UNIVERSITY OF BIRMINGHAM

WM-Air Impact Case Study

Developing best practice for local authorities on the use of low-cost sensors networks for air quality

Demonstrable collaborations with the public sector and industry

Research used to define best practice and used by practitioners

Government analysts adopting approach-based advice

Effective and demonstrable collaboration - with local authorities

Practice – new best practice guidance + advice

Environment – new local insights into Particulate Matter

One of the early aims of WM-Air was to provide increased observational capability for air quality in the West Midlands. Particulate Matter (PM) was a key target for the project, given the increasing importance of monitoring non-exhaust emissions as the region transitions towards net zero as well as gaseous pollutants being increasingly tackled by interventions such as the Birmingham clean air zone. This case study focuses on impact outcomes from the deployment of air quality sensor networks across the West Midlands.

Background - why does this work matter?

Understanding the sources and distribution of fine PM is becoming increasingly important, especially as gaseous pollutants become increasingly tackled by interventions such as clean air zones and transition to electric vehicles (EVs). Monitoring PM using networks of low-cost sensors helps to better understand hyperlocal non-exhaust emissions, including PM from resuspension, brake- and tyre wear- issues (not tackled by the transition to EVs) as well as other non vehicle emissions such as s residential woodburning.

Method – what did we do?

WM-Air worked collaboratively with Local Authorities across the West Midlands – notably Coventry and Birmingham City Councils – to develop and deploy a new low-cost sensor for increasing air quality monitoring capacity and improving situational awareness. This data was used for a range of real-world applications in Birmingham and Coventry, including Birmingham 2022 Commonwealth Games, the Birmingham Clean Air Zone, Coventry Air Quality improvement schemes, and Edgbaston cricket's Go Green Game. Learnings from these deployments were used to develop a guidance note on procuring and deploying low-cost and commercial AQ sensing networks for local authorities.

What tools/outputs were developed?

The team at University of Birmingham had previously achieved commercial success in the development of Internet of Things (IoT) sensors for meteorological applications in transport. Working in collaboration with a University of Birmingham operating division (Altasense), a technology transfer project was completed to apply IoT sensing principles to PM. The result was

a self-contained, low-cost, sensor which could be produced for less than £200 and therefore had the potential to be deployed in sufficient numbers to underpin a dense network across an urban area. Working with the relevant local authorities, two operational networks of sensors were deployed across the West Midlands in Birmingham and Coventry.

Outcomes, Impacts and Benefits delivered

Practitioners have used the research findings in conducting their work

Through demonstrable colloborations with the public sector, trial deployments across the West Midlands gained visibility to the low cost sensing approach where it has influenced practice. A notable example of this is in Coventry, where the work featured regularly in their Air Quality annual status report.

This usage of the data is evidenced in emails from the Coventry City Council environmental health officer (EHO). Examples include:

- Development planning in areas of high PM pollution. A presentation was made by CCC to the RTPI (Royal Town Planning Institute) on how better to integrate planning and air quality from an EHO's perspective).
- Cov & Warks Public Health to target future air quality interventions in areas with high incidence of heart disease and respiratory illness and linking to NHS admissions.
- Highways & Transportation colleagues who were interested in terms of monitoring areas where highway improvements, infrastructure changes and cycle routes are being undertaken to see what effects on air quality have been achieved.

Data from the Birmingham network was also used to investigate the impact of the CAZ and to explore the remaining areas of exceedance within the CAZ for BCC. The data has also been used at sporting events, for example Edgbaston Cricket have used the data to assess the impact of their 'Go Green Game' public-transport-only sustainability days. Indeed, in line with the rest of WM-Air, interest was shown right across the West Midlands and Warwickshire with support voiced by the West Midlands Environmental Protection Group, West Midlands Combined Authority and the Coventry & Warwickshire Air Quality Alliance.

Demonstrable collaborations with industry

The innovative nature of the PM sensor networks in Birmingham and Coventry caught the attention of Siemens Mobility Ltd, who were keen to implement the sensor into their larger product offering. Similarly, although originally designed for outdoor use, the application of the sensor in an indoor environment was also explored by Unilever. Although these early trials were largely successful, technical difficulties moving from the early prototype proved challenging and difficult to overcome. However, the learnings from these commercial activities, along with the broad public sector engagement set the foundations to steer best practice more generally.

The research has been used to define best practice

A key development during the early phase of WM-Air was the award of additional funding from EPSRC when Birmingham received support to develop an urban observatory across the city. Air Quality was a key target of the observatory resulting in the procurement of range of commercial sensors which were deployed as nested networks across the city, allowing for unprecedented intercomparisions of sensors and unprecedented spatial insights on air quality. Combiningg these experiences with the documented engagement with industry and the public sector provided the team with a unique opportunity to develop best practice guidance on the procurement and deployment of low cost sensors for air quality. Originally, produced as a

> **"The existence of the sensors means that we may be able to use data in reference to planning applications and addressing issues of development in areas of high PM pollution... So many colleagues and partners are aware of the growing health threat from PM as we address NO2 and that is why your work is so valuable to us all going forward."**
>
> **Steve Dewer, Coventry City Council**

EPSRC: UK Collaboratorium for research in infrastructure and cities, Birmingham Urban Observatory (£1.04m)

DfT: Towards a mobility digital twin (£300k)

DfT: Towards a digital twin for urban transport (£300k)

> "[The Council utilised] AQ sensors to consider the impact of the Clean Air Zone, Low Traffic Neighbourhoods and associated support measures for encouraging behaviour change and modal shift, supporting economic growth and accelerating transition to a low emission economy."
>
> **Stephen Arnold (Head of Clean Air Zone), BCC**

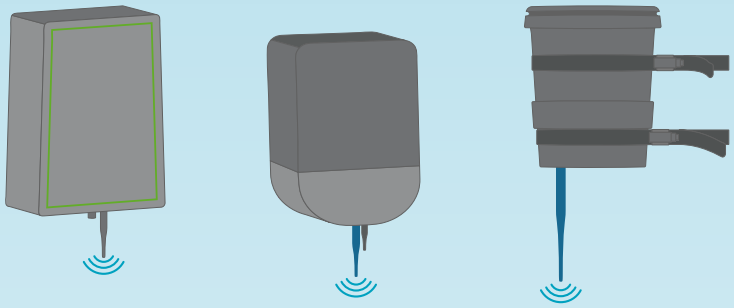
About WM-Air: Clean Air Science for the West Midlands

WM-Air ("Clean Air Science for the West Midlands") is a NERC-funded initiative, led by the University of Birmingham, working in collaboration with over 20 cross sector partners, to apply environmental science research expertise to improve air quality in the West Midlands, delivering health, economic and environmental benefits.

wm-air.org.uk

UKRI Natural Environment Research Council

Guidance Note on Low Cost Sensors for Air Quality Monitoring, the resource has been accessed >150 times, with >5000 impressions on LinkedIn and >2500 views on Twitter. Wider exposure was then obtained by the publication of an abbreviated version in the commercial air quality procurement guide, which was sent out to >10,000 recipients.



Looking to the Future/Legacy

Government analysts are now adopting innovative methodological or approach-based advice from researchers.

The combined insights of WM-Air and Urban Observatories also unlocked government funding for two projects with the Department for Transport. These were funded by the treasury using the Economic Data Innovation Fund and sought to develop best practice in terms of data curation to underpin the proposed national digital twin. Air quality, in particular, low traffic neighbourhoods, were developed as use cases.

Underpinning Science

- Cowell, N., Chapman, L., Bloss, W., Baldo, C., & Zhong, J (In Press). What can we learn from nested IoT low-cost sensor networks for air quality? A case study of PM2.5 in Birmingham, UK. *Meteorological Applications*.
- Cowell, N., Chapman, L., Bloss, W., Srivastava, D., Bartington, S., & Singh, A. (2023). Particulate matter in a lockdown home: evaluation, calibration, results and health risk from an IoT enabled low-cost sensor network for residential air quality monitoring. *Environmental Science: Atmospheres*.
- Cowell, N., Chapman, L., Bloss, W.J., Pope, F. (2022) Field calibration and evaluation of an Internet of Things based particulate matter sensor. *Frontiers in Environmental Science*.

Partners

Birmingham City Council

Coventry City Council

Department for Transport

More info and URLs: