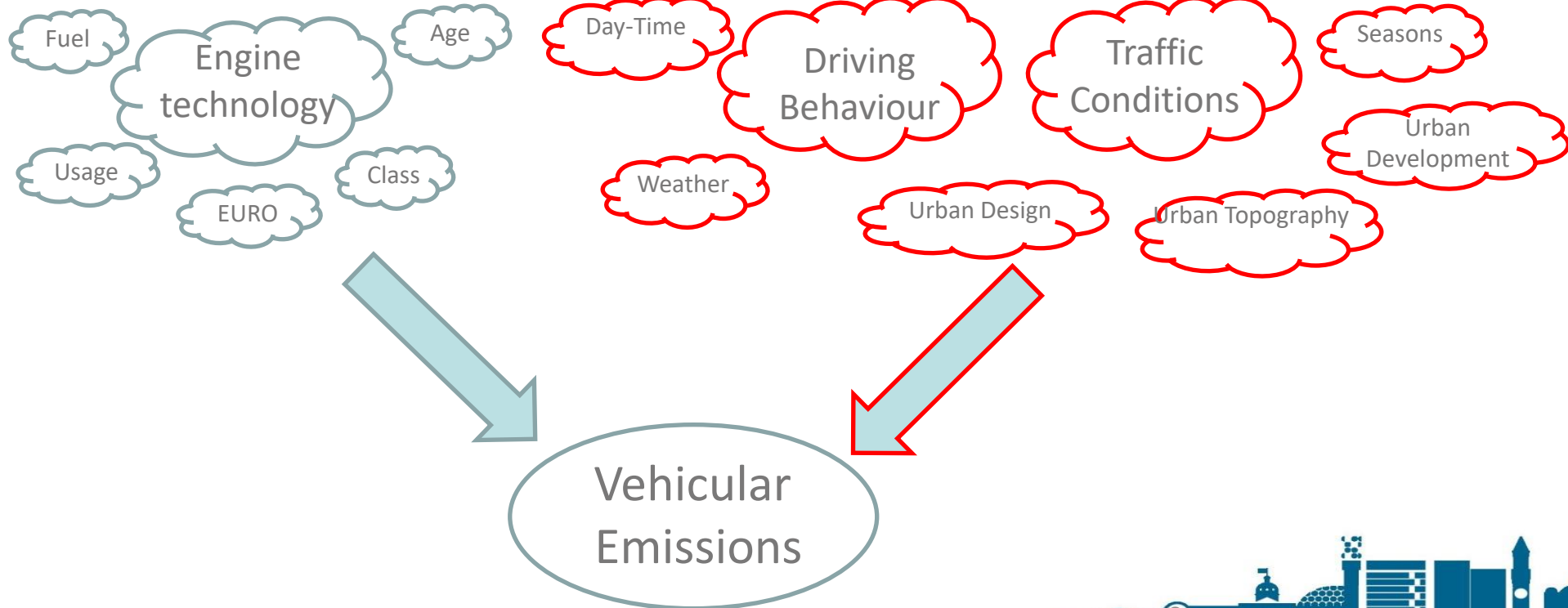


# WP# 2, Vehicular Emission

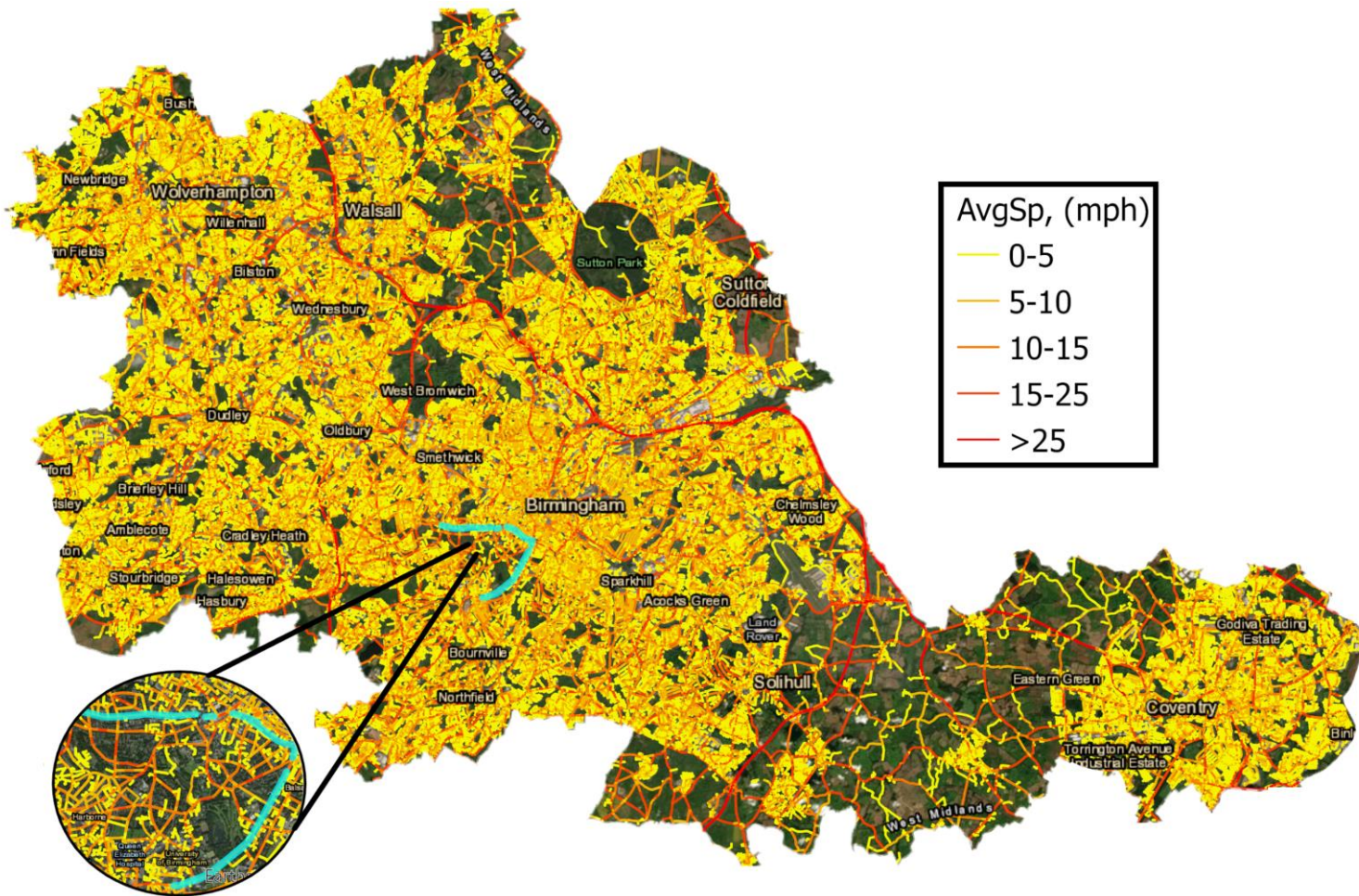
Prof Francis D. Pope  
Dr Omid Ghaffarpasand  
Elizabeth Stephens  
Sophie Morris  
Anwar Almojarkesh  
Dr Mark Burke







# Geo Spatial and Mapping of Urban Mobility



2016, 2018 and 2021 datasets

Cumulative approach is also used to analyse the impact of CAZ as well as LTNs

It provides new insights into

- Economic Recovery; lockdowns were eased in May 2021
- Birmingham CAZ impacts; CAZ has been implemented since June 2021
- BCC provided detailed fleet composition data (ANPR cameras)



**THE FLOW**



# Sandwell Metropolitan Borough - Air Quality

- 12<sup>th</sup> most deprived borough in England (2019)
- Declared an Air Quality Management Area in 2005 (NO<sub>2</sub>)
- Currently monitor at 123 diffusion tube sites, 5 automatic continuous monitoring stations and have 21 low cost air quality monitors – ‘Zephyrs’.



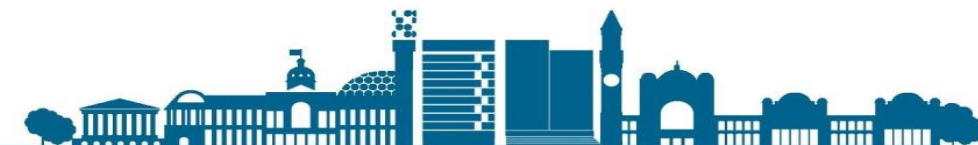
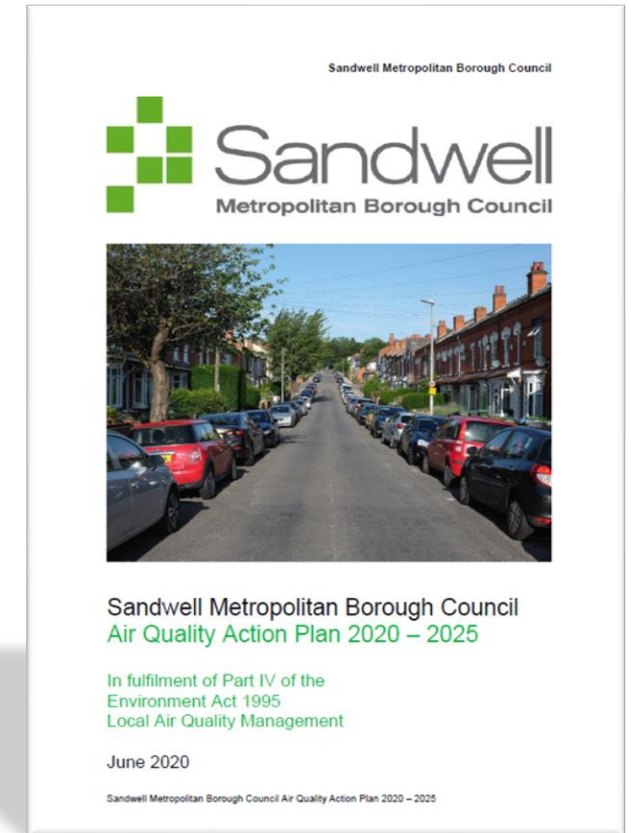
# Sandwell's Air Quality Action Plan

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## What are we doing to improve air quality?

### Sandwell's Air Quality Action Plan 2020-2025 prioritises:

- Community work to reduce NO<sub>2</sub>
- Promoting and enabling sustainable and low emission transport
- Reducing council fleet emissions
- Reducing Taxi and Private Hire Vehicle emissions
- Planning policies to support AQ improvements
- Publicity campaigns and engagement





# What about Noise Pollution in Sandwell?

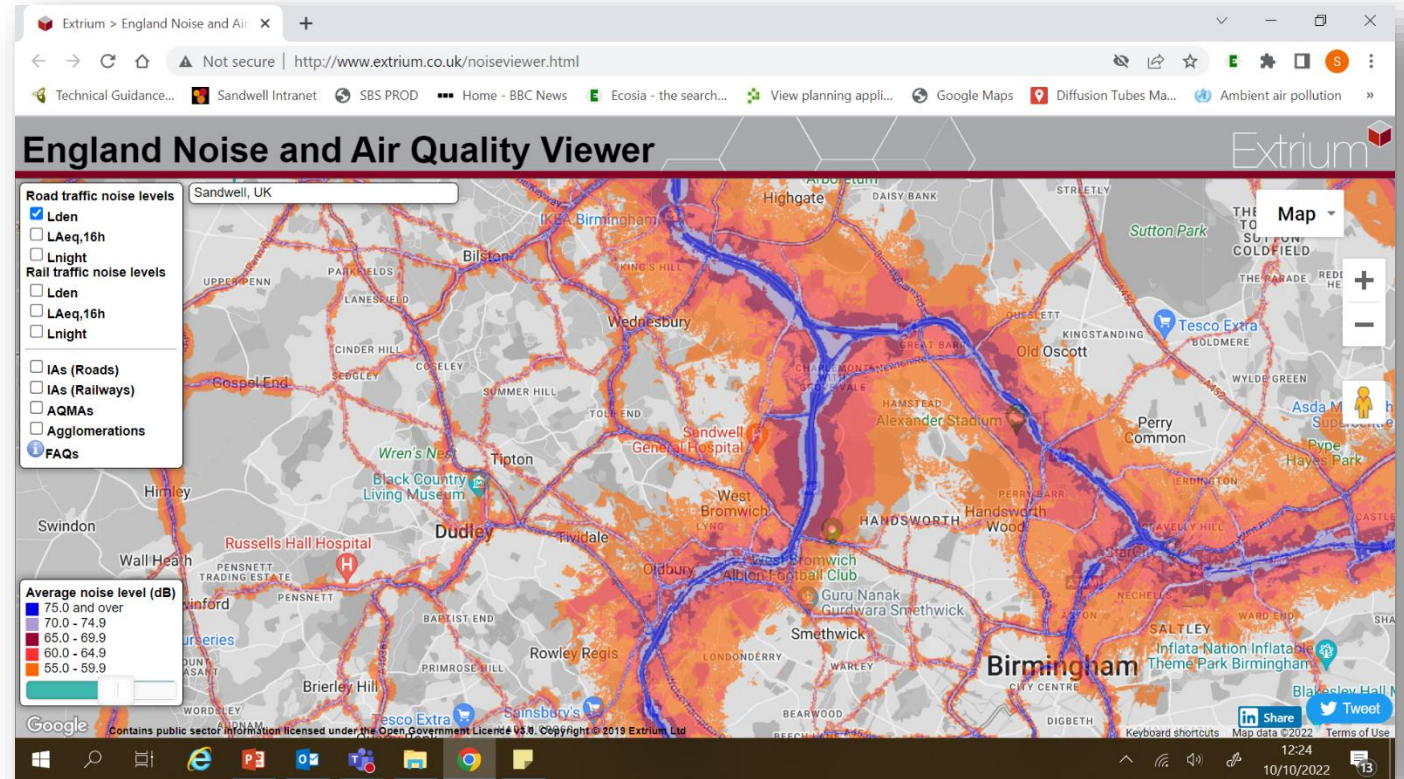
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- Sandwell receives noise complaints daily, covering a wide range of sources, including neighbours, traffic and businesses.
- Noise pollution is often closely associated with air pollution e.g. traffic and an significant issue in urban areas, such as Sandwell.
- Noise produces stimuli to the central nervous system, resulting in a release of hormones that can increase the risk of hypertension.
- These same hormones are related to many other cardiovascular and cerebrovascular diseases, as well as being known to cause heart attacks and strokes.



# What about Noise Pollution in Sandwell?

- Noise above 65dB is considered noise pollution, and 75dB and above is considered harmful to health
- Sources include traffic, aircrafts, construction, industry, commercial processes and nightlife
- Impacts physical wellbeing, mental wellbeing, sleep, memory and concentration



# How 'Traffic Ear' Can Help Us to Improve and Manage Noise and Air Pollution in Sandwell

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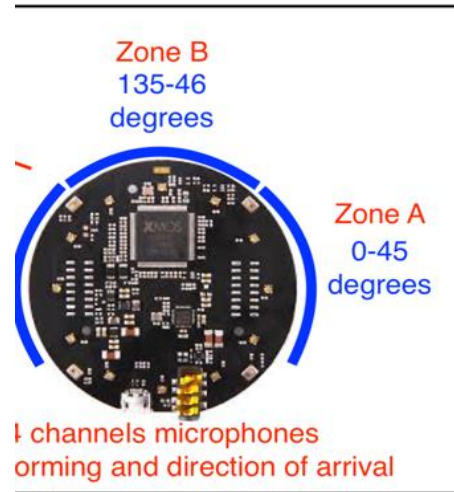
- Enable a deeper understanding of the specific sources and locations of noise and air pollution in Sandwell
- Assist with future plans and strategies, by providing visual air and noise pollution data that can be shared with stakeholders including:
  - ✓ Highways
  - ✓ Traffic Management
  - ✓ Planning
  - ✓ Elected Members
  - ✓ The Public





# Traffic Noise; Traffic EAR

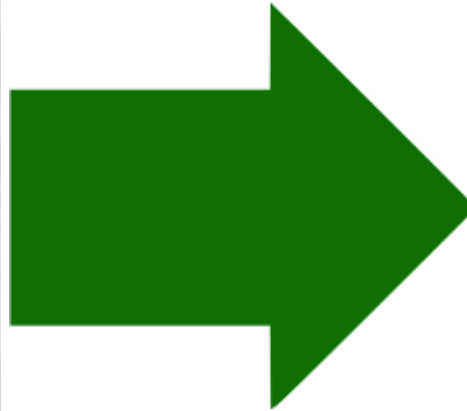
- Enable a deeper understanding of the specific sources and locations of noise and air pollution in Sandwell
- Assist with future plans and strategies, by providing visual air and noise pollution data that can be shared with stakeholders including:
  - ✓ Highways
  - ✓ Traffic Management
  - ✓ Planning
  - ✓ Elected Members
  - ✓ The Public



Innovate  
UK



# Traffic Ear; the application of AI in noise detecting



timestamp	sound level	PMS 1.0	PMS 2.5	PMS 10	Total Veh	Car	Bus	Van	Truck	Engine Type	Speed	Nox	PM
2022-09-08T23:18:14	52.69	18	25	26	1	1	0	0	0	petrol	23.54		
2022-09-08T23:18:14	52.69	18	25	26	2	0	0	0	0	diesel	22.58		
2022-09-08T23:18:57	55.65	16	21	23	3	1	0	0	0	petrol	25.02		
2022-09-08T23:20:12	52.44	17	23	24	4	1	0	0	0	petrol	23.46		
2022-09-08T23:20:19	52.91	17	23	24	5	1	0	0	0	petrol	22.38		
2022-09-08T23:20:22	55.37	17	23	23	6	1	0	0	0	diesel	25.52		
2022-09-08T23:20:24	56.78	16	22	22	7	1	0	0	0	petrol	26.99		
2022-09-08T23:20:24	56.78	16	22	22	8	1	0	0	0	diesel	25.05		
2022-09-08T23:20:27	55.61	17	22	23	9	1	0	0	0	petrol	26.4		
2022-09-08T23:20:27	55.61	17	22	23	10	1	0	0	0	diesel	26.73		
2022-09-08T23:20:30	54.44	17	21	22	11	1	0	0	0	diesel	23.5		
2022-09-08T23:20:50	54.3	18	23	23	12	1	0	0	0	diesel	23.46		
2022-09-08T23:20:57	53.44	18	23	24	13	1	0	0	0	diesel	23.06		
2022-09-08T23:21:00	55.15	19	26	27	14	1	0	0	0	petrol	25.58		
2022-09-08T23:21:04	54.27	19	27	27	15	0	0	1	0	diesel	22.95		
2022-09-08T23:21:04	54.27	19	27	27	16	0	0	0	1	diesel	22.08		
2022-09-08T23:21:34	53.62				17	1	0	0	0	petrol	22.77		
2022-09-08T23:21:39	54.35	17	23	25	18	1	0	0	0	diesel	23.93		
2022-09-08T23:21:48	55.24	16	22	24	19	1	0	0	0	petrol	26.39		
2022-09-08T23:21:48	55.24	16	22	24	20	1	0	0	0	diesel	26.75		
2022-09-08T23:22:54	54.85	19	27	29	21	1	0	0	0	diesel	22.53		
2022-09-08T23:23:20	54.89	18	23	27	22	1	0	0	0	petrol	22.41		
2022-09-08T23:23:21	55.12	18	24	28	23	1	0	0	0	petrol	25.73		
2022-09-08T23:23:36	54.32	18	22	25	24	0	0	0	0	diesel	22.96		
2022-09-08T23:23:40	52.89	20	25	26	25	1	0	0	0	petrol	23.4		
2022-09-08T23:23:43	56.31	20	26	26	26	1	0	0	0	petrol	25.74		
2022-09-08T23:23:43	56.31	20	26	26	27	1	0	0	0	petrol	26.14		
2022-09-08T23:23:43	56.31	20	26	26	28	1	0	0	0	petrol	26.28		
2022-09-08T23:23:43	56.01	21	26	26	28	1	0	0	0	petrol	26.18		





# Traffic Ear Outputs

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- Timestamps - every 1 sec
- PM levels: PM1.0, PM2.5, PM10.0
- Vehicle counts
- Vehicle Type
- Sound levels in dB
- Engine type (Diesel, Petrol).
- Speed estimation (miles/hour)
- Vehicle emission estimation (NO<sub>x</sub>, PM)





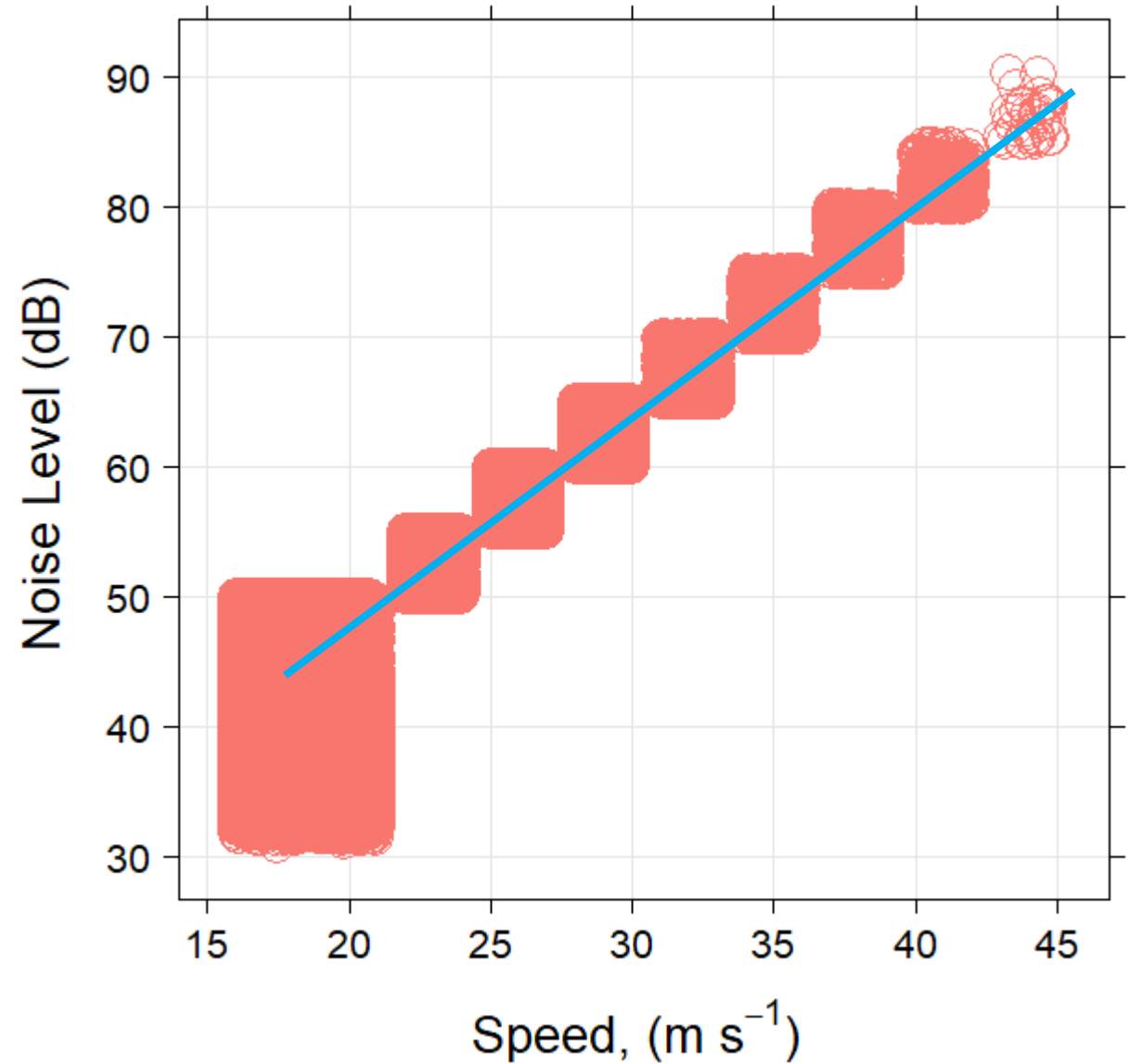
# Engine Type Detection

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	timestamp	sound level	PMS 1.0	PMS 2.5	PMS 10	Total Veh	Car	Bus	Van	Truck	Engine Type	Speed	Nox	PM
2	2022-09-08T23:18:14	52.69	18	25	26	1	1	0	0		petrol	23.54		
3	2022-09-08T23:18:14	52.69	18	25	26	2	0	0	0		diesel	22.58		
4	2022-09-08T23:18:57	55.65	16	21	23	3	1	0	0		petrol	25.02		
5	2022-09-08T23:20:12	52.44	17	23	24	4	1	0	0		petrol	23.46		
6	2022-09-08T23:20:19	52.91	17	23	24	5	1	0	0		petrol	22.38		
7	2022-09-08T23:20:22	55.37	17	23	23	6	1	0	0		diesel	25.52		
8	2022-09-08T23:20:24	56.78	16	22	22	7	1	0	0		petrol	26.99		
9	2022-09-08T23:20:24	56.78	16	22	22	8	1	0	0		diesel	25.05		
10	2022-09-08T23:20:27	55.61	17	22	23	9	1	0	0		petrol	26.4		
11	2022-09-08T23:20:27	55.61	17	22	23	10	1	0	0		diesel	26.73		
12	2022-09-08T23:20:30	54.44	17	21	22	11	1	0	0		diesel	23.5		
13	2022-09-08T23:20:50	54.3	18	23	23	12	1	0	0		diesel	23.46		
14	2022-09-08T23:20:57	53.44	18	23	24	13	1	0	0		diesel	22.95		
15	2022-09-08T23:21:00	55.15	19	26	27	14	1	0	0		petrol	26.39		
16	2022-09-08T23:21:04	54.27	19	27	27	15	0	0	1		diesel	22.08		
17	2022-09-08T23:21:04	54.27	19	27	27	16	0	0	0		diesel	22.77		
18	2022-09-08T23:21:34	53.62				17	1	0	0		petrol	23.93		
19	2022-09-08T23:21:39	54.35	17	23	25	18	1	0	0		diesel	26.39		
20	2022-09-08T23:21:48	55.24	16	22	24	19	1	0	0		petrol	26.75		
21	2022-09-08T23:21:48	55.24	16	22	24	20	1	0	0		diesel	22.53		
22	2022-09-08T23:22:54	54.85	19	27	29	21	1	0	0		diesel	22.41		
23	2022-09-08T23:23:20	54.89	18	23	27	22	1	0	0		petrol	25.73		
24	2022-09-08T23:23:21	55.12	18	24	28	23	1	0	0		petrol	22.96		
25	2022-09-08T23:23:36	54.32	18	22	25	24	0	0	0		diesel	23.4		
26	2022-09-08T23:23:40	52.89	20	25	26	25	1	0	0		petrol	25.74		
27	2022-09-08T23:23:43	56.31	20	26	26	26	1	0	0		petrol	26.14		
28	2022-09-08T23:23:43	56.31	20	26	26	27	1	0	0		petrol	26.28		
29	2022-09-08T23:23:43	56.31	20	26	26	28	1	0	0		petrol	26.18		
30	2022-09-08T23:26:11	56.91	21	29	29	29	1	0	0		petrol			



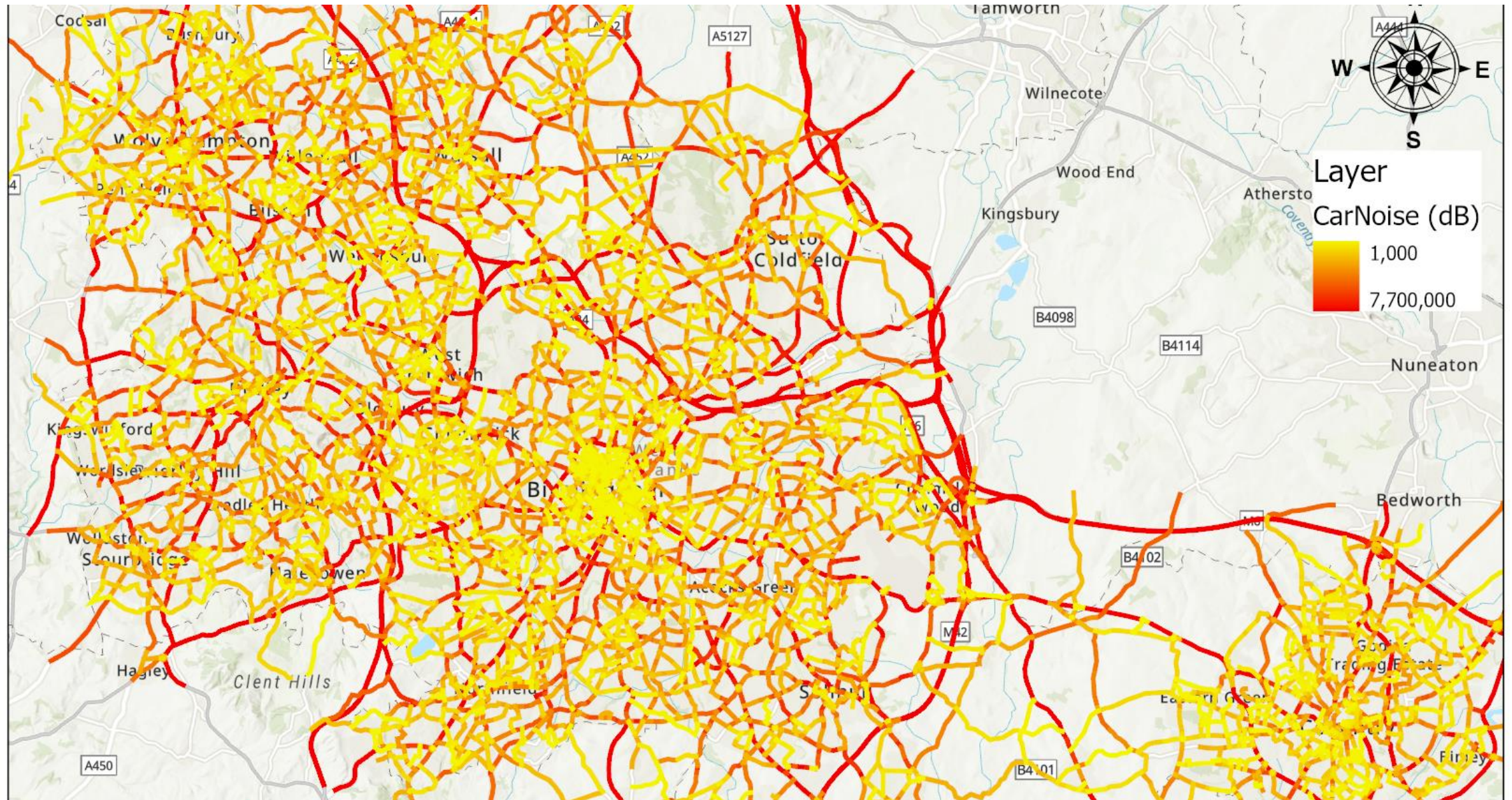
# Average Speed vs Noise Level

**$dB = 2.3 * (speed) - 5.2, R^2 = 0.86$**





# Traffic noise across the West Midlands





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**THANK  
YOU!**

