in Scotland is Glasgow Kerbside, which has been monitoring PM_{10} since early 1997. Figure 1.13 shows a smoothed trend plot of de-seasonalised monthly mean PM_{10} at this site. Although concentrations are lower in 2012 than pre-2000, the decrease has not been consistent, with increases and decreases over the years.

Seven traffic-related sites have been in operation since 2005 or earlier. These are the long-running Glasgow Kerbside site, together with Perth High Street, Perth Atholl Street, Aberdeen Anderson Drive, Aberdeen Union Street, East Dunbartonshire Bishopbriggs and Glasgow Byres Road. Trends in de-seasonalised monthly mean PM_{10} concentration are shown in Figure 4.4. All show significant downward trends, in some cases decreasing by more than 1 μgm^{-3} per year. The trends at these sites indicate that PM_{10} is decreasing year on year, in most cases at a similar rate to that seen at urban background sites.

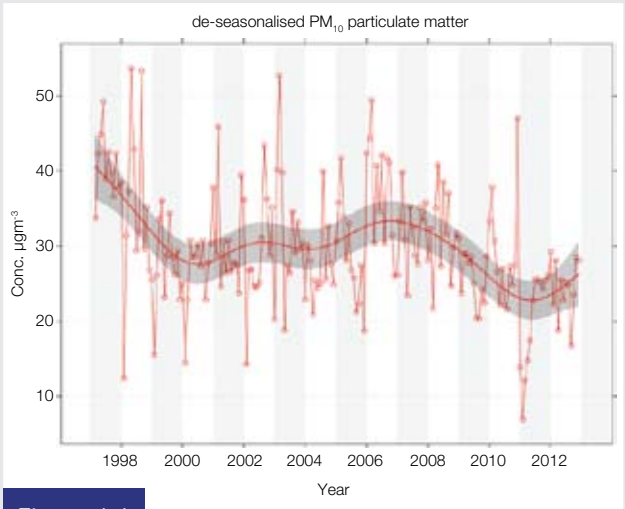


Figure 4.4

Smoothed Trend Plot of PM_{10} Concentration at Glasgow Kerbside, 1997 – 2012

The average PM_{10} concentration for all traffic-related sites in 2012 was 16 μgm^{-3}: this is within the Scottish AQS Objective of 18 μgm^{-3}. However, not all of the sites met the objective, as discussed in Section 3

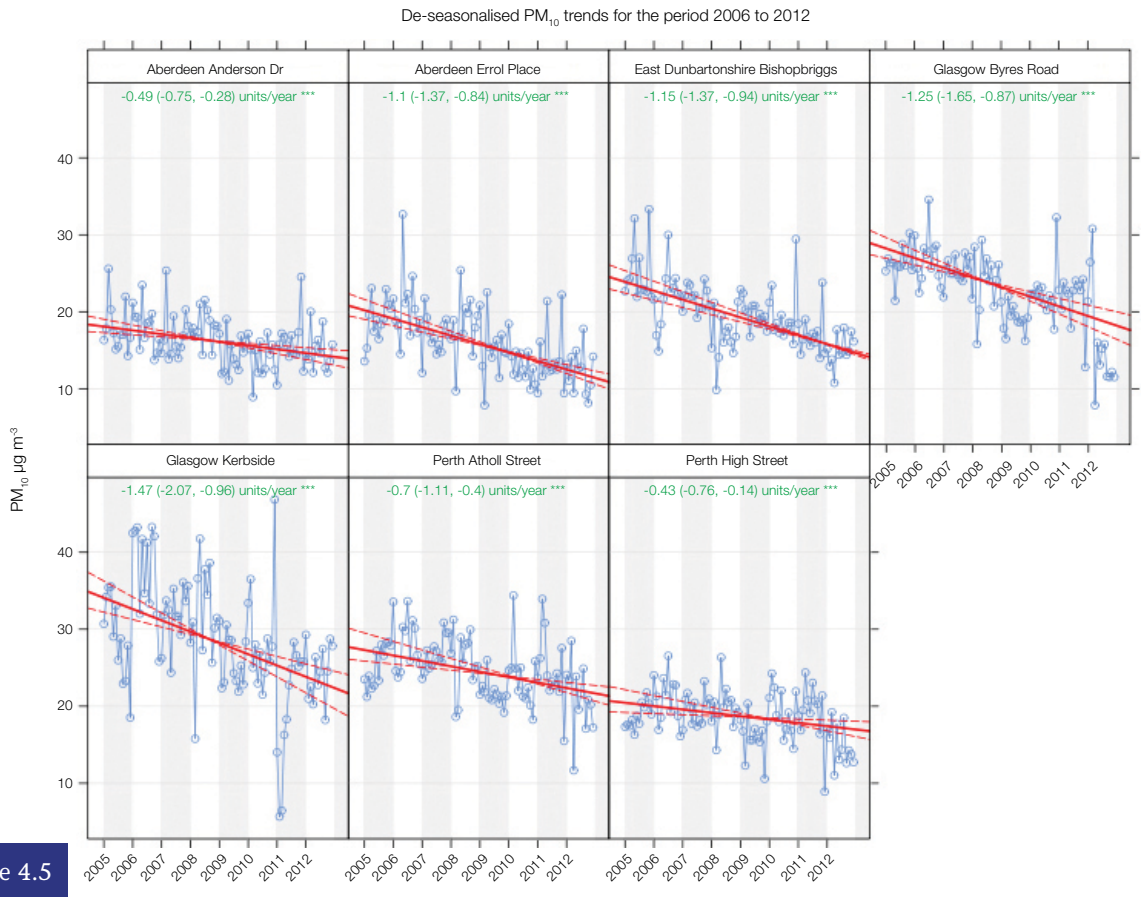


Figure 4.5

Trends in PM_{10} Concentration at Long-Running Scottish Traffic Urban Sites, 2005 – 2012

5

Maps of Air Quality

As part of the Scottish Air Quality Database project, Ricardo-AEA calculates maps of modelled pollutant concentrations on a 1 x 1 km square grid basis. These pollution maps combine measurements from Scottish air quality monitoring sites, emissions data from the National Atmospheric Emissions Inventory (NAEI), and Scottish meteorology data (from RAF Leuchars) to provide estimated pollutant concentrations for the whole of Scotland. Roadside and background concentrations are modelled.

This section discusses some of the maps of pollutant concentrations produced for the Scottish Government. The full range of maps, together with a technical report describing the method[2], will be published on the "Maps" page of the Scottish Air Quality website at http://www.scottishairquality.co.uk/maps.php.

In this year's brochure, we have focused on oxides of nitrogen and PM_{10}. The other pollutants will be discussed in the main report, to be produced later in 2013. Only the background maps are discussed here: the roadside maps can be viewed on the Scottish Air Quality website, and will be included in the main report to be produced later this year.

5.1 Oxides of Nitrogen: Maps for 2011

The 2011 annual mean concentration of total NO_X and of NO_2 were modelled for Scotland at roadside and background locations. The emissions factors used to produce these maps incorporate the findings of Carlslaw et al. (2011)[3]. This report investigated the reasons why ambient NO_2 concentrations have decreased less than would be expected on the basis of estimated emissions. The report concluded that several factors were involved, including:

- An increase in the proportion of NO_X emitted as NO_2:
- Older vehicles may emit more NO_2 than was previously thought.
- An increased proportion of diesel vehicles.
- Selective catalytic reduction (SCR) NO_X-reduction systems, used on HGVs, are ineffective under slow urban driving conditions.

The NO_X emission factors used to produce the 2010 maps were updated accordingly in-light of the findings of Carlslaw et al. and other improvements in our understanding of NO_X trends. The 2011 maps presented here incorporate the most recent NO_X emission factors taken from COPERT4 and ANPR/DVLA-scaled data to represent the most up-to-date vehicle fleet information for Scotland. More details will be provided when the maps are published online.

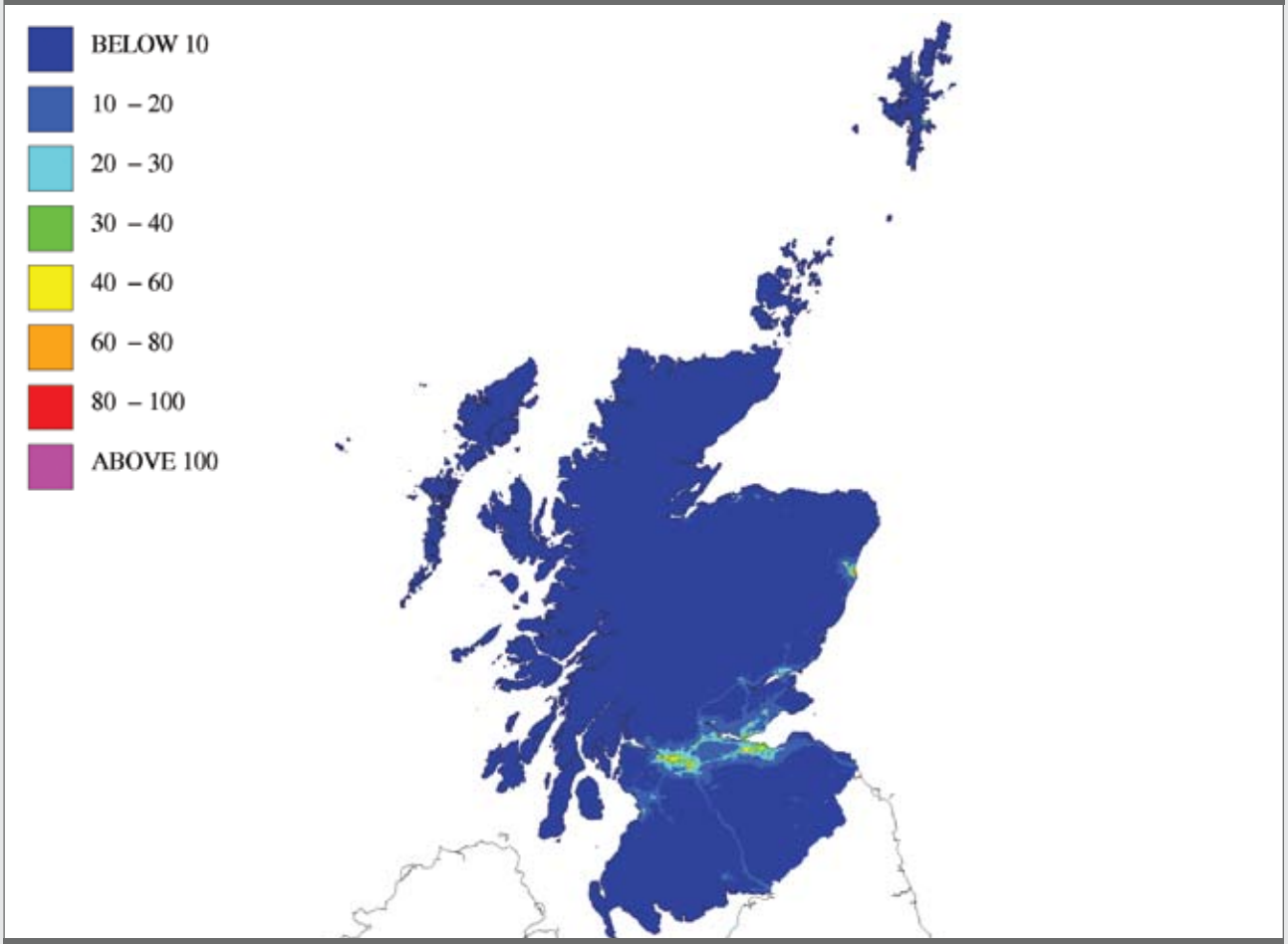
Figure 5-1 shows the 2011 modelled annual mean background concentrations of NO_X and NO_2 for the whole of Scotland, and for the central area of the country where most of the urban areas are located. Throughout much of Scotland, modelled concentrations of both NO_X and NO_2 concentrations were low (less than 10 µg m^{-3}). Higher concentrations are evident within built-up areas due to combustion-derived NO_X emissions, mainly from road transport. The outlines of the major cities, and the main road links between them, are clearly visible.

Areas coloured yellow and orange in the right-hand panel of Figure 5-1 indicate background NO_2 concentrations of 30-40 and greater than 40 µg m^{-3}, respectively. In the case of NO_2, this is the case only for small areas in central Glasgow and Edinburgh, and a small area on the coastline at Aberdeen. This is consistent with the monitoring results: all the sites that exceeded the Scottish NO_2 AQS objective of 40 µg m^{-3} in 2011 were located at the roadside or kerbside.

[2]Lingard J.J.N.: Pollutant modelling for 2009 and projected concentrations for 2010, 2015 and 2020 NOX, NO2 and PM10. AEAT/ENV/R/3156 Issue Number 2. http://www.scottishairquality.co.uk/documents/reports2/ScottishAQmapping2009_Finalv2.pdf (Accessed 14 Mar 2013).

[3]Carslaw D., Beevers S. Westmoreland E., Williams M., Tate J., Murrells T., Stedman J., Li Y., Grice S., Kent A., Tsagatakis I. (2011). "Trends in NOx and NO2 emissions and ambient measurements in the UK. Version: 18th July 2011". [online]. Available at http://uk-air.defra.gov.uk/reports/cat05/1108251149_110718_AQ0724_Final_report.pdf (Accessed 22 Feb 2012).

NO_x (as No_2) - All Scotland



NO_x Central areas

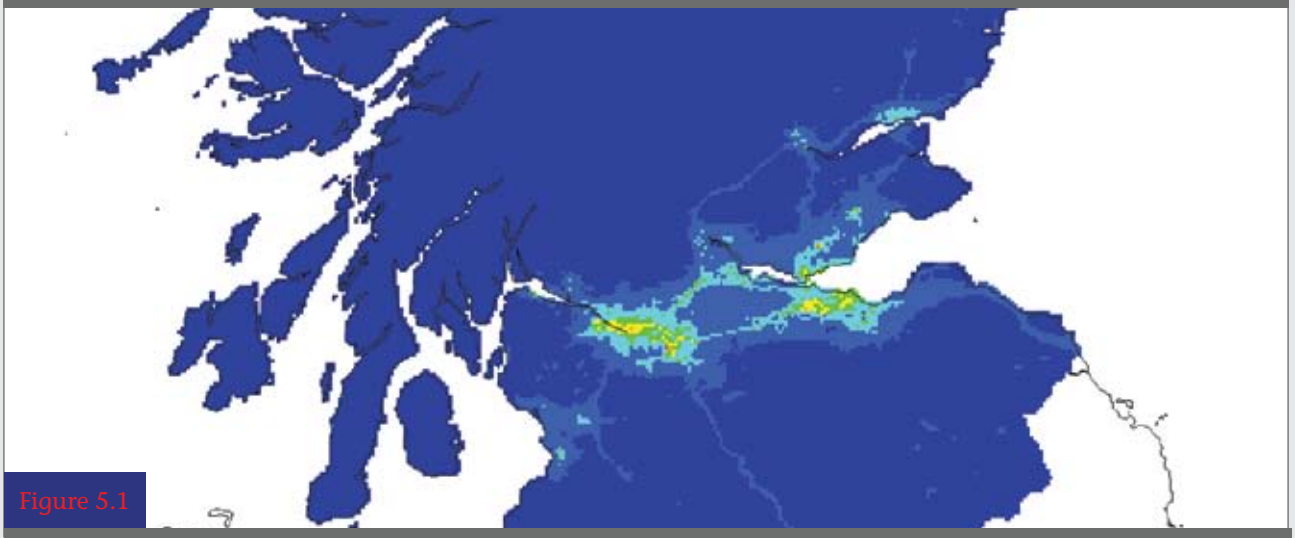
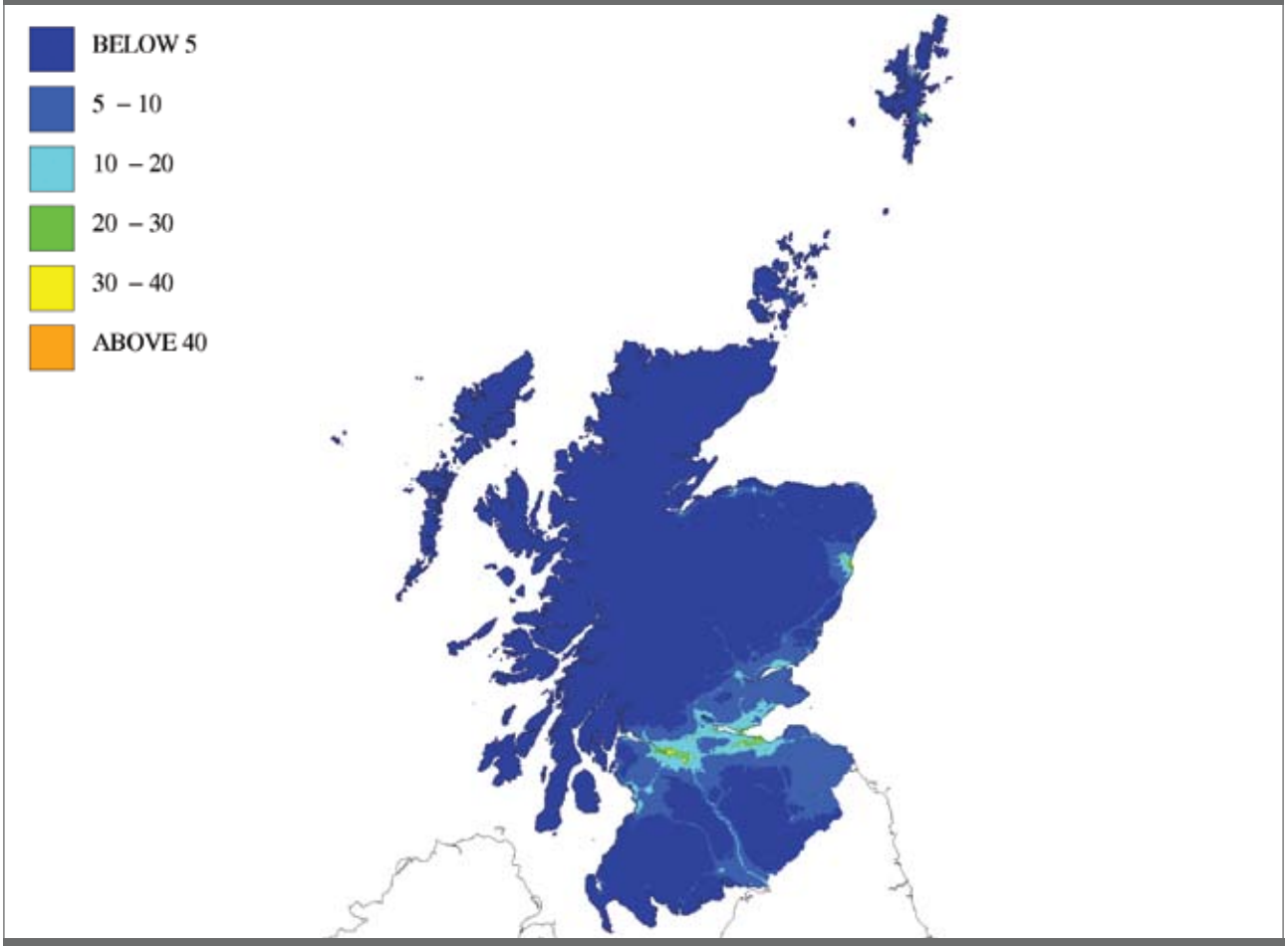


Figure 5.1

2011 background annual mean NO_x and NO_2 concentration in Scotland (Scotland-specific model, µg m^{-3}).

NO_2 - All Scotland



NO_2 - Central areas

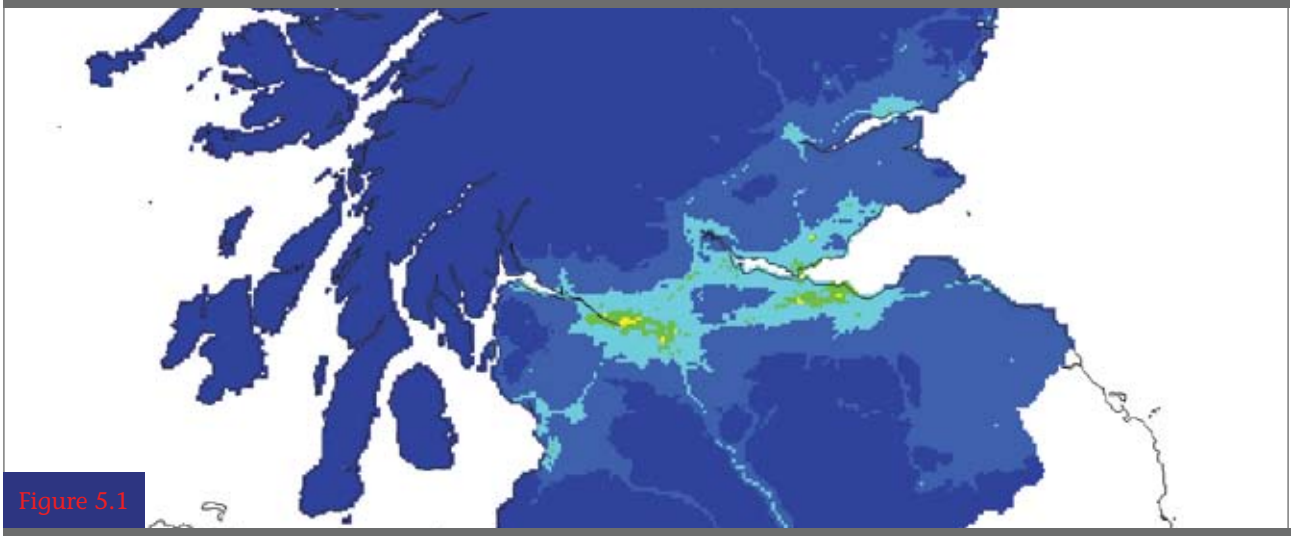


Figure 5.1

2011 background annual mean NO_x and NO_2 concentration in Scotland (Scotland-specific model, µg m^{-3}).

5.2 PM_{10}: Maps for 2011

The 2011 annual mean PM_{10} concentrations (as gravimetric equivalent) were modelled for Scotland at background and roadside locations (Figure 6.2). Again, only the background maps are discussed here: the roadside maps will be published on the Scottish Air Quality website.

Throughout much of Scotland, the 2011 ambient PM_{10} concentrations were low. Typically PM_{10} concentrations were less than 10 µg m^{-3}, and therefore well below the Scottish PM_{10} AQS objective of 18 µg m^{-3}. As in previous years, the spatial variation of PM_{10} reflects the location of built-up areas, major road links, and the contribution of combustion derived PM_{10} emissions to ambient concentrations. For example, the A74 heading southwards from Glasgow towards the border is clearly visible in Figure 5.2.

Road transport is not the sole source of ambient PM_{10}. Other components include:

a) Secondary inorganic aerosols (e.g., sulphate, nitrate, ammonium)

b) Secondary organic aerosols

c) Long-range transport primary component

d) Sea salt contributions, and

e) Iron and calcium associated dusts.

These natural and secondary components contribute to the total background PM_{10} mass concentration as there are few combustion sources. Wind-blown sea salt and dusts, e.g. soil, are believed to be the source of the relatively higher PM_{10} concentrations along the east coast and in Shetland.

Figure 5.2 includes an enlarged image of the central belt of Scotland. The influence of road traffic emissions is clearly visible. The triangle of roads formed by the M8, M9 and A80 linking Glasgow, western Edinburgh and Falkirk can be clearly seen.

The modelled annual mean PM_{10} concentration exceeded the Scottish PM_{10} AQS objective by up to 4 µg m^{-3} in thirty-one locations. These are shown as red in the maps and are distributed around key urban centres, such as Edinburgh, Glasgow and Aberdeen. The largest proportions of exceedances are located on the western outskirts of Edinburgh, around the junction of the M8 and M9. This location is also close to Edinburgh airport and contains various industrial sources which are believed to contribute to the elevated modelled PM_{10} concentrations in this area. There are a small number of further exceedances around Edinburgh and Glasgow. The causes of exceedances modelled in these areas are varied: exceedances in grid cells adjacent to major arterial roads are often due to the contribution of road transport emissions to background PM_{10} concentrations. Others are related to residential emissions of PM_{10}, such as the small cluster to the north of Aberdeen along the A947, and PM_{10} from wind-blown dusts.

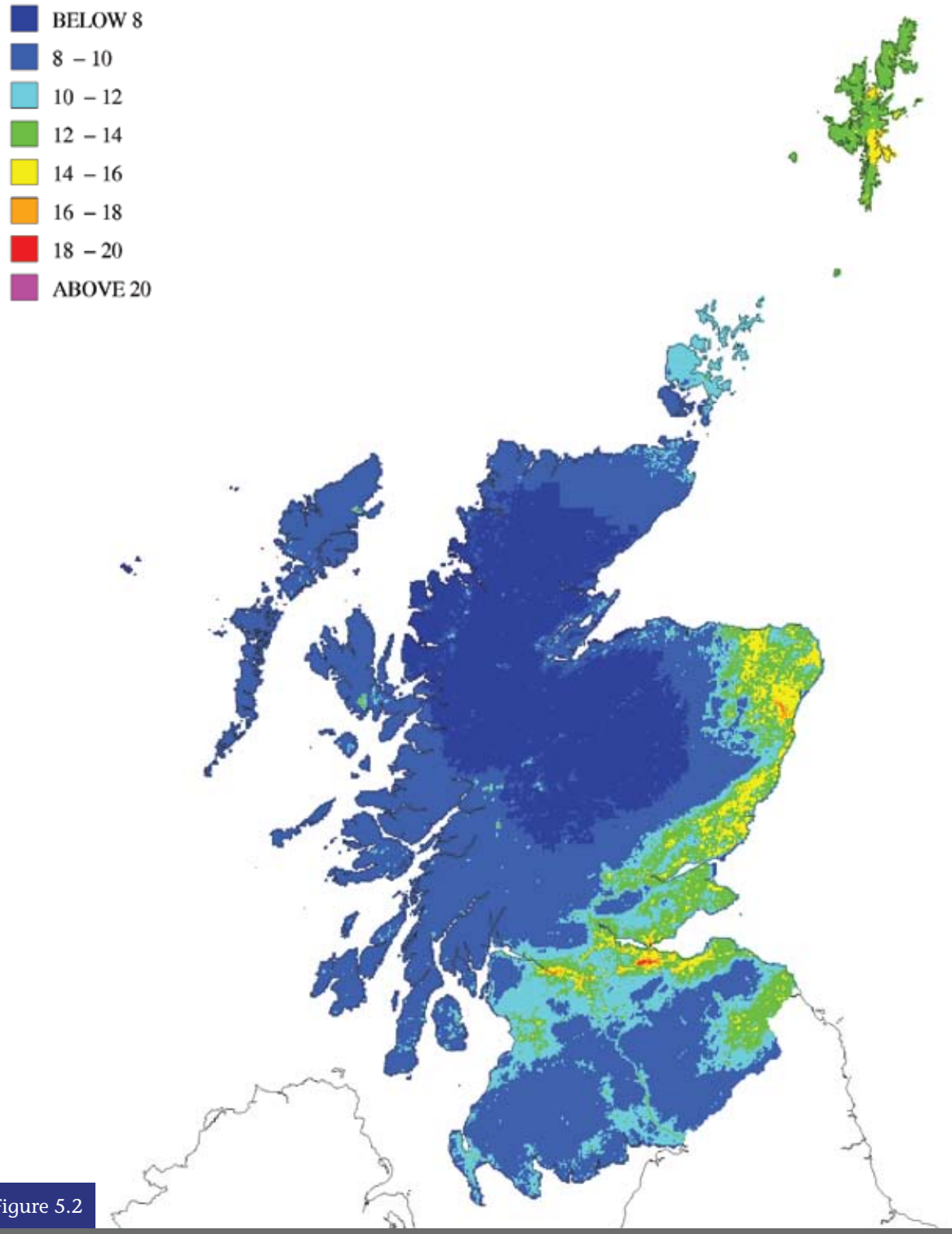


Figure 5.2

2011 background annual mean PM10 concentration in Scotland (Scotland-specific model, µg m-3).

6

Air Quality Scotland – Recent Developments

The Scottish Air Quality Database and Website has developed continuously since its initial development in 2006, and 2012 was no exception. During 2012 numerous advances and improvements were introduced to the project, and some of these are summarized briefly below.

6.1 Openair analysis tools

In 2011, an openair data analysis toolset capability was added to the Scottish Air Quality Database with an interactive user interface. The openair project is a Natural Environment Research Council knowledge exchange project that aims to provide a collection of open-source tools for the analysis of air pollution data. The addition of the open source openair capability provided users of the website with easy access to a powerful suite of data analysis tools to produce report quality graphics for long-term trends, seasonal, daily and weekly pollutant patterns.

However, until recently, the ability to use many of the data analysis tools included within openair on the Scottish Air Quality Database were restricted by access to meteorological data, meaning analyses like wind and pollution roses, and analyses of seasonal or annual trends with meteorological factors decoupled could not be undertaken. In late 2012 this issue was addressed by the addition of Weather Research Forecasting hourly modelled meteorological data for all monitoring stations included in the Scottish Air Quality Database and the further development of the user interface to allow interactive access to the new database features and tools. This development enables the ready analysis of likely sources of pollutants under different conditions and the presentation of result as report quality graphics, CSV files for spreadsheets and R-data objects.

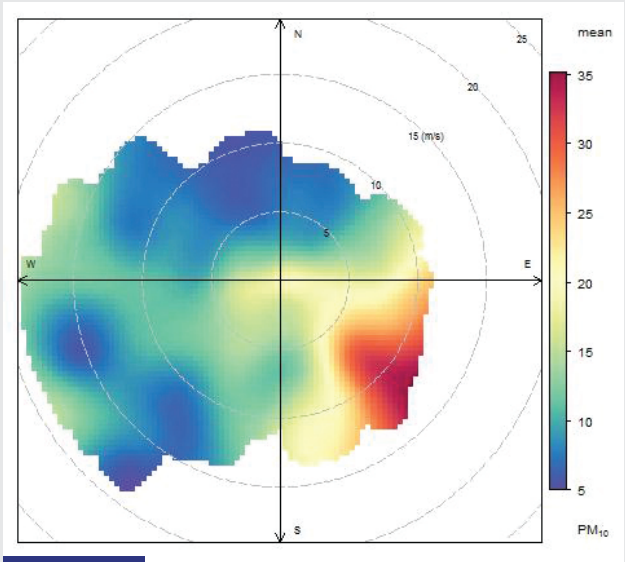


Figure 6.1

Openair output

6.2 Enhanced Local Site Operator Training

During 2012 an enhanced programme of Local Site Operator (LSO) Training was undertaken as part of the Scottish Air Quality Database project. The enhanced training component was introduced to the project with the intention of improving each local site operators' understanding and confidence in the duties they are required to undertake and enhance the quality of site operator interactions with the sites (callouts and calibrations) with the ultimately aim of improving data capture and data quality.

The training comprises of three inter-related components:

1. In-house training event for each council
2. Tutorial Videos
3. Scottish Network LSO Manual

Each authority which had one or more monitoring site included within the Scottish Air Quality Database was offered training in local site operator activities. The in-house training included a presentation at the council's offices including a general overview of the network and its objectives, highlighting in particular the duties of the LSO in terms of the calibration and maintenance of monitoring sites. The presentation was supplemented with on-site training at one of the local authority's monitoring sites to meet the specific needs of each site operator. This provided the opportunity for site operators to raise any specific issues or concerns and also enabled the QA/QC unit to resolve any readily identifiable errors.

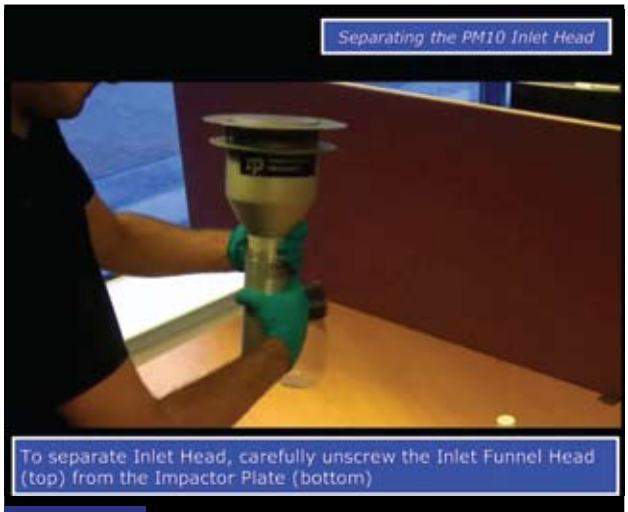


Figure 6.2

Screenshot of LSO Training Video

In addition to the in-house training, a Scottish Air Quality Database LSO manual has been prepared to provide detailed guidance to site operators working within the Scottish network. The manual has been designed specifically for the Scottish network and includes a series of training videos to help site operators when undertaking their duties. Initially 5 training videos covering (1) TEOM Calibration, (2) TEOM FDMS Calibration, (3) BAM Calibration, (4) PM inlet head cleaning and (5) Gaseous Analyser Calibrations will be embedded within the manual.

7

More information

Know and Respond - Scotland

In January 2012, the new Know and Respond air pollution alert service was launched in Scotland. This free service, funded by the Scottish Government, provides alert messages, via SMS, e-mail or voicemail when poor air quality is forecast for the day ahead. It is aimed primarily at people with health problems that may make them sensitive to air pollution. Scotland is the first country within the UK to provide this service on a national basis and several hundred people have registered with the service since its launch.

To find out more about Know & Respond, or to register yourself (or someone you look after), please see the Know & Respond web pages at http://www.scottishairquality.co.uk/know-and-respond/.

Where to find out more about Air Quality in Scotland:

More information on air quality in Scotland can be found on the Scottish Air Quality web pages at http://www.scottishairquality.co.uk/.

The Scottish Government's Environment web pages at

http://www.scotland.gov.uk/Topics/Environment and the Scotland's Environment web pages at http://www.environment.scotland.gov.uk/ provide information on a range of environmental issues including air quality and climate change.

National and local air quality forecasts are available from:

- The Air Pollution Information Service on freephone 0800 556677
- The Defra UK Air Information Resource (UK-AIR) at http://uk-air.defra.gov.uk/.

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

The Scottish Government

RICARDO-AEA

This report has been produced by Ricardo-AEA on behalf of the Scottish Government.

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