Air quality

Our understanding of the sources and impacts of air pollution has improved over the years and applying it has led to better air quality in some areas. However, there are still areas in Scotland where poor air quality affects human health and the environment.

Summary

Key messages

- Air quality has improved significantly since the 1950s, with dramatic reductions in some pollutants, such as sulphur dioxide.
- However, air pollution still damages our health and the environment. It is caused by emissions from industry, transport, energy and agriculture, as well as some household activities, such as heating.
- A number of pollutants are continuously measured across a range of urban and rural locations throughout Scotland. Where air quality standards are not being met, local authorities set up Air Quality Management Areas (AQMAs). As monitoring and assessment activities in Scotland increase, more AQMAs have been identified and declared.
- Although there are a number of policy and legislative measures in place aimed at reducing air pollution, wider measures will need to be considered to achieve further reductions.

State and trend

State: Moderate - high agreement, medium evidence

Trend: Improving/stable - medium agreement, medium evidence

There is an explanation of the diagram and further information on how we carried out the assessments on the summary pages.

- The condition of the air environment has been assessed as moderate, with the majority of pollutants well below limits set for protecting human health and the environment, whilst in some areas pollutants are still above such limits. The overall assessment for air is therefore a simplification of all the different pollutant concentrations in the atmosphere.

- We have taken account of the scale of any damage to the environment and human health in these assessments; impacts of some types of air pollution can be locally damaging but may have little effect on a national scale (e.g. hotspots of urban air pollution caused by traffic congestion), whereas other types of air pollution may cause damage at a national scale (e.g. atmospheric deposition of acids and nutrients).
- The concentrations of some pollutants are decreasing rapidly; others are decreasing more slowly. Thus the overall trend is assessed as improving / stable.
- We have stated how confident we are in the assessments based on the level of agreement between the specialists involved, and the quality and quantity of the supporting evidence.

Overview

The quality of the air around us is affected by the pollutants released into the atmosphere through human activities, such as transport and industry, as well as from natural sources. The quality of Scotland's air has improved considerably over the last few decades, and the air we breathe today is cleaner than at any time since the Industrial Revolution. Although many consider our air to be pristine, we still have similar issues to those of other industrialised countries.

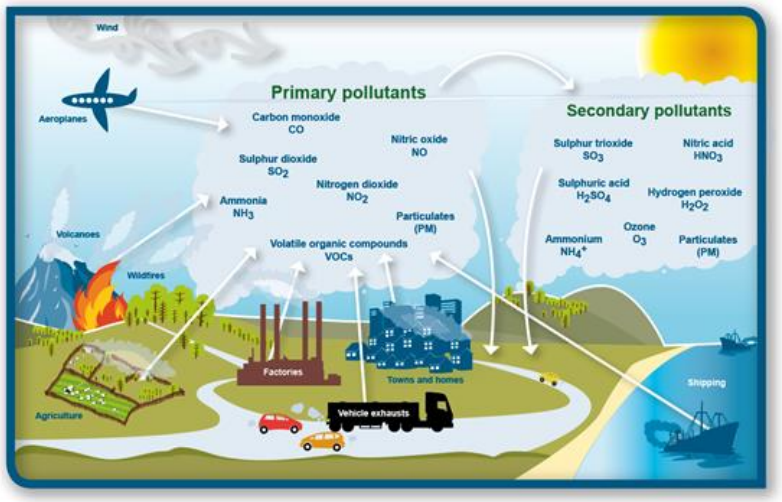

Figure 1: Sources of air pollution

Why does the quality of our air matter?

Air pollution is something that we all contribute to and are exposed to. Poor air quality, particularly within urban areas, can be bad for our health. In general, healthy people may not suffer from any serious ill effects, particularly resulting from the levels of pollution that are commonly experienced in Scotland's urban environment. However, people with pre-existing health conditions (such as heart disease, lung conditions and asthma) may be adversely affected by day-to-day changes in air pollution levels.

While the majority of us do not suffer from any ill effects in the short term, continual exposure can cause harm over the long term. Public Health England have presented findings of a study on the increase in mortality risk associated with long-term exposure to particulate air pollution which estimated that in 2010, tiny particles in the air could have contributed to the deaths of 2094 people in Scotland.

Air pollution can also damage the wider environment. It can cause the acidification of soils and water, damaging plant and animal life in forests, lakes and rivers. It can also add nutrients to water and soils, which can damage biodiversity. Air pollution can also damage the fabric of buildings and monuments.

What are the main pollutants?

The main air pollutants are listed in Table 1 along with their main sources and effects. There are a wide range of human and natural sources.

Table 1: Main air pollutants, sources and effects

Pollutant	Sources	Effects
Nitrogen oxides (NO_x)	Mainly from combustion – including emissions from vehicle exhausts as well as from power generation, industry and households. The main source is transport, closely followed by energy generation.	Harms human health (increases symptoms of chronic lung disease). One of the causes of acid rain – contributing to the acidification of soils and water and damaging buildings. Contributes to nitrogen enrichment of soils and water. A key component in increased levels of ground-level ozone (O_3).
Particulate matter (PM) (fine dust)	Mainly from combustion – including emission from vehicles, ships, power generation and households. The main source is burning coal and solid fuel, closely followed by transport. Also from natural sources, such as sea salt, wind-blown soil and sand.	Health concerns focus on particles of less than 10 micrometres (µm) in diameter (PM_{10}) – especially those of less than 2.5 µm across ($PM_{2.5}$) – which contribute to chronic lung and heart disease.

Sulphur dioxide (SO_2)	Mainly from combustion of sulphur-containing fuels, such as coal. Also from industry, shipping and households.	Harms human health (increases symptoms of chronic lung disease). One of the causes of acid rain – contributing to acidification of soils and water and damaging buildings.
Ammonia (NH_3)	Mainly from agriculture – emissions from livestock farming, manure handling and the use of nitrogen fertilisers.	Harms human health as it contributes to the formation of secondary PM. Contributes to acidification and nutrient enrichment of soils and water.
Volatile organic compounds (VOCs)	Mainly from the use of solvents in products and industry, road vehicles, household heating and power generation.	VOCs are a key component in the formation of ground-level ozone – see below.
Ozone (O_3)	A secondary pollutant produced under certain conditions in the atmosphere, including the presence of NO_x and VOCs.	Harms human health (increases symptoms of chronic lung disease). Damages crops. Damages metals and paints.

The main air pollutants affect urban and rural environments, although the sources and effects may be different in the two environments.

Towns and cities have always suffered from some of the poorest levels of air quality. In the past, coal fires were a significant source of urban air pollution. During the winter months, emissions from domestic coal fires would often result in severe smog, which was common in many big cities, including Glasgow and Edinburgh. In London during the winter of 1952, there was a particularly bad smog episode in which the air was so polluted that sulphuric acid formed in the air. The smog lasted for five days and was estimated to be responsible for 4,000 deaths. This led to the government introducing the Clean Air Act in 1956 to prevent it happening again.

The black smoke and acidic pollutants associated with urban smog also caused significant damage to the stonework of many important buildings. Although the winter smog has gone, we now see summer smog (photochemical smog), which is a mixture of pollutants including ground-level ozone (O_3). Summer smog can damage the external fabric of buildings.

Although emissions from industrial and domestic sources have declined significantly, we still have areas (or hotspots) where air quality is of concern today, mainly as a result of transport emissions.

In general, air in our countryside is of much better quality than the air in our towns and cities. However, our rural environment can still be affected by air pollution.

The sources and effects of the pollution can be very different from those in the urban environment. Agricultural activity is one of the main sources of air pollution in rural areas (such as emissions from pig and poultry farms).

Pollutants can undergo a variety of chemical changes in the air (including the formation of secondary pollutants) before being deposited back onto the ground, where they can damage soils and vegetation. Pollutants can also travel long distances in the atmosphere before being deposited on our countryside.

The deposition of acid and nitrogen-rich pollutants (such as NO_X and NH_3) can damage habitats by acidifying the soil and water and, and also by increasing the availability of nitrogen. This can affect the type and number of species present, particularly in ecosystems sensitive to those changes.

Air quality standards and objectives

To protect human health and the environment from poor air quality, a set of standards and objectives has been developed, which form the basis of our national air quality policies. The standards are concentrations of pollutants that are considered safe for humans and the environment. Air quality objectives take into account wider issues and can therefore represent either dates by which a standard must be achieved or a number of days in a year that a standard must not be exceeded.

State

The quality of Scotland's air has improved considerably over the last few decades. We have significantly reduced some pollutants through tighter controls on emissions from industry, transport and domestic sources. However, there is still a significant amount of work to be done. Air Quality Management Areas (AQMAs) are still being declared, and significant areas of our natural environment are still affected by pollutants from the air.

In Scotland there are 92 sites automatically monitoring pollutant concentrations in the air (Figure 2). These sites are mostly operated by local authorities, and a few are run as part of a UK-wide monitoring network.

The sites are spread across a range of urban and rural locations. The Scottish Air Quality Database (SAQD) hosts most of the air quality data collected across Scotland.

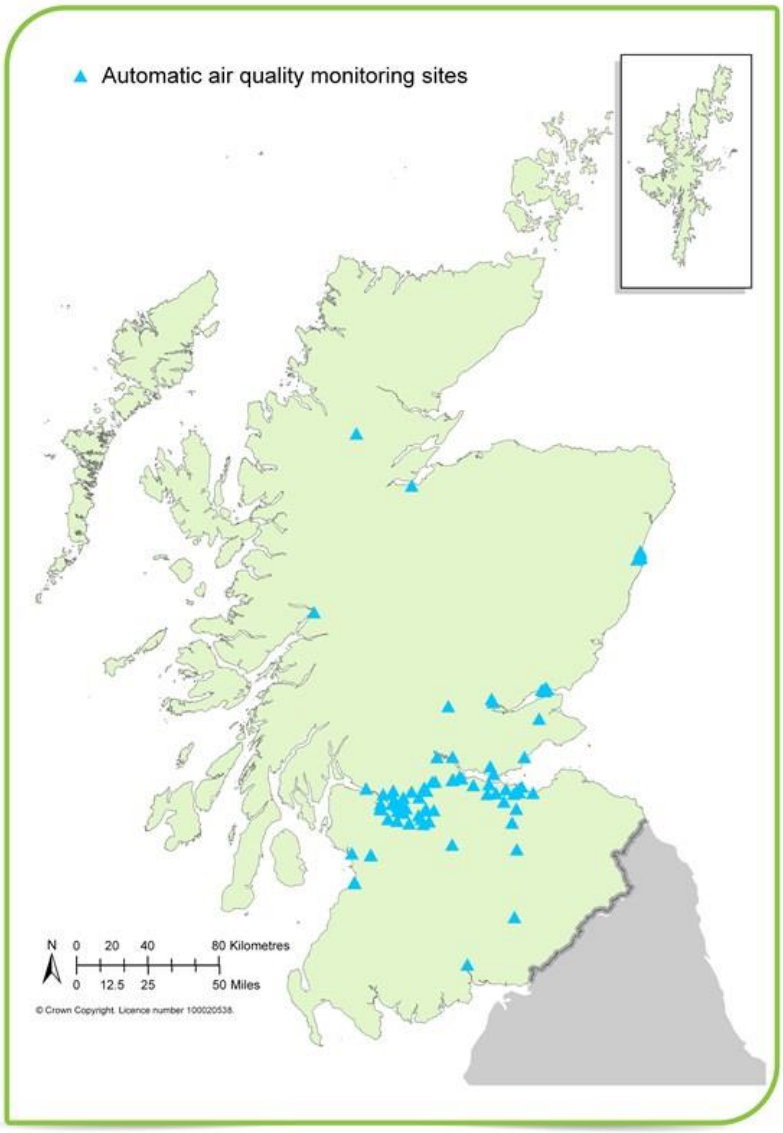

Figure 2: Locations of automatic air quality monitoring sites in Scotland

Source: Air Quality in Scotland

The data collected and held within the SAQD have been used to assess the state and trends in air quality throughout Scotland.

Nitrogen dioxide (NO_2)

There are 76 sites in the SAQD that continually monitor NO_2 in the atmosphere. The annual mean concentrations of NO_2 across sites affected by traffic are very variable and do not show any clear trends. Figure 3 shows the average annual mean NO_2 concentrations at sites across Scotland in 2012; 17 sites had NO_2 concentrations higher than the annual objective.

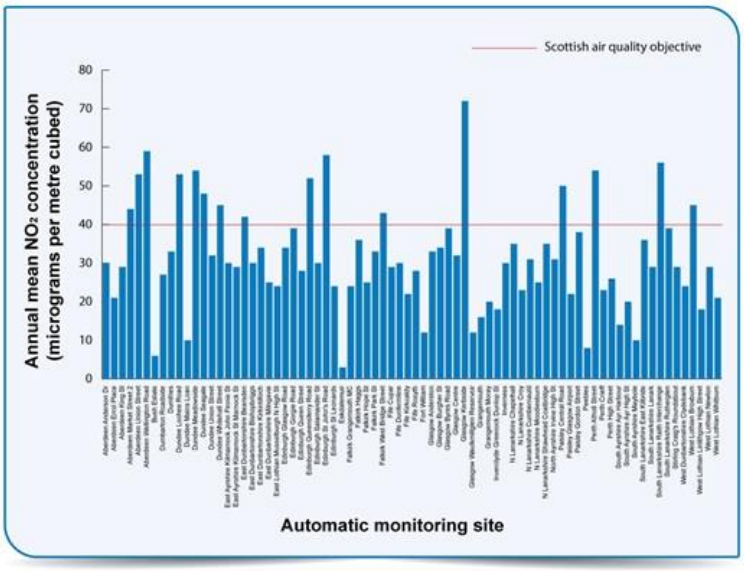

Figure 3: Annual mean nitrogen dioxide (NO_2) concentration across automatic monitoring sites in 2012. The Scottish air quality objective is shown in red

Source: Air Pollution in Scotland 2012 – Ricardo-AEA

Particulate matter

There are currently 74 sites in the SAQD that continually monitor PM_{10} concentration. Although urban background PM_{10} concentrations have been declining since the early 1990s, there is considerable yearly and daily variation across sites where there is traffic.

In 2012 the acceptable annual mean PM_{10} concentration was exceeded at 12 sites, while the acceptable daily mean concentration was exceeded at seven sites (Figure 4).

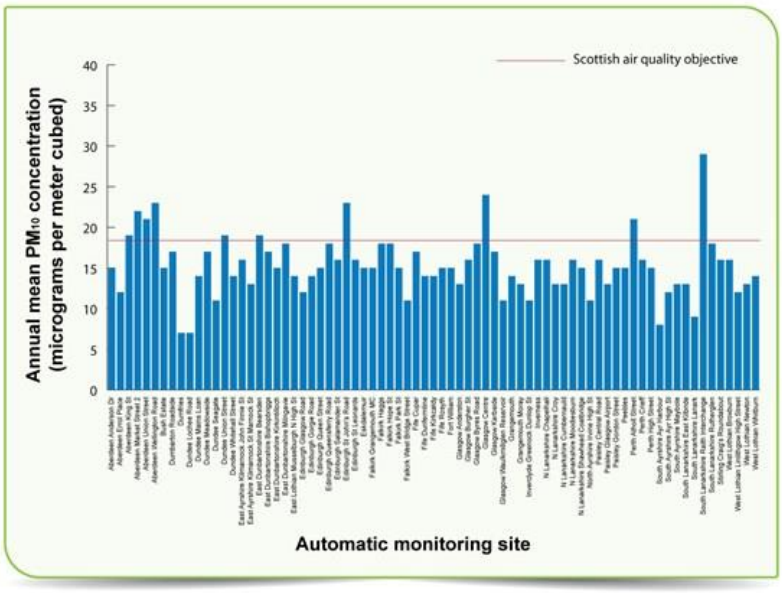

Figure 4: Annual mean PM_{10} concentration across automatic monitoring sites in 2012. The Scottish air quality objective is shown in red

Source: Air Pollution in Scotland 2012 – Ricardo-AEA

As part of a UK-wide monitoring network, six sites now measure $PM_{2.5}$ concentrations. Of these six sites, only four had enough data to calculate representative annual means in 2012. Three of these sites recorded annual mean concentrations below the acceptable air quality objective, while one site in Glasgow recorded an annual mean concentration above the acceptable limit.

Sulphur dioxide (SO_2)

There are currently 10 sites in the SAQD that continually monitor SO2 concentration. There has been a significant reduction in SO_2 concentrations in Scotland since the implementation of the Clean Air Acts in the 1950s and 1960s. This trend continued well into the 1990s and early 2000's, when tighter controls placed on industrial and transport emissions decreased urban concentrations of SO_2.

The decrease in concentrations levelled off in the mid-2000s and they are now continually low. Figure 5 shows SO_2 concentrations at a city-centre site in Glasgow from 1996 to 2012.

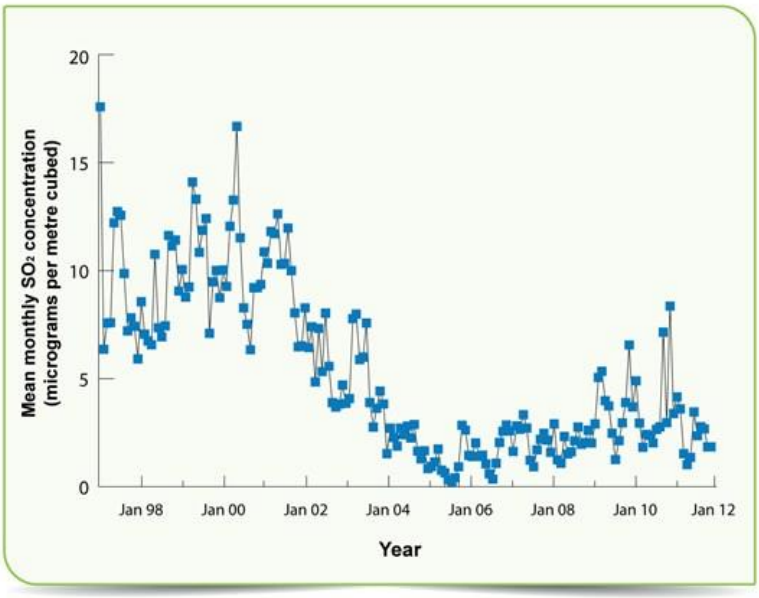

Figure 5: Monthly concentrations of SO_2 at a long-term city centre sampling location (Glasgow)

Source: Data obtained from Air Quality in Scotland – created using OpenAir

Ozone (O_3)

There has been a significant decline in the number of days when ground-level ozone concentrations are high over the last 20 years. Despite this, background levels have continued to rise across Europe and the UK, due in part to the long-range transport of pollutants from other parts of the world.

Ground-level ozone concentrations are generally lower in areas where there is traffic because gases in the exhaust emissions destroy the ozone.

Figure 6 shows the difference between ozone concentrations in a city centre location and a suburban location over the same time period.

Figure 6: Concentrations of ozone (O_3) measured at a city-centre location and a suburban location in Glasgow in 2011

Source: Data obtained from Air Quality in Scotland – created using OpenAir

Ammonia (NH_3)

Ammonia (NH_3) and particulate ammonium (NH_{4+}) are measured as part of the UK National Ammonia Monitoring Network (NAMN). There are currently 85 sites in the NAMN, with 20 located in Scotland. Although there is considerable variation in levels of NH_3 and NH_{4+} in different regions, depending on local emission sources, the general background concentrations are below 2 micrograms per metre cubed

(μgm_{-3}). Figure 7 shows NH_3 concentrations measured near Penicuik from 1996 until 2010.

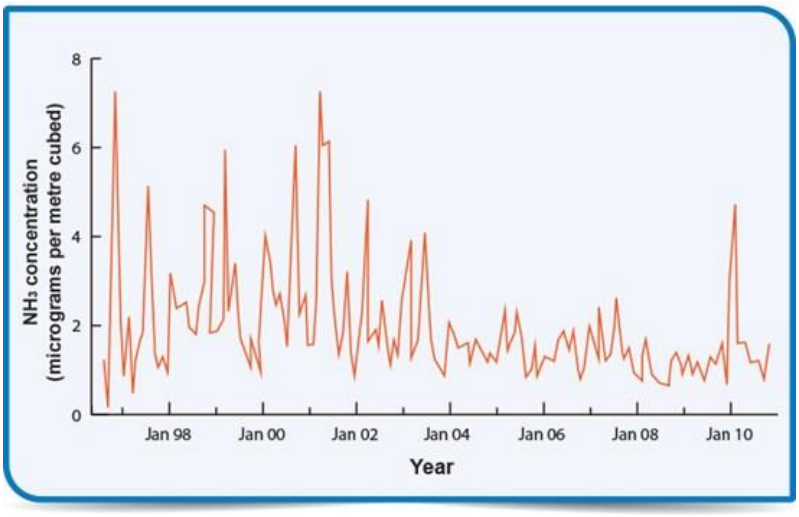

Figure 7: Concentrations of NH_3 monitored at Bush Estate, near Penicuik, Edinburgh 1996–2010

Source: Data obtained from the Defra National Ammonia Monitoring Network

Pressures affecting air quality

There are many pressures that affect air quality. Some relate directly to emissions, while others are more subtle, such as land use and urban planning.

The National Atmospheric Emissions Inventory (NAEI) has been collating emissions data for the UK since 1970, and provides an estimate of emissions in Scotland. Scottish emissions for all pollutants have decreased since 2000. However, the extent of reductions differs between pollutants. Table 2 shows how the main air pollutant emissions have changed since 2000 and suggests how they might change in future.

Table 2: Emissions of the key pollutants in Scotland, 2000-2011

Pollutant	Emissions (thousand tonnes per year)			Main Sources
	2000	2011	Trend	
Nitrogen oxides (NO_x)	177.00	98.00	▼45%	Transport is still the largest source of NO_X, accounting for 29%, while emissions from energy-generating sources account for 25%. As renewable energy sources increase, it is expected that the contribution from energy generation will continue to decrease.
Particulate matter (PM_{10})	17.90	12.30	▼31%	Burning coal and solid fuels is the largest source of PM_{10} emissions. Transport is also a significant source (17%), particularly in urban areas. Biomass (organic matter used as fuel) is a relatively small source, but if the rate of uptake continues as forecast its contributions will become increasingly important, especially in urban areas.
Sulphur dioxide (SO_2)	134.80	61.30	▼31%	Power generation is still the most significant source, accounting for 68%. However, this sector has reduced significantly as the use of gas and renewable energy sources has increased.
Ammonia (NH_3)	40.00	36.00	▼10%	Agricultural emission is the dominant source for ammonia, accounting for 65%. Emissions from waste (10%) have increased by 155% since 2008, mainly because of the increase in composting and anaerobic digestion.

Source: NAEI, Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2011

What is being done

Despite the significant improvements in air quality that have been achieved over the years, further measures are required to continue improving Scotland's air quality.

Legislation

In Europe more people die as a result of poor air quality than in road traffic accidents. It is the main environmental cause of preventable illness and premature death in the EU.

Poor air quality also affects the environment; therefore, the European Commission has adopted a series of legislative measures to reduce air pollution.

Two main pieces of EU legislation dealing with air pollution.

- The directive on ambient air quality and cleaner air for Europe, which sets EU air-quality standards for ground-level ozone, particulate matter, nitrogen oxides, heavy metals and a number of other pollutants.
- The National Emission Ceilings Directive (NECD) which sets emission limits for sulphur dioxide, nitrogen oxides, ammonia and volatile organic compounds (VOCs), reducing national emissions to meet international agreements.

The European Commission has recently reviewed the EU's air-quality policy and legislation, and a revised Clean Air Policy Package for Europe was published in December 2013. The main components of the package are:

- A Clean Air Programme for Europe which includes measures to ensure that existing ambient air quality targets are met by 2020, and new air quality objectives to bring down pollution emissions by 2030.
- a revised NECD with stricter national targets for the main pollutants;
- a proposed directive to reduce pollution from medium-scale combustion activities.

The UK's Air Quality Strategy for England, Scotland, Wales and Northern Ireland was developed to improve air quality in the UK, to protect our health and the environment. It sets UK objectives for reducing a series of pollutants. For some pollutants Scotland has adopted more stringent objectives than the rest of the UK. The strategy sets out the UK's system for local air quality management (LAQM). The LAQM system is currently being reviewed and the proposals for the revision of the objectives will be released during 2014.

Local authorities

Local authorities must review and assess a range of pollutants that are set out within the Air Quality Strategy, declare as Air Quality Management Areas (AQMAs) any areas where standards are not being met, and put in place an action plan to reduce pollution levels. At present, 13 local authorities in the most densely populated areas of Scotland have declared AQMAs. The number of areas declared has increased from 26 in 2011 to 32 in 2013 and it is expected that this number may continue to rise in the future. Most AQMAs have been declared due to emissions from traffic.

The LAQM process has contributed significantly to the understanding of air quality, but more progress must be made, particularly in areas where the main source of pollution is road traffic, in order to be successful in improving air quality.

Local authorities also manage air quality in terms of planning and development, considering the impacts that development may have on local air quality.

Transport

Transport is the most significant source contributing to poor air quality in urban areas. Although emissions from transport have declined over the years, the rate of decline has started to level off. Therefore without additional measures to tackle transport-related pollution, it is possible that emissions will begin to increase again. Central and local governments have a long-term commitment to de-carbonise the transport fleet by 2050.

There are various measures available to improve air quality, such as Low Emission Zones, congestion charges, vehicles that run on alternative fuel and initiatives to encourage a shift from private to public transport. However, there has been limited progress in introducing larger-scale improvement measures. To help facilitate further improvements in urban air quality, the Scottish Government is currently developing a national low emission strategy for Scotland.

The public also have a role to play, such as using their vehicles less and, where possible, using public transport. By reducing congestion and individual vehicle mileage, this approach would reduce overall emissions. However, this requires a change in people's thinking and more effective and integrated public transport.

Industry

Considerable progress has been made over recent decades in controlling emissions from industrial sources. Robust legislation and stringent operating conditions, combined with technological developments, have significantly reduced national emissions. Further developments in technology and legislation will continue to drive down emissions.

Biomass

Emissions from well-operated and well-maintained modern biomass boilers are generally lower than for coal or oil equivalents. However, when they replace gas-fired appliances in urban areas, where poor air quality may already be an issue, emissions may contribute to local air quality issues. Therefore, biomass uptake in urban areas, both domestic (i.e. wood-burning stoves) and large scale must be carefully controlled.

Citizen science

We can help in identify local issues through citizen science programmes. This approach allows people to provide information that can be used alongside the information already obtained from the monitoring sites in the SAQD, while raising awareness of air quality. Examples include monitoring air quality at a school or choosing to use less polluting forms of transport.