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Getting more from air quality data

Getting more from AIR QUALITY DATA

Improving the quality of the air we breathe in our urban centres has become one of the most pressing problems for town and city authorities around the world. The new RapidAir® software from Ricardo provides a much-needed diagnostics and decision-support capability to help tackle the challenge of improving urban air quality

The link between air pollution and negative health outcomes for the inhabitants of towns and cities around the world – including increased mortality rates associated with respiratory illnesses – is now universally accepted. Increasing urbanization, industrial processes, and the effects of motor transport within the enclosed ‘urban canyons’ of densely developed cities, leads to local street-level concentrations of pollutants including oxides of nitrogen (NO_x, and NO₂ in particular), microfine carbonaceous particles, ozone and carbon monoxide.

The negative effect of this poor air quality for urban citizens is tangible. In the UK in August 2018, for example, the government-sponsored Committee on the Medical Effects of Air Pollutants (COMEAP) published the results of a

four-year project which estimated that between 28,000 and 36,000 premature deaths annually could be linked to long-term exposure to air pollution.

City authorities have a wide range of policy levers at their disposal in order to help improve urban air quality, particularly with regard to the management of traffic flows and the mix of vehicle types that are permitted in different areas. But to be successful in delivering significant air quality improvement outcomes, such policy initiatives need to be based on reliable information about the distribution of concentrations of pollution across the city, and ideally include an understanding of its original source.

Limitations of monitoring

Roadside air pollution monitoring stations are used to great effect across the UK

and other countries to monitor and report on local pollution levels. While the information obtained is extremely useful, it has its limitations too. Monitoring stations report the history of pollution but cannot predict when air quality is likely to change. Furthermore, they can only monitor a single location point, while air quality can change substantially over comparatively small distances.

“In areas surrounded by tall buildings, air pollution can become trapped, especially if the wind is blowing in a direction perpendicular to the urban canyon formed by the street,” explains Dr Nicola Masey, consultant for environmental evidence and data at Ricardo Energy & Environment. “We need to build on the air quality monitoring systems that are already in place across the UK and elsewhere – particularly



“I am convinced that RapidAir® provides a cost-effective, city-scale dispersion model which retains the best features and functionality of conventional air quality modelling tools, but with the benefit of fast operation and simplicity” Dr Scott Hamilton, Ricardo Energy & Environment

RapidAir® software provides a powerful diagnostics and decision support capability to help tackle the challenge of improving urban air quality; visualization of NO₂ in London* (cover and P11) and in 3D (above), and as postcode averaged data in Fife, Scotland* (below, left); and average concentration of NO₂ in building footprints (below, right)

→ in the larger towns and cities – and enhance the temporal and spatial extent and resolution information that we can provide to both the public and to policymakers.”

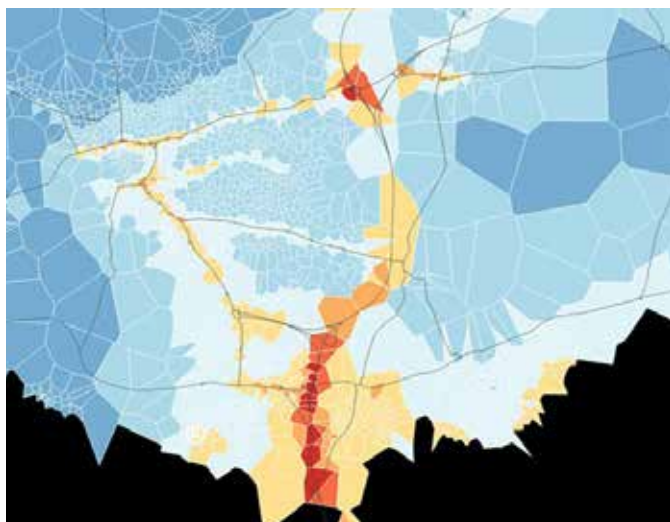
Introducing Ricardo RapidAir®

In order to address this requirement, Ricardo has developed its RapidAir® urban air quality diagnostics tool. Underpinned by the United States Environmental Protection Agency’s AERMOD modelling codes, RapidAir® includes an emissions model with up-to-date, fully validated and peer reviewed emission factors, and supports modelling of emissions from all of the common source sectors – including transport, industry, construction,

demolition and landfill. It facilitates fast and efficient city-scale air quality modelling and mitigation scenario testing for a comprehensive range of emission sources and pollutants. With spatial resolution down to one metre, and run times in minutes, the software enables policymakers to test and optimize complex air pollution abatement strategies with unrivalled power and

speed. As an operational air pollution tool, RapidAir® also provides advanced air quality diagnostics and ‘what if’ scenario-testing capabilities.

Modelled pollutants include nitrogen oxides (NO_x), NO₂, sulfur dioxide (SO₂) and carbon monoxide (CO) gases, as well as PM10 and PM2.5 ultrafine particles. In each case, the software can provide mass and volume concentration



predictions over domains that range from individual streets to city, regional and national scales. RapidAir® also integrates local emissions, meteorology and measurements to ensure a complete representation of urban air quality.

In research work carried out by Nicola Masey in parallel to the development of the RapidAir® software, the use of well-known mathematical equations to describe street canyon concentrations was investigated. These were compared with concentrations estimated using more traditional empirical approaches that incorporated geomorphological analysis tools that estimate how densely 'built-up' an area is. For example, sky view factor, hill shade and wind effect are all used by urban designers to assess thermal comfort and solar shading, but these metrics are not commonly used in air pollution studies.

"Having helped in its development and evaluation, I am convinced that RapidAir® provides a cost-effective, city-scale dispersion model which retains the best features and functionality of conventional air quality modelling tools, but with the benefit of fast operation and simplicity," commented Dr Scott Hamilton, technical lead in air quality modelling for Ricardo Energy & Environment. "The system relies on air quality data that is generally already available, so it can be used in any city in any part of the world – as long as there is local measurement data, details of traffic flows and compositions and building data available for us to use with the model."

International application

The international reach of the Ricardo team responsible for the development of RapidAir® has already proved its value. For example, Ricardo recently secured a major two-year study commissioned by the Asian Development Bank into improving air quality in three cities in China, a project designed to support the billion-dollar investments into improving air quality being made by the bank in north-eastern China.

Until recently, cities of the greater Beijing-Tianjin-Hebei region of China were among the highest polluted conurbations in the world. Substantial work is under way to deliver improvements in air quality in the region, but levels remain well above national and international standards.

Ricardo is working closely with environmental protection officials in three case study cities to investigate air quality improvement measures further. The RapidAir® system is being deployed in the study to perform a detailed cost-benefit analysis and

health impact assessment of potential pollution mitigation measures. This will support policy makers to identify the optimum policy mix to improve air quality and population health, with guidance influencing the development of air quality management plans to 2030.

"Environmental protection officers in north-east China are at the forefront of tackling some of the toughest air pollution problems in the world," commented project director Ben Grebot. "The Asian Development Bank's commitment to investing in air quality improvements enables us to bring our air quality policy and modelling expertise to work alongside the city bureaux and national experts to deliver real air quality benefits."

Ricardo is working on this important project together with in-country experts from Tsinghua University and the Chinese Academy of Environmental Planning.

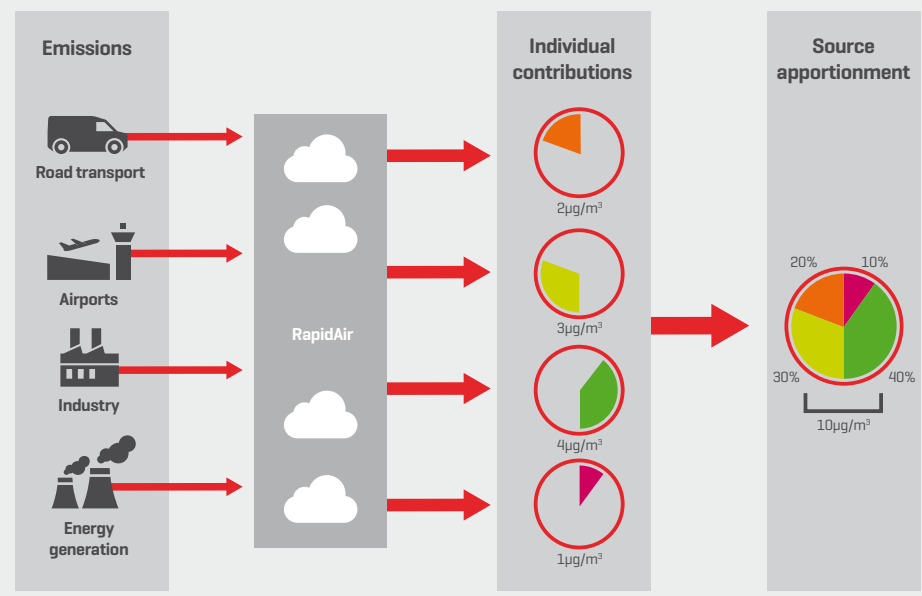
Urban air quality is one of the great environmental challenges for town and

city authorities around the world. As we report in the lead feature of this issue of RQ, Ricardo is making significant contributions to the science of vehicle emissions measurement – both in terms of RDE testing and roadside vehicle emissions monitoring – and the engineering of new aftertreatment solutions to ensure that future vehicles are cleaner than ever before.

The development of RapidAir® thus adds a complementary and highly valuable additional capability to the Ricardo portfolio, enabling the company's air quality specialists to apply new levels of analytical rigour to the development of local, regional and national policy aimed at reducing the pollution concentrations to which citizens are subjected, and hence improving health outcomes.

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Key features of RapidAir®



- » Industry-leading run times for large urban domains
- » Hundreds of millions of receptor locations at metre-scale resolution
- » Treatment of emissions from traffic and stationary sources
- » Up-to-date emissions model for vehicle technology categories
- » Full complement of ambient air pollutants modelled
- » Extensive model validation and calibration suite
- » Works in a geographic information system environment or from a command line
- » Custom modules for meteorology, street canyons, NOx:NO₂ chemistry, secondary particle formation, source apportionment, neighbourhood analysis
- » Sophisticated output visualizations including via Google Earth™
- » Outputs can be combined with regional models such as CMAQ and WRF-Chem

For more information on Ricardo air quality modelling and forecasting, and RapidAir® software, visit: ee.ricardo.com/air-quality/modelling-and-forecasting



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