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WM-NET ZERO

A Health-centred Systems Approach Towards Net-Zero:
Transforming Regional Climate Mitigation Policies

Improving air quality and environmental health inequalities in a metropolitan area of the United Kingdom

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The WM-NetZero project is supported by Wellcome Trust (227150_Z_23_Z) under the *Advancing climate mitigation policy solutions with health co-benefits in G7 countries* scheme.

Introduction

- Ambient air pollution is the largest environmental risk to human health globally
- ~4.2 million premature deaths annually worldwide
- 26,000 - 38,000 premature annual deaths in England or a 6-month reduction in life expectancy
- The most disadvantaged communities generally experience the worst pollution and are less likely to have capability to make lifestyle changes to reduce exposure

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Background

- WHO updated the 2005 Global Air Quality Guidelines (AQGs) in September 2021 along with Interim Targets

Pollutant	Averaging Time	Air Quality Objectives (England)	WHO Guideline 2005	WHO 2021 Update				
				Interim Targets				Guideline
				1	2	3	4	
Fine Particles, $PM_{2.5}$	Daily (24-hour)mean		25[1]	75	50	37.5	25	15[1]
	Annual mean	**25**	10	35	25	15	10	5
Nitrogen Dioxide, NO_2	Daily (24-hour) mean			120	50			25[1]
	Annual mean	**40**	40	40	30	20		10

- Not legally binding, however
- Introduction of a 10 μg m^{-3} threshold target and Population Exposure Reduction Target (PERT) to achieve a 35% reduction in population exposure to $PM_{2.5}$ by 2040

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Study Area

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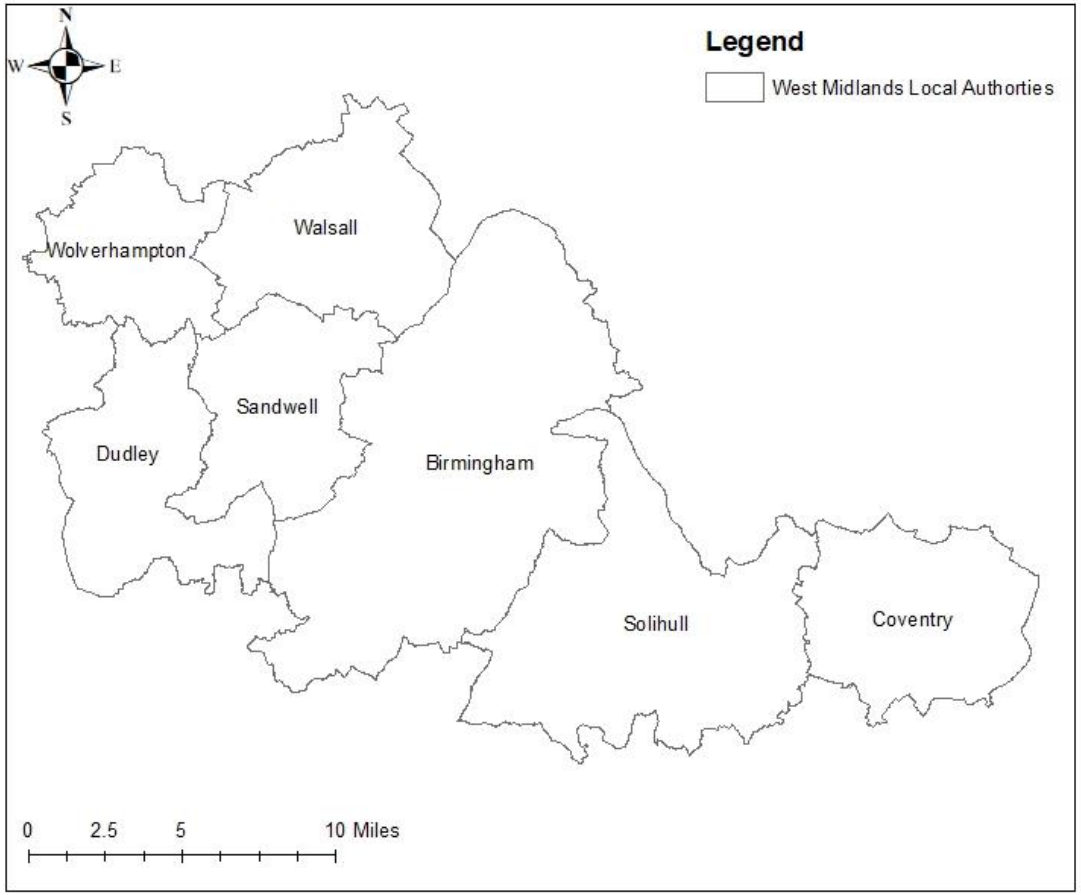

- Seven metropolitan areas with a diverse population of ~2.9 million
- In the West Midlands, up to 2,300 premature deaths each year were attributable to air pollution, with the greatest mortality burden occurring in Birmingham and Sandwell (Hall *et al*., 2024)
- Chaired by an elected Mayor with devolved powers and has a committed vision to deliver a carbon-neutral region by 2041.
- Air Quality Framework that aims to deliver regional air quality that is safe for all and will improve public health and the environment
- Includes a focus on PM, where previous government and local authority targets and challenges have been around exceedances of NO_2

Hall, J. et al. (2024) Regional impact assessment of air quality improvement: The air quality lifecourse assessment tool (AQ-LAT) for the West Midlands combined authority (WMCA) area, Environmental Pollution, 356, 123871, https://doi.org/10.1016/j.envpol.2024.123871

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Air Quality Data

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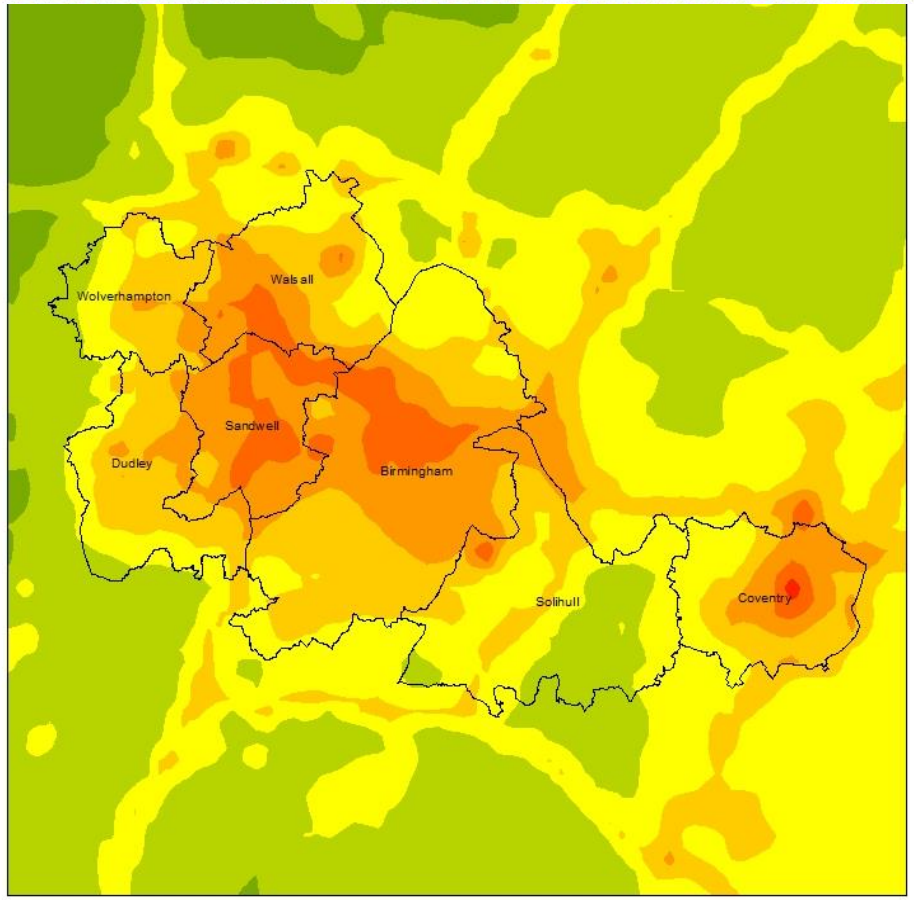
- Defra's background air quality concentrations map
- Mean estimated annual average $PM_{2.5}$ concentration for 2019 assigned to 1 km grids across the West Midlands.
- Interpolated via ordinary kriging within a GIS to generate a midlands-wide $PM_{2.5}$ map
- Defra data utilised for public and UK-wide replication: WM-Air modelled $PM_{2.5}$ levels provide higher resolution spatial information and can distinguish between different PM sources



https://uk-air.defra.gov.uk/data/pcm-data

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Demographic and Socio-Economic Data

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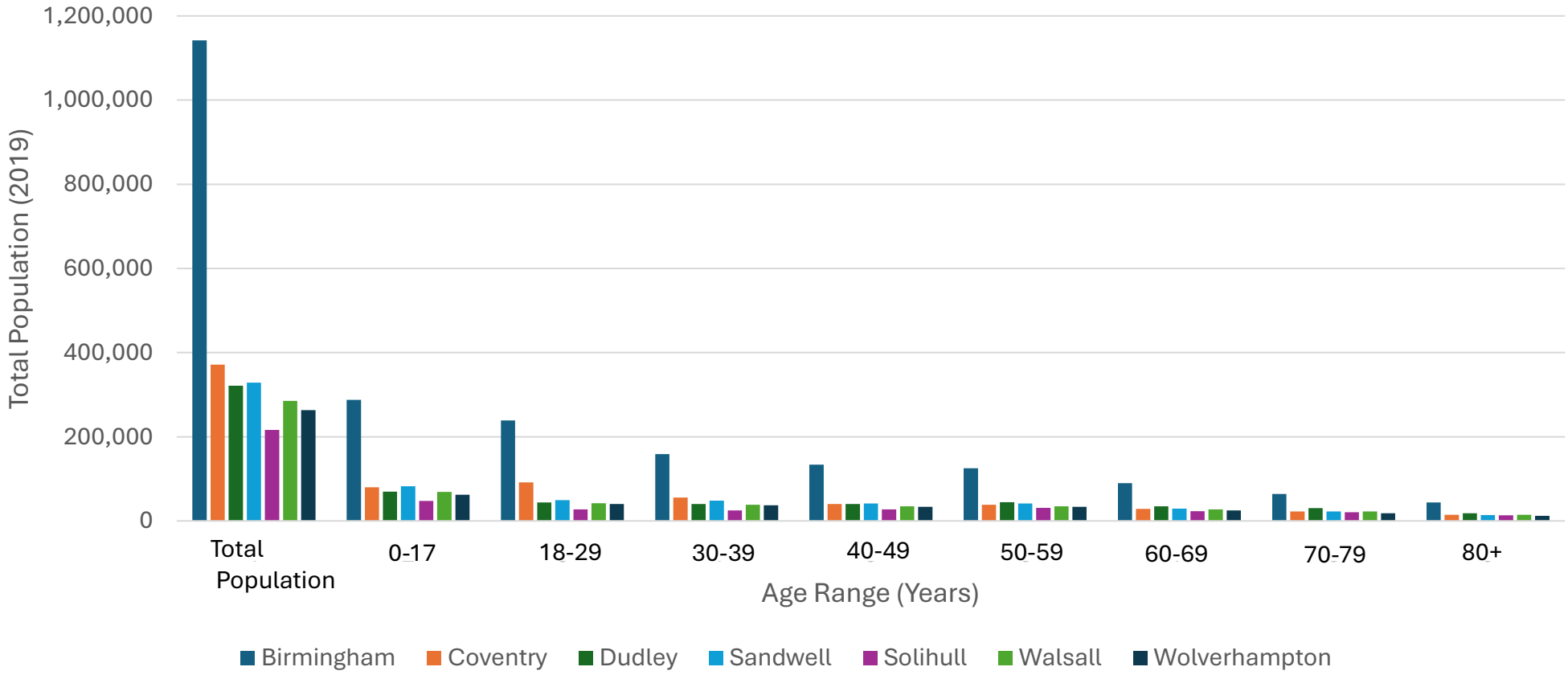

- On average, the WMCA population is younger than the England average

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Population Weighted Exposure Level (PWEL)

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- PWEL has been utilised in previous studies to provide a measure of exposure assessment that takes into account the spatial distribution of the population and air pollution concentrations across a defined geographical area (Shafie *et al*., 2022; Shakor *et al*., 2020; Shendie and Qureshi, 2022).
- In this study, PWEL was applied at ward level across the WMCA region (total population):

$$\text{PWEL } (\mu g/m^3) = \frac{\text{Study Area } PM_{2.5} \text{ (ward)} \times \text{Study Area (ward)}}{\text{Total Population (WMCA)}}$$

Shafie et al. (2022) https://doi.org/10.1186/s13717-021-00342-0

Shakor et al. (2020) https://doi.org/10.1155/2020/1561823

Shendie and Qureshi (2022) https://doi.org/10.4491/eer.2021.042

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Air Quality Scenarios

- Three air quality scenarios were examined to determine how changing annual average $PM_{2.5}$ concentrations over the WMCA area would influence future population exposure values relevant to 2019 levels:

A. Reducing (ward average) $PM_{2.5}$ concentrations to 10 µg/m^3 (WHO AQG Interim Target 4)

B. Reducing (ward average) $PM_{2.5}$ concentrations to 5 µg/m^3 (WHO AQG)

C. Reduce ward level concentrations by 35% of 2019 levels through a lowering of ward-average $PM_{2.5}$ concentrations (Population Exposure Reduction Target)

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WHO AQG Exceedances

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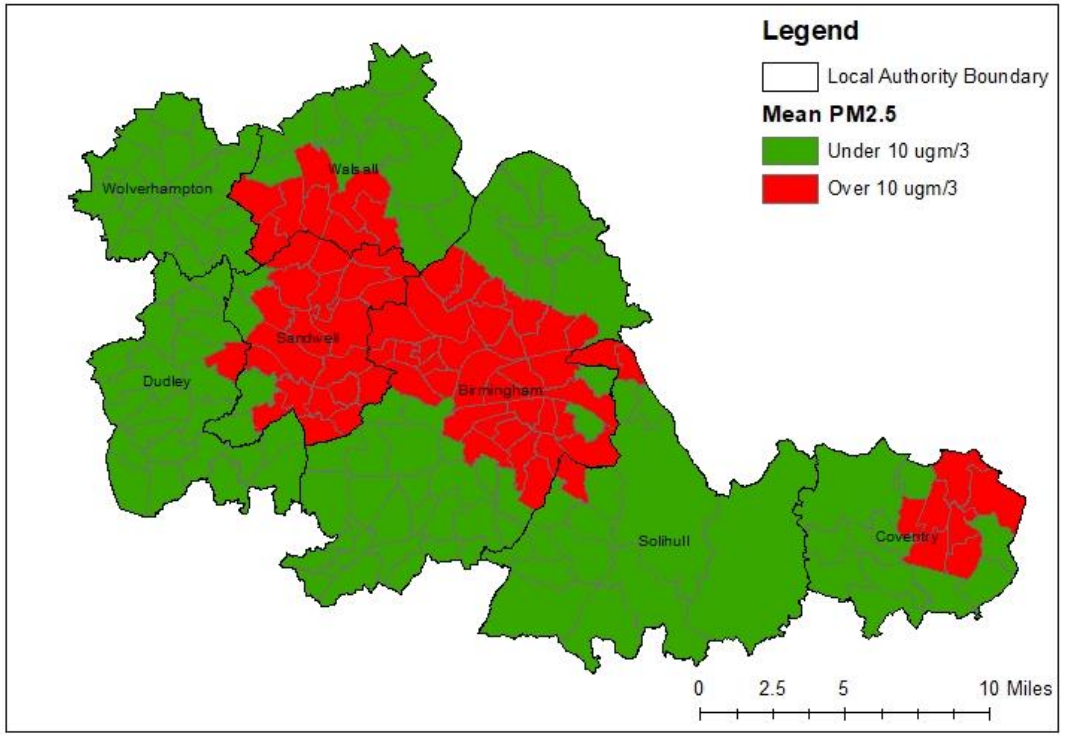

- 72 wards exceeded the WHO AQG Interim Target 4 of 10 µg/m^3 for $PM_{2.5}$ in 2019
- ~1,197,119 people or 40.9% of the WMCA population
- Majority of these wards are in central Birmingham, Sandwell and south-central Walsall
- Wolverhampton is the only local authority to have no wards over 10 µg/m^3
- Larger number of exceeding wards in more deprived deciles

Decile	>10 µgm/^{3}
1	15
2	12
3	10
4	11
5	6
6	7
7	6
8	3
9	2
10	0

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Population Exposure Reduction Scenarios

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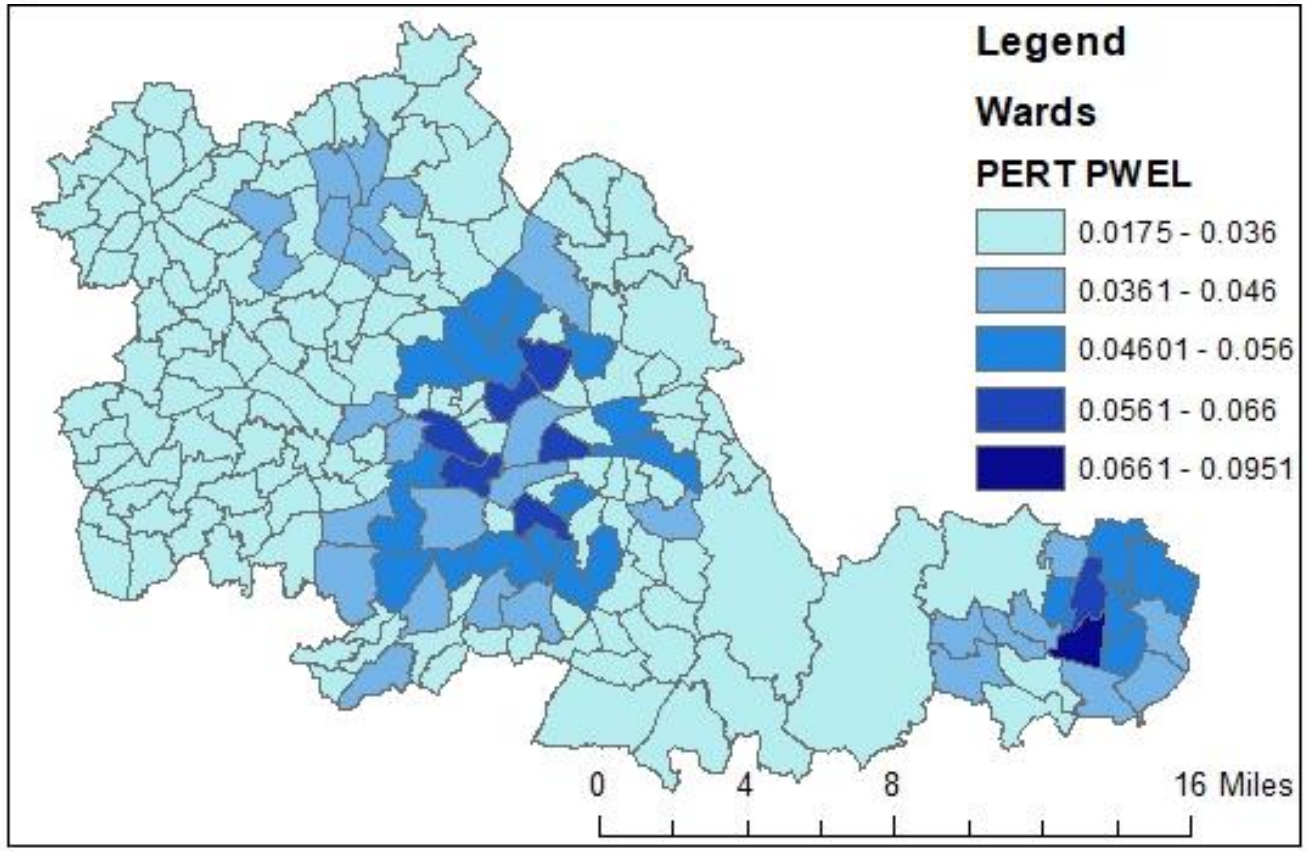

Scenario C

- Achieving the PERT target of a concentration reduction of 35% would greatly reduce PWEL across the region
- Large population centres have higher PWEL values

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Modelled AQ and Index of Multiple Deprivation Data

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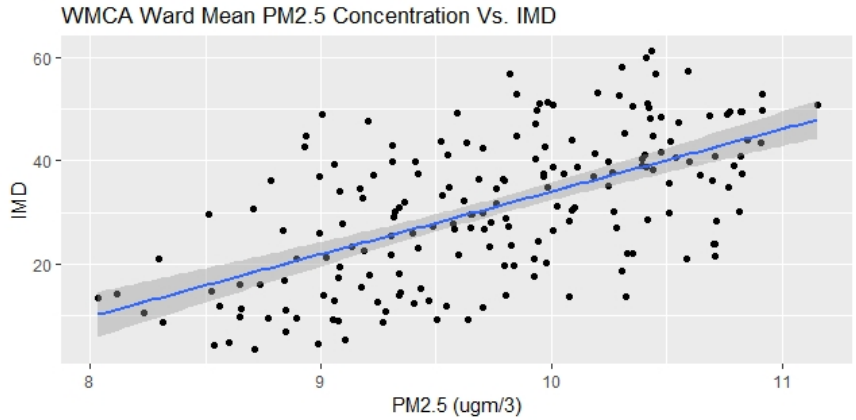

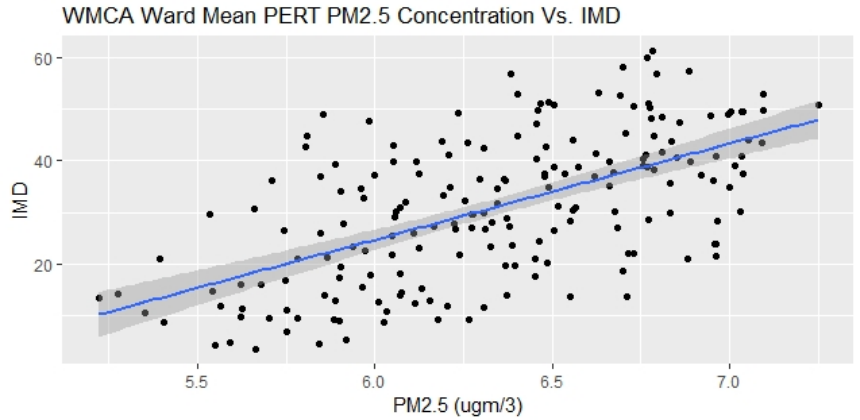

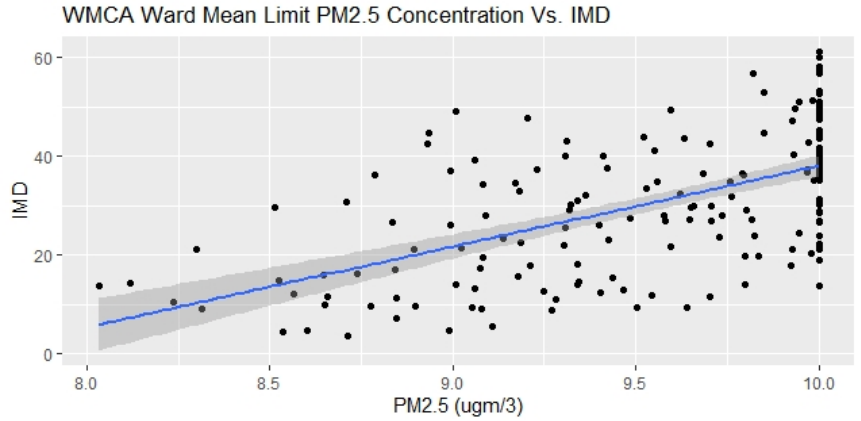

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Local Authority Changes

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Local Authority	Mean $PM_{2.5}$ Baseline	Mean $PM_{2.5}$ Scenario A	Mean $PM_{2.5}$ Scenario B	Mean $PM_{2.5}$ Scenario C	PWEL Baseline	PWEL Scenario A	PWEL Scenario B	PWEL Scenario C
Birmingham	9.91	9.68	5	6.44	9.81	9.62	0.028	6.38
Coventry	9.88	9.69	5	6.42	1.27	1.23	0.634	0.82
Dudley	9.29	9.28	5	6.04	1.02	1.02	0.023	0.67
Sandwell	10.39	9.97	5	6.75	1.17	1.12	0.023	0.76
Solihull	9.3	9.24	5	6.04	0.69	0.68	0.369	0.45
Walsall	9.87	9.7	5	6.41	0.97	0.95	0.024	0.63
Wolverhampton	9.1	9.1	5	5.92	0.82	0.82	0.022	0.53

- $PM_{2.5}$ concentrations were lowest in Wolverhampton and highest in Sandwell
- Birmingham has the highest population so the largest PWEL value
- Birmingham, Sandwell and Coventry would see the greatest population-level benefit from reduced concentrations

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Conclusions

- The WMCA is strongly influenced by $PM_{2.5}$ pollution
  - 72 wards / ~1.2 m people / 40.9% of the population exceeding 10 µg/m^3
- More deprived wards in the WMCA typically having poorer air quality and higher PWEL values
- Meeting WHO Interim Target 4 would benefit the most deprived wards / urban city centres
- Meeting the PERT target would have the greatest overall population benefit, but the most deprived wards would still experience poorer air quality

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Thank you for your attention!

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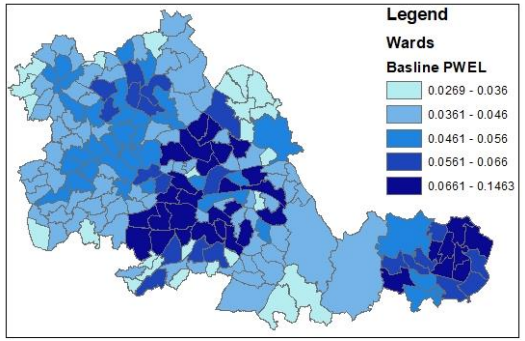

Get involved and stay connected

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