Realising the Health Benefits of Cleaner Air in Scotland

Fintan Hurley
fintan.hurley@iom-world.org

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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
  - Health and Environment WG: Colin Ramsay, HPS et al
Outdoor air pollution is a mixture...

• ...of particles (Particulate Matter: PM) and gases
• Gases emitted from combustion (burning); especially
  • Nitrogen dioxide (NO2) (mostly traffic),
  • Sulphur dioxide (SO2) (mostly industry), [CO - mostly traffic]
• Gases formed later: Ground-level ozone (O3), from NOx
• 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 (NO2, SO2) interact with e.g. ammonia

• For example: particulate matter (PM) from near a steel mill in South Wales
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$_{2.5}$, also NO$_2$ and ozone
  - Biggest public health effects

- No known safe level of PM (PM$_{2.5}$)
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$_{2.5}$ 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](https://www.pnas.org/content/115/38/9592)

*State of Global Air 2018 Special Report*. Health Effects Institute, Boston [https://www.stateofglobalair.org](https://www.stateofglobalair.org)

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Estimated annual average outdoor PM$_{2.5}$ worldwide 2015 – Scotland is low...

Annual average PM$_{2.5}$ 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 µg.m$^{-3}$ PM$_{2.5}$: 29,000 deaths in 2008
  - **Scotland**: Estimated 5 µg.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!

If PM$_{2.5}$ is the main problem... What’s the point in reducing NO$_2$?

- WHO (2013) REVIHAAP: Review of studies of people living close to busy roads... Something more than PM$_{2.5}$
  - Maybe NO$_2$, maybe other traffic pollutants (e.g. particle number)
  - Some effect of NO$_2$ itself but unclear how much.

- Most AQMAs (Air Quality Management Areas) are based on limiting NO$_2$ - best to control traffic pollution as a whole, not just NO$_2$ only.
  - COMEAP (2018) used PM$_{2.5}$ and NO$_2$ 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!).

Do international results apply also in Scotland? (1): PM$_{2.5}$ 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$_{2.5}$ concentrations (>90% lived at levels between 6 and 16 µg.m$^{-3}$)
  - Risks of death overall similar to usual:
    - 7.3% (95% CI 7.1-7.5) increase in risk per 10 µg.m$^{-3}$ PM$_{2.5}$
    - (COMEAP uses 6% increase per 10 µg.m$^{-3}$ PM$_{2.5}$)
    - Higher risks in people who lived at below 12 µg.m$^{-3}$ PM$_{2.5}$
      - 13.6% (95% CI 13.1-14.1) increase in risk per 10 µg.m$^{-3}$ PM$_{2.5}$
    - Higher risks from PM$_{2.5}$ in men; black, Asian and Hispanic people; and poorer people - among black people, risks 3 times general population

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$_{2.5}$ 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
- Up to 50%... CAFS, Para 6.6, p33

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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$_{2.5}$ 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

Agriculture / Ammonia

- 90% of ammonia emissions come from agriculture - urine; fertiliser
- In the atmosphere ammonia binds with gases (NO$_2$, SO$_2$) to form small particles (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?
Integrated Strategies (Thematic and Organisational)

• Policies and plans at national and local levels for climate change... and... noise reduction... [and place-making] should be closely co-ordinated 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.