Supplementary

Title: Development of Land Use Regression Models for Particulate Matter and Associated Components in Low Air Pollutant Concentration Airshed

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Table S1

Descriptive summary of predictor variables for developing LUR Models in Perth, Western Australia

Predictor Variable	Variable Name	Unit	Buffer (m)	Mean	Std. Dev.	Min	Max
Distance to the nearest road	Dist	m	-	23.40	14.15	1.83	69.09
Distance to the nearest primary distributor road	Pdist	m	-	1110.62	1084.74	11.43	4677.46
Distance to the nearest diatributor A road	Adist	m	-	522.01	572.61	9.60	3104.51
Distance to the nearest distributor B road	Bdist	m	-	817.18	905.47	5.594	4885.11
Road length of all roads in a buffer	Roadlength_x	m	25	26.96	22.01	0	79.81
			50	117.57	57.29	0	259.61
			100	426.55	134.08	66.194	667.01
			300	3638.30	1083.28	439.73	6195.16
			500	9458.72	2919.35	1504.71	17293.23
			1000	33902.29	10475.92	5865.12	57307.99
Length of primary distributor roads in a buffer	Proadlength_x		25	4.91	13.69	0	44.47
			50	21.70	53.43	0	178.15
			100	57.81	135.34	0	393.68
			300	216.88	446.72	0	1558.42
			500	425.13	827.68	0	3596.24
			1000	1879.47	2321.27	0	12233.61
Length of distributor A roads in a buffer (m)	Aroadlength_x	m	25	4.177	12.07	0	46.16
			50	16.88	41.88	0	171.89
			100	44.17	107.92	0	386.99
			300	329.33	472.72	0	1522.13
			500	851.31	1107.96	0	4747.214
			1000	3392.80	3272.07	0	15578.54

Predictor Variable	Variable Name	Unit	Buffer (m)	Mean	Std. Dev.	Min	Max
Length of distributor B roads in a buffer	Broadlength_x	m	25	4.61	13.01	0	48.73
			50	13.27	32.82	0	99.32
			100	34.67	76.57	0	266.72
			300	200.18	352.31	0	1446.99
			500	420.31	673.50	0	2559.98
			1000	1443.37	1694.66	0	5858.61
Traffic intensity on nearest road	Trafnear	Veh/day	-	9108	11768	130	55870
Traffic intensity on nearest primary distributor road	Ptrafnear	Veh/day	-	25412	9277	15050	55870
Traffic intensity on nearest distributor A road	Atrafnear	Veh/day	-	11083	2366	8070	14990
Traffic intensity on nearest distributor A road	Btrafnear	Veh/day	-	7111	632	6060	8000
Traffic intensity of heavy vehicle on nearest road	Heavytrafnear	Veh/day	-	51	174	0	1054
Traffic intensity of heavy vehicle on nearest rrimary distributor road	Pheavytrafnear	Veh/day	-	339	864	0	4458
Traffic intensity of heavy vehicle on nearest distributor A road	Aheavytrafnear	Veh/day	-	136	296	0	1402
Traffic intensity of heavy vehicle on nearest distributor B road	Bheavytrafnear	Veh/day	-	63	173	0	991
Traffic load on nearest road	Trafload_x	Veh/day.m	25	239565.80	381902.90	0	1460982.00
			50	1053283.00	1489288.00	0	5458598.00
			100	3215676.00	4690086.00	31774.29	2.46e+07
			300	1.82e+07	1.67e+07	211068.2	9.41e+07
			500	4.24e+07	3.68e+07	722262.5	2.31e+08
			1000	7.81e+08	4.35e+08	2.66e+08	2.64e+09
Traffic load on nearest primary distributor road	Ptrafload_x	Veh/day.m	25	136993.40	388261.50	0	1460031.00
			50	646911.60	1545041.00	0	5458598.00
			100	1866880	4686638.00	0	2.20e+07
			300	6931479	1.54e+07	0	6.99e+07
			500	1.39e+07	3.03e+07	0	1.59e+08
			1000	6.75e+08	4.38e+08	2.27e+08	2.59e+09
Traffic load on nearest distributor A road	Atrafload_x	Veh/day.m	25	43719.66	127329.9	0	519217.3
			50	185567	479667.9	0	2025788
			100	517939.20	1318387	0	5293936
			300	3873116	5684221	0	1.98e+07
			500	9938597	1.34e+07	0	5.02e+07
			1000	3.91e+07	3.88e+07	0	1.79e+08
Traffic load on nearest distributor B road	Btrafload_x	Veh/day.m	25	31659.38	89742.35	0	358635.40
			50	92646.72	229807.30	0	731001.60
			100	367324.70	1120513	0	6758114
			300	1441293.00	2524719	0	9786469

Predictor Variable	Variable Name	Unit	Buffer (m)	Mean	Std. Dev.	Min	Max
			500	3046204.00	4842808	0	1.80e+07
			1000	9935090.00	1.22e+07	0	4.08e+07
Heavy traffic load on nearest road	Heavytrafload_x	Veh/day.m	25	350361.60	1819469	0	1.19e+07
			50	1520976.00	7585819	0	4.96e+07
			100	4275135.00	1.72e+07	0	1.10e+08
			300	2.06e+07	5.61e+07	0	3.46e+08
			500	4.10e+07	7.36e+07	0	3.43e+08
			1000	6.69e+08	8.74e+08	0	4.69e+09
Heavy traffic load on nearest primary distributor road	Pheavytrafload_x	Veh/day.m	25	275751.10	1808221.00	0	1.19e+07
			50	1283966.00	7496255.00	0	4.89e+07
			100	3231271	1.70e+07	0	1.08e+08
			300	1.19e+07	5.32e+07	0	3.32e+08
			500	1.84e+07	5.71e+07	0	2.90e+08
			1000	5.39e+08	8.14e+08	0	4.57e+09
Heavy traffic load on nearest distributor A road	Aheavytrafload_x	Veh/day.m	25	18503.09	121332.80	0	795632.70
			50	42649.93	279674.30	0	1833947.00
			100	88002.13	577068.60	0	3784092.00
			300	1487249.00	4484209.00	0	2.27e+07
			500	5848260.00	1.74e+07	0	1.03e+08
			1000	2.54e+07	3.26e+07	0	1.53e+08
Heavy traffic load on nearest distributor B road	Bheavytrafload_x	Veh/day.m	25	40381.56	251613.00	0	1649723
			50	78200.17	512792.80	0	3362607
			100	420388.00	1989155.00	0	1.13e+07
			300	2155860.00	7507585	0	4.06e+07
			500	4284110.00	1.33e+07	0	6.85e+07
			1000	5978632.00	1.09e+07	0	5.62e+07
Number of inhabitants within a buffer	Pop_x	Person	100	69	39	1	216
			300	592	259	14	1296
			500	1555	619	40	2699
			1000	5539	2289	116	9873
			5000	91132	39599	4443	157798
Number of households within a buffer	Hhold_x	Number	100	46	45	0	269
			300	286	162	15	849
			500	684	315	27	1395
			1000	2338	1166	35	5354
			5000	35432	17248	1725	69617
Surface area of land for building footprints in buffer	Building_x	m^2	100	7011.93	2812.23	0	14140.42
			300	60405.70	21859.14	0	115343.30
			500	158487.50	57005.04	775.25	298490.20
			1000	568687.30	199860.80	13788.76	881975.50
			5000	1.00e+07	4135397.00	290755.20	1.72e+07
Surface area of land for industry type-1 (industry, commercial primary/rural, and utilities/ communication) in a buffer	Industry1_x	m^2	100	1452.71	3924.18	0	20860.44
			300	16926.78	32101.86	0	155689.00
			500	51631.63	81380	0	377231.50
			1000	220739.10	283685.40	0	1162433.00
			5000	5083574.00	2835241.00	376000.00	1.36e+07
Surface area of land for industry type-2 (iIndustry, primary/rural, and utilities/	Industry2_x	m^2	100	399.05	1295.10	0	7029.87
			300	6330.71	18979.12	0	90788.80
			500	22161.04	44662.94	0	199412.10
			1000	114236.10	178136.60	0	806557.50
			5000	2673710.00	1703639.00	154452.40	6498963.00

Predictor Variable	Variable Name	Unit	Buffer (m)	Mean	Std. Dev.	Min	Max
communication) in a buffer							
Surface area of land for industry type-3 (ndustry and commercial) in a buffer	Industry3_x	m^2	100	1238.72	3752.36	0	20860.44
			300	12720.45	27046.01	0	155668.10
			500	42579.39	75178.17	0	377182.60
			1000	189133.10	260021.	0	1161373.00
			5000	4471981	2789537.0	199450.00	1.29e+07
Normalized Difference Vegetation Index (**NDVI**) in a buffer	Ndvi_x	-	100	0.07	0.07	-0.10	0.25
			300	0.07	0.06	-0.16	0.27
			500	0.08	0.06	-0.08	0.28
			1000	0.07	0.08	-0.07	0.28
			5000	0.01	0.14	-0.28	0.25
Surface area of land for water bodies in a buffer	Water_x	m^2	100	0	0	0	0
			300	283.0165	940.9244	0	4155.135
			500	8927.538	23343.52	0	104335.3
			1000	161983.6	243950	0	897272.6
			5000	1.44e+07	1.32e+07	196649.9	5.04e+07

Table S2

Unadjusted Average Concentrations of $PM_{2.5}$ elements (ng/m^3) in Perth, Western Australia, 2012 (N = 19 sites)

No	Elements	Mean	Std. Dev.	Min	Max
1	Na	0.235269	0.173176	0.061730	1.020246
2	Mg	0.003821	0.006391	-0.001654	0.019955
3	Al	0.052108	0.064217	0.005591	0.418863
4	Si	0.095306	0.106379	0.021130	0.626174
5	P	0.006738	0.002719	0.003102	0.014478
6	S	0.247715	0.113915	0.092592	0.541113
7	Cl	0.225471	0.407341	-0.000681	2.247529
8	K	0.090517	0.038499	0.018999	0.158510
9	Ca	0.077090	0.069819	0.013909	0.406912
10	Sc	0.000120	0.000441	-0.000006	0.002802
11	Ti	0.007536	0.008689	0.000920	0.059153
12	V	0.000487	0.000403	-0.000005	0.001666
13	Cr	0.001276	0.001532	-0.000011	0.007236
14	Mn	0.004380	0.004873	0.000485	0.026196
15	Fe	0.096652	0.076999	0.011520	0.407247
16	Co	0.000018	0.000077	-0.000007	0.000316
17	Ni	0.000470	0.000603	-0.000186	0.003545
18	Cu	0.002295	0.002252	-0.000080	0.009212
19	Zn	0.010011	0.008692	0.002031	0.044132
20	Ga	0.000105	0.000157	-0.000012	0.000566
21	As	0.000877	0.000702	-0.000002	0.002883
22	Se	0.000261	0.000170	-0.000004	0.000819
23	br	0.002927	0.001444	0.000466	0.008441
24	Rb	0.000169	0.000162	-0.000016	0.000787
25	Sr	0.000553	0.000539	-0.000019	0.003057
26	Y	0.000192	0.000212	-0.000032	0.000874
27	Zr	0.000605	0.000578	-0.000012	0.002762
28	Nb	0.000197	0.000221	-0.000009	0.000874
29	Mo	0.000716	0.000574	-0.000072	0.002542
30	Ag	0.000447	0.000707	-0.000044	0.003089
31	Cd	0.000610	0.000983	-0.000109	0.003725
32	In	0.000447	0.001132	-0.000131	0.005839
33	Sn	0.001955	0.002389	-0.000251	0.009942
34	Sb	0.002966	0.002931	-0.000365	0.011360
35	Cs	0.000335	0.000982	-0.000011	0.005643
36	Ba	0.001712	0.002261	-0.000050	0.010132
37	La	0.000477	0.000602	-0.000050	0.001741
38	Ce	0.000541	0.000535	-0.000033	0.002102
39	Sm	-0.000002	0.000034	-0.000008	0.000236
40	Eu	0.006854	0.007415	0.000458	0.037611
41	Tb	0.004764	0.003826	-0.000007	0.016507

No	Elements	Mean	Std. Dev.	Min	Max
42	Hf	0.000675	0.000488	-0.000051	0.001846
43	Ta	0.000166	0.000389	-0.000060	0.001657
44	W	0.000152	0.000383	-0.000020	0.001706
45	Ir	-0.000002	0.000068	-0.000023	0.000350
46	Au	0.000043	0.000155	-0.000020	0.000904
47	Hg	0.000033	0.000166	-0.000002	0.001173
48	Pb	0.004074	0.003014	-0.000002	0.012542

Table S3

Unadjusted Average Concentrations of PM_{10} elements (ng/m^3) in Perth, Western Australia, 2012 (N = 19 sites)

No	Elements	Mean	Std. Dev.	Min	Max
1	Na	0.98597	0.37571	0.17930	2.26412
2	Mg	0.00478	0.00892	-0.00369	0.04241
3	Al	0.18440	0.11668	0.03505	0.49224
4	Si	0.37752	0.23544	0.04289	1.03034
5	P	0.01529	0.00529	0.00678	0.03250
6	S	0.41756	0.16110	0.13768	0.76244
7	Cl	2.06142	0.87256	0.11967	4.79976
8	K	0.18267	0.05043	0.07183	0.29313
9	Ca	0.34413	0.14277	0.04896	0.93810
10	Sc	0.00052	0.00072	-0.00001	0.00211
11	Ti	0.02759	0.01510	0.00438	0.07319
12	V	0.00097	0.00055	0.00005	0.00222
13	Cr	0.00251	0.00277	0.00037	0.01416
14	Mn	0.00623	0.00460	0.00118	0.02866
15	Fe	0.31516	0.18820	0.03210	0.98850
16	Co	0.00001	0.00009	-0.00002	0.00061
17	Ni	0.00090	0.00074	-0.00016	0.00394
18	Cu	0.00747	0.00770	0.00007	0.03303
19	Zn	0.01266	0.00787	0.00365	0.03473
20	Ga	0.00018	0.00025	-0.00001	0.00128
21	As	0.00075	0.00060	0.00000	0.00253
22	Se	0.00031	0.00011	0.00007	0.00049
23	br	0.00620	0.00146	0.00263	0.00949
24	Rb	0.00036	0.00024	-0.00002	0.00105
25	Sr	0.00284	0.00100	0.00064	0.00617
26	Y	0.00025	0.00024	-0.00007	0.00088
27	Zr	0.00251	0.00246	0.00002	0.01464
28	Nb	0.00025	0.00032	-0.00002	0.00111
29	Mo	0.00124	0.00089	0.00017	0.00438
30	Ag	0.00057	0.00084	-0.00010	0.00328
31	Cd	0.00125	0.00187	-0.00011	0.00717

No	Elements	Mean	Std. Dev.	Min	Max
32	In	0.00130	0.00182	-0.00020	0.00664
33	Sn	0.00449	0.00934	-0.00025	0.06306
34	Sb	0.00308	0.00401	-0.00057	0.01336
35	Cs	0.00034	0.00091	-0.00002	0.00429
36	Ba	0.00636	0.00734	-0.00011	0.03148
37	La	0.00085	0.00131	-0.00008	0.00461
38	Ce	0.00140	0.00100	-0.00003	0.00374
39	Sm	-0.00001	0.00000	-0.00002	-0.00001
40	Eu	0.00973	0.00779	-0.00002	0.04667
41	Tb	0.01203	0.00651	0.00035	0.03121
42	Hf	0.00104	0.00073	-0.00008	0.00329
43	Ta	0.00003	0.00031	-0.00009	0.00162
44	W	0.00015	0.00045	-0.00002	0.00242
45	Ir	0.00001	0.00013	-0.00005	0.00071
46	Au	0.00001	0.00007	-0.00004	0.00025
47	Hg	0.00001	0.00003	0.00000	0.00015
48	Pb	0.00360	0.00298	0.00005	0.01388

Table S4

The correlation values between the annual averages of PM_{10}, PM_{coarse}, $PM_{2.5}$, and $PM_{2.5}$Abs, and $PM_{2.5}$ and PM_{10} elements

	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Absorbance
PM_{10}	1.00		
$PM_{2.5}$	-0.13	1.00	
$PM_{2.5}$ Absorbance	-0.16	0.57	1.00
PM_{coarse}	0.95	-0.42	-0.31
PM_{10} Si	0.28	0.17	0.35
PM_{10} S	0.52	0.31	0.60
PM_{10} K	0.37	0.10	0.34
PM_{10} V	0.27	0.24	0.58
PM_{10} Mn	0.33	0.09	0.06
PM_{10} Fe	0.22	0.10	0.13
PM_{10} Cu	0.17	0.09	-0.05
PM_{10} Zn	0.20	-0.08	-0.04
$PM_{2.5}$ S	0.15	0.22	-0.07
$PM_{2.5}$K	0.13	0.53	0.24
$PM_{2.5}$ V	0.23	-0.48	-0.13
$PM_{2.5}$ Mn	-0.04	0.45	0.63
$PM_{2.5}$ Fe	0.11	0.48	0.60
$PM_{2.5}$ Zn	0.02	0.35	0.63

Table S5

Summary of final LUR model structures and performance for $PM_{2.5}$, PM_{10}, $PM_{2.5A}$, PM_{10} elements and $PM_{2.5}$ elements in Perth Metropolitan Area, Western Australia, 2012

Predictors Variables	Standardised Coeff[a]	Obs	R^2 model	RMSE model	R^2 LOOCV	RMSE LOOCV
Model for PM_{10}:						
Intercept	4.648	19	0.35	4.04	0.26	3.81
Open green spaces within 5000m (m^2)	-3.370					
Heavy traffic intensity on the nearest road (vehicle per day)	3.335					
Building area within 100m (m^2)	1.255					
Model for $PM_{2.5}$:						
Intercept	4.683	19	0.67	0.94	0.50	1.53
Water body area within 5000m (m^2)	-1.520					
Population density within 100m (number of persons)	0.540					
Open green spaces within 1000m (m^2)	-0.775					
Traffic intensity on the nearest Distributor A road (vehicle per day)	0.603					
Distance to coast (m)	0.758					
Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m)	0.358					
Model for $PM_{2.5}$ A:						
Intercept	0.674	19	0.82	0.14	0.67	0.22
Traffic load on any roads within 500m (vehicle per day*m)	0.183					
Population density within 500m (number of persons)	0.116					
Industry and commercial area within 5000m (m^2)	0.090					
Water body area within 1000 (m^2)	-0.046					
Distance to coast (m)	0.040					
Model for PM_{10} – Si:						
Intercept	0.3841	19	0.71	0.127	0.61	0.154
Distance to primary distributor road (m)	-0.0983					
Length of distributor B road within 500m (m)	0.0972					
Open green spaces within 500m (m^2)	-0.0784					
Model for PM_{10} – K:						
Intercept	0.1848	19	0.68	0.027	0.55	0.034
Traffic load on distributor B road within 500 m (vehicle per day*m)	0.0086					
Traffic intensity on the nearest primary distributor road (vehicle per day)	0.0134					
Distance to distributor B road (m)	-0.0152					
Distance to primary distributor (m)	-0.0187					
Open green spaces within 500m (m^2)	-0.0158					
Model for PM_{10} –V:						
Intercept	0.0012	19	0.67	0.0002	0.53	0.0003
Traffic load on any roads within 300m (vehicle per day*m)	0.0003					
Distance to coast (m)	0.0001					
Open green spaces within 5000m (m^2)	-0.0004					

Predictors Variables	Standardised Coeff[a]	Obs	R^2 model	RMSE model	R^2 LOOCV	RMSE LOOCV
Model for PM_{10} – S:						
Intercept	0.4862	19	0.59	0.079	0.45	0.092
Traffic load on primary distributor road within 500m (vehicle per day*m)	0.0847					
Heavy vehicle traffic load on distributor B road within 1000m (vehicle per day*m)	0.0434					
Open green spaces within 5000m (m^2)	-0.0401					
Model for PM_{10} – Fe :						
Intercept	0.2732	18 [b)]	0.52	0.125	0.38	0.141
Traffic load on distributor B road within 500 m (vehicle per day*m)	0.0842					
Distance to primary distributor (m)	-0.0349					
Open green spaces within 5000m (m^2)	-0.0582					
Housing density within 100m (number of dwelling in an area)	0.0411					
Model for PM_{10} – Mn:						
Intercept	0.0051	18 [b)]	0.34	0.003	0.15	0.004
Traffic load on Distributor B roads within 500m (vehicle per day*m)	0.0013					
Open green spaces within 1000m (m^2)	-0.0015					
Housing density within 100m (number of housing)	0.0011					
Model for Fe – $PM_{2.5}$:						
Intercept	0.0863	19	0.55	0.031	0.41	0.036
Distance to river (m)	-0.0147					
Traffic load on primary distributor within 1000m (vehicle per day*m)	0.0176					
Traffic intensity on the nearest Distributor A (vehicle per day)	0.0202					
Water body area within 5000m (m^2)	-0.0166					
Population density within 1000m (number of housing)	0.0138					
Model for $PM_{2.5}$ – Mn:						
Intercept	0.0035	19	0.91	0.001	0.86	0.001
Traffic load on any roads within 1000m (vehicle per day*m)	0.0033					
Water body area within 5000m (m^2)	-0.0014					
Industrial area within 1000 (m^2)	0.0005					
Open green spaces within 1000m (m^2)	-0.0006					
Model for $PM_{2.5}$ – V:						
Intercept	0.0007	18 [b)]	0.45	0.0002	0.30	0.0003
Distance to coast (m)	-0.0003					
Industry and commercial area within 1000m (m^2)	0.0001					
Distance to river (m)	-0.0003					
Model for $PM_{2.5}$ – Zn:						
Intercept	0.0071	19	0.89	0.002	0.72	0.003
Traffic load on any roads within 1000m (vehicle per day*m)	0.0046					
Water body area within 5000m (m^2)	-0.0015					
Length of Distributor B roads within 500m (m)	0.0012					
Length of Primary Distributor roads within 1000m (m)	0.0011					

Predictors Variables	Standardised Coeff[a]	Obs	R^2 model	RMSE model	R^2 LOOCV	RMSE LOOCV
Model for $PM_{2.5}$ – K:						
Intercept	0.0815	19	0.33	0.017	0.07	0.021
Distance to river (m)	-0.0054					
Length of Distributor B roads within 300m (m)	0.0098					
Water body area within 5000m (m^2)	-0.0072					
Traffic intensity on the nearest Distributor A (vehicle per day)	0.0049					

a) The coefficients were obtained from a final model that was developed based on standardised predictor variables. Standardised predictor variables were generated by subtracting the mean for each variable from each value for that variable and dividing by SD

b) One site was excluded from the final model due to high Cooks'D

Table S6

Results of Moran's I statistical analysis of final LUR models for the $PM_{2.5}$ A, $PM_{2.5}$ and PM_{10} and the element model residuals

LUR Model	z - score	p - value	Moran's I Index
PM_{10}	0.571	0.568	-0.000
$PM_{2.5}$	0.970	0.332	0.030
$PM_{2.5}$ A	0.083	0.933	-0.042
$PM_{2.5}$ – Mn	0.0422	0.966	-0.051
$PM_{2.5}$ – Zn	2.307	0.021	0.166
$PM_{2.5}$ – Fe	0.311	0.756	-0.025
$PM_{2.5}$ – K	-0.539	0.589	-0.106
$PM_{2.5}$ – V	0.830	0.406	0.023
$PM_{2.5}$ – Si	-0.990	0.322	-0.149
$PM_{2.5}$ – K	-0.472	0.637	-0.098
$PM_{2.5}$ – S	-0.272	0.785	-0.080
$PM_{2.5}$ – Fe	-0.534	0.592	-0.106

Table S7

Results of hold-out validation analysis for $PM_{2.5}$ and $PM_{2.5}$ Absorbance

Set	Predictor variables included in the training models	R^2	
		Training (n=10)	Test (n=9)
$PM_{2.5}$			
1	Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.84	0.24
2	Water body area within 5000m (m^2) Population density within 100m (number of persons) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m)	0.96	0.37
3	Water body area within 5000m (m^2) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.80	0.01
4	Water body area within 5000m (m^2) Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m)	0.72	0.48
5	Water body area within 5000m (m^2) Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.80	0.92
6	Water body area within 5000m (m^2) Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.74	0.51
7	Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m)	0.92	0.3
8	Water body area within 5000m (m^2) Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.14	0.71
9	Water body area within 5000m (m^2) Population density within 100m (number of persons) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m)	0.68	0.78
10	Water body area within 5000m (m^2) Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Heavy vehicles traffic load on Distributor B within 500m (vehicle per day*m) Distance to coast (m)	0.79	0.4
$PM_{2.5}$ Absorbance			
1	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons)	0.89	0.93

Set	Predictor variables included in the training models	R^2	
		Training (n=10)	Test (n=9)
	Industry and commercial area within 5000m (m^2) Distance to coast (m)		
2	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 1000 (m2) Distance to coast (m)	0.71	0.83
3	Traffic load on any roads within 500m (vehicle per day*m) Industry and commercial area within 5000m (m2) Water body area within 1000 (m^2) Distance to coast (m)	0.88	0.44
4	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.85	0.71
5	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 1000 (m^2) Distance to coast (m)	0.69	0.85
6	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 1000 (m^2) Distance to coast (m)	0.78	0.67
7	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2)	0.84	0.69
8	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 1000 (m^2) Distance to coast (m)	0.14	0.74
9	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 1000 (m^2) Distance to coast (m)	0.75	0.81
10	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.83	0.66

Table S8

Results of cross hold out validation method : adjusted R^2 and structure of evaluation models for $PM_{2.5}$ and $PM_{2.5}A$, developed based on N-1 sites (18 sites)

Evaluation model	Predictor variables	R^2
$PM_{2.5}$:		
1	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Distance to coast (m) Heavy vehicles traffic load on Distributor B within 300m (vehicle per day*m)	0.68
2	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Distance to coast (m) Heavy vehicles traffic load on Distributor B within 300m (vehicle per day*m)	0.80
3	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Distance to coast (m) Heavy vehicles traffic load on Distributor B within 300m (vehicle per day*m)	0.73
4	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Traffic load on Distributor B within 50m (vehicle per day*m)	0.64
5	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 1000m (m^2) Traffic intensity on the nearest Distributor A road (vehicle per day) Traffic load on Distributor B within 500m (vehicle per day*m) Length of Primary Distributor road within 50m buffer	0.65
6	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic load on Distributor B within 500m (vehicle per day*m) Heavy vehicles traffic load on Primary Distributor within 300m (vehicle per day*m)	0.70
7	Water body area within 5000m buffer Population density within 100m (number of persons) Heavy vehicles traffic load any roads within 500m (vehicle per day*m)	0.54
8	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic load on Distributor B within 500m (vehicle per day*m) Heavy vehicles traffic load on Distributor A within 300m (vehicle per day*m) Traffic intensity on nearest primary distributor road (vehicle per day) Traffic intensity on nearest Distributor A road (vehicle per day)	0.74
9	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A road (vehicle per day)	0.78

Evaluation model	Predictor variables	R^2
	Traffic intensity on nearest primary distributor road (vehicle per day) Heavy vehicles traffic load on any roads within 300m (vehicle per day*m)	
10	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A roads (vehicle per day) Traffic intensity on nearest Primary Distributor road (vehicle per day) Heavy vehicles traffic load on Distributor B roads within 500m (vehicle per day*m)	0.67
11	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A roads (vehicle per day) Distance to river (m) Heavy vehicles traffic intensity on nearest Distributor B roads (vehicle per day)	0.84
12	Water body area within 5000m buffer Population density within 100m (number of persons) Heavy vehicles traffic intensity on nearest Distributor A roads (vehicle per day) Heavy vehicles traffic load on any roads within 500m (vehicle per day) Length of Distributor B roads within 50m buffer (m)	0.64
13	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A roads (vehicle per day) Traffic intensity on nearest Primary Distributor roads (vehicle per day) Heavy vehicles traffic load on Distributor B roads within 500m (vehicle per day)	0.67
14	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Heavy vehicles traffic intensity on nearest Distributor A roads (vehicle per day)	0.62
15	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Heavy vehicles traffic load on Distributor B roads within 500m (vehicle per day) Traffic intensity on nearest Distributor A roads (vehicle per day)	0.70
16	Water body area within 5000m buffer Population density within 100m (number of persons) Traffic intensity on nearest Distributor A roads (vehicle per day) Length of Distributor A roads within 300m buffer (m)	0.74
17	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A roads (vehicle per day) Heavy vehicles traffic load on Distributor B roads within 1000m (vehicle per day) Traffic intensity on nearest Primary Distributor roads (vehicle per day)	0.67
18	Water body area within 5000m buffer Population density within 100m (number of persons) Open green spaces within 500m (m^2) Distance to coast (m) Traffic intensity on nearest Distributor A roads (vehicle per day) Distance to river (m) Heavy vehicles traffic load on Distributor B roads within 300m (vehicle per day)	0.73

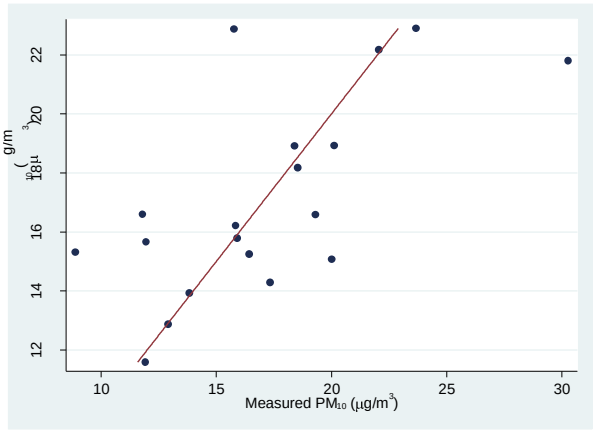
Evaluation model	Predictor variables	R^2
	Industrial area within 500m (m^2)	
19	Water body area within 5000m buffer Population density within 100m (number of persons) Heavy vehicles traffic load on Distributor A roads within 300m (vehicle per day) Traffic load on Distributor B roads within 500m (vehicle per day)	0.57
$PM_{2.5}$ Absorbance:		
1	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.81
2	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.83
3	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.83
4	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.86
5	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to the nearest Primary Distributor road (m) Water body area within 5000m (m^2)	0.82
6	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.82
7	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 500m (m^2)	0.84
8	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.83
9	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Water body area within 1000m buffer	0.83
10	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Water body area within 1000m buffer	0.83

Evaluation model	Predictor variables	R^2
11	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.82
12	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.83
13	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.80
14	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Water body area within 5000m	0.78
15	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m)	0.81
16	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2)	0.80
17	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.82
18	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.83
19	Traffic load on any roads within 500m (vehicle per day*m) Population density within 500m (number of persons) Industry and commercial area within 5000m (m^2) Distance to coast (m) Distance to river (m)	0.84

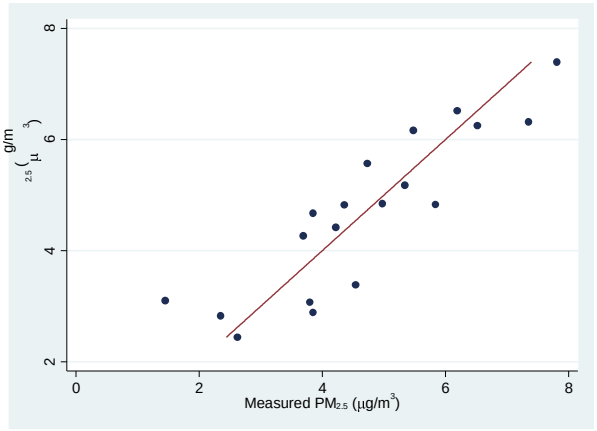
Table S9

Results of cross hold out validation method: Comparison between the measured and predicted concentrations of $PM_{2.5}$ Absorbance and $PM_{2.5}$ at the site that was not used for developing evaluation model, and the corresponding true hold out R^2.

Evaluation model	**$PM_{2.5}$ Absorbance concentrations ($10^{-5}m^{-1}$)**		**$PM_{2.5}$ concentrations ($\mu g/m^3$)**	
	Measured	**Predicted**	**Measured**	**Predicted**
1	0.51	0.52	3.69	4.32
2	0.54	0.50	1.45	3.47
3	0.79	0.61	4.54	2.45
4	0.93	1.17	4.73	7.82
5	1.50	1.00	7.81	5.29
6	0.79	0.91	4.22	9.02
7	0.84	0.59	7.35	5.58
8	0.86	0.82	3.85	4.91
9	1.07	0.76	6.19	6.28
10	0.79	0.97	5.48	7.92
11	0.72	0.51	3.80	2.07
12	0.74	0.91	4.98	7.33
13	0.19	0.26	2.62	2.95
14	0.25	0.14	4.36	5.77
15	0.35	0.48	5.84	4.13
16	0.29	0.47	3.85	-0.04
17	0.48	0.43	2.35	3.82
18	0.67	0.69	5.34	5.40
19	0.51	0.65	6.52	5.30
True hold-out R^2	**61%**		**14%**	



(a)



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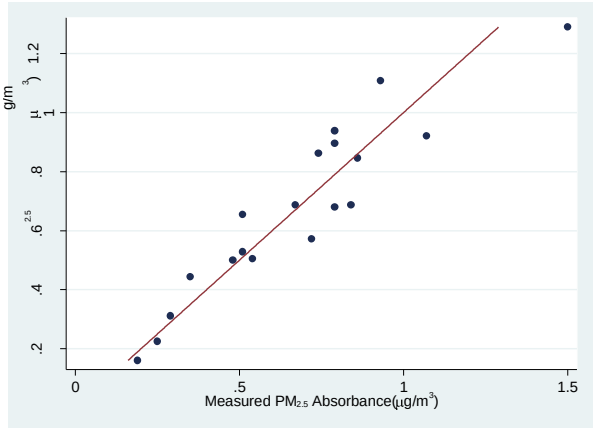

(c)

Figure S1

Scatter plots of predicted vs measured concentrations of PM_{10} (a), $PM_{2.5}$ (b) and $PM_{2.5}$Absorbance (c) in Perth, Western Australia