

Towards a smog free city



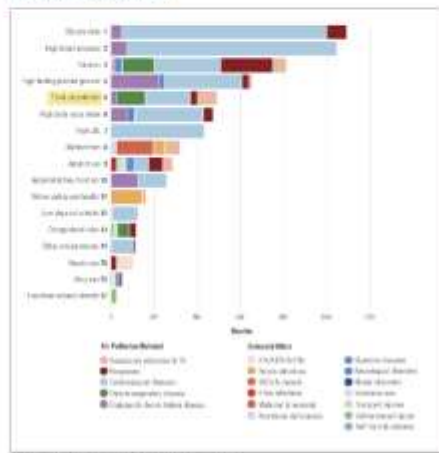
Part 1 – A health emergency



Air pollution is a global health emergency*

Air pollution is the fifth leading risk factor for mortality worldwide. It is responsible for more deaths than many better-known risk factors such as malnutrition, alcohol use, and physical inactivity. Each year, more people die from air pollution-related disease than from road traffic injuries or malaria.

Figure 1. Global ranking of risk factors by total number of deaths from all causes for all ages and both sexes in 2017.



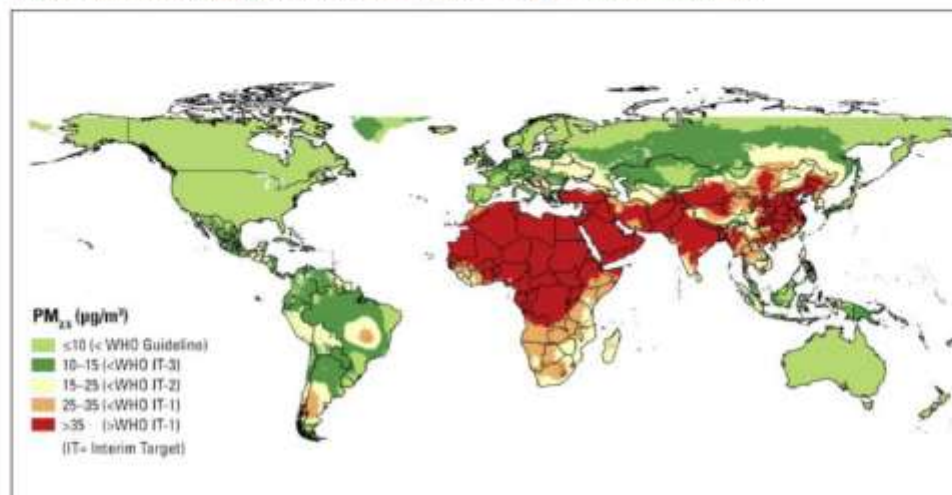
4.9 million
early deaths,
each year

* Says WHO



Air pollution is a global health emergency

Figure 2. Annual average $PM_{2.5}$ concentrations in 2017 relative to the WHO Air Quality Guideline.



Health impacts in the UK (annual)

Estimates of annual deaths attributable to air pollution in the UK

- 29,000 (COMEAP, 2011) (PM2.5)
- 40,000 (RcP 2016) (PM2.5 and NO2)
- 55,000 (EEA, 2017) (PM2.5, NO2 and O3)
- **28,000 – 36,000 (COMEAP, 2018) (PM2.5 and NO2)**
- 64,000 – Lelievre et al 2019 using new global air pollution impact analysis
- 99,000 from global estimates Vohri et al 2021

Local estimates for 2014 for PM2.5 only

- Brighton – 115 or 5.4% for all deaths
- Lewes - 48 or 4.6 %



Estimating Local Mortality Burdens
associated with Particulate Air Pollution

3,600 to 4,100 deaths
— estimated to be
attributable to human-
made PM2.5 & NO2 in
London, annually

Ella Kissi-Debrah – 1st
person in UK to have
air pollution listed as a
cause of death.



Photo Ella Roberts Family Foundation

Where does the health evidence come from?

- Near Liege, the Meuse Valley smog of 1930 killed 60 people in 3 days (Firket, 1936, Nemery, 2001).
- Their demise was horrific; painful chests, coughing and breathlessness followed in some cases by foaming at the mouth and vomiting before total heart failure. Many cattle had to be slaughtered and others were only saved by herding them up the hillsides, above the fog.
- London & Donora (1948)
- Poza Rica, Mexico (1950)
- But they didn't have measurements, or in the case of London in 1948, they ignored them.



London 1952

- it took a disaster for air pollution and health to be finally connected

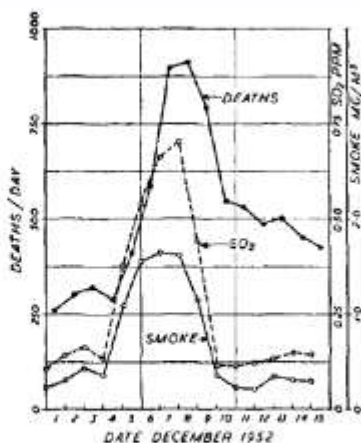


Figure 1. Daily air pollution and deaths.

Air pollution aspects of the London fog of December 1952

By E. T. WILKINS
D.R.R., Fuel Research Station, Greenwich

MoH report (1954) – 4,000 deaths
Bell et al 2001 – 12,000 deaths

They have no memorial except in the 1956
Clean Air Act and a book (last slide)



Then in 1993 - the six cities study

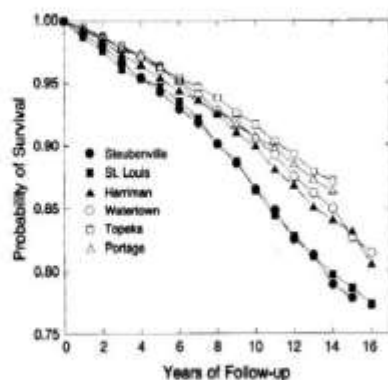
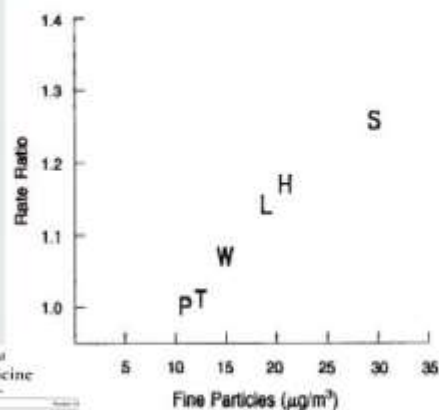


Figure 2. Crude Probability of Survival in the Six Cities, Acc to Years of Follow-up.

The New England
Journal of Medicine

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We are now learning that air pollution can have life-long impacts

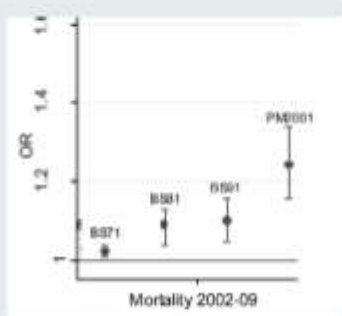


Figure 3 ORs (95% CI) per $10 \mu\text{g}/\text{m}^3$ for BS exposure in 1971, 1981 and 1991 and PM_{10} in 2001 and mortality in each subsequent decades. Adjusted for age and sex, social class of individual and area, population density and geographical region. Source: ONS Longitudinal Study (authors' own work). CV, BS, black smoker; cardiovascular disease; ONS, Office for National Statistics.



Thames Valley University
Thames Valley University, published on February 8, 2016 in 10.1111/resp.12711

ORIGINAL ARTICLE
OPEN ACCESS

Historic air pollution exposure and long-term mortality risks in England and Wales: prospective longitudinal cohort study

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(With all credit to Jim Gauderman et al for pioneering this type of study)

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Pollutionwatch *An pollution*

It's not just oceans: scientists find plastic is also polluting the air

From coastlines to the heart of cities, microplastics are becoming a global problem



PM_{2.5} annual mean across Indian cities

190 µg m⁻³ (WHO)

100% 100%

190 $\mu\text{g m}^{-3}$
(WHO)



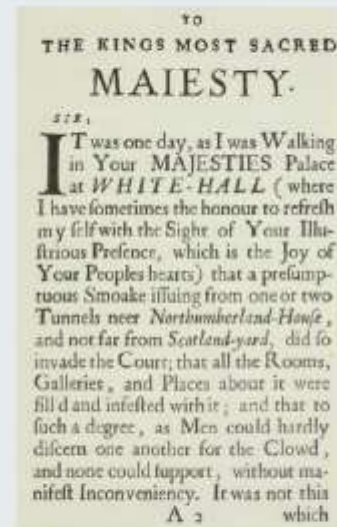
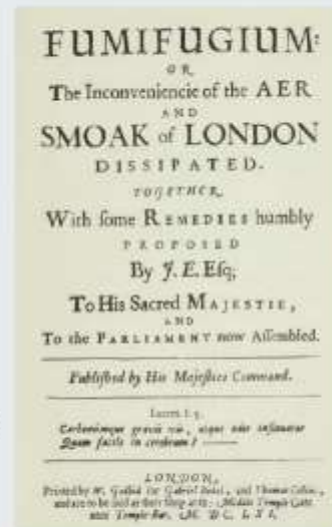
Normally the story starts in Medieval London



In 1661 the writer, gardener and diarist John Evelyn wrote a letter and essay to the King Charles II and parliament

"Indeed, this smoke is so heavy with soot that it falls upon the city where it disperses and spreads, making London look like Troy after the Greeks sacked it."

Reports French vines being killed by smoke from England



It is hard to know what this looked like, let alone what past concentrations were..

Claude Monet. London. The Waterloo Bridge. 1803. Oil on canvas. The Carnegie Institute, Museum of Art, Pittsburgh, USA.



Imperial College
London

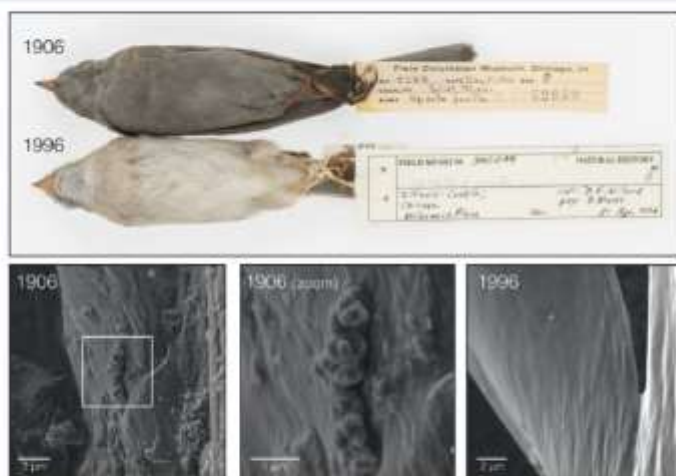
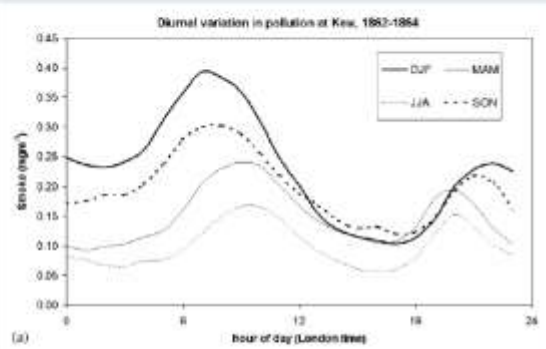


Fig. 1. Comparison of two Field Sparrows (*S. pusilla pusilla*), one from 1906 and one from 1996. (Lower) SEM micrographs of belly feathers plucked from the specimens in Upper. SEM micrographs of the Field Sparrow from 1906 show black carbon aggregates composed of small spherules (a detailed description of black carbon morphology with microscopy images can be found in Bond et al., 2013 [1]). The feather from the 1996 specimen lacks black carbon deposition. Both specimens were collected during spring months in the vicinity of Chicago. SEM images were made with a Tescan (USA) field emission microscope with secondary electron (SE) detection and an accelerating voltage (kV) of 2.0 kV. Feather samples were carbon-coated before imaging.

Bird specimens track 135 years of atmospheric black carbon and environmental policy

David A. Bond^{1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,234,235,236,237,238,239,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,296,297,298,299,300,301,302,303,304,305,306,307,308,309,310,311,312,313,314,315,316,317,318,319,320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,358,359,360,361,362,363,364,365,366,367,368,369,370,371,372,373,374,375,376,377,378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,398,399,400,401,402,403,404,405,406,407,408,409,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,498,499,500,501,502,503,504,505,506,507,508,509,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525,526,527,528,529,530,531,532,533,534,535,536,537,538,539,540,541,542,543,544,545,546,547,548,549,550,551,552,553,554,555,556,557,558,559,560,561,562,563,564,565,566,567,568,569,570,571,572,573,574,575,576,577,578,579,580,581,582,583,584,585,586,587,588,589,590,591,592,593,594,595,596,597,598,599,600,601,602,603,604,605,606,607,608,609,610,611,612,613,614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672,673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715,716,717,718,719,720,721,722,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754,755,756,757,758,759,760,761,762,763,764,765,766,767,768,769,770,771,772,773,774,775,776,777,778,779,780,781,782,783,784,785,786,787,788,789,790,791,792,793,794,795,796,797,798,799,800,801,802,803,804,805,806,807,808,809,810,811,812,813,814,815,816,817,818,819,820,821,822,823,824,825,826,827,828,829,830,831,832,833,834,835,836,837,838,839,840,841,842,843,844,845,846,847,848,849,850,851,852,853,854,855,856,857,858,859,860,861,862,863,864,865,866,867,868,869,870,871,872,873,874,875,876,877,878,879,880,881,882,883,884,885,886,887,888,889,890,891,892,893,894,895,896,897,898,899,900,901,902,903,904,905,906,907,908,909,910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,927,928,929,930,931,932,933,934,935,936,937,938,939,940,941,942,943,944,945,946,947,948,949,950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000,1001,1002,1003,1004,1005,1006,1007,1008,1009,1010,1011,1012,1013,1014,1015,1016,1017,1018,1019,1020,1021,1022,1023,1024,1025,1026,1027,1028,1029,1030,1031,1032,1033,1034,1035,1036,1037,1038,1039,1040,1041,1042,1043,1044,1045,1046,1047,1048,1049,1050,1051,1052,1053,1054,1055,1056,1057,1058,1059,1060,1061,1062,1063,1064,1065,1066,1067,1068,1069,1070,1071,1072,1073,1074,1075,1076,1077,1078,1079,1080,1081,1082,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1109,1110,1111,1112,1113,1114,1115,1116,1117,1118,1119,1120,1121,1122,1123,1124,1125,1126,1127,1128,1129,1130,1131,1132,1133,1134,1135,1136,1137,1138,1139,1140,1141,1142,1143,1144,1145,1146,1147,1148,1149,1150,1151,1152,1153,1154,1155,1156,1157,1158,1159,1160,1161,1162,1163,1164,1165,1166,1167,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,1196,1197,1198,1199,1200,1201,1202,1203,1204,1205,1206,1207,1208,1209,1210,1211,1212,1213,1214,1215,1216,1217,1218,1219,1220,1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London in the 1860's



Used electrical properties of the atmosphere as a surrogate from Whipple (1929).

Also some measurements are available from John Read, 10 Parkside, Knightsbridge from 1789 – 1791 showing two daily peaks between 100 – 200 $\mu\text{g m}^{-3}$ – Harrison (2009)

~150 $\mu\text{g m}^{-3}$ annual mean would have been in the top 10 for $\text{PM}_{2.5}$ but less than our cyclist in India!

WHIPPLE—POTENTIAL GRADIENT & ATMOSPHERIC POLLUTION 261

POTENTIAL GRADIENT AND ATMOSPHERIC POLLUTION: THE INFLUENCE OF "SUMMER TIME"

By F. J. W. WHIPPLE, S.D.

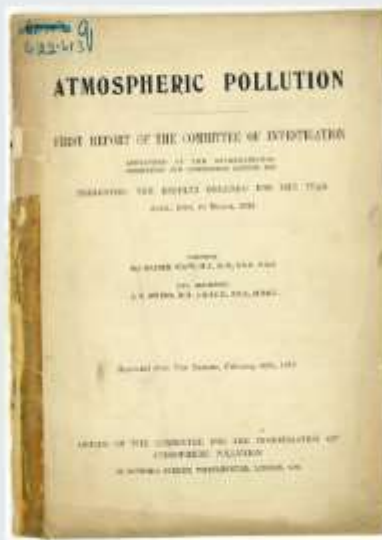
(Manuscript received March 26, 1929; final June 15, 1929.)



Mid-nineteenth century smoke concentrations near London

R.G. Harrison^a, K.L. Aglen^b

The world's first air quality network – started in the UK in 1912



The world's first national air pollution measurement network was started in the UK in 1912.

A voluntary group of local authorities and smoke abatement societies (NGOs), later supported by industry and government.

Aimed to make systematic measurements that were "comparable from place to place, month to month, season to season and for different places over the same time period"

Huge thanks to Alison Loader & Ricardo for their kind donation to the King's library.

Where is the data?



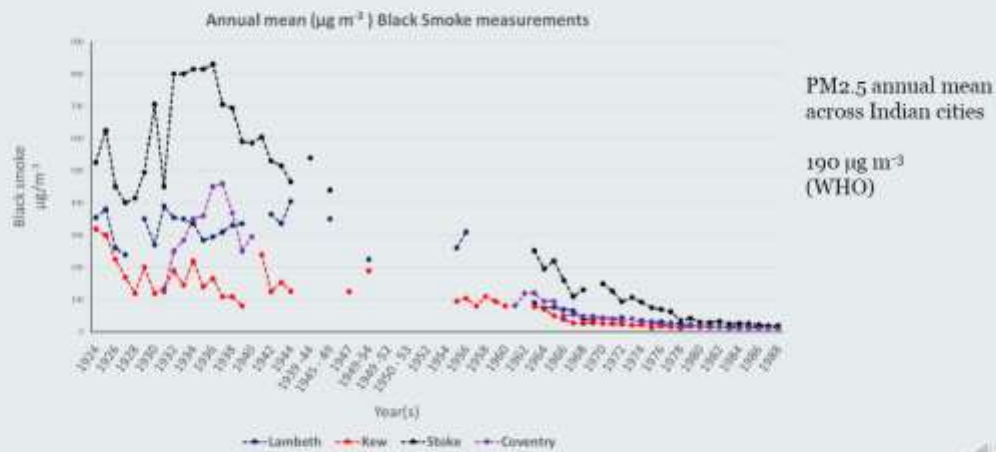
Pilot project – to assemble a 100 year PM dataset for key UK cities (with Pam Davy)



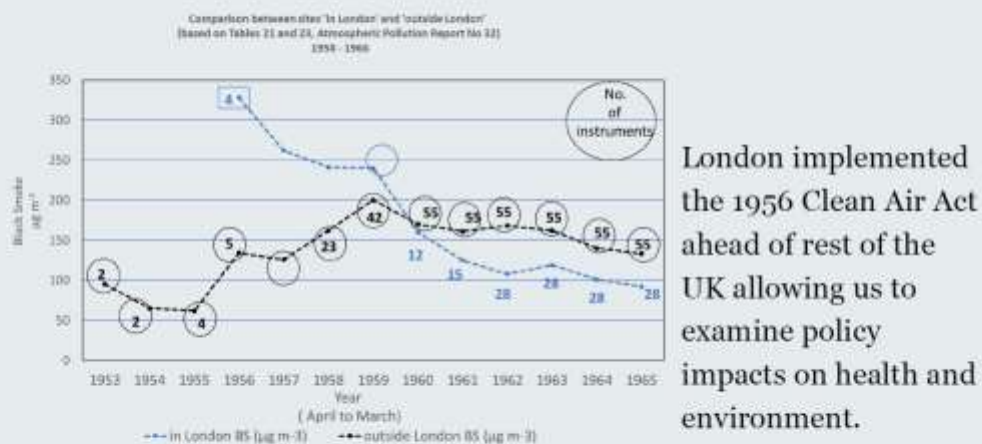
Fig. 3.



Spanning the century



Spanning the century



The worst air pollution ever?



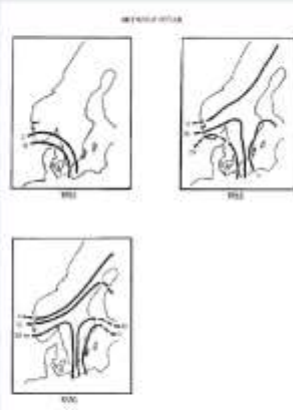
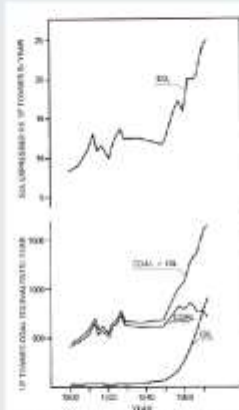
Probably not...

Millions of Indians are living with PM_{2.5} nearly 20 times WHO Guidelines.

We know what their future may be without robust actions.

And there's other pollutants too....

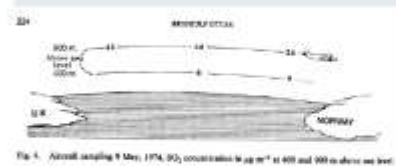
So 1956, that was air pollution all sorted?



Smokeless fuels and tall chimneys did nothing for sulphur emissions.

In the 1970s more sulphur was falling from the skies in Norway than Norway emitted!

Brynjulf Ottar, 1976,1977



So that was air pollution all sorted?

Columbo – Dagger of the Mind (1972)



So that was air pollution all sorted?

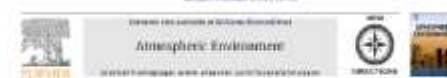


Other types of polluting diesel vehicles are available



Wood burning – solid fuel is back in fashion

The UK's largest single source of primary PM_{2.5}



Part 2 – The future?



Measurement focuses on determining legal limits

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London

◆ This article is more than 2 years old

London reaches legal air pollution limit just one month into the new year

Timing is a significant improvement, due in part to mayor's measures, but campaigners say national government must get a grip on toxic air

Dominic Carrington
Environment editor
@guardianyc

Tue 10 Jan 2012 12:10 GMT

173 522



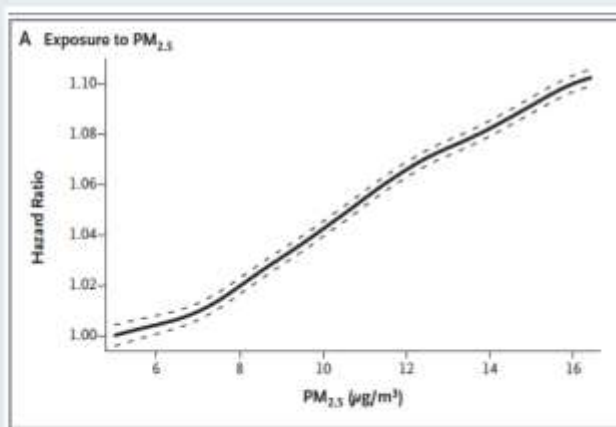
▲ At last! London has reached the legal limit for air pollution. Photograph: Reuters/Markus/PA

Air pollution in London has reached the legal limit for the whole of 2012 less than a month into the year, prompting calls for the government to "get a grip

Advertisement: N°7 THE UK'S NO.1 SKINCARE BRAND**

Health evidence does not support a threshold

Health effects found to the lowest levels measured and well below current EU Limits $25 \mu\text{g m}^{-3}$, US limits of $12 \mu\text{g m}^{-3}$ and WHO Guidelines of $10 \mu\text{g m}^{-3}$



Perils of focusing on limit values?

Allowing pollution up to the limits

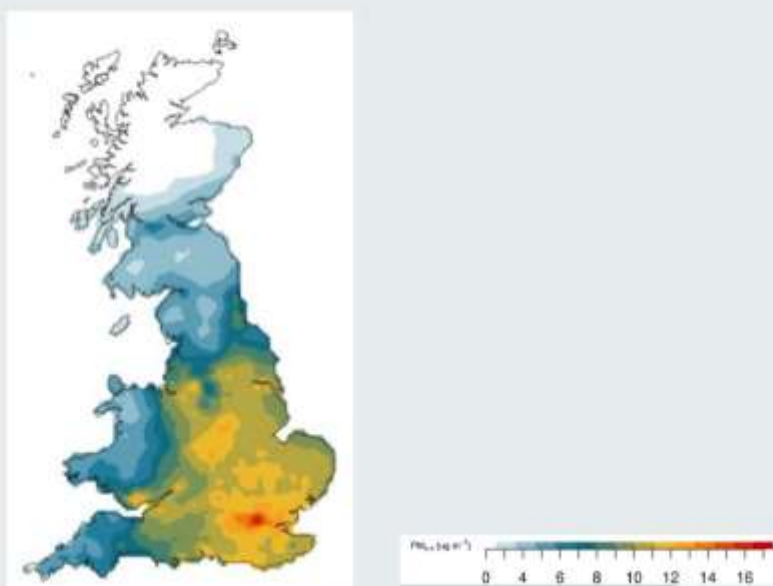


Table 6.3: Impact descriptors for individual receptors.

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

WHO Guideline for PM_{2.5} in UK law?

It's great but it only benefits 2/3 of England and south Wales.



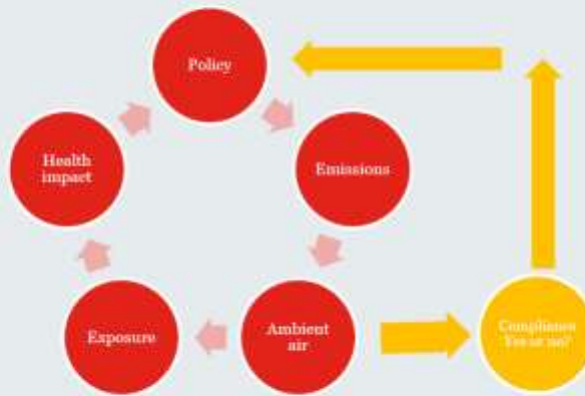
Keeping air pollution policies on track

Focusing on trends rather than compliance can lead to more effective policies

Andrew W. Hoggan and Andy Hoggan

A recent focus on trends in air pollution has led to a renewed interest in air quality.

The need for this change in emphasis, and how best to achieve it, are discussed in this article.

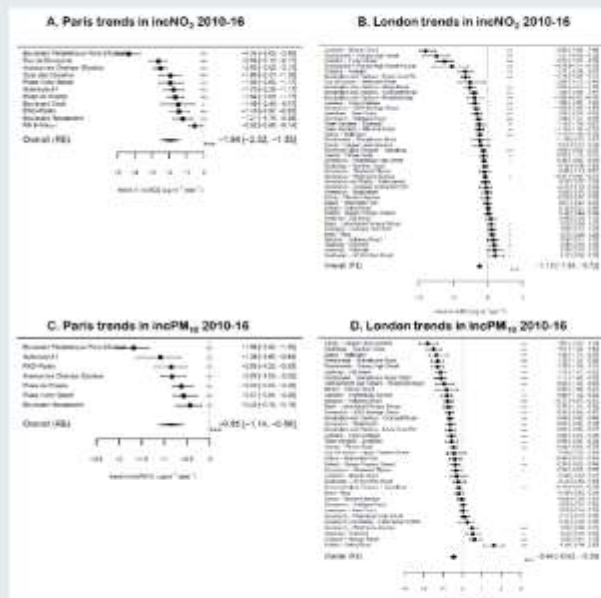


Adapted from an idea from the HEI

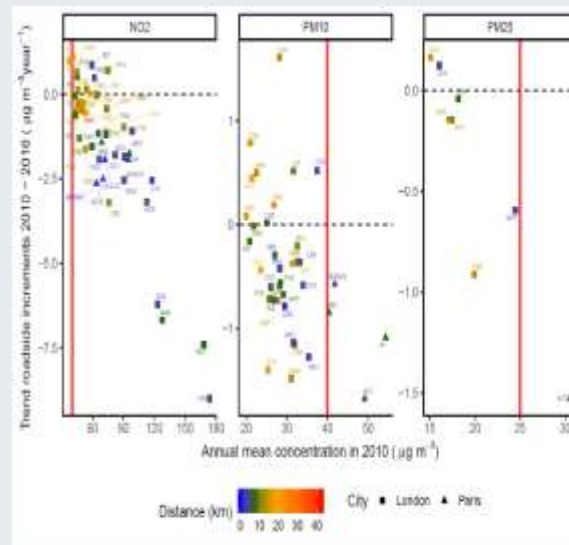
Despite policies, air pollution next to roads in London and Paris has not improved in consistent way.



A tale of two cities: in air pollution improving in Paris and London.¹⁴
 Andrew Hoggan^{1,2*}, Sarah Hoggan¹, Maria Bolognini^{1,2}, Yvonne G. Gaudet¹,
 Gary W. Hoggan^{1,2}



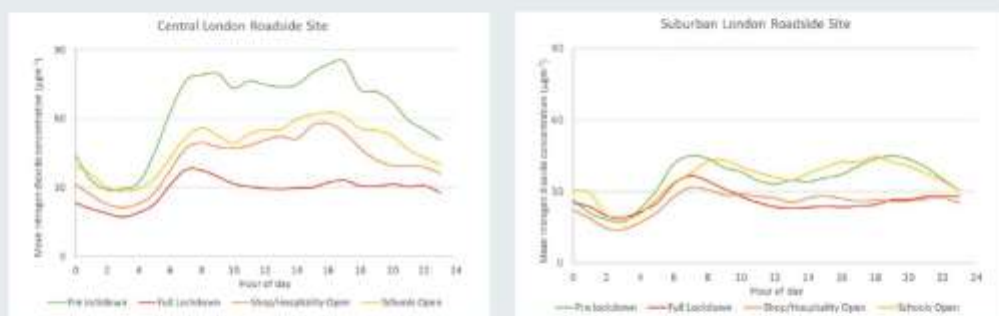
Despite policies, air pollution next to roads in London and Paris has not improved in consistent way.

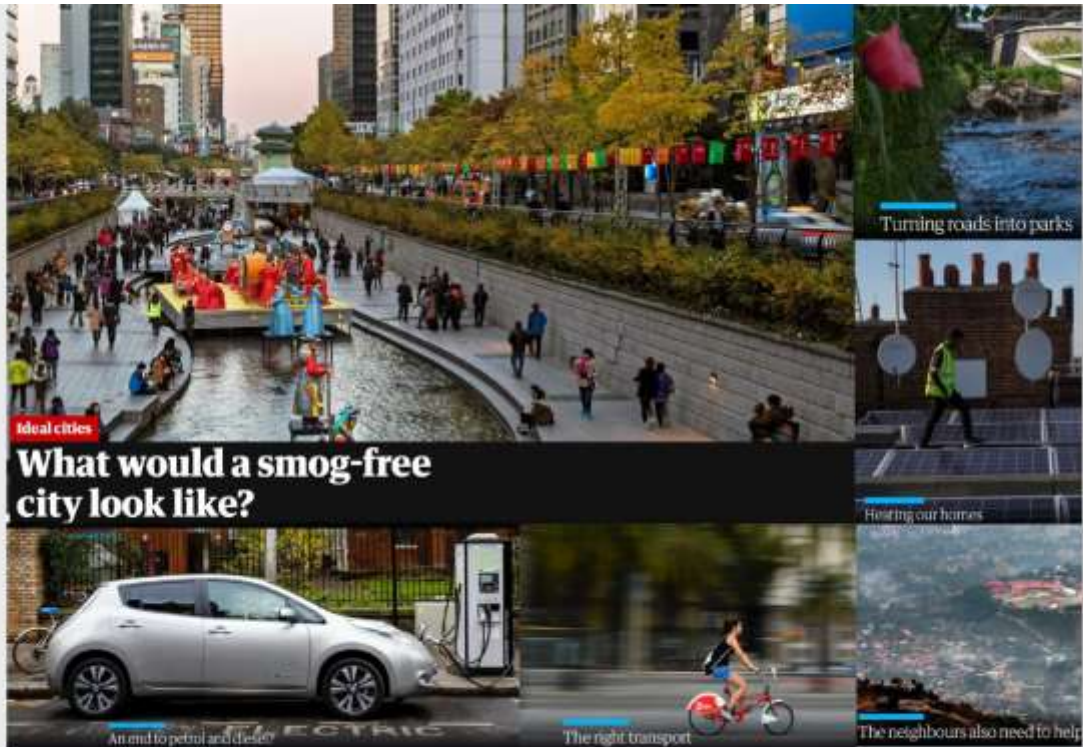


2003 CONGESTION CHARGING SCHEME 2008 LONDON LOW EMISSION ZONE 2019 LONDON ULTRA LOW EMISSION ZONE



Covid and NO_2





<https://www.theguardian.com/cities/2018/nov/13/what-would-a-smog-free-city-look-like-air-pollution>

And the way that we travel at work & home: Car journeys in England & Wales (DfT2016)



60 % are less than 5 miles
23 % are less than 2 miles

260,000 UK workers studied for five years

Cyclists commuters were living longer....

Walking commuters had less heart disease...

Compared to car commuters

Celis-Morales et al 2017



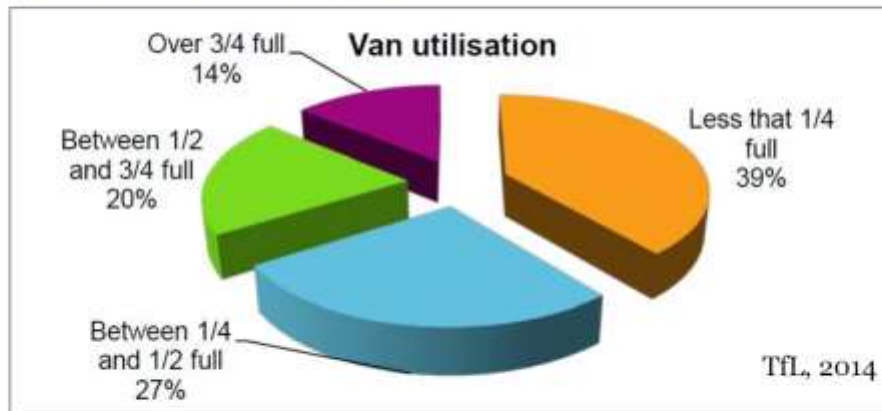
benefit to risk ratio = 70:1 !

Rojas-Rueda et al 2011 BGN photo fabn Martinez, Santander bikes.



Let's think about deliveries

Figure 6 Vans – average load factor.



One solution is to consolidate your orders for supplies



Euston → St Pancras via London's first Wellbeing route



**51% less air pollution compared to
walking along Euston Road**

Urban Partners, black carbon measurements by Andrew Grieve, King's College London

**In 1661 the John Evelyn
observed - air pollution
is an issue of urban
design**

**We need to solve the problem at
source -**

not like this.....!

Pollutionwatch!
Air pollution

**Pollutionwatch: why cleaning the air
is like taking milk out of tea**

Gary Fuller

#pollutionwatch

This is the future

21.10.2017

23 15



▲ A 400 metre tower in that they're trying to filter the city's air. Photograph: Instagram/airfilter/1260000000



15 minute neighbourhoods



A low emission / clean air zone for Leeds?

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Ignore the naysayers: low emission zones do work

By Jonathan Laitman, author of 'The Low Carbon Revolution'

Jonathan Laitman is a leading expert on low carbon living and the author of 'The Low Carbon Revolution'.

Could it be the case that the naysayers are wrong? The answer is yes. Low emission zones (LEZs) do work. They reduce the number of cars in the zone, reduce the number of cars that are polluting, and reduce the number of cars that are causing congestion. They also reduce the number of cars that are causing noise. They also reduce the number of cars that are causing air pollution. They also reduce the number of cars that are causing climate change. They also reduce the number of cars that are causing health problems. They also reduce the number of cars that are causing economic problems. They also reduce the number of cars that are causing social problems. They also reduce the number of cars that are causing environmental problems. They also reduce the number of cars that are causing all of these problems.

LEEDSDOY.UK

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What you can do

Take action to reduce your emissions by:

- + Leaving your car at home
- + Turning off your engine
- + Switching to an electric vehicle
- + Reducing flexitime and remote working permanently
- + Supporting sustainable travel in your workplace
- + Encouraging sustainable travel and reducing air pollution at school
- + Reducing air pollution from your open fire or wood burning stove

Un-building roads - Cheonggyecheon River project



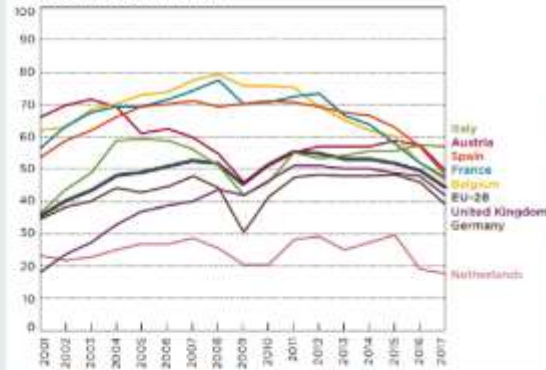
Fighting back

James Galloway and Stephen Fryer



Fighting back - loosing confidence in diesels

Market share, diesel vehicles (in %)



UK car sales drop as diesel demand plummets for 14th month in a row

Consumer wariness that growth is a false dawn as car prices continue to rise

Car sales fell 1.1% in January 2018 from 1.2% in December 2017



Data ICCT

The need for political leadership



"The sky over the Ruhr region must be blue again." This demand made by Willy Brandt during a speech on 28 April 1961 in the Bonn Beethoven Hall is rightfully seen as the start of environmentally conscious political thinking in Germany. www.zeitungsonline.de & 1961 Brandt photograph



The need for political leadership



"The sky over the Ruhr region must be blue again." This demand made by Willy Brandt during a speech on 28 April 1961 in the Bonn Beethoven Hall is rightfully seen as the start of environmentally conscious political thinking in Germany. www.zeitungsonline.de & Willy Brandt photograph

The Invisible Killer
The Rising Global Threat of Air Pollution – and How We Can Fight Back
Gary Fuller



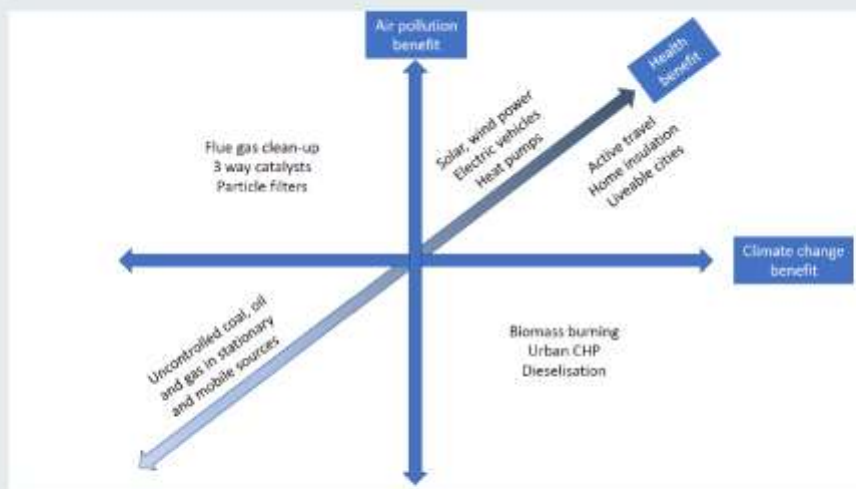
Tackling air quality and climate change together



Tackling climate change: what is the impact on air pollution?



Tackling air quality and climate change together



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Pollutionwatch
Air pollution

It's not just oceans: scientists find plastic is also polluting the air

New research links Delhi's thick smogs to burning of plastics

Gary Fuller
@garyfuller
11.10.16 14:30 (16/10/2016)

757 185

▲ From left: a runner along a road in Delhi, India, in 2015. Photograph: AP/Wide World

Future urban areas?



**Imperial College
London**

Dr Gary Fuller

gary.fuller@imperial.ac.uk

@drgaryFuller

www.londonair.org.uk

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Great Ormond Street Hospital turns the road outside from a problem to an asset – pure inspiration!

<https://vimeo.com/348195177>

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