

# Realising the Health Benefits of Cleaner Air in Scotland

Fintan Hurley  
[fintan.hurley@iom-world.org](mailto:fintan.hurley@iom-world.org)

PHINS Seminar, Glasgow  
13 September 2019

# You are influential... and air pollution matters...

- It's a major public health issue
  - 6-7 million (!!!) deaths per year worldwide -
  - 1,500-2,000 (!) deaths per year in Scotland
- Environmental justice issues:
  - Everybody is exposed: you can reduce exposure but you can't escape it
  - Effects are distributed unequally
- There are significant win-wins in tackling it - with climate change, with health benefits of active travel etc. etc.

# ...and it matters to me

- 70 next birthday - and retired from paid work
- We have three great linked environmental crises from human activities
  - Global warming (overheating) and climate disruption
  - Resource depletion - including loss of biodiversity
  - Environmental pollution - air, water...
- I see these as having a common underlying cause
  - Society designed around growth and short-term profit - greed has been institutionalised
  - Also causing gross inequalities
  - Maintained in part by organising prejudice and the normalisation of lies and 'fake news'
- So if I can still do a little to help better understanding... I will

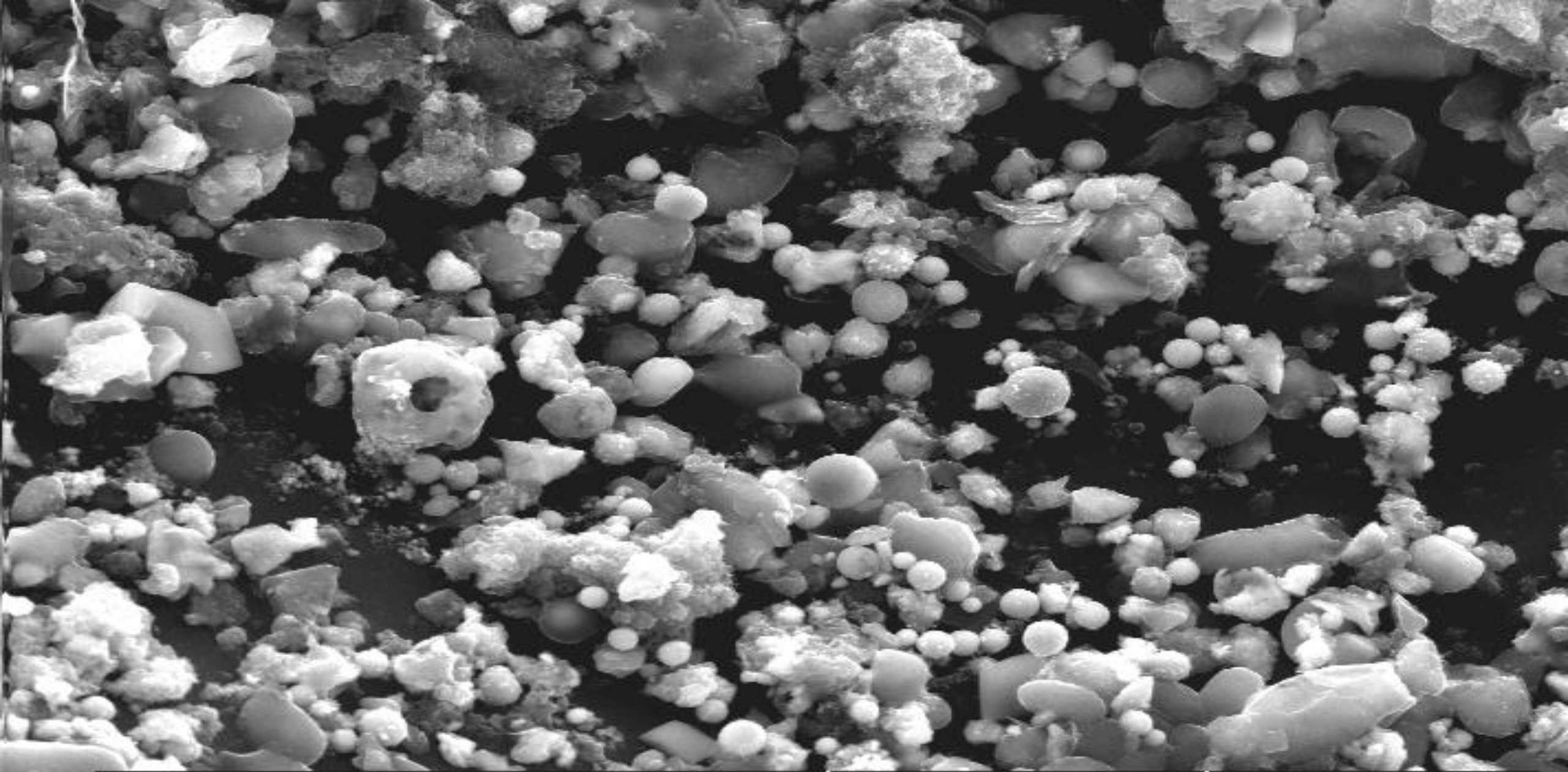
# This talk: 'Realising' the effects...

- What is the problem and how big is it?
- What can we do about it?
- Independent review of the Cleaner Air for Scotland (CAFS) Strategy - published 29 August 2019
  - Overall Report: Prof Campbell Gemmell et al  
<https://www.gov.scot/publications/cleaner-air-scotland-strategy-independent-review/>
  - Health and Environment WG: Colin Ramsay, HPS et al  
<http://www.scottishairquality.scot/assets/documents/Health-Environment-Working-Group-Report.pdf>

# Outdoor air pollution is a mixture...

- ...of particles (Particulate Matter: PM) and gases
- Gases emitted from combustion (burning); especially
  - Nitrogen dioxide (NO<sub>2</sub>) (mostly traffic),
  - Sulphur dioxide (SO<sub>2</sub>) (mostly industry), [CO - mostly traffic]
- Gases formed later: Ground-level ozone (O<sub>3</sub>), from NO<sub>x</sub>
- PM is itself a mixture - varies by size, composition, surface properties
  - Primary particles (i) from combustion (traffic, industry, heating) (ii) brakes and tyres, natural dusts, re-suspended road dusts...
  - Secondary particles - nitrates and sulphates - formed over longer distances when gases (NO<sub>2</sub>, SO<sub>2</sub>) interact with e.g. ammonia
- For example: particulate matter (PM) from near a steel mill in South Wales





Acc.V Spot Magn Det WD Exp |-----| 20 μm  
20.0 kV 4.0 1500x SE 10.0 33 Port Talbot2

# Epidemiology studies: Air pollution and health



- Effects of short-term exposure (day-to-day variations in pollution)
  - Air pollution episodes, like the London smog(s) of the 1950s
    - Clear evidence of effects - unclear which pollutant
  - Effects of day-to-day pollution at 'ordinary' levels on 'health' (deaths; hospital admissions; etc.) on the same day or immediately following days
    - Thousands of good studies worldwide, typically in large cities show increased risks with many pollutants at 'ordinary' levels
    - Pollution at 'ordinary' levels is bad for you
- Effects of long-term (annual average) exposure:
  - People living long-term exposed to different levels and kinds of air pollution (e.g. in different cities)
  - Taking account of personal and city characteristics
  - Relationships with PM<sub>2.5</sub>, also NO<sub>2</sub> and ozone
  - Biggest public health effects
- No known safe level of PM (PM<sub>2.5</sub>)

# Like smoking, air pollution has multiple effects on health

- From mother's exposure pre-birth - prematurity; small size for gestational age;
  - Through infant mortality and impaired lung development
  - Through multiple cardiovascular and respiratory effects - some reversible, some chronic;
  - Lung cancer; diabetes; dementia...
  - More GP visits, more hospitalisation, more days off work
  - Earlier death - and earlier chronic illness
  - Not a happy picture!
- 
- In this talk we focus on the biggest public health burden i.e.
  - Increased deaths from long-term exposure to air pollution...
  - ...especially PM<sub>2.5</sub> as the most likely responsible pollutant (mixture)

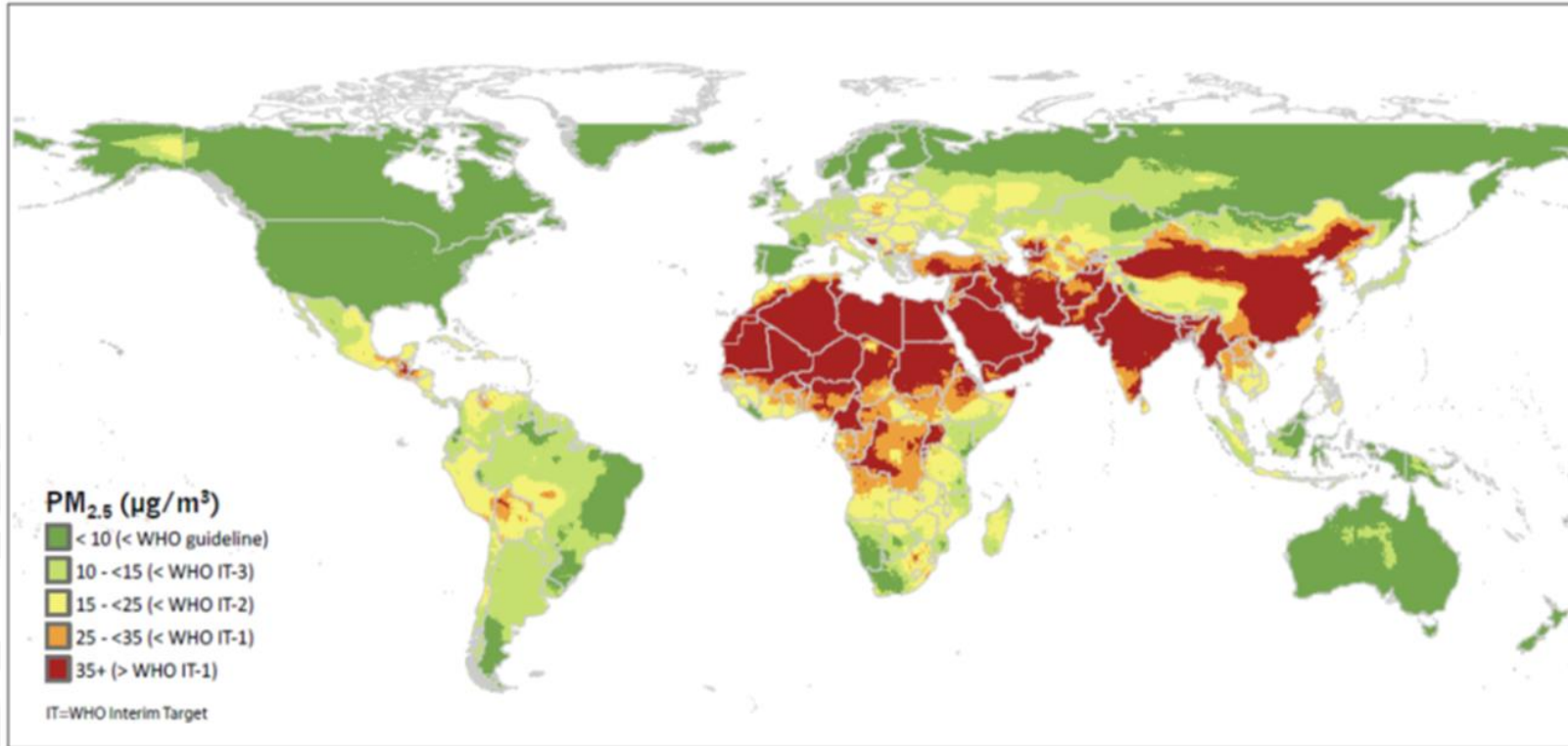


# Attributable deaths worldwide in 2016

- Attributable to outdoor air pollution:
  - 4.3 million people per year (!!!); especially in mega-cities of India and China... (4.1 from PM, 0.2 from ozone)
- Attributable to household air pollution – burning solid fuels for heating, cooking, lighting
  - 2.6 million people per year (!!!); especially in sub-Saharan Africa
- Total attributable to air pollution:
  - 6.1 million people per year (!!!); [Overlap of 0.8m between ambient and household]
- New estimate (Burnett et al., 2018): 8.9 million deaths per year for outdoor air pollution only (!!!!). <https://www.pnas.org/content/115/38/9592>

*State of Global Air 2018 Special Report.* Health Effects Institute, Boston <https://www.stateofglobalair.org>

# Estimated annual average outdoor PM<sub>2.5</sub> worldwide 2015 – Scotland is low...



Annual average PM<sub>2.5</sub> concentrations in 2015 compared to the WHO Air Quality guideline and interim targets.

From Figure 3 *State of Global Air 2017 Special Report*. Health Effects Institute, Boston <https://www.stateofglobalair.org/>

# But there is still a big problem: Annual deaths due to air pollution: Scotland...



- COMEAP 2010: Applied international risks to the UK, using  $PM_{2.5}$  as an indicator of the overall pollution mixture
  - UK: Estimated  $9 \mu\text{g.m}^{-3} PM_{2.5}$ : 29,000 deaths in 2008
  - Scotland: Estimated  $5 \mu\text{g.m}^{-3} PM_{2.5}$ : 1560 deaths in 2008
  - Later Health Protection Scotland (Briefing Note, June 2018), similar methods, gives higher estimates 1780 deaths in 2013; 1724 in 2016.
- What do they mean? COMEAP (2010) tried to explain...
  - Because air pollution is one factor among many, the number of individuals with lives shortened by air pollution may be much larger
  - “Air pollution may have made some contribution to the earlier deaths of up to 200,000 [in the UK] in 2008...This assumption remains speculative.”
  - A good way to convey the size of the public health problem to compare with other risks: “...*equivalent to 29,000 deaths per year (at typical ages)*”
  - In Scotland, 10,000-15,000 individuals per year? SPECULATIVE!

COMEAP 2010: <https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk>

# If PM<sub>2.5</sub> is the main problem... What's the point in reducing NO<sub>2</sub>?

- WHO (2013) REVIHAAP: Review of studies of people living close to busy roads... Something more than PM<sub>2.5</sub>
  - Maybe NO<sub>2</sub>, maybe other traffic pollutants (e.g. particle number)
  - Some effect of NO<sub>2</sub> itself but unclear how much.
- Most AQMAs (Air Quality Management Areas) are based on limiting NO<sub>2</sub> - best to control traffic pollution as a whole, not just NO<sub>2</sub> only.
  - COMEAP (2018) used PM<sub>2.5</sub> and NO<sub>2</sub> together to estimate deaths
  - Best (not agreed) estimate 28,000 to 35,000 deaths per year UK-wide
  - No Scottish results but *pro rata* 1,500-2,000 deaths per year
- An epidemic! (Imagine if these were infectious diseases!).

WHO (2013) [http://www.euro.who.int/\\_data/assets/pdf\\_file/0004/193108/REVIHAAP-Final-technical-report.pdf](http://www.euro.who.int/_data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report.pdf)

COMEAP 2018: <https://www.gov.uk/government/publications/nitrogen-dioxide-effects-on-mortality>

# Do international results apply also in Scotland?

## (1): PM<sub>2.5</sub> and deaths from cardiovascular causes

- Strong international evidence of
  - Respiratory effects - in Scottish studies also
  - Cardiovascular effects - but several epidemiological studies in Scotland do not find this.
  - Based on review by Prof Duncan Lee (Univ Glasgow), for CAFS review
  - NB We do not know why.
- Implications - c/f CAFS review
  - As a precaution, accept the international evidence (supported by mechanistic evidence) that there are CV effects
  - But retain some scepticism about “the size of the problem” as estimated from international data
  - And acknowledge that even the Scottish studies show significant adverse health effects



# Do international results apply also in Scotland?

## (2): Effects at low average concentrations

- Identified by CAFS as a knowledge gap / need to review
- Di et al. (2017) showed clear effects at low exposures in the USA:
  - Huge study: Medicare population: >60m people; >20m deaths (!)
  - Generally low annual average PM<sub>2.5</sub> concentrations (>90% lived at levels between 6 and 16 µg.m<sup>-3</sup>)
  - Risks of death overall similar to usual:
    - 7.3% (95% CI 7.1-7.5) increase in risk per 10 µg.m<sup>-3</sup> PM<sub>2.5</sub>
    - (COMEAP uses 6% increase per 10 µg.m<sup>-3</sup> PM<sub>2.5</sub>)
  - Higher risks in people who lived at below 12 µg.m<sup>-3</sup> PM<sub>2.5</sub>
    - 13.6% (95% CI 13.1-14.1) increase in risk per 10 µg.m<sup>-3</sup> PM<sub>2.5</sub>
  - Higher risks from PM<sub>2.5</sub> in men; black, Asian and Hispanic people; and poorer people - among black people, risks 3 times general population

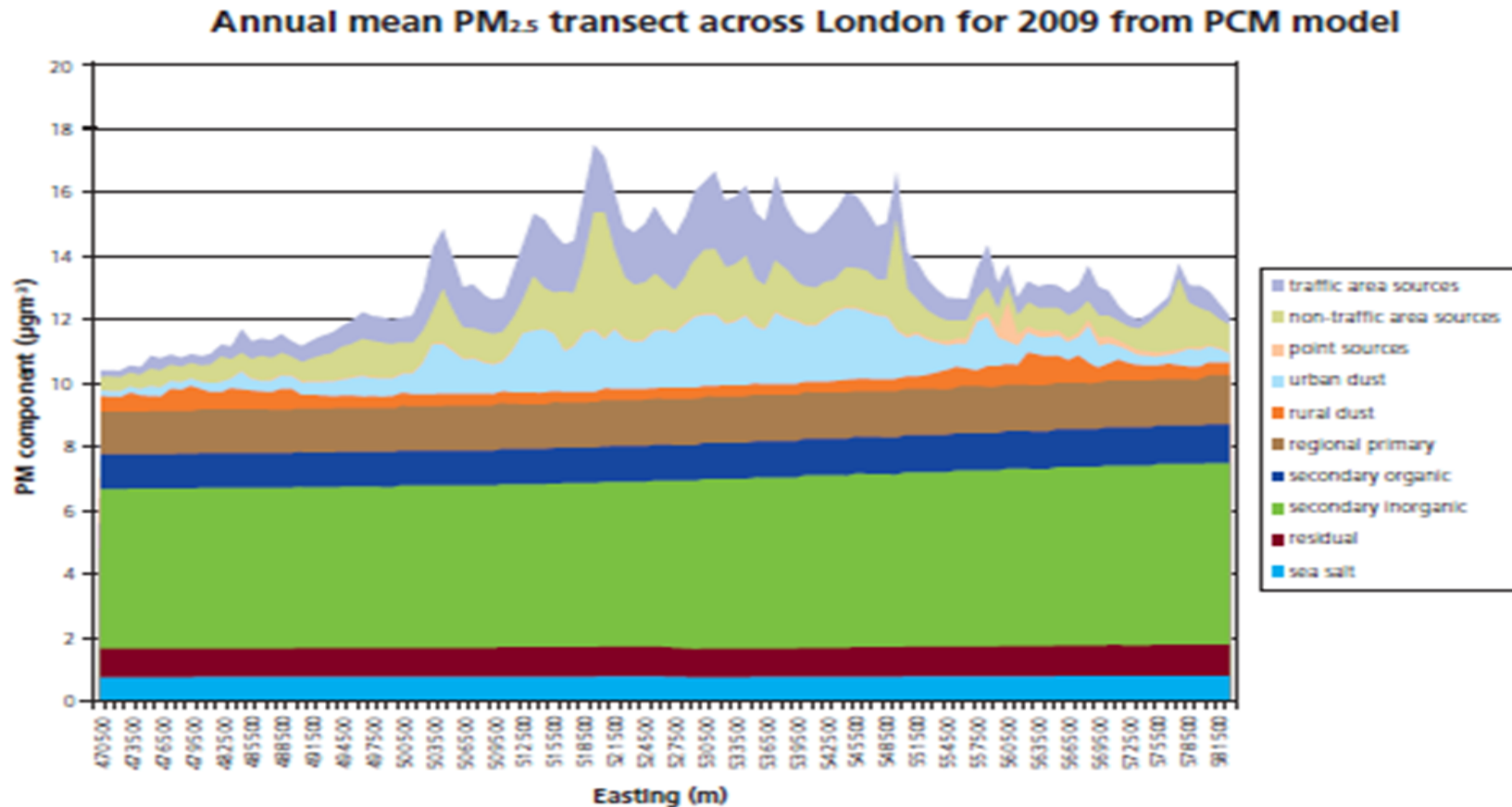
Qian Di et al. (2017) N Engl J Med 2017; 376:2513-22. DOI: 10.1056/NEJMoa1702747

# Air pollution and health: we are all at risk but some more than others. Inequalities...

- In concentrations and exposures experienced
- In susceptibility to the same pollution, i.e. in % change in health effect per unit pollution
  - Varies by age, poverty/ deprivation, ethnicity... sometimes by location
- In background rates of death and disease, and so in public health effects, even for same exposures and same % higher risk:
  - Typically air pollution “amplifies” existing differences in background rates of mortality and morbidity, by some % increase
  - Older people, poorer people, people with serious disease, have higher background rates of mortality and morbidity - and so the same % increase has a bigger impact, per 100,000 people exposed.
- In take-up of interventions / ‘solutions’

Similar environmental justice issue to climate disruption? Those who most cause the problem not the same as those who get the worst effects

# Pollution travels... Up to 50% PM<sub>2.5</sub> in Scotland from elsewhere... Co-operation is essential!



- AQEG (2012) Fig 5.6: London: From West to East: Henley-on-Thames to Southend-on-Sea [https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1212141150\\_AQEG\\_Fine\\_Part particulate\\_Matter\\_in\\_the\\_UK.pdf](https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1212141150_AQEG_Fine_Part particulate_Matter_in_the_UK.pdf)
- Up to 50%... CAFS, Para 6.6, p33

# Transport (from CAFS Exec Summary)

- Interventions need to be coupled to encouraging people to change their habitual transport choices... [requiring] more and better coordinated government action.
- More focus on inter-related interventions including:
  - Improved transport infrastructure that encourages higher levels of active travel (walking, cycling);
  - Improved access to accessible, affordable and better quality public transport offering more attractive alternatives to private vehicles;
  - Greater encouragement to adopt less polluting private personal transport (e.g. low and zero emission vehicles).
  - More and better public information on pollution and transport
- Low Emission Zones... are a necessary and important commitment in delivering cleaner air and they need to be effectively implemented.
- AQMAs can and need to be operated more effectively.

# Domestic Burning

- Coal, oil, gas, wood for heating and cooking
- **Outdoor Air:** CAFS review: Domestic sources... are significant contributors to air pollution in Scotland - not included in CAFS 2015.
  - Better performance of domestic fires and stoves
  - Appropriate fuel attributes and
  - Local authority powers to permit and control these issues
- **Indoor Air: (Pollution from indoor sources)**
  - IAPAH Study - Univ Galway, Univ Aberdeen, IOM Edinburgh
  - The main indoor source of PM<sub>2.5</sub> was indoor tobacco smoking (where this occurred) - far greater than coal, gas, peat for heating or cooking
  - NB: Insulation can lock in pollution from indoor sources

Semple et al. (2012) Indoor Air 22:212-223. doi: 10.1111/j.1600-0668.2011.00755.x.



- 90% of ammonia emissions come from agriculture - urine; fertiliser
- In the atmosphere ammonia binds with gases ( $\text{NO}_2$ ,  $\text{SO}_2$ ) to form small particles ( $\text{PM}_{2.5}$ )
- CAFS proposes education and (as a minimum) a voluntary Code of Practice (c/f DEFRA / UK Clean Air Strategy). From CAFS para 6.26:
  - Many emission reduction practices of have long-term positive business benefits if taken up quickly;
  - If uptake is slow... more direct regulatory intervention
  - Despite guidance available in Scotland over the last 15 years, very little reduction in ammonia emissions.
- Again, co-benefits with reducing greenhouse gas emissions - methane from agriculture
- Not my specialism but... both for ammonia and methane reduction:
  - Is it intensive in-house (dairy?) herds, rather than animal grazing?

- Policies and plans at national and local levels for climate change... and... noise reduction... [and place-making] should be closely coordinated and aligned with air quality action plans and with each other in order to maximise co-benefits.
- Local government... [and central government too]... must act in a more coherent manner to ensure strategies and plans to fit together and cross-professional and functional effort is strongly aligned.
- Consider... “a presumption that any major new development (e.g. a new road or housing development)
  - must not lead to a net increase in carbon emissions,
  - must not worsen air quality, and
  - must not exacerbate existing health inequalities”.

AIR POLLUTION IS A MAJOR PUBLIC HEALTH ISSUE

CLEANER AIR IS POSSIBLE...  
PLEASE WORK FOR IT!

THANK YOU.