Clean Air – Still a Political Objective After 60 years

As the 60th anniversary of the Great Smog of London passes, Jim Mills, Managing Director of Air Monitors, explains why air quality is once again at the top of the political agenda.

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It is now just over 60 years since the Great Smog of London that was responsible for the deaths of around 4,000 people and led to the development of the Clean Air Act of 1956. This landmark piece of environmental legislation resulted in substantial improvements to ambient air quality. However, large numbers of people are still dying from air pollution and as a result, air quality is once again making the headlines.

The 1956 Clean Air Act introduced a number of measures to reduce air pollution, such as the introduction of smoke control areas in selected towns and cities in which only smokeless fuels could be burned. Industrial furnaces could no longer emit 'dark smoke' and households were offered grants to convert from coal to smokeless fuel.

The move to cleaner forms of heating, including electricity and gas, significantly lowered levels of particulate and sulphur dioxide pollution. In addition, the Act relocated power stations away from cities, and forced the height of some industrial chimneys to be increased.

60 years later

Despite the improvements that have been made to certain aspects of air quality, large numbers of deaths still result from air pollution. According to the European Commission, some 500,000 people die prematurely in the EU 27, mainly due to exposure to high levels of fine particulate matter (atmospheric microparticles or 'dust' of a diameter of less than 2.5 microns), which originates from residential heating, transport (diesel cars and trucks, ships and planes), agriculture, industrial processes and power production.

Europe is not the only region to be affected. A report recently published in The Lancet entitled 'Global Burden of Disease' reported that in 2010, more than 2.1 million people in Asia died prematurely from air pollution, mostly from the minute particles of diesel soot and gases emitted from cars and trucks. Worldwide, a record 3.2 million people a year died from air pollution in 2010, compared with 800,000 in 2000, the report said. As a consequence, air pollution now ranks in the world's top 10 list of killer diseases for the first time.

Research, published in the Lancet on 10th July 2013, demonstrated a direct link between particulate matter exposure and the incidence of lung cancer. The researchers studied 312,944 cohort members which contributed 4,013,131 person-years at risk. During the follow-up period (mean 12.8 years), there were 2,095 incidents of lung cancer and a statistically significant association was found between the risk for lung cancer and the levels of fine particulates.

In a separate study, also published in the Lancet, researchers concluded that air pollution has a close temporal association with heart failure hospitalisation and heart failure mortality. Although more studies from developing nations are required, the report described air pollution as 'a pervasive public health issue with major cardiovascular and health economic consequences, and it should remain a key target for global health policy.'

Air quality is good over most of the UK but towns and cities continue to suffer. It has been estimated that 4,300 Londoners now die prematurely each year as a result of air pollution (29,000 UK-wide, according to the Department for the Environment, Food and Rural Affairs). This is no longer because of coal fires but is attributed to nitrogen dioxide and fine particulates, mainly from vehicles. London may have the highest levels of nitrogen dioxide of any capital city in the EU, with some areas of the city showing three times the legal limit.

The populations of the world's major cities have rocketed in recent decades and the volume of traffic has grown exponentially, so it is hardly surprising that a new set of air quality challenges have arisen.

Political recognition

In November 2011 Janez Potočnik, European Commissioner for the Environment, expressed his determination to make 2013 the 'Year of Air'. He acknowledged that there has been substantial improvement in air quality in recent decades but in the light of the environmental/climate issues surrounding air quality and the large number of premature deaths resulting from air pollution, he said: "The challenge for all of us is to address the shortcomings of existing regulations in a decisive and coordinated way. This will require the goodwill of policy-makers at all levels – European, national, regional and local – as well as other stakeholders such as the automotive and oil industries."

The European Environment Agency's 2011 report on air quality reflects air quality improvements for a number of key parameters, with concentrations of sulphur dioxide and carbon monoxide falling by about half in the decade ending in 2009. However, the report also shows that in 2008, levels of nitrogen oxide, ozone and particulate matter have risen, fuelling concerns about overall air quality, especially in urban areas.

A further problem associated with tiny particles is their ability to act as "sponges" carrying small amounts of toxic species such as PAH's and Dioxins which are adsorbed onto Black Carbon particles and transported deep into the body. PM10 and PM2.5 monitoring measurements provide a total figure for everything with mass in the sample and thereby assume that all particles are of equal significance. In reality this is not the case because some of the particles are benign from a human health perspective or are not anthropogenic so are of less interest from an air quality management perspective.

It is fortunate that the fine particles (from the combustion of fossil fuels) that are of most interest are Black Carbon and can be measured with an Aethalometer, which employs an optical method to only measure those fine particles which are black. A further consideration with Black Carbon is its role in climate change because, after carbon dioxide, it is the second largest contributor to current global warming.

Encouragingly, as of 7th February 2013, 27 countries, including the UK, the European Union, and all of the partners of the UNEP Climate and Clean Air Coalition (CCAC) have agreed to implement 'fast action on reducing black carbon, methane, some hydrofluorocarbons (HFCs) and other short-lived climate pollutants (SLCPs)'. These reductions have the potential to slow a global temperature rise by up to 0.5 degrees C by 2050, to reduce air pollution-related deaths by as much as 2.4 million and crop losses by around 30 million tonnes annually.

The United Nations recently published data which showed that mercury emissions are rising in a number of developing nations.

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However, in January 2013 more than 140 countries agreed a set of legally binding measures to curb mercury pollution, which included measures to reduce emissions from power plants and metals production facilities.

In the UK, one of the Coalition's original pledges was to work towards EU air quality standards although this has been refined into a mid-term 'to-do' list which seeks to curb air pollution in towns and cities.

Urban air quality

Initiatives to improve air quality are focused on those urban areas that suffer from the highest levels of pollution. For example, air quality improvements can be made by: improving the availability of public transport; by improving traffic management; by restricting vehicular access; by limiting industrial emissions and by improving the quality of vehicle emissions.

It is likely that air quality improvements will be possible through the development of appropriate traffic management systems. For example, an EU funded project CARBOTRAF, combines real-time monitoring of traffic and air pollution in Glasgow and Graz with simulation models for the prediction of CO2 and black carbon emissions in order to provide on-line recommendations for alternative traffic management options. The research is ongoing, but the participants hope to develop a system which combines air quality monitoring with traffic management to automatically protect air quality.

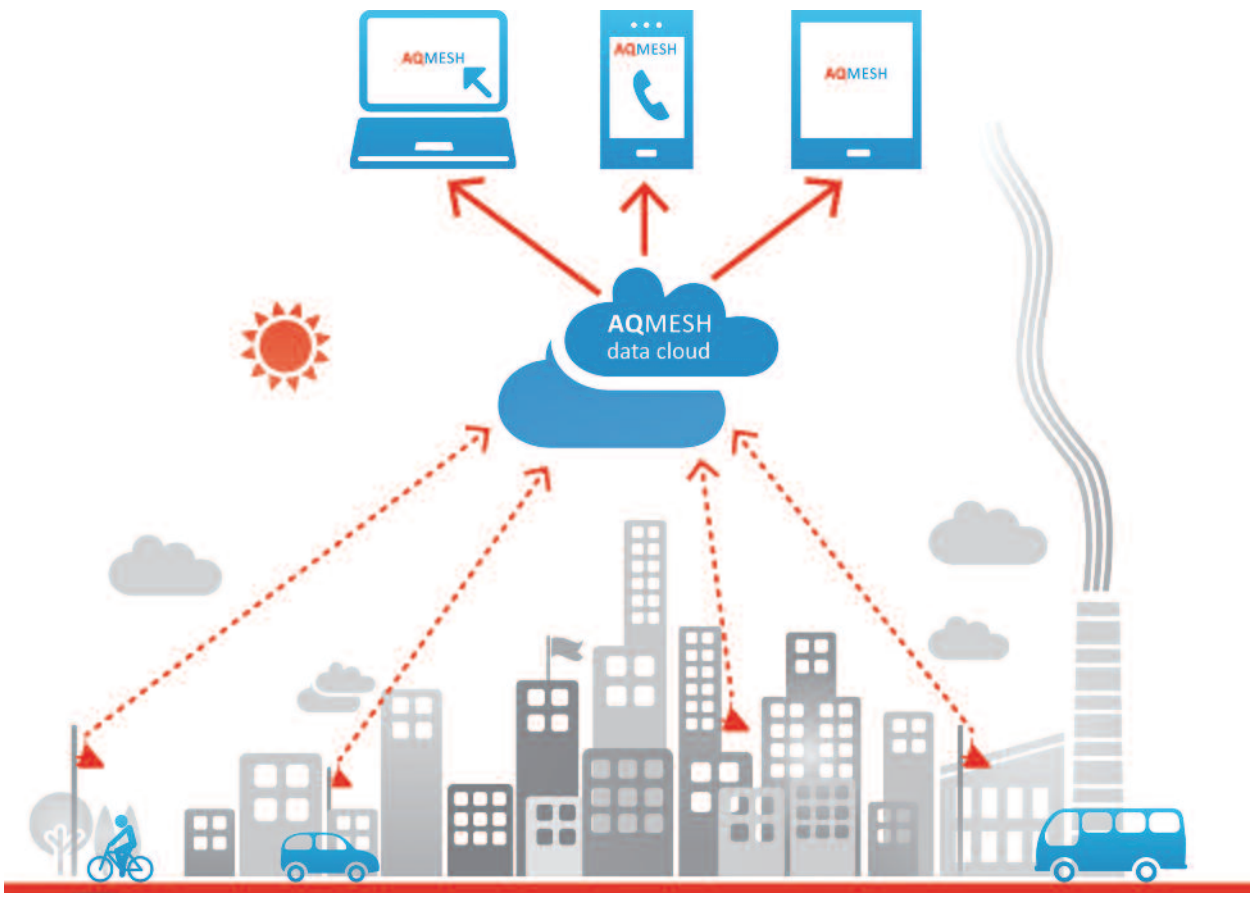
The role of air quality monitoring

Clearly, policy makers need reliable air quality data to make informed decisions and to be able to measure the effects of policy. Monitoring technology therefore has a vital role to perform. However, the developers and manufacturers of air quality monitoring equipment have to design instruments that meet the requirements of standards such as BS, AFNOR, ASTM, TÜV, EN and ISO, so it is important that these standards reflect the needs of society. For example, early monitoring standards for particulates measured particles according to their size and weight, but took little account of finer particles including black carbon and those with a diameter of less than 1 micron (PM1) due to their much lower mass.

It has now become clear that finer particulates are responsible for many of the deaths attributable to poor air quality, so new standards are required. Finer particles are able to travel deeper into the respiratory system, and because these tiny particles can act as sponges, they can carry small amounts of toxic species such as PAH's and Dioxins which are adsorbed onto black carbon particles and transported deep into the body.

Instrument manufacturers are therefore developing new technologies that are able to provide more information on these finer particles. For example, a new Fine Dust Analysis System (FIDAS) has been developed in Germany which offers additional information on both particle size distribution from 0.18 – 30 microns and on particle number in each size range. It also provides continuous real-time simultaneous mass concentration measurements of Total Suspended Particulates, PM1, PM2.5 and PM10. This will improve our understanding of particulate pollution and complement existing PM monitoring technology such as the TEOM FDMS, which is a standard method in many countries.

The standard methods for measuring pollutants such as particulates are extremely important because they can have an enormous impact on air quality. For example, if the methods for measuring particulates change to include finer particulates, the designers of vehicle engines and industrial combustion processes will have to respond accordingly.



Some of the ways in which advances in monitoring technology can help improve our understanding of the factors affecting air quality and the relationship between air quality and health were discussed by speakers at the AQE 2013 show – an international event dedicated to air quality (see www.aqeshow.com).

Monitoring sites

Traditionally, one of the greatest challenges in monitoring urban air quality is finding a suitable location at which to site the monitoring station. Standard reference method analysers are generally housed in a large air conditioned chamber that requires mains power and necessitates a significant footprint which, in towns and cities, usually means that planning permission is necessary. As a result, many of these stations are not necessarily located in the best position for sampling the air that people are breathing, so the Holy Grail for ambient air monitoring is a smaller battery powered station that delivers data of a similar quality.

In recent years, low cost electrochemical sensors have advanced considerably and have begun to offer an opportunity for supplementing standard monitoring systems with larger numbers of smaller, more flexible, monitors. However, until recently, these electrochemical sensors have been unable to deliver sufficiently accurate data at the low levels required – parts per billion (ppb).

In September 2013 a new type of ambient monitor will be made available to the market. Known as 'AQMesh' the new monitors are low cost, small, battery powered, web enabled and suitable for mounting on a normal lamp post. This dramatically alters ambient air quality monitoring, because it enables the location of accurate monitoring systems at the location of most interest.

AQMesh will supplement existing networks by enabling air quality to be monitored in the locations that need to be monitored rather than where equipment can be conveniently positioned. The small post-mounted units are completely wireless, using battery power and GPRS communications. AQMesh 'pods' measure the main air polluting gases and wirelessly communicate data to a 'cloud' where sophisticated data management generate highly accurate readings. Users can view or download data from up to hundreds of pods via an online portal.

Looking forward

With so many political agreements and with air quality regularly making the headlines, it appears that Janez Potočnik's desire for 2013 to be the year of air, will come true. However, it is clear that developments in monitoring technology have the potential to drive improvements in air quality as long as standards are updated quickly so that new improved technologies can be assimilated into monitoring networks.

As the quality and effectiveness of air quality monitoring improves, scientists will be in a better position to understand the interactions between different pollutants, their causes, and the effects that they have on human health and the environment.