



Air Quality Policy Evaluation Toolkit (AQ-PET): Evaluating Birmingham's Clean Air Zone (CAZ)

'AQ-PET' toolkit integrating auto-machine learning and causal inference method for air quality policy evaluation

Open-source R package for efficient data handling, data presentation and visualisation

'AQ-PET' offers user-friendly functions for non-specialists for rapid assessment

Causal effectiveness of Birmingham Clean Air Zone (CAZ) on local air quality evaluated

Impacts of London Ultra Low Emission Zone (ULEZ) evaluated



Effective Collaboration/ Co-creation - with WMCA and BCC

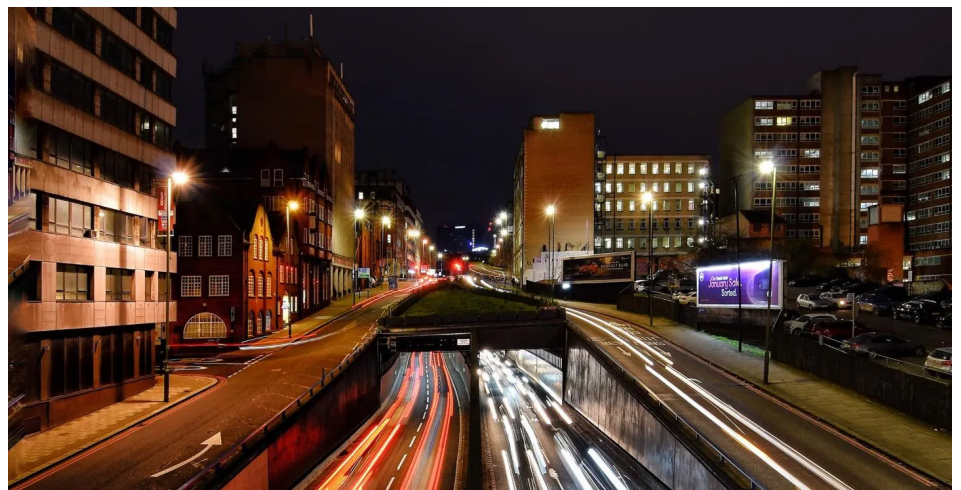


Knowledge Exchange & Capacity Building – via workshops and training for 40+ participants



Practice - enhanced learning and understanding of the Birmingham CAZ effects

WM-Air team developed an open-source R package toolkit - "AQ-PET", which facilitates the evaluation of air quality policies by addressing challenges like weather variability that complicate policy assessments. By integrating auto-machine learning and causal inference methods, 'AQ-PET' offers tools for data collection, model building, performance evaluation, and causal policy evaluation. By streamlining these processes, 'AQ-PET' enables efficient, interactive policy evaluation, aiding future decision-making in air quality management around the world. The toolkit was used to evaluate the impact of Birmingham Clean Air Zone (CAZ) and London Ultra Low Emission Zone (ULEZ) (in progress) on local air quality.



Background - why does this work matter?

Air pollution is a leading environmental threat to public health and economic growth. Understanding the effectiveness of clean air policies is critical, yet isolating their direct impact on air quality is challenging due to meteorological influences and other factors. Weather conditions, such as wind and temperature, can obscure short-term changes in pollution, making it difficult to attribute improvements to policy interventions. Additionally, natural emission changes, atmospheric chemistry, and socio-economic factors further complicate assessments. Many previous studies fail to fully account for these complexities, leading to unreliable results.

Air pollution is a major public health risk, yet policymakers and practitioners often lack efficient tools to assess clean air policies. 'AQ-PET' fills this gap by streamlining data collection, running model analyses, visualizing data, and

generating evidence-based policy reports, enabling more accurate evaluations and informed decision-making on air quality improvements around the world.

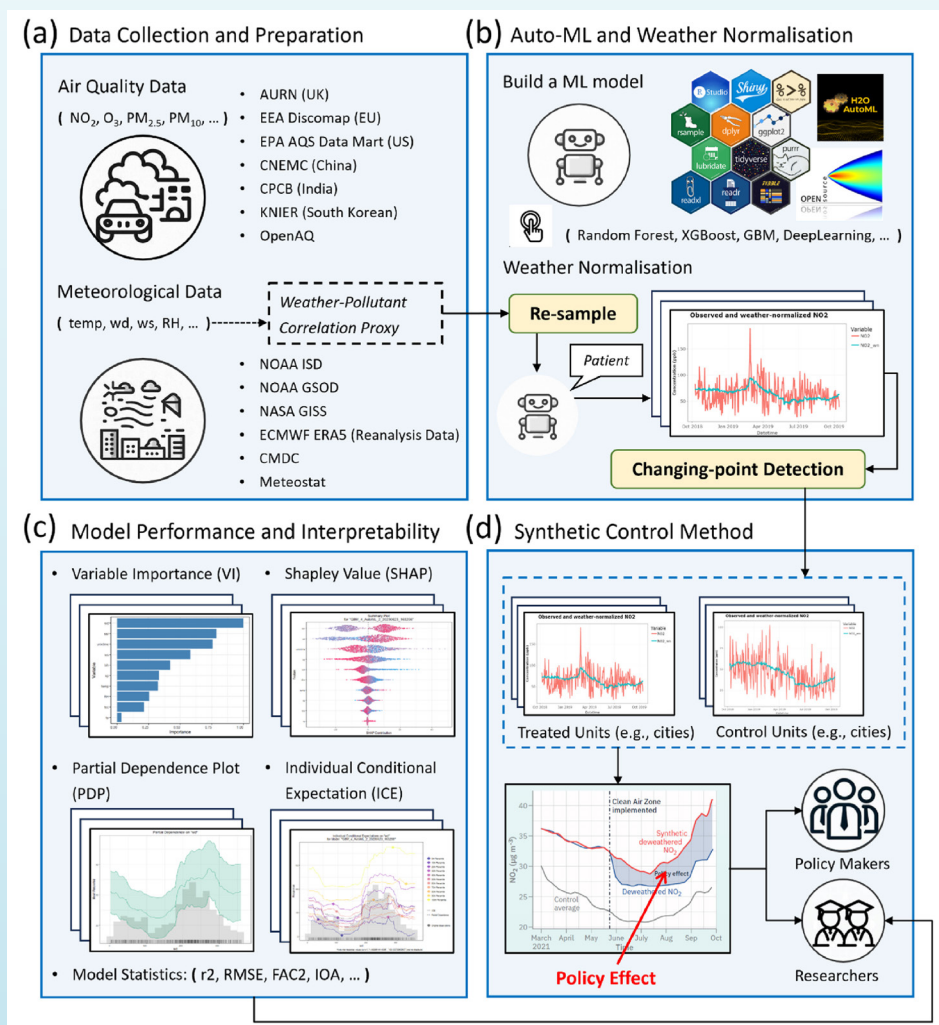
Method – what did we do?

In response, we developed 'AQ-PET,' an R package that applies auto-machine learning to remove weather effects and uses causal inference methods to evaluate policy impact accurately. By streamlining the analysis process and providing reliable results based on observational data, 'AQ-PET' assists researchers and policymakers to effectively quantify the impacts of air quality regulations and related policy initiatives, leading to better-informed decisions for improving public health and environmental outcomes.

What tools/outputs were developed?

'AQ-PET' toolkit- R package:

Dai, Y., Liu, B., Tong, C., & Shi, Z. (2024). AQ-PET—An R package for air quality policy evaluation. *Environmental Modelling & Software*, 177, 106052.



"...deliverables which have helped Birmingham City Council include... the benefit arising from the CAZ when the weather component was disaggregated from the model."

Mark Wolstencroft,
Operations Manager
Environmental Protection,
Birmingham City Council

£21,297 Awarded, "Quantifying the impact of Clean Air Policy Interventions", Funded by "Research England QR Enhancing Research and Knowledge Exchange Funding Programme", Dec 2021

£25471 Awarded, "Evaluating the impact of Birmingham Clean Air Zone on local air quality", Funded by "Research England QR Enhancing Research and Knowledge Exchange Funding Programme", Jan 2022

£30,763 Awarded, Evaluating the effectiveness of London Ultra Low Emission Zone (ULEZ), Funded by "Research England QR Enhancing Research and Knowledge Exchange Funding Programme", Dec 2022

Technical report/ briefing:

Shi, Z., Liu, B., Cheng, K., Elliott, R.J.R., Cole, M.A., Bryson, J.R., 2022. Quantifying the impact of Clean Air Policy: For air quality management.

Birmingham CAZ evaluation paper:

Liu, B., Bryson, J. R., Sevinc, D., Cole, M. A., Elliott, R. J., Bartington, S. E., ... & Shi, Z. (2023). Assessing the impacts of Birmingham's clean air zone on air quality: estimates from a machine learning and synthetic control approach. *Environmental and Resource Economics*, 86(1), 203-231.

2 Blogs published:

Clean Air Zone reduces air pollution levels in Birmingham - study. Scientists

“Researchers in the WM-Air team have also analysed the early data on the NO₂ changes seen over the first 3 months of implementation of the CAZ. This provisional analysis – using data from automatic monitoring stations – applied a machine learning weather normalisation approach to correct for meteorological factors, and an augmented synthetic control methodology to isolate the impact of the CAZ policy. The intention of the CAZ was to reduce NO₂ emissions, and analysis indicates reductions in average NO₂ concentration ranging from 1–6 micrograms/m³ at sites within the CAZ with no clear evidence of displacement effects, although the monitoring network is limited. Analysis found no significant impact attributable to the CAZ on local PM_{2.5} concentrations within the CAZ.”

Case study on CAZ by Chris Baggott, Claire Humphries, Mary Orhewere, Humera Sultan, Justin Varney

More info and URLs:



use innovative techniques to map the environmental impact of Birmingham’s Clean Air Zone

Reducing the risk – Clean Air Zone sees Birmingham air quality improvement. Birmingham’s Clean Air Zone has emerged as a focal point of debate as policymakers wrestle with the challenges of urban air quality and sustainable development

Outcomes, Impacts and Benefits delivered

Application in Birmingham and London: WM-Air evaluated the causal effectiveness of Birmingham Clean Air Zone (CAZ) on local air quality, and the impacts of London Ultra Low Emission Zone (ULEZ), including original policy and the following two expansions.

The team conducted **effective collaboration and co-creation** with WMCA and BCC, enhancing learning and understanding of the impact of Birmingham’s CAZ.

A series of workshops were delivered to launch the toolkit and train government air quality officials, leading to **knowledge exchange** and **capacity building of over 40 participants**.

Media Coverage:

BBC News: Birmingham Clean Air Zone pollution cut ‘smaller than thought’ (31 Aug 2023).

BBC Midlands Today: Is the Birmingham Clean Air Zone really working? By David Gregory-Kumar (regional science and environment correspondent, BBC Midlands Today)

Daily Mail: So much for the health boost from ULEZ? Birmingham’s Clean Air Zone only cut air pollution by 7% - HALF as much as previously claimed, study finds.

UK Automotive: Does Birmingham’s Clean Air Zone work?

Birmingham LIVE: Clean Air Zone backed - as boffins find gas emission cut is far lower than council claim.

Other media platforms include: Yahoo News, Cycling Industry news, MSN, Mail Online.

Looking to the Future/Legacy

Future applications for additional policy scenarios, both regionally and nationally.

Underpinning Science

- Dai, Y., Liu, B., Tong, C., & Shi, Z. (2024). AQ-PET—An R package for air quality policy evaluation. *Environmental Modelling & Software*, 177, 106052.
- Liu, B., Bryson, J. R., Sevinc, D., Cole, M. A., Elliott, R. J., Bartington, S. E., ... & Shi, Z. (2023). Assessing the impacts of Birmingham’s clean air zone on air quality: estimates from a machine learning and synthetic control approach. *Environmental and Resource Economics*, 86(1), 203-231.)
- Shi, Z, Liu, B, Cheng, K, Elliott, R, Cole, M & Bryson, J 2022, Quantifying the impact of clean air policy interventions for air quality management. University of Birmingham.

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

Partners



Birmingham City Council



Natural Environment Research Council



Research England