Assessing the Impacts of Birmingham's Clean Air Zone (CAZ) on air quality (paper forthcoming)
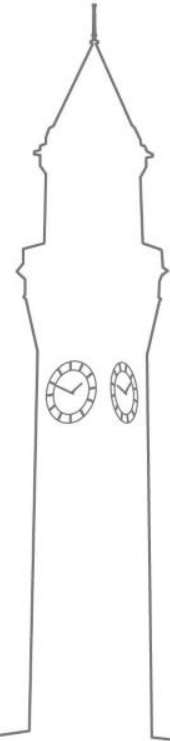
Bowen Liu, John R. Bryson, Deniz Sevinc, Matthew A. Cole, Robert J. R. Elliott, Suzanne E. Bartington, William J. Bloss, and Zongbo Shi

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Clean Air Zones- Policy Overview

- Aim - to achieve compliance with statutory air quality objectives in the shortest possible timescale

- Mechanism – discourage use of the most polluting vehicles in urban areas (charging or non-charging)

- Four increasingly stringent classes (charging zones):

  A – Buses, coaches, taxies, private hire vehicles

  B – Buses, coaches, taxies, private hire vehicles, heavy goods vehicles (HGVs)

  C – Buses, coaches, taxies, private hire vehicles, HGVs, vans, minibuses

  D – Buses, coaches, taxies, private hire vehicles, HGVs, vans, minibuses, cars. (option to include motorcycles).

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UK clean air zones

- No plan for a clean air zone
- Under review
- CAZ expected in 2023
- CAZ expected in 2024
- CAZ in place

(Source: Green Alliance (2021)

Clean Air Zones – Policy Vision

"Clean Air Zones improve the urban environment to support public health and the local economy, making cities more attractive places to live, work, do business and spend leisure time. They support cities to grow and transition to a low emission economy thus ensuring these benefits are sustainable for the long term." – *Government vision for Clean Air Zones (2020)*

Introduction

- We apply a data-driven technique to assess the initial impacts of CAZ (June 2021 to June 2022) on air quality in Birmingham

- We will illustrate the concept of our method

- We will present some preliminary results of the Birmingham CAZ impacts on NO_2 NO_X and $PM_{2.5}$

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Our method: two step ML+ASCM

- The machine learning based "weather normalisation" technique can help more flexibly and efficiently addressing the impact of weather conditions on air pollutant concentrations

- The Augmented SCM (ASCM) can help identifying the causal impact of policy intervention
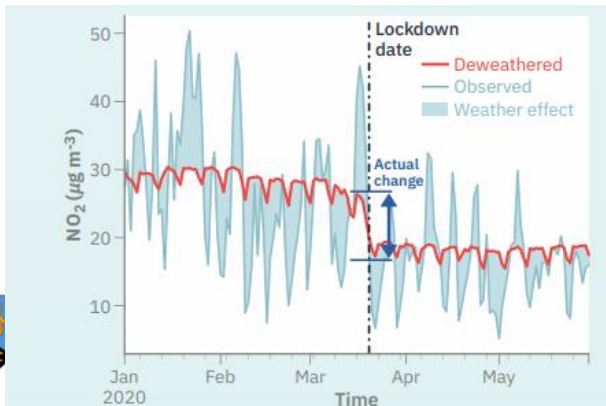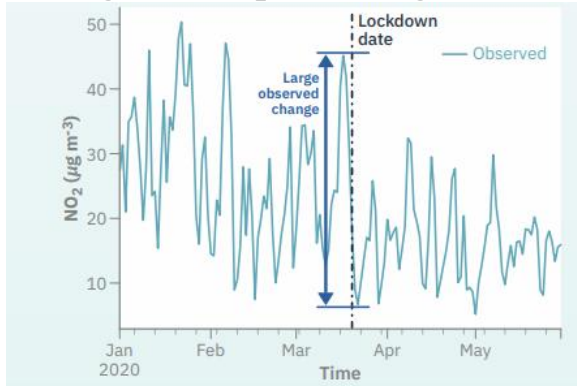
For our method:

Step 1: "weather normalisation" technique to remove the impact of weather on observed pollution levels

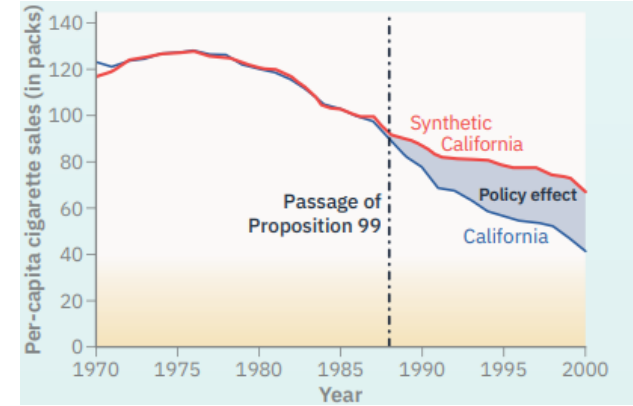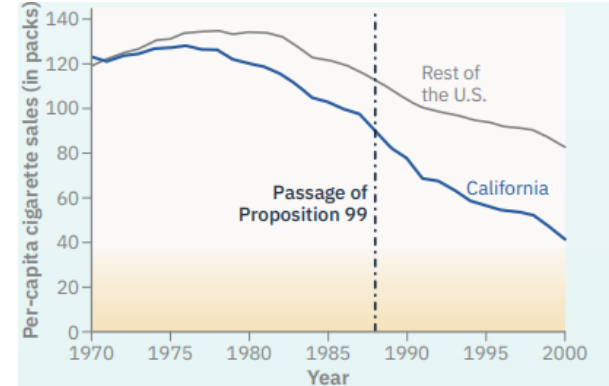**Step 2**: "SCM" on "weather normalised" pollution levels to identify the causal policy impact

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Methodological motivations

Step 1: A **machine learning (ML)** based "Deweathering" technique (Grange and Carslaw, 2019)

Step 2: Causal Inference- the Synthetic Control Method (SCM) (Abadie et al., 2010)
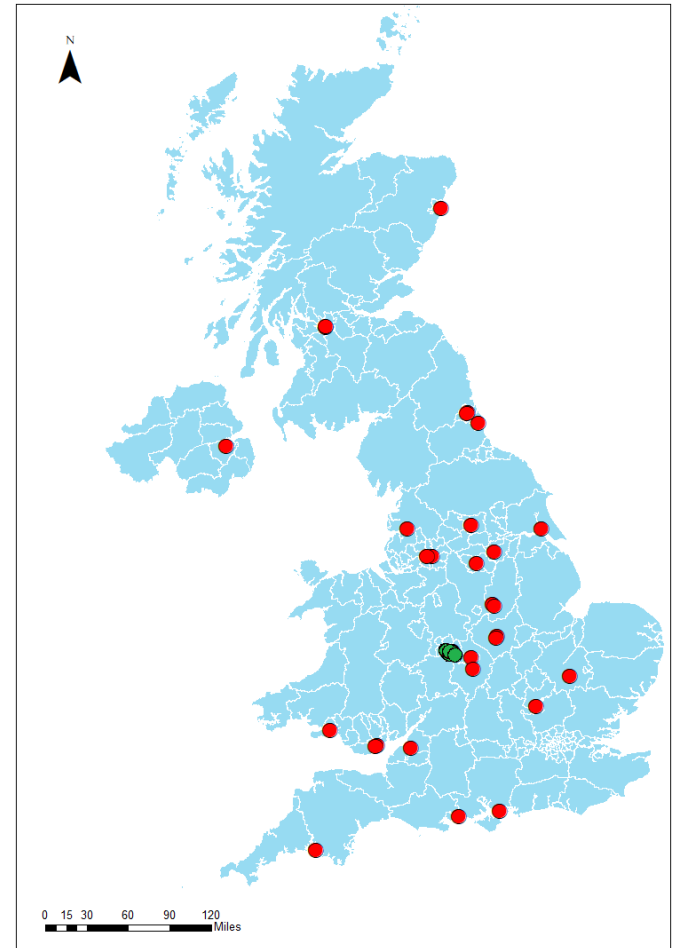
Data

Hourly site-level air pollutant concentrations :

Between Jan. 2021 to June. 2022

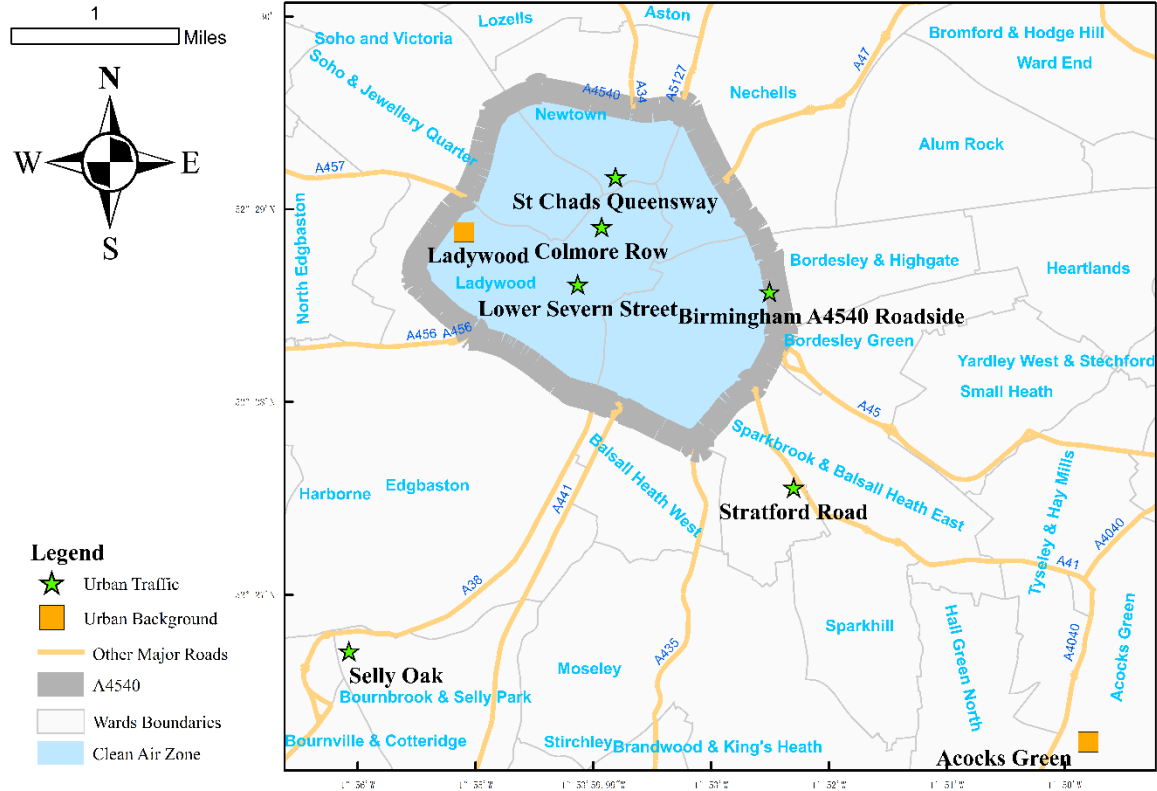Defra 'UK Automatic Urban and Rural Network (AURN)' and sites operated by Birmingham City Council.

Matched with hourly weather variables

🟢 Treatment sites: exposed to Birmingham CAZ

🔴 Control sites: not exposed to Birmingham CAZ
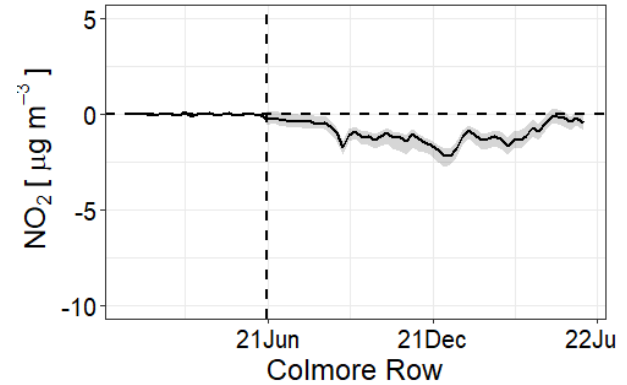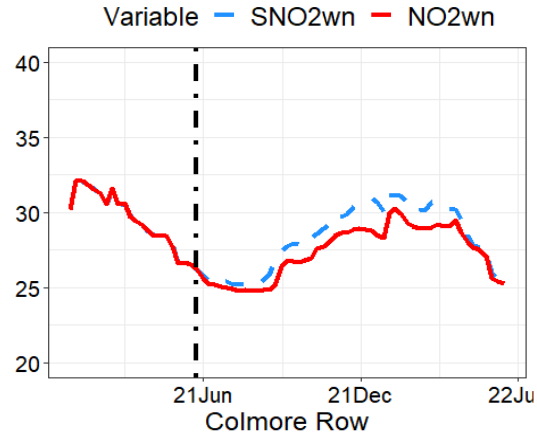

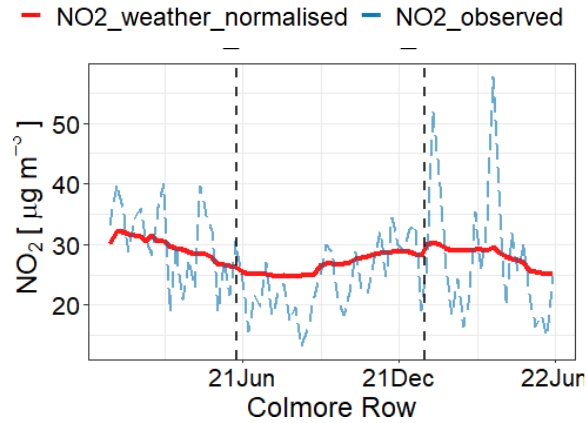A map of site location used in our study

Figure A1. Map of Birmingham Clean Air Zone

Results

The Causal impact of CAZ on NO2- using "Colmore Row" as an example

SNO2wn – synthetic / predicted NO₂wn

NO2wn – observed NO₂wn

Change due to CAZ:
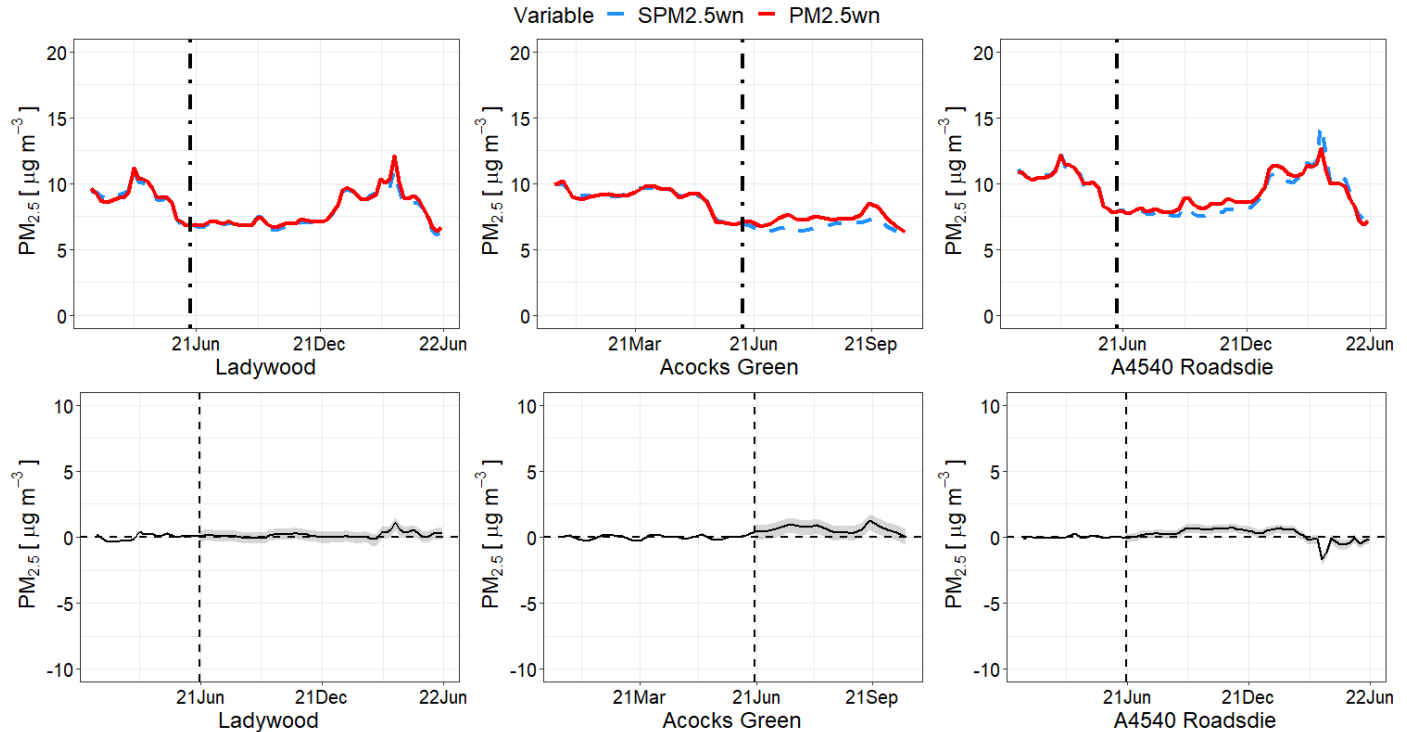SNO2wn – NO2wn
(Shading = 95% uncertainty range)

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Results

The CAZ impact on PM$_{2.5}$ for 3 Birmingham sites

no discernible impact of CAZ on PM2.5

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Results

**CAZ impact on observed weather normalised NO$_2$ and NOx relative to synthetic control, for Birmingham sites**
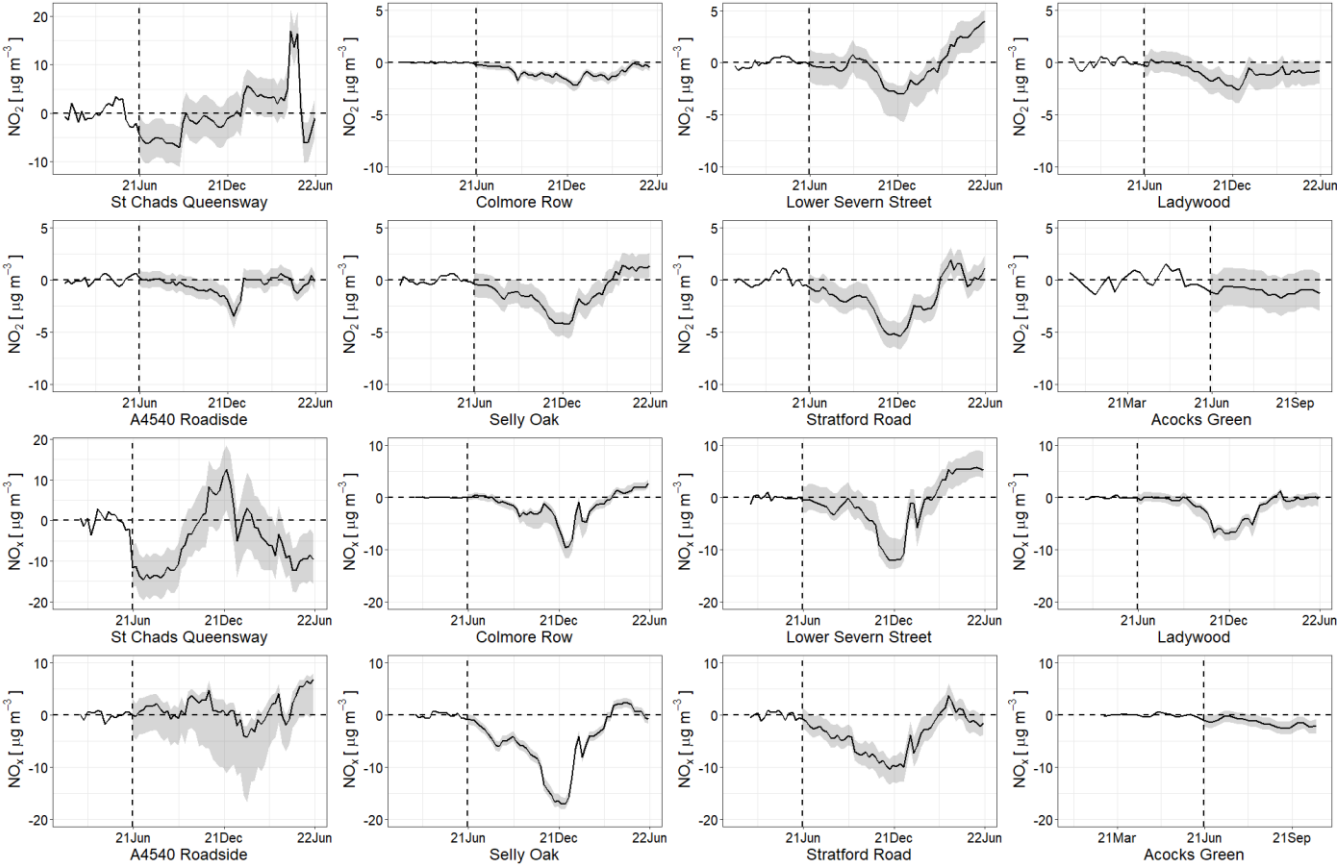
Findings and Implications

- Overall, the Birmingham CAZ led to modest reductions in NO_2 and NO_X levels (~ widening non-compliance?) with the largest reductions at roadside.

- There was no detectable change in $PM_{2.5}$ (~ tackle multiple pollutants?) the most harmful pollutant for health

- Positive spill-over effects for the concentrations at sites outsides the CAZ (~ Expansion of CAZ coverage?)

- More rigorous policy interventions will be needed to deliver public health benefits

- Impacts on carbon dioxide emissions, travel behaviour and potential wider impacts remain undefined

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TRANSITION Clean Air Network - Policy and Practice Tools

- Workshop - *Beyond the Clean Air Zone* held in Birmingham, 16 June 2022
- Briefing note – current knowledge, lessons learned, evidence gaps
- Practitioner toolkit (in progress)- guidance, best practice, resources
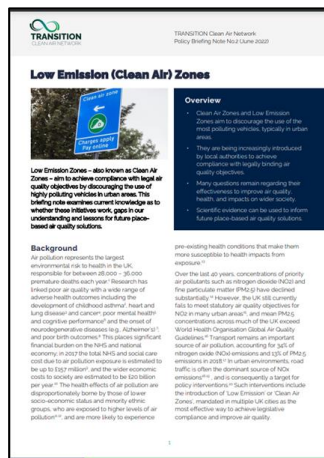
Available at: https://transition-air.org.uk/ (Email: info@transition-air.org.uk)