

# **Air pollution and Health Impacts**

## **A Scottish Context**

**Cleaner Air for Scotland Review**  
**10<sup>th</sup> January 2019**

Dr. Colin N. Ramsay,  
Consultant Epidemiologist in Environmental Public Health,  
Deputy Interim Clinical Director,  
HPS.

# Air Pollution and Health Impacts

- Which air pollutants matter most?
- What effects do pollutants have on health?
- What is the evidence linking air pollution and health impacts in Scotland?
- How much difference might interventions (e.g. LEZs) make on health outcomes in Scotland.



## Air pollution 'causing deadly public health crisis'

By James Gallagher

Health editor, BBC News website

Health editor, BBC News website



Nitrogen dioxide is a by-product of diesel engines

New schools, care homes and hospitals should be built far away from major roads because of the dangers of air pollution, a report by MPs says.

The Environmental Audit Committee argues air pollution is a "public health crisis" causing nearly as many deaths as smoking.

It also suggested a scrappage scheme for diesel cars to cut emissions.

### Related Stories

[Air pollution link to 29,000 deaths](#)

[EU takes UK to court over dirty air](#)

[EU cleans air over](#)



The Lancet Commission on pollution and health. October 19, 2017

“Glasgow is one of the most polluted parts of the UK”

“Glasgow more polluted than London”







The Lancet Commission on pollution and health.  
October 19, 2017

- $PM_{2.5}$  levels from 51 cities compared to WHO limit of  $10 \mu\text{g}/\text{m}^3$
- Glasgow had  $16 \mu\text{g}/\text{m}^3$  (one single roadside monitor)
- London and Leeds had  $15 \mu\text{g}/\text{m}^3$



# Which pollutants matter most?

- **Air pollution is a complex interacting mixture**
  - Particulates (PM), Nitrogen Oxides (NO<sub>x</sub>, NO<sub>2</sub>), Ozone (O<sub>3</sub>), NMVOCs, etc.
  - PM + NO<sub>x</sub> are most important in terms of human health impacts,
  - Effects closely interlinked – hard to calculate impact of single pollutants.
- **Natural sources**
  - Environmental background (soil, sea salt) transboundary (volcanoes/Sahara dust) - non-preventable
- **Manmade sources (anthropogenic)**
  - Emissions from industry, domestic heating, transport:
    - trains, aircraft, ships and especially road vehicles.
  - Preventable - potentially

## Health Effects of Particulates (PM)

### Short-term increases in PM levels - associated with acute health effects:

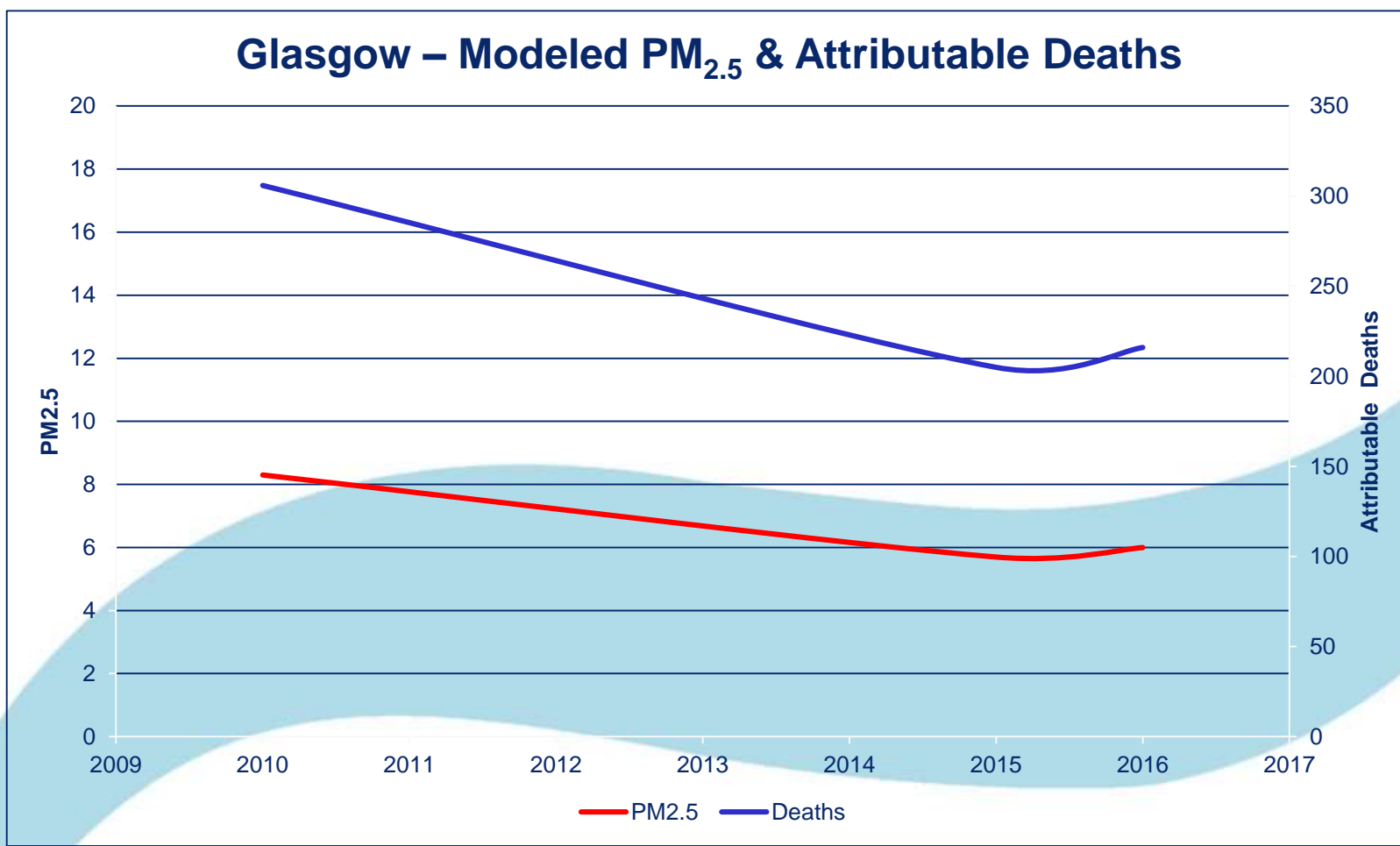
- increased use of medication (e.g. asthma inhalers),
  - days off work and days with restricted activity,
  - hospital admission for lung and heart diseases,
  - risk of death from asthma, COPD, heart disease.
- Impacts identified at progressively lower PM concentrations.
  - Probably no lower threshold limit for adverse effects.

## Long term exposure to particulates - PM<sub>2.5</sub>

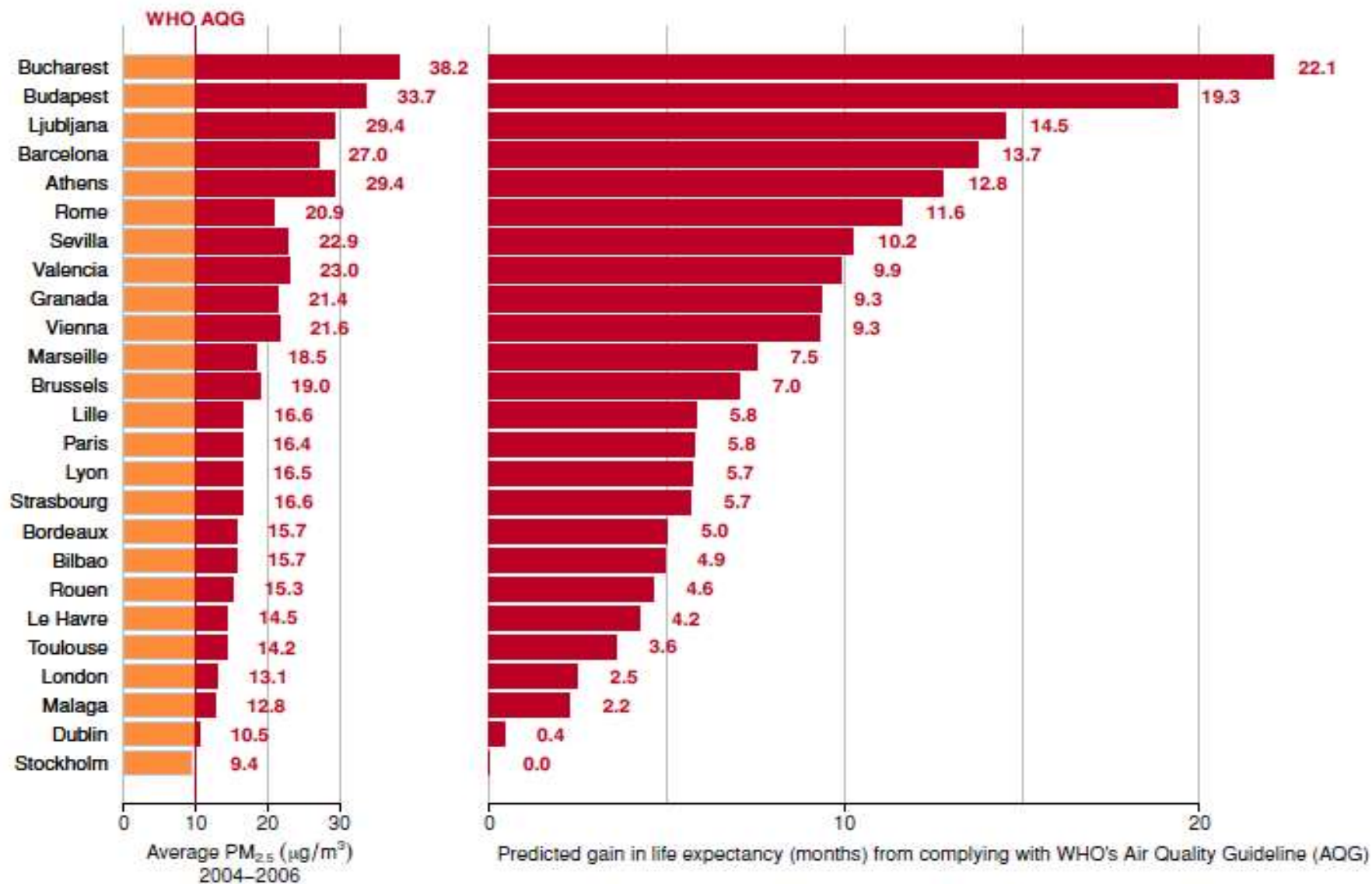
- increased deaths from all causes, heart attack, chronic lung disease, stroke and lung cancer.
- Estimated reduction in average life expectancy of 3-4 months in Scotland (COMEAP 2010).
- Estimated (statistically) as equivalent to approx. 1700 “excess” deaths at 2016 levels of anthropogenic PM<sub>2.5</sub> (assumes PM<sub>2.5</sub> is the sole cause of death – but it isn’t!)
- NB. - interpret estimates of “excess deaths caused by AP” with caution – not actual deaths (cf. RTA deaths).



## PM<sub>2.5</sub> Attributable Mortality in Glasgow using COMEAP (2010) excess mortality hazard ratio (1.06)



## Predicted average gain in life expectancy (months) for persons 30 years of age and older in 25 Apekom cities for a decrease in average annual level of PM<sub>2.5</sub> to 10 µg/m<sup>3</sup> (WHO's Air Quality Guideline)



## **Additional effects of long term PM<sub>2.5</sub> exposure**

### **- emerging evidence:**

- less strong but associations also identified with:
  - adverse birth outcomes, low birth weight,
  - childhood asthma,
  - cognitive dysfunction – dementia,
  - chronic metabolic disease e.g. diabetes.

## Recent trends in air quality in Scotland

- Levels of main pollutants (PM, NO<sub>x</sub>) have steadily reduced over past decades,
- average ambient air pollution levels are now among the lowest in the UK and Europe.

### ***But***

- EU annual mean limit value for NO<sub>2</sub> (40µg/m<sup>3</sup>) is being exceeded at some city centre locations.

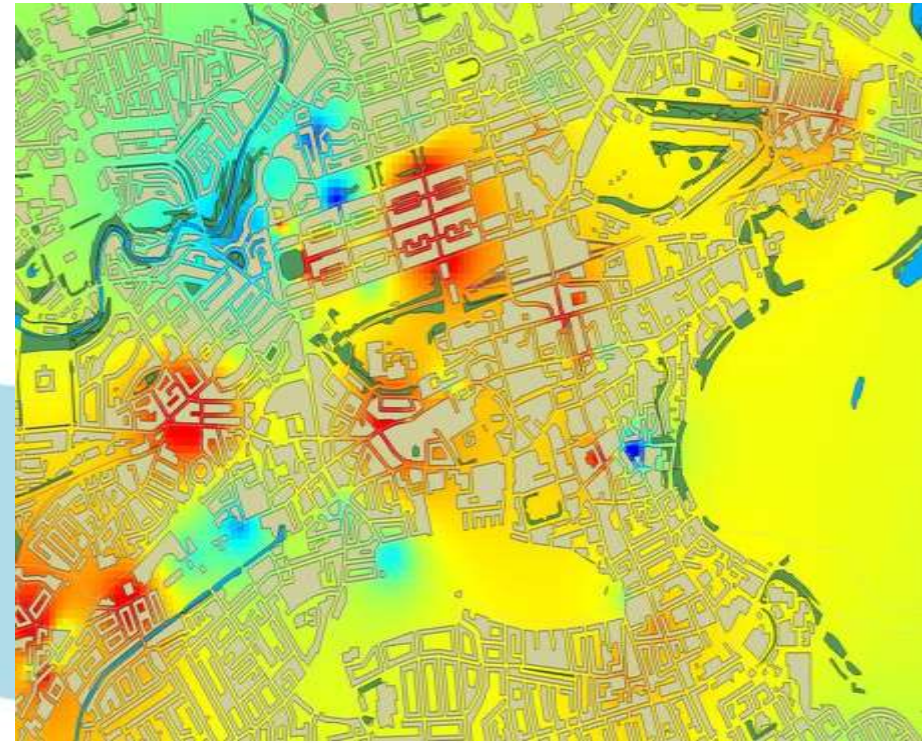
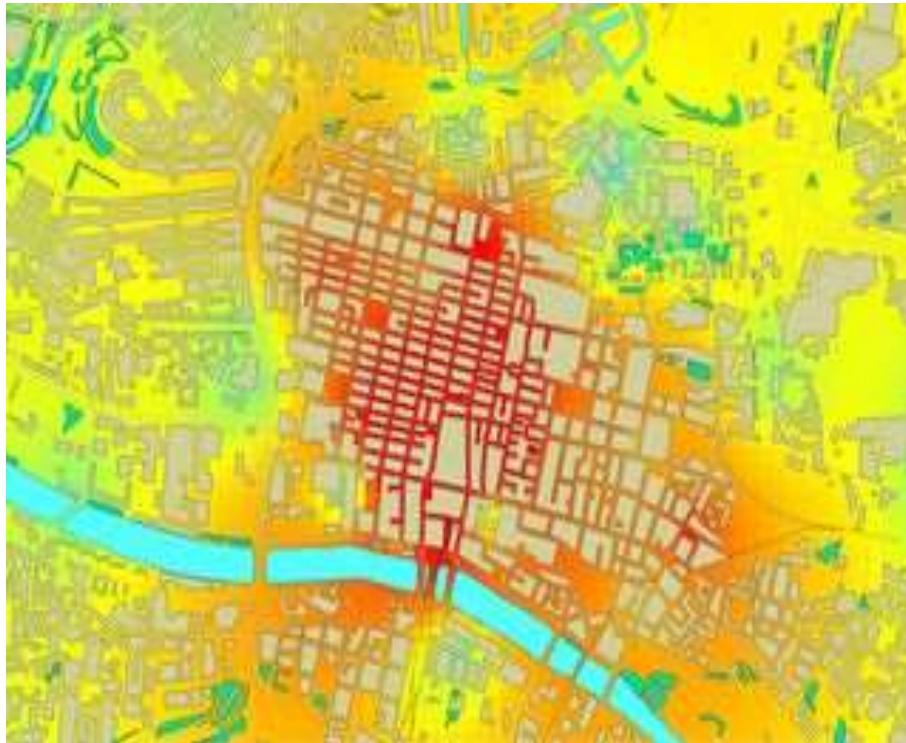


## Nitrogen dioxide levels, in Glasgow and Edinburgh

(Friends of the Earth Scotland).

“Air pollution: the mass killer that keeps on killing”

(Sunday Herald New Era magazine, 19 May 2013)





# Health Impacts of NO<sub>2</sub> exposure

## Short-term (acute) and long-term (chronic) impacts:

- increased mortality (deaths),
- increased hospital admissions (especially for chronic respiratory illness),
- impacts probably caused by NO<sub>2</sub> alone but strong correlation with PM exposure health effects,
- COMEAP (2018) report on estimates of combined effects of NO<sub>2</sub> and PM – ranges of effect estimates.

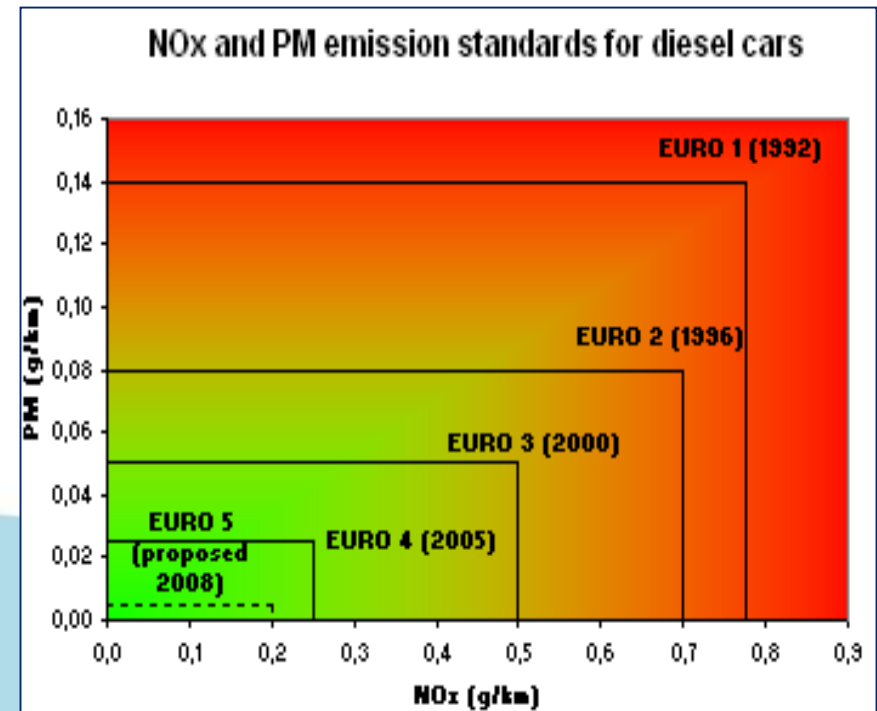
## Health Effects of Air Pollution in Scotland

Various local studies; mixed findings of effects:

- Small area comparison of PM, NO<sub>x</sub> and health (Lee *et al* 2019),
- Positive association linking PM and NO<sub>x</sub> exposure with:
  - ↑ Respiratory hospital admissions 5.8% ↑ for 1 µg/m<sup>3</sup> PM<sub>2.5</sub>
  - 2.8% ↑ for 5 µg/m<sup>3</sup> NO<sub>2</sub>
- Respiratory deaths associated with PM<sub>2.5</sub> but not NO<sub>x</sub> / NO<sub>2</sub>
  - 4.5% ↑ in deaths from respiratory disease per 1 µg/m<sup>3</sup> PM<sub>2.5</sub>
- No association of any air pollutants with cardiovascular deaths or hospitalisations.

# Low Emission Zones (LEZs)

- First adopted Sweden 1996.
- Based on EU vehicle emission standards
- Progressively stricter controls:
  - Euro 6 from 2014
- PM<sub>10</sub> - 24hr AQ objective
  - 50µg/m<sup>3</sup>
- NO<sub>2</sub> - EU annual mean limit value
  - 40µg/m<sup>3</sup>



# Impact of LEZs on Air Pollution

## 2016 AIRUSE Report - 200 LEZs in Europe:

- inconsistent evidence of reduction in pollutant levels

### **PM<sub>10</sub>**

- up to 12% reduction in Munich;
- but most LEZs had no effect on annual mean PM<sub>10</sub>

### **PM<sub>2.5</sub>**

- reduced in Munich and London but not Amsterdam.

### **NO<sub>2</sub>**

- reduced by 4% to 10% in Berlin and other German cities
- no impact in London or 11 Dutch cities.



# London LEZ – Health Impacts

## London LEZ Baseline Study (HEI 2011)

- No positive association between  $\text{NO}_x$  and adverse health outcomes e.g. respiratory, cardiac disease.



## Respiratory/allergic symptoms in school children (Wood et al 2015)

- “current rhinitis” associated with  $\text{NO}_2$ ,  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  levels,
- no association between pollutants and other respiratory/allergic symptoms.

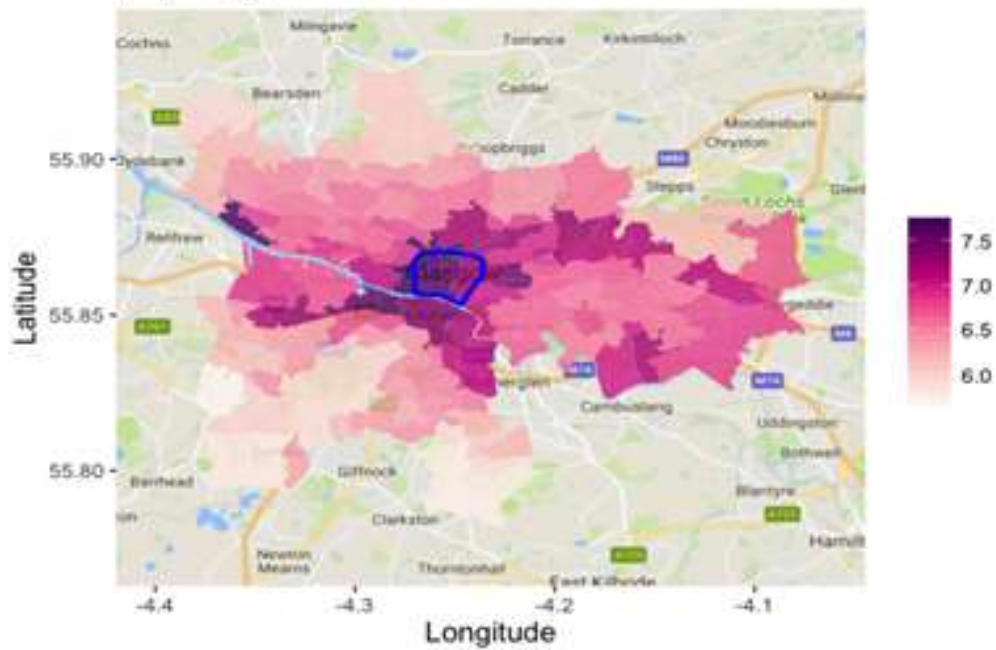


## **Glasgow LEZ – impacts on health** (Lee et al 2019)

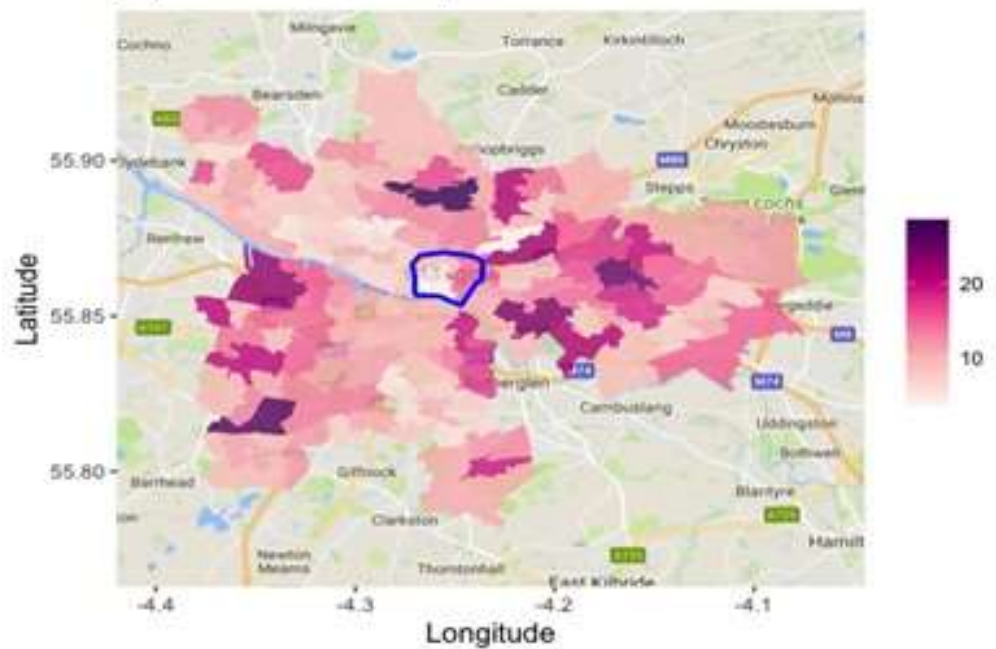
Estimated reductions in respiratory hospital admissions and deaths over 2 year period (2015/2016).

- $PM_{2.5}$  ↓  $1\mu g/m^3$ 
  - 27 fewer hospital admissions (14/year) (versus 1576 across CGC area),
  - 1 fewer death (versus 78 across CGC area).
- $NO_2$  ↓  $5\mu g/m^3$ 
  - 13 fewer hospital admissions (versus 784 across CGC area).
- Limited beneficial effect due to low resident population in city centre - LEZ area.

(D) PM<sub>2.5</sub>



(C) Reduction in hospitalisations



## Conclusions on air pollution and health

- AP does not directly cause distinctive diseases.
- AP magnifies effects of existing vulnerability factors:
  - age: very young & very old,
  - socio-economic status/ deprivation; tobacco smoking
- Worsens existing poor health among vulnerable people
  - respiratory illness: asthma, COPD;
  - cardiovascular & cerebrovascular disease.
- Air pollution is a health inequalities issue.

## Conclusions on air pollution and health

- **Air pollution (AP) is bad for health** - *we don't fully understand how but we know enough to want to reduce it.*
- **Particulates (PM) and nitrogen oxides (NO<sub>x</sub>/ NO<sub>2</sub>) have most impact on public health** - *but we know more about the effects on populations than on individual people*
- **Manmade AP is preventable** - **road transport is a major source of manmade air pollution.**
- **LEZs have a role in reducing AP and preventing adverse health impacts** *but need to be part of a comprehensive health improvement strategy.*

# Cleaner Air for Scotland (CAFS) Strategy

## Multi-focus approach to reduce air pollution and adverse health impacts

- establish Low Emission Zones (LEZs) in Aberdeen, Dundee, Glasgow, Edinburgh,
- change travel behaviour - reduce commuting,
- encourage public transport use,
- encourage modal shift - ULE vehicles,
- support active travel with more infrastructure.

