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# Vehicle emissions and health

Matt Henshaw



# Introduction

## Myself

- Deloitte's Capital Markets Group since 2012
- FIA 2015 – Life Insurance
- Actuarial, modelling & analytics



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# Introduction

## Why this topic

- Andrew Smith and cycling
- Big data, machine learning and HexScore
- The countryside and a trip to Beijing



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# Agenda

- Introduction to pollution
- Data sources
- UK examples
- Challenges and limitations
- Effects
- Conclusions



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# Pollution

## Breakdown of gases

# Air Pollution

Greenhouse  
Gases

Nitrogen and  
Sulphur  
Oxides

Particulate  
Matter

CO, CO<sub>2</sub>

Methane

NO, NO<sub>2</sub>

SO<sub>2</sub>

Coarse

Fine

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# Pollution

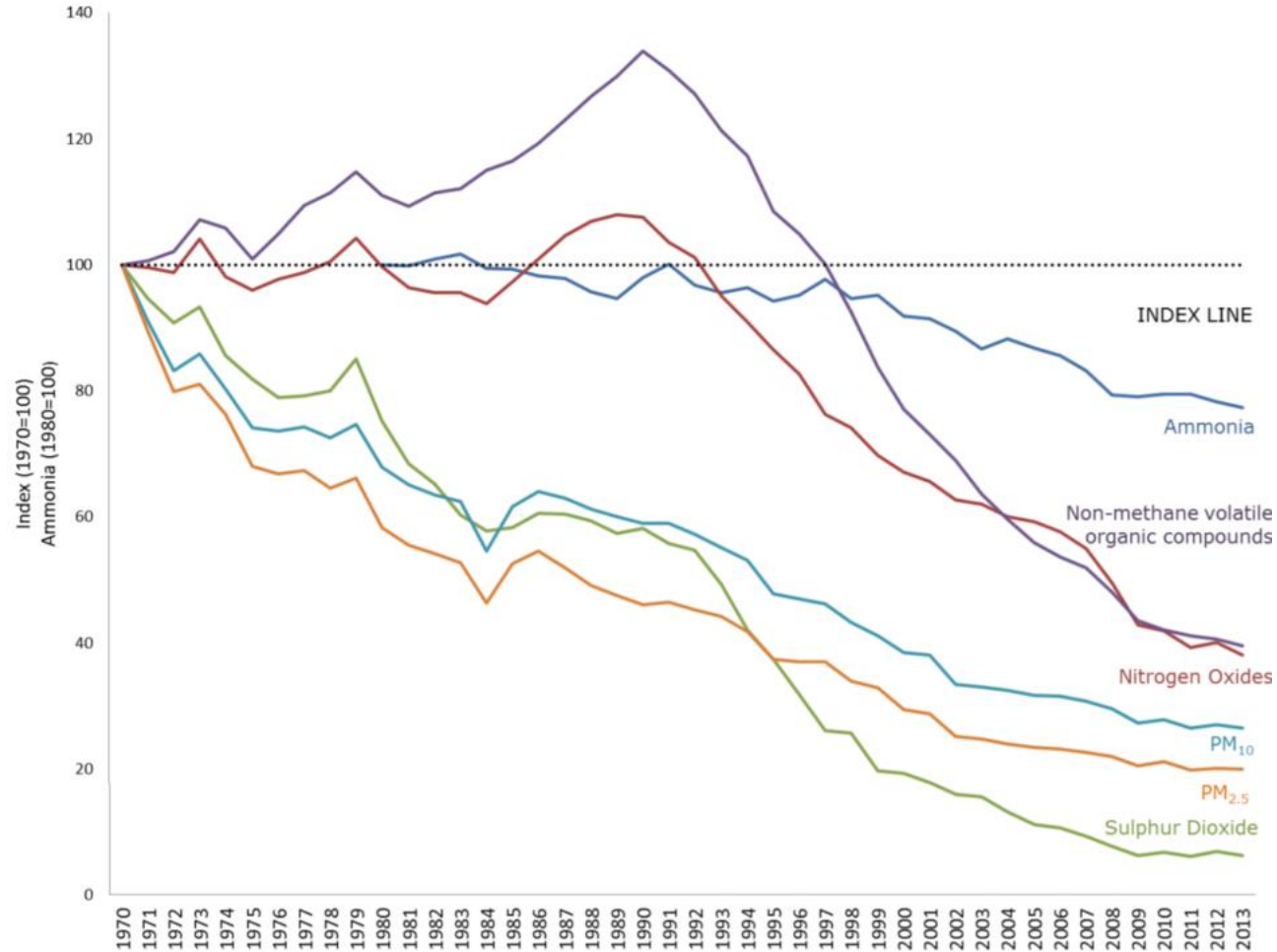
## Overall effects

- 40,000 – 50,000 early deaths per year in the UK
- 6,000 deaths from emissions produced in the EU
- £15-20bn cost per year to the UK economy



# Pollution

## Current levels



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# Greenhouse gases

## Summary

- Carbon monoxide (CO)
  - Highly toxic but quickly oxidises in the air after being emitted
- Carbon dioxide (CO<sub>2</sub>)
  - Responsible for global warming and toxic at high concentration
- Methane
  - Large contributor to climate change





# Nitrogen and sulphur oxides

## Summary

- Sulphur dioxide ( $\text{SO}_2$ )
  - Naturally occurring, industrial processes, traffic.
- Nitrogen oxide ( $\text{NO}$ )
  - Rapidly oxidises in the air after being emitted
- Nitrogen dioxide ( $\text{NO}_2$ )
  - Harmful pollutant associated with traffic and industry



# Nitrogen and sulphur oxides

## Effects

- Associated with respiratory diseases
  - Chronic Obstructive Pulmonary Disease (COPD),
  - Asthma aggravation
- UK over NO<sub>2</sub> limit in 38 of 43 areas
  - Year 2030 before all of UK is compliant
- Poor dispersal rate and water soluble causing acid rain
  - Damaging eco-systems as well as human health



# Nitrogen and sulphur oxides Action

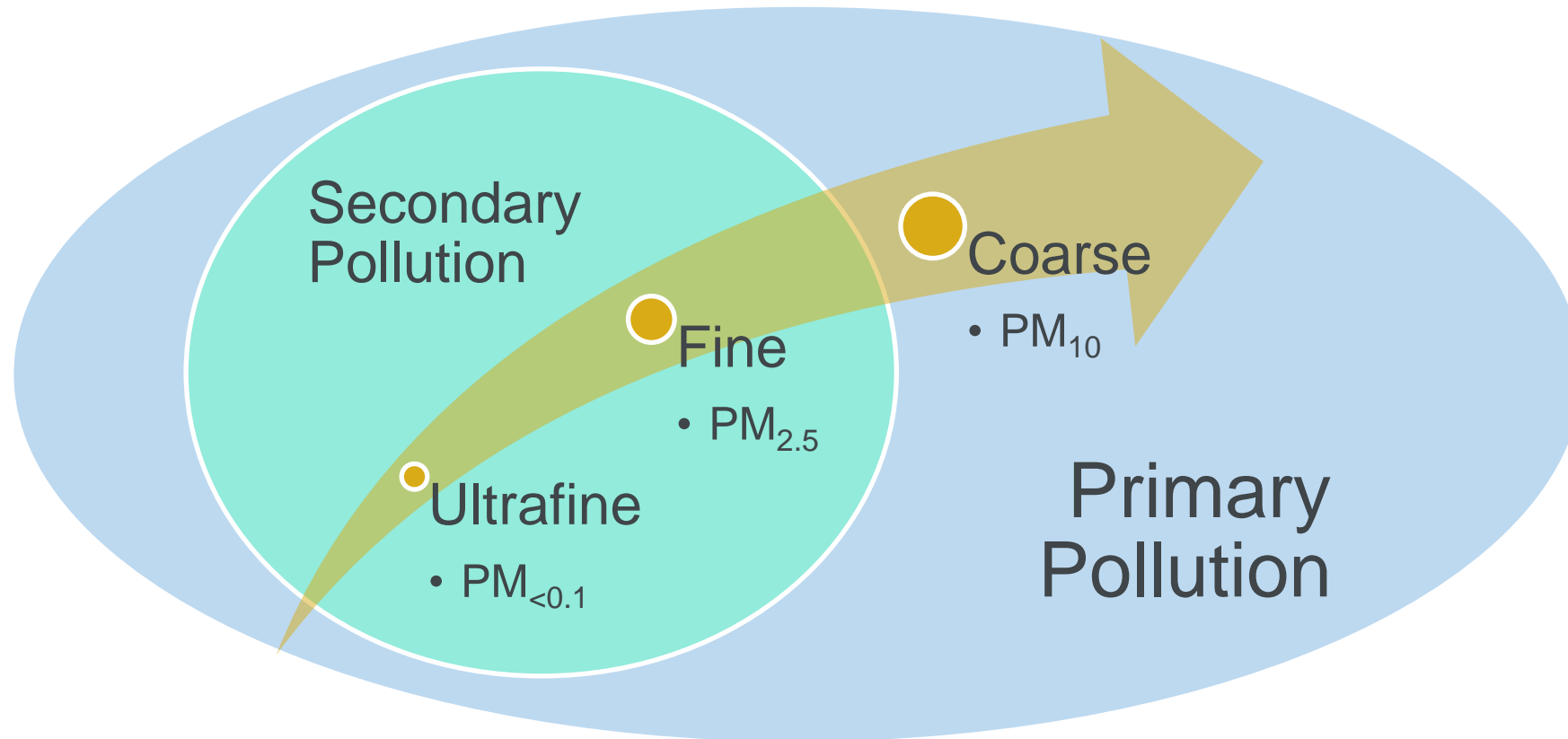
- Paris restrictions and other European cities
- New EU testing standards in 2017
- Long-term considerations and continued UK problems



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# Particulate matter

## Summary



# Particulate matter

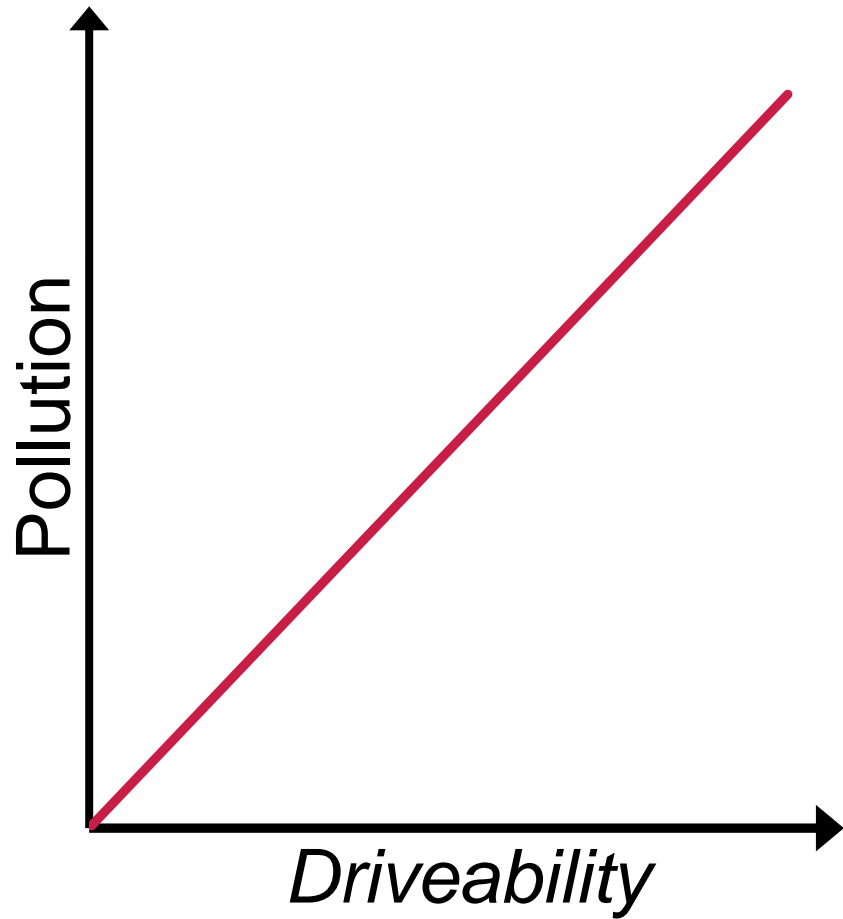
## Causes

- Wear and tear on tyres
- Brake discs
- Partially burnt hydrocarbon fuels
- Diesel engines



# Particulate matter

## VW Scandal



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# Particulate matter

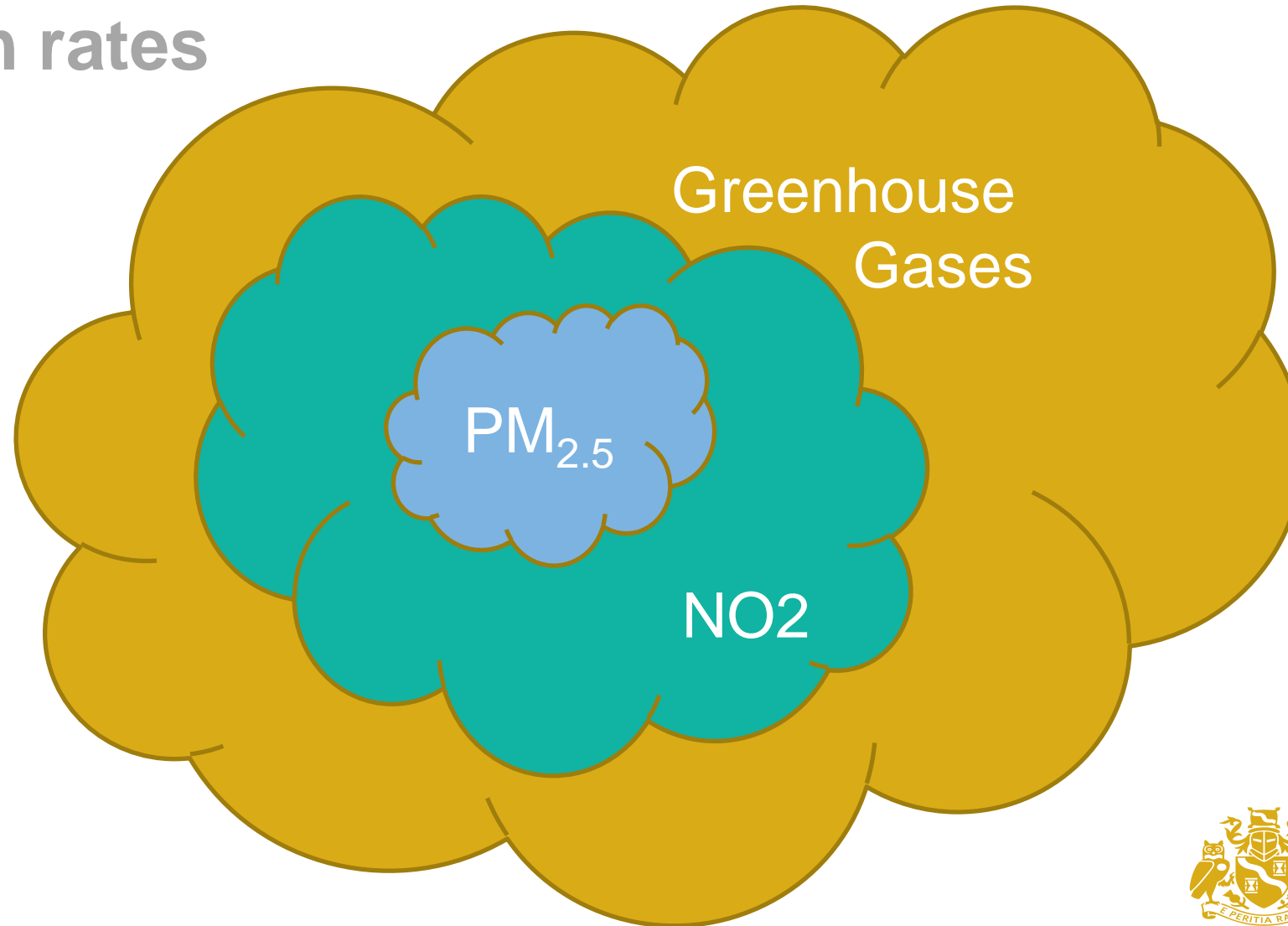
## Effects

- Severe and wide ranging
  - Respiratory (COPD)
  - Circulatory
  - Internal organs
  - Nervous system
- Children vulnerable to long term health problems
- The elderly suffer intensified effects



# Particulate matter

## Dispersion rates



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# Data sources

## Pollution

- Pollution
  - Department of Environment, Food and Rural Affairs (DEFRA)
  - Clean Air London
- Proxy – Traffic
  - Live traffic
  - HERE
  - Data.gov AADF



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# Data sources

## AADF Sample

Year	CP	Region	Local Auth.	Road	Easting	Northing	AADF
2013	55	South West	Isles of Scilly	A3110	91800	10890	326
2014	55	South West	Isles of Scilly	A3110	91800	10890	341
2014	60	Midlands	Notts	A6097	469894	341668	15916
2015	60	Midlands	Notts	A6097	469894	341668	16621
2012	61	Scotland	Glasgow	A8	257982	664405	6393
2013	61	Scotland	Glasgow	A8	257982	664405	6491
2004	501	Wales	Newport	M4	328570	187000	114626
2005	501	Wales	Newport	M4	328570	187000	114804



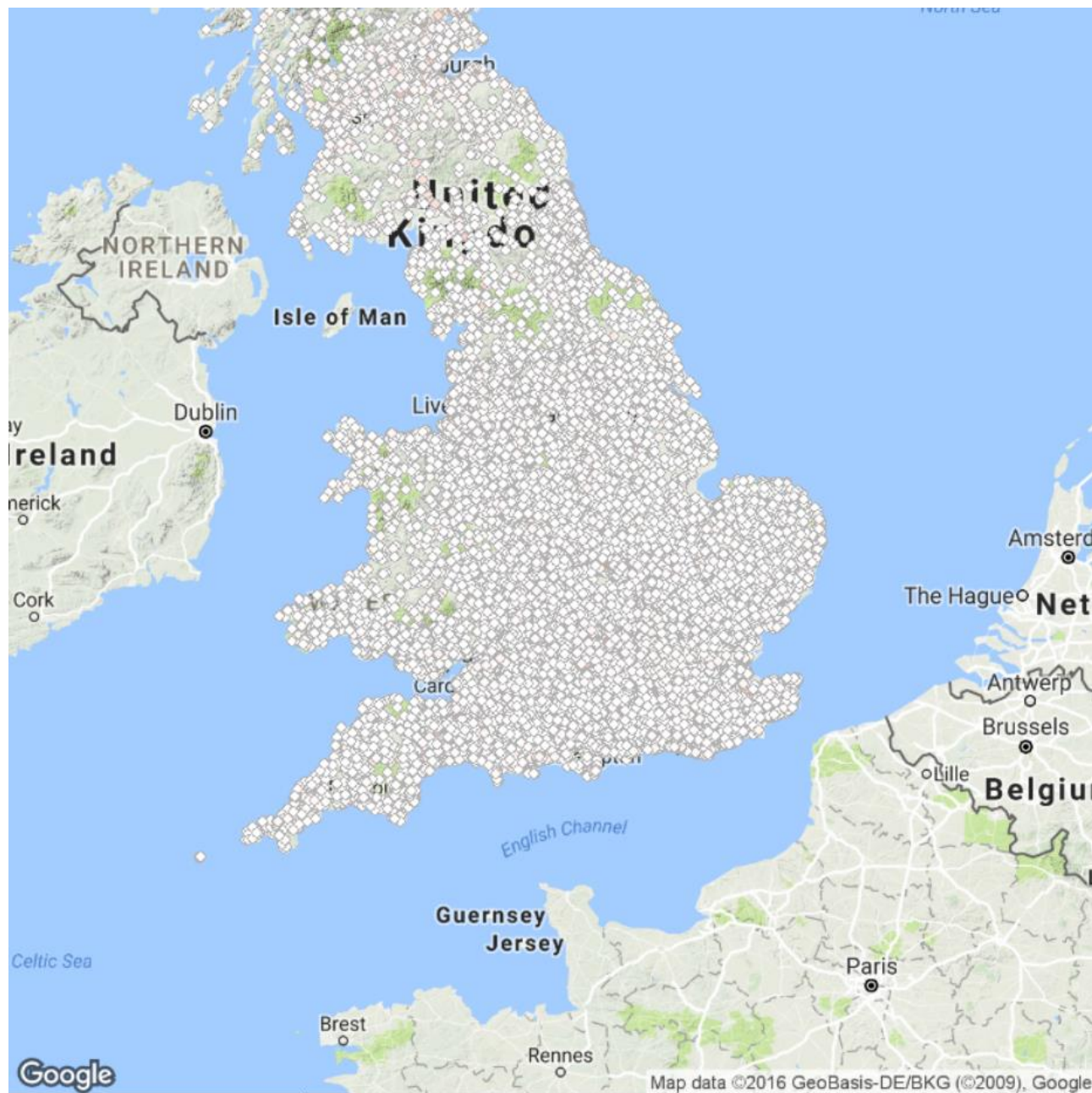
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# Data sources

## Life and health

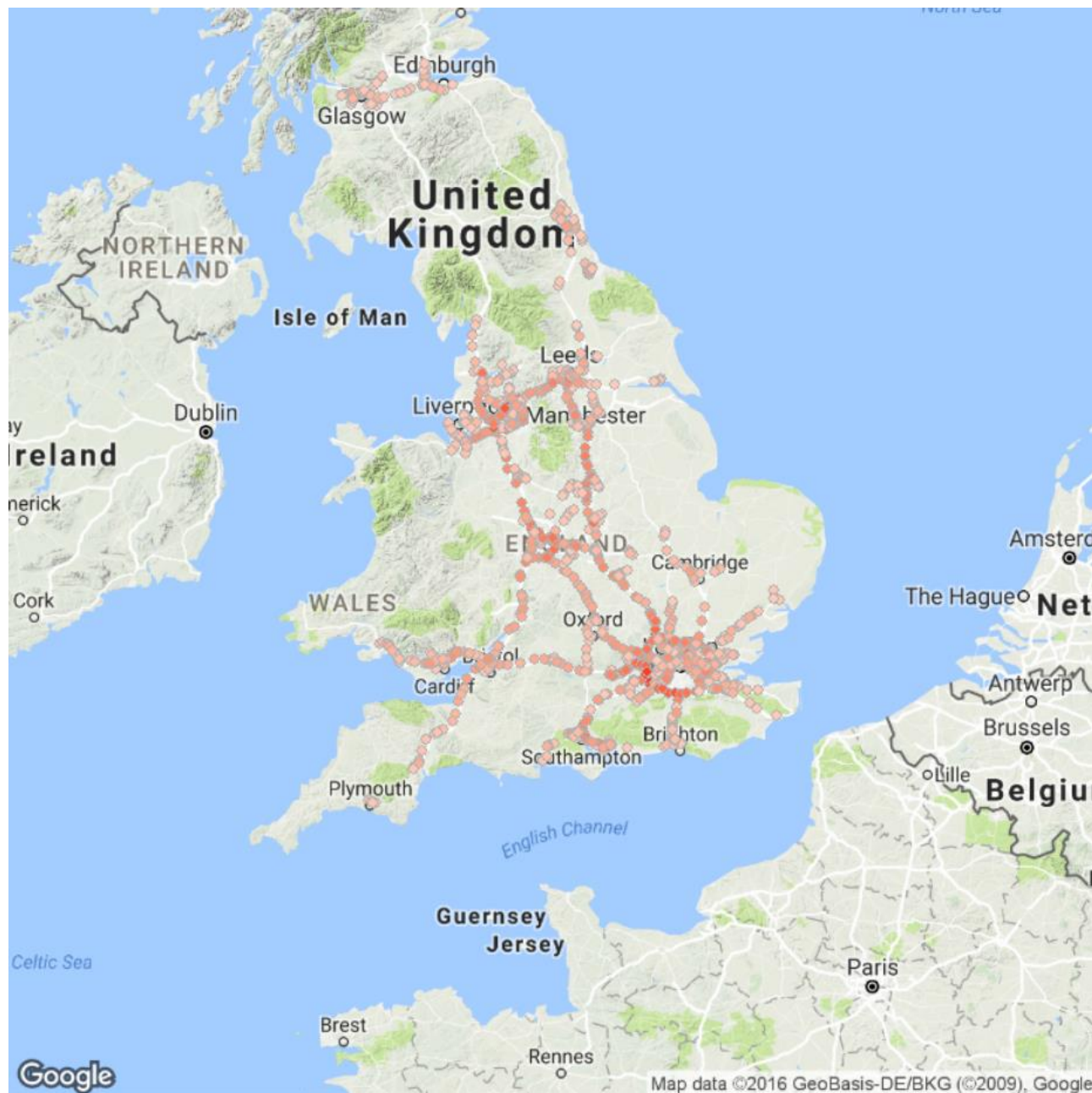
- Hospitals
  - Admissions and mortalities
  - No longer publicly available data
- General Practitioner data
  - Diagnosed diseases and prescribed medicines



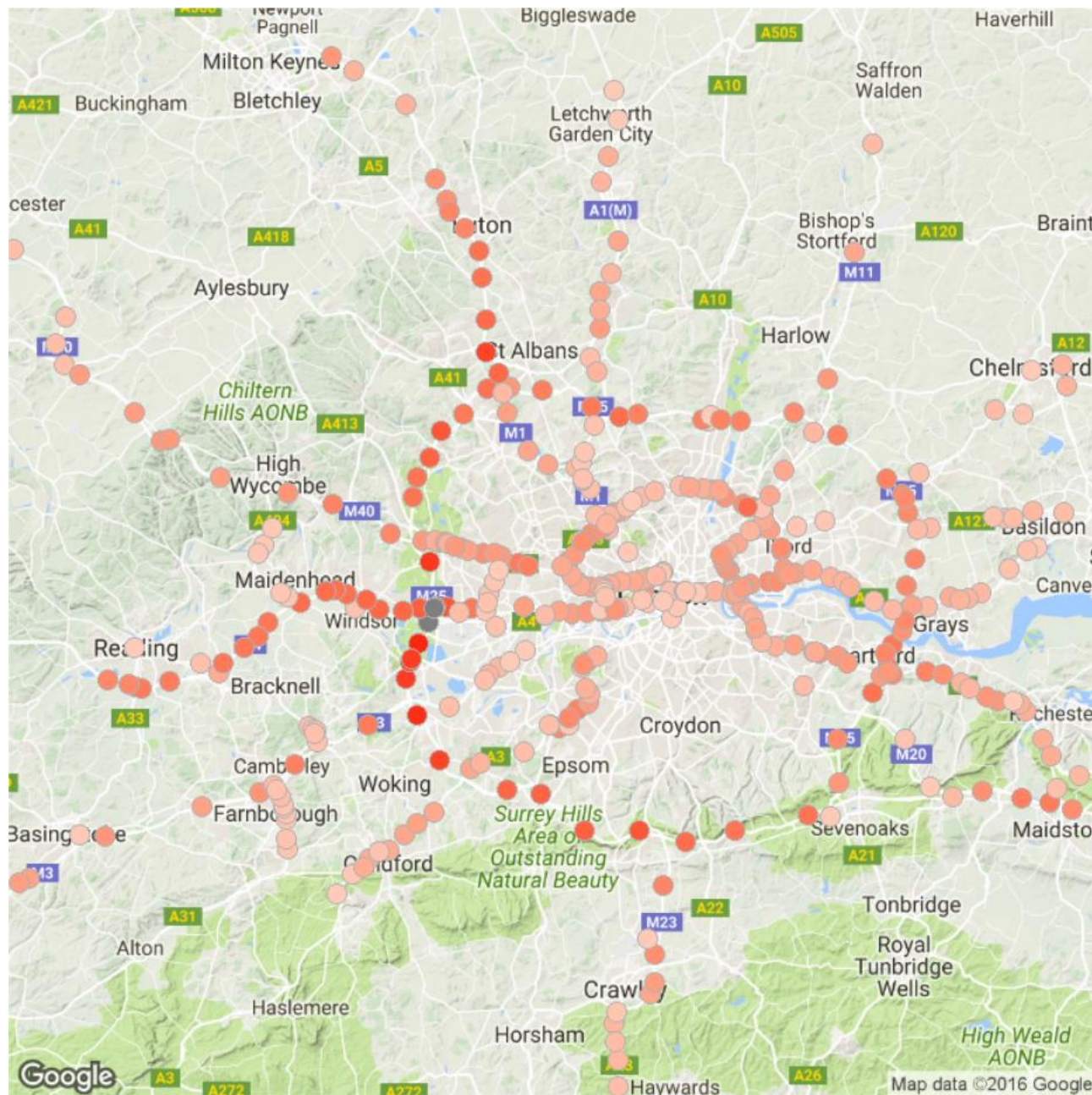


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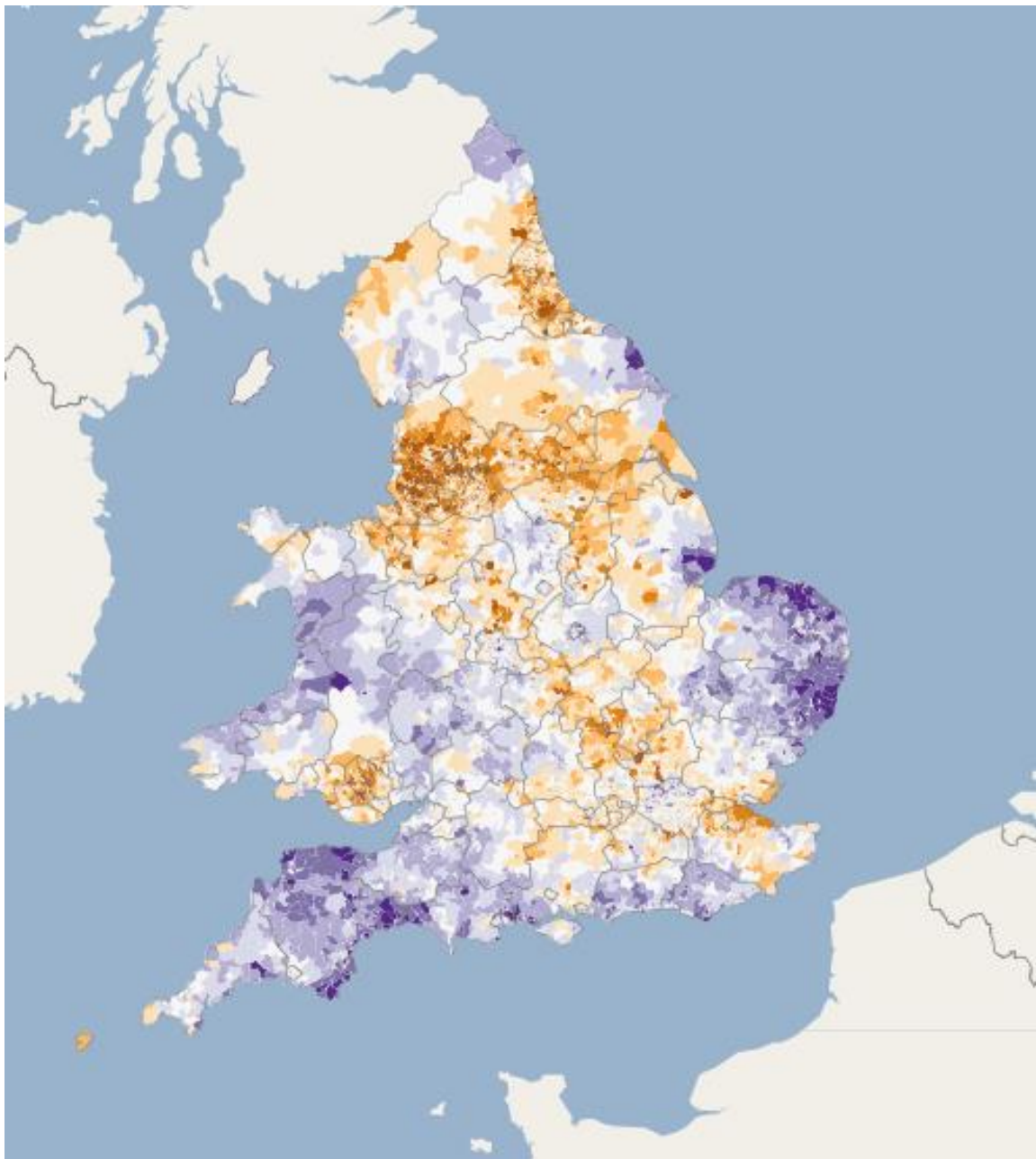


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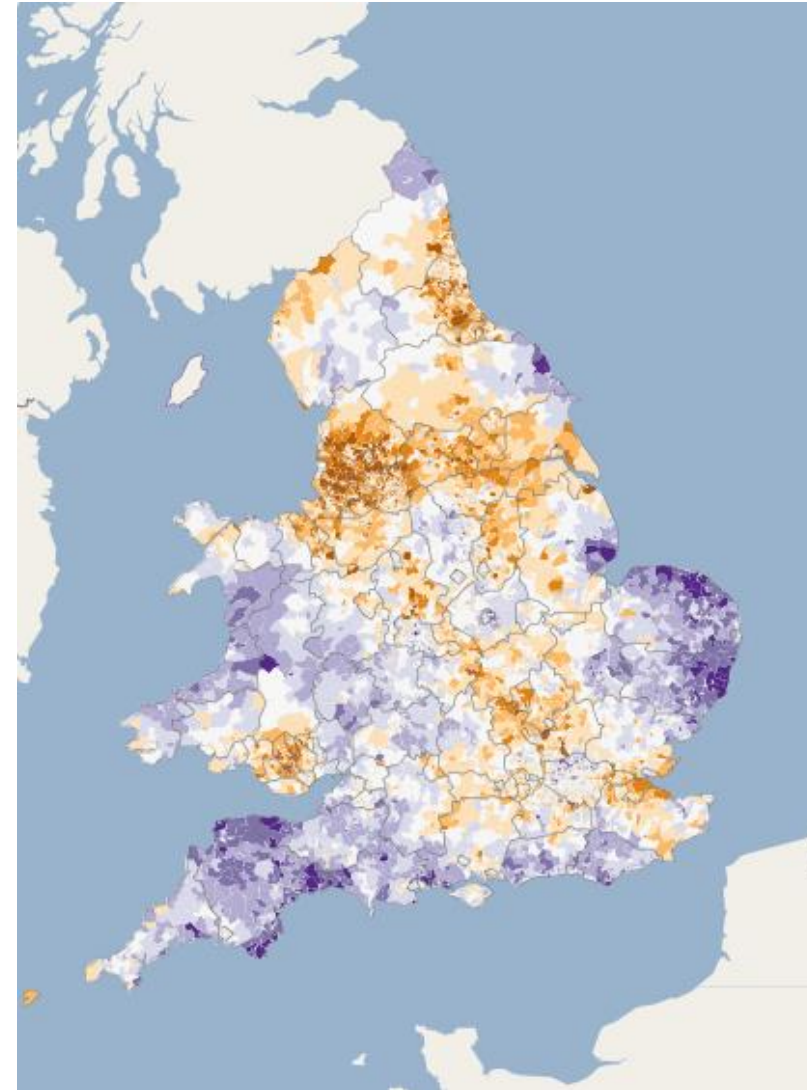


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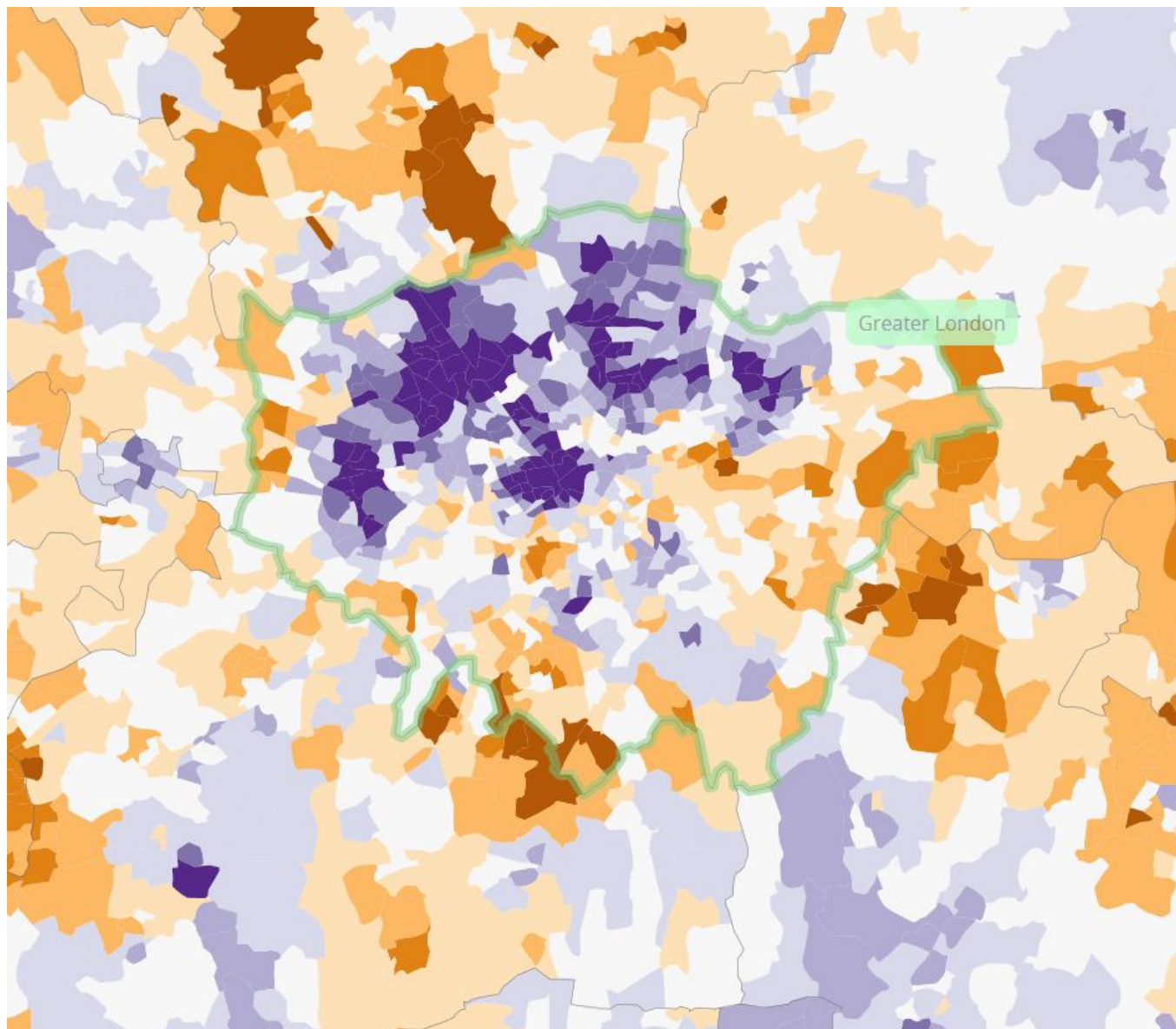




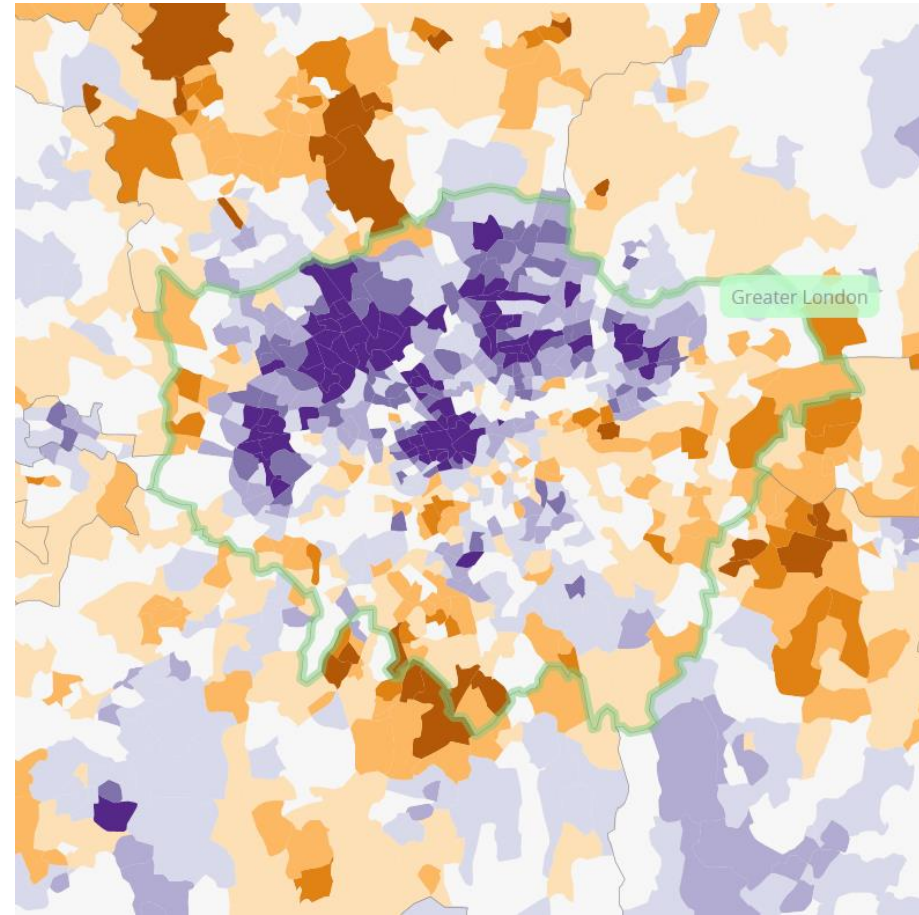
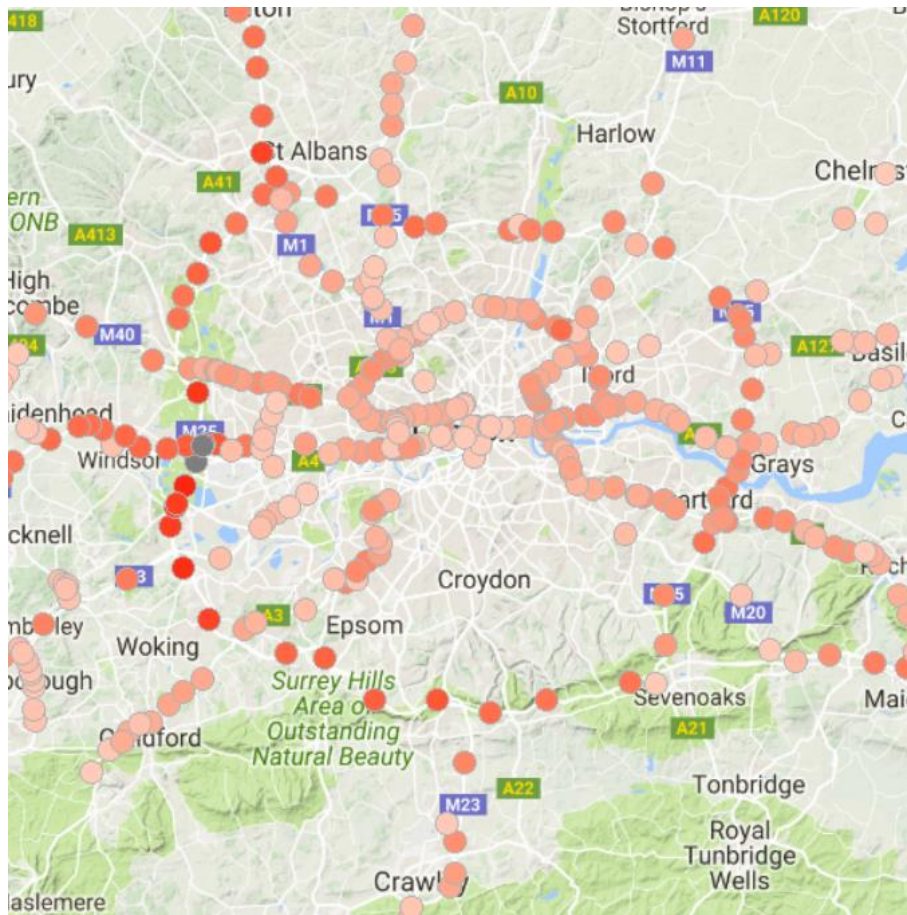
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# Developments

- Analyse effects of different groups of vehicles
- Consider more specific diseases and medication
- More granular investigation – road by road?
- Model effects of pollution over longer time periods

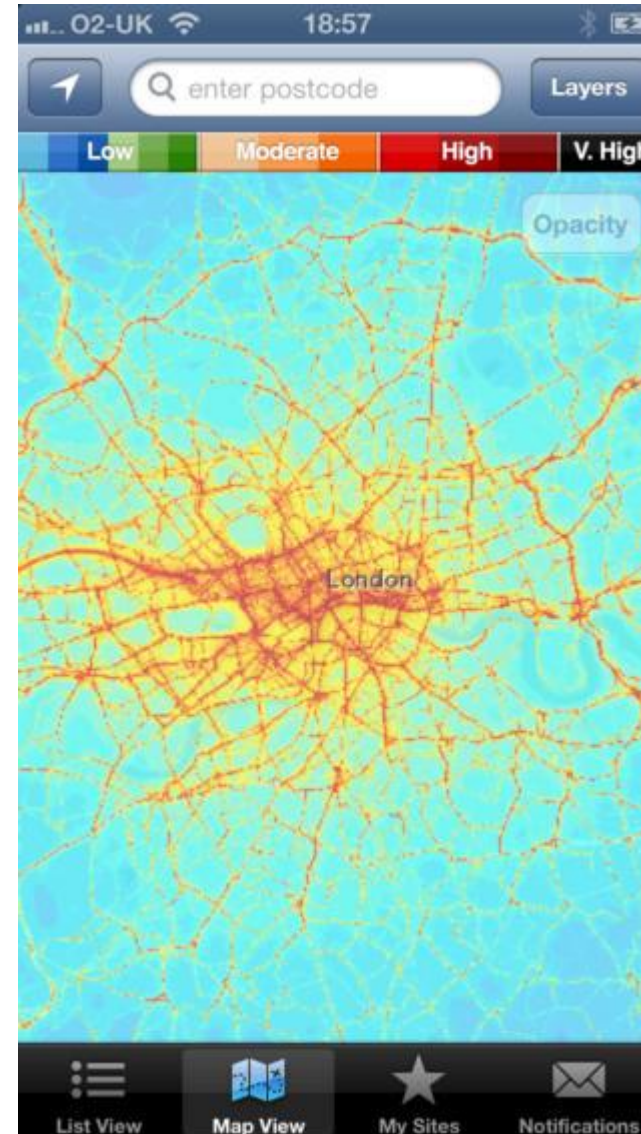




# Challenges

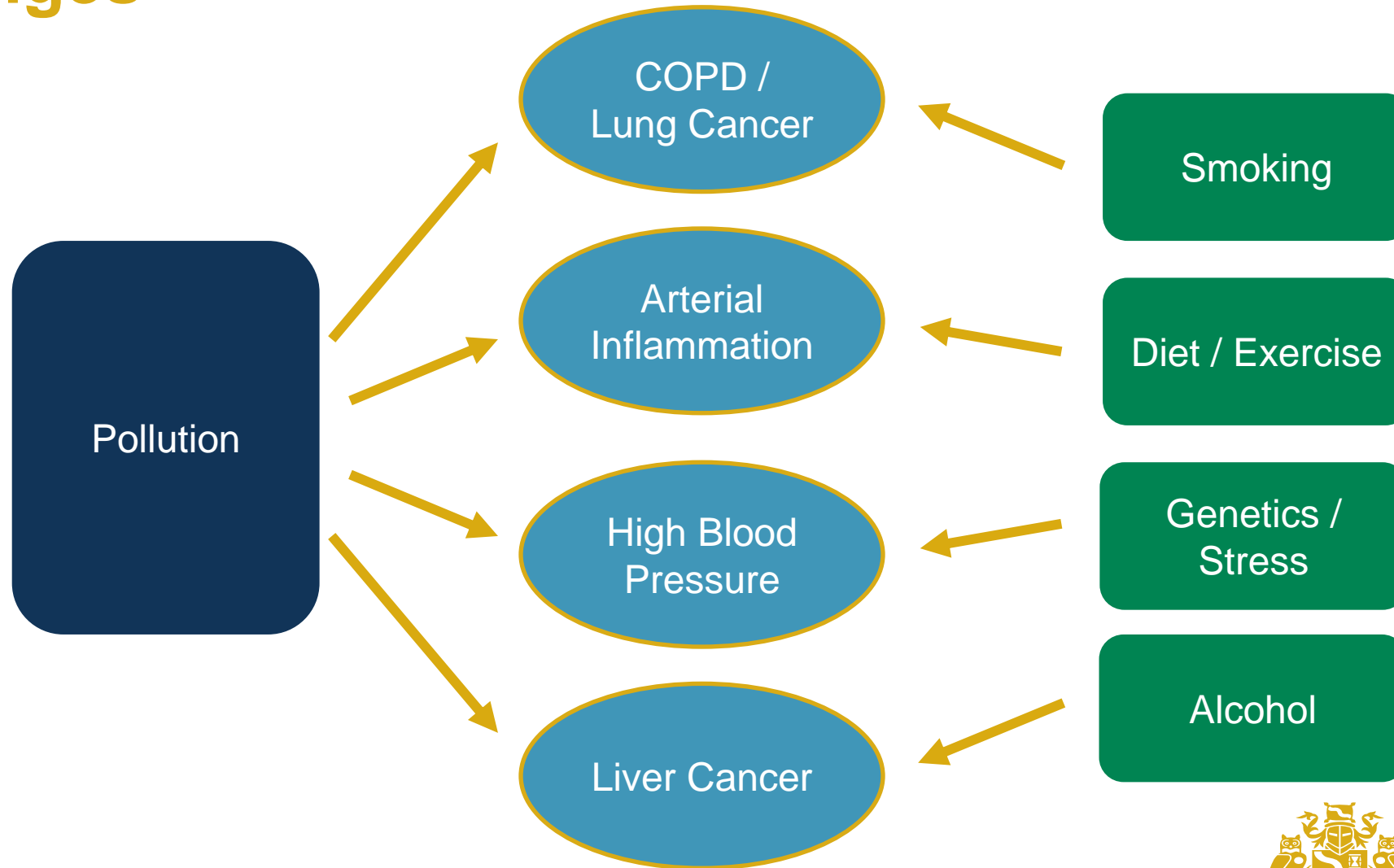
## Measuring pollution

- CO2 readings
  - Cheap & fast
- PM readings
  - Expensive & manual
- Kings College
  - “London Air”



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# Challenges



# Challenges

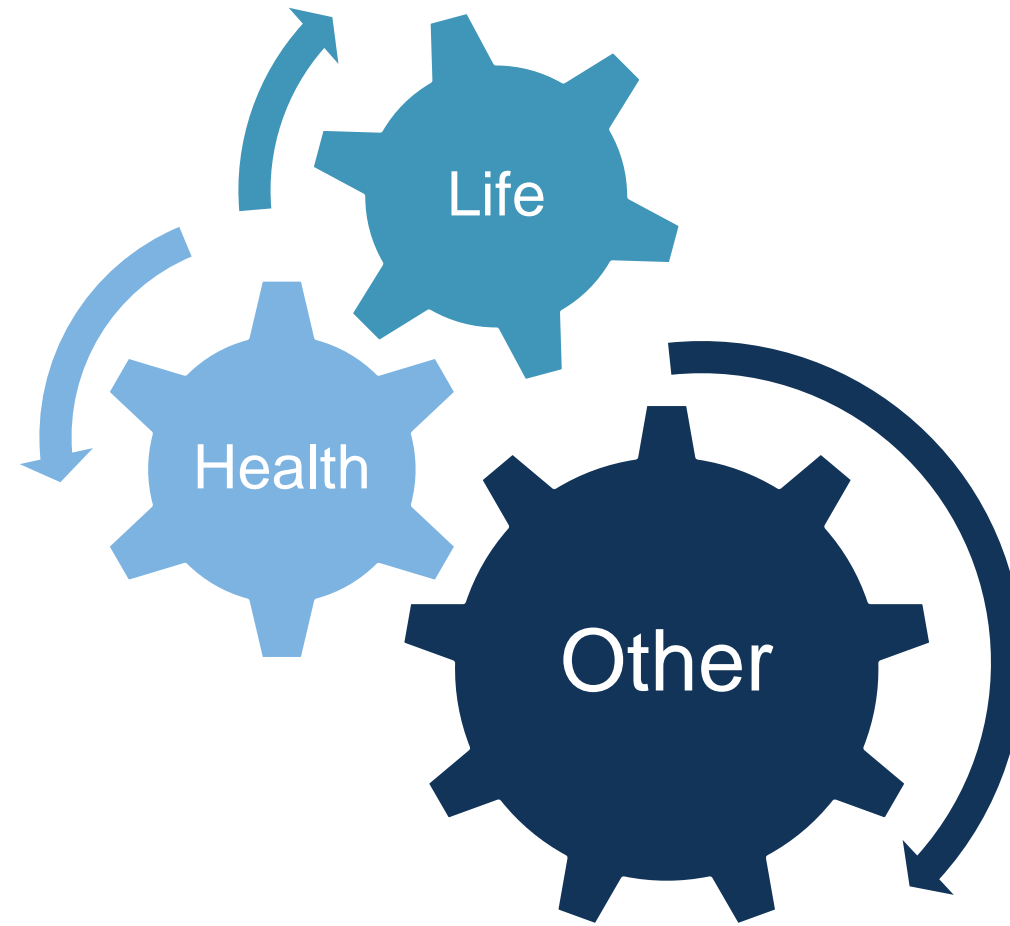
## Long-term

- Predicting pollution levels in key areas
  - Increasing traffic volume and industry output
  - Low emission zones, electric cars, etc...
- Modelling effects of pollution on mortality
  - Shape of the curve: Exposure vs Mortality
  - Measuring the time lapse in the effects



# Effects

## Short-term and long-term



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# Questions

# Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



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