QCumber-EnvHealth
Stakeholder Workshop

27 September 2017
The Lighthouse, Glasgow

Project Overview

David Carruthers, CERC

Project background

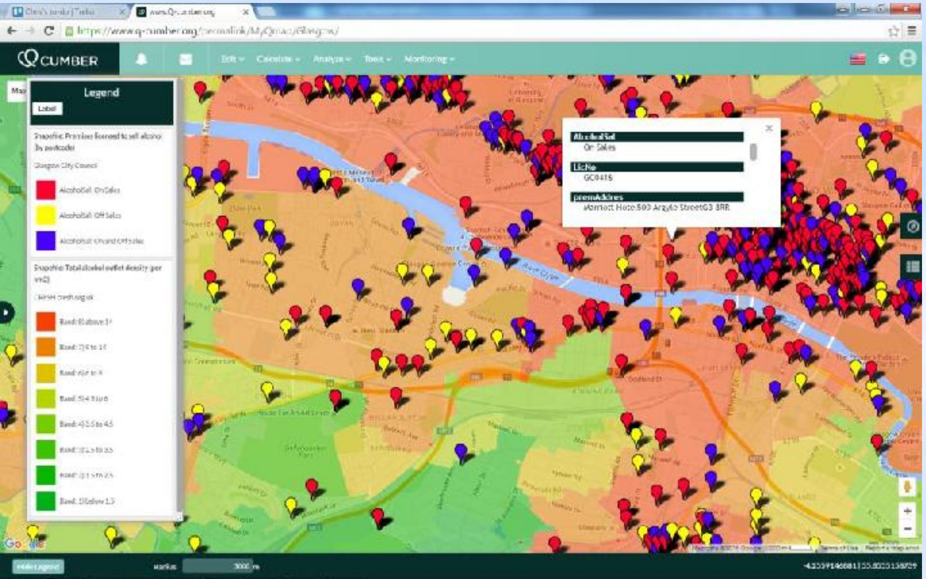
A new integrated decision-making tool for urban health and policy evaluation: 'QCumber-EnvHealth'

- Innovate UK collaborative research and development project under their competition *Solving urban challenges with data*
- Project runs November 2015 to October 2017

Innovate UK
Technology Strategy Board

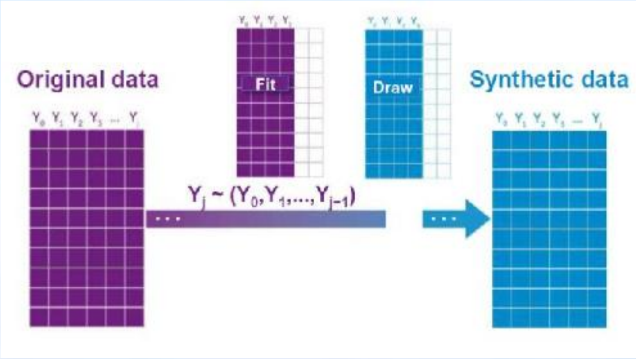
Project Goal

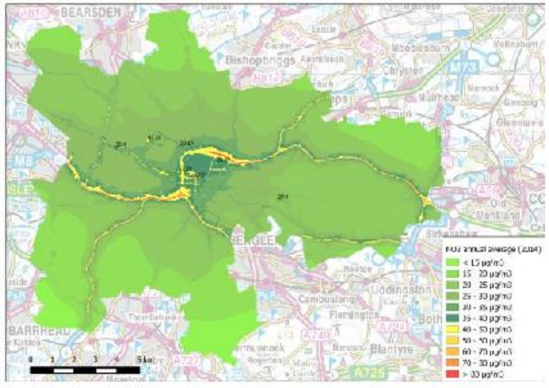
- In the context of Glasgow with its wealth of data, build on the QCumber system with state-of-the-art research and end-user participation to create an integrated platform for environmental health policy and well-being/inequality related decision making.



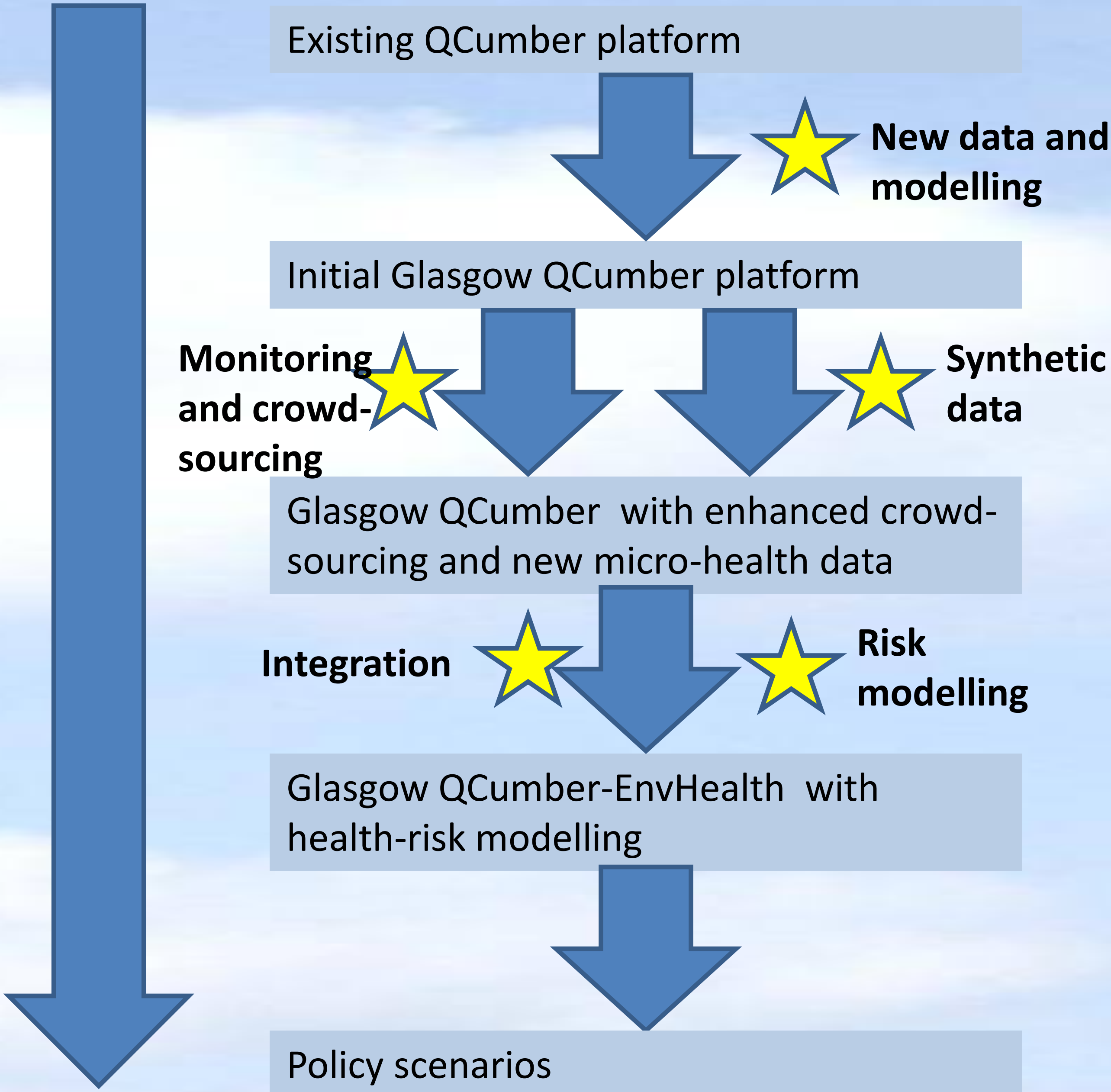
Innovations

- New health related behaviour data and exposure modelling
- Integration of crowd-sourcing and monitoring
- Creation and integration of accessible personal data (synthetic data)
- End-user led health risk modelling and policy scenarios





Project overview



Project partners

- CERC
- University of Edinburgh
- University of Strathclyde
- University of Glasgow
- Transport Scotland

Formative stakeholders

- Glasgow City Council
- Health Protection Scotland
- NHS Greater Glasgow & Clyde
- SEPA

Workshop objectives

- Brief stakeholders on the project
- Present policy case study assessments
- Elicit feed back on the assessments

Policy case studies

- Transport and air quality
  - Low Emissions Zones
  - Phasing out petrol/diesel cars/vans
- Green space
  - Converting vacant/derelict land to greenspace
- Tobacco retail
  - Reducing tobacco retail outlet density

Thanks for your attention

David Carruthers, CERC

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The Lighthouse, Glasgow

The Glasgow Platform

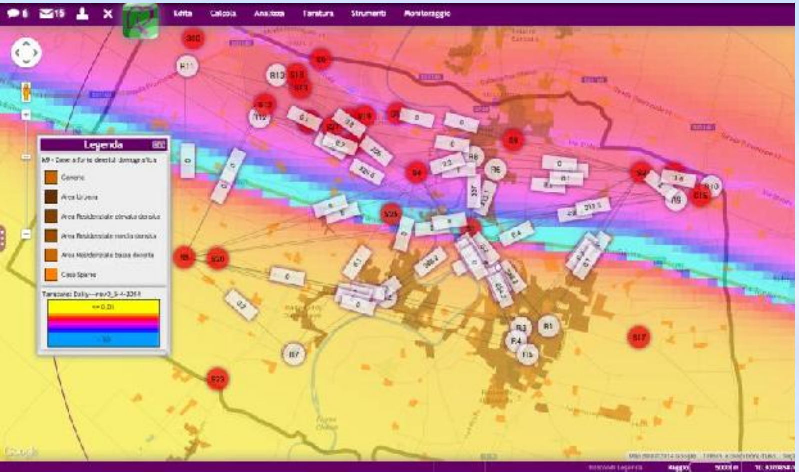
Mark Jackson, CERC
Chris Johnson, CERC

The Glasgow Platform

- QCumber
- Data for Glasgow
- Air quality modelling for Glasgow
- Transport routing tool
- Demonstration

QCumber

- QCumber is a usable, fast, city data platform
  - Website and phone app
  - Interactive map visualisation using Google Maps
  - Integrated data and tools
  - Social media and crowd-sourcing
  - Adopted by many institutions in Italy



Public Glasgow Platform

- QCumber has been set up for Glasgow
- Public platform produced www.q-cumber.org
- First launched in 2016; now enhanced
- Data, modelling and tools
  - Open data
  - ADMS-Urban air quality modelling
  - **Transport routing**
  - **Health risk tools**

Data integrated: publishers

Glasgow City Council

Transport Scotland
Còmhdhail Alba

CRESH

DATA.GOV.UK
Opening up Government

Community Safety Glasgow

sustrans
Join the movement

Ordnance Survey

ScotPHO
Public Health Information for Scotland

NCR

OpenStreetMap
The Free Wiki World Map

Glasgow Data Launchpad

PREV'AIR

Scottish Natural Heritage
All of nature for all of Scotland

ISD Scotland

NHS
National Services Scotland

Department for Environment Food & Rural Affairs

National Records of Scotland

SEPA
Scottish Environment Protection Agency

Met Office

Scottish Neighbourhood **Statistics**

National Atmospheric Emissions Inventory

Department for Transport

Datasets integrated

Transport
- **Cycle**
  - Cycle racks
  - Cycling routes
- **Rail**
  - Train tracks
- **Road**
  - Traffic signals
  - Electric vehicle charging points
  - Reported road accidents
  - Travel time to GP
  - City roads
- **Mode**
  - Travel mode to school

Transport Scotland
- Glasgow traffic model link locations
- Traffic count locations
- Major road sections

Social
- **Social**
  - Community Safety Index
  - Scottish Index of Multiple Deprivation score
  - Health deprivation rank

Exposure
- **Alcohol**
  - Licensed Premises
  - On-Sales outlet density
  - Off-Sales outlet density
  - Total outlet density
- **Green spaces**
  - Multifunctional greenspace
  - Country parks
  - Nature reserves
  - SSSI
  - PAN 65 open space types
  - Greenspace percentage
- **Health services**
  - Patients by GP
- **Physical environment**
  - MEDIx and MEDClass
- **Tobacco**
  - Tobacco outlet density

Environment
- **Air Quality**
  - ADMS model input
  - ADMS model output
  - NO2 diffusion tubes
  - Monitors
  - Air Quality Management Areas
- **Waste**
  - Waste sites
  - Landfill capacity

Health
- **Alcohol**
  - Patients hospitalised
  - Hospital episodes
  - Standardised Mortality Ratio
- **Births**
  - Breastfeeding
  - Teenage pregnancy
  - Low birth weight
  - Smoking status at maternity
- **General health**
  - NRAC Morbidity and Life Circumstances index
  - Long-term health problem or disability
  - General health
- **Life expectancy**
  - Life expectancy
- **Respiratory**
  - Patients hospitalised with asthma
  - Respiratory disease
  - Lung cancer
  - Smoking prevalence
  - Standardised Mortality Ratio

Demography
- **Population**
  - Population count

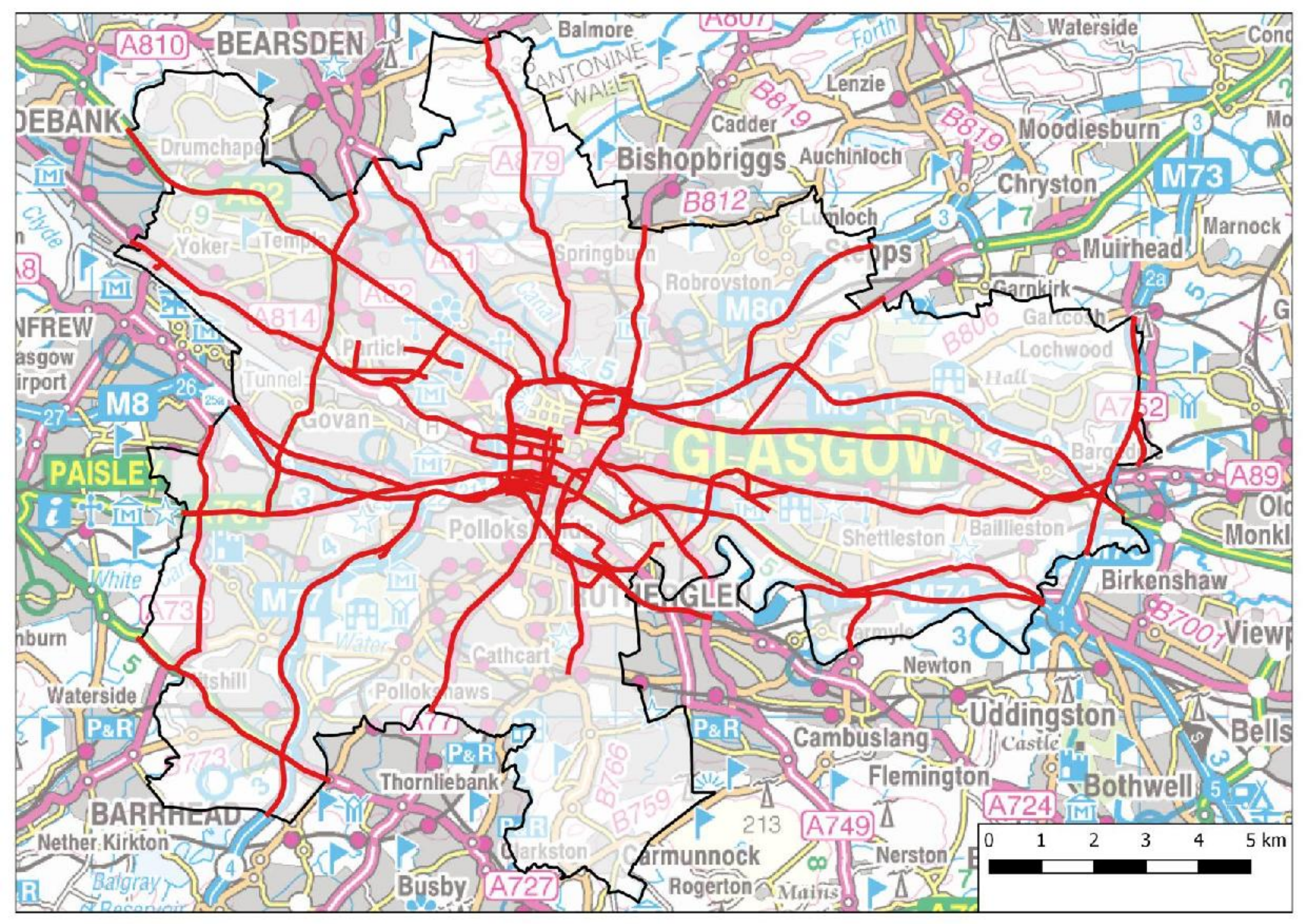
Air quality modelling for Glasgow

- High resolution air quality modelling
- For comparison with air quality standards
- To provide air quality exposure for health modelling
- To be combined with measurements
- For transport routing tool
- A starting point for policy scenario assessments

ADMS-Urban air quality modelling

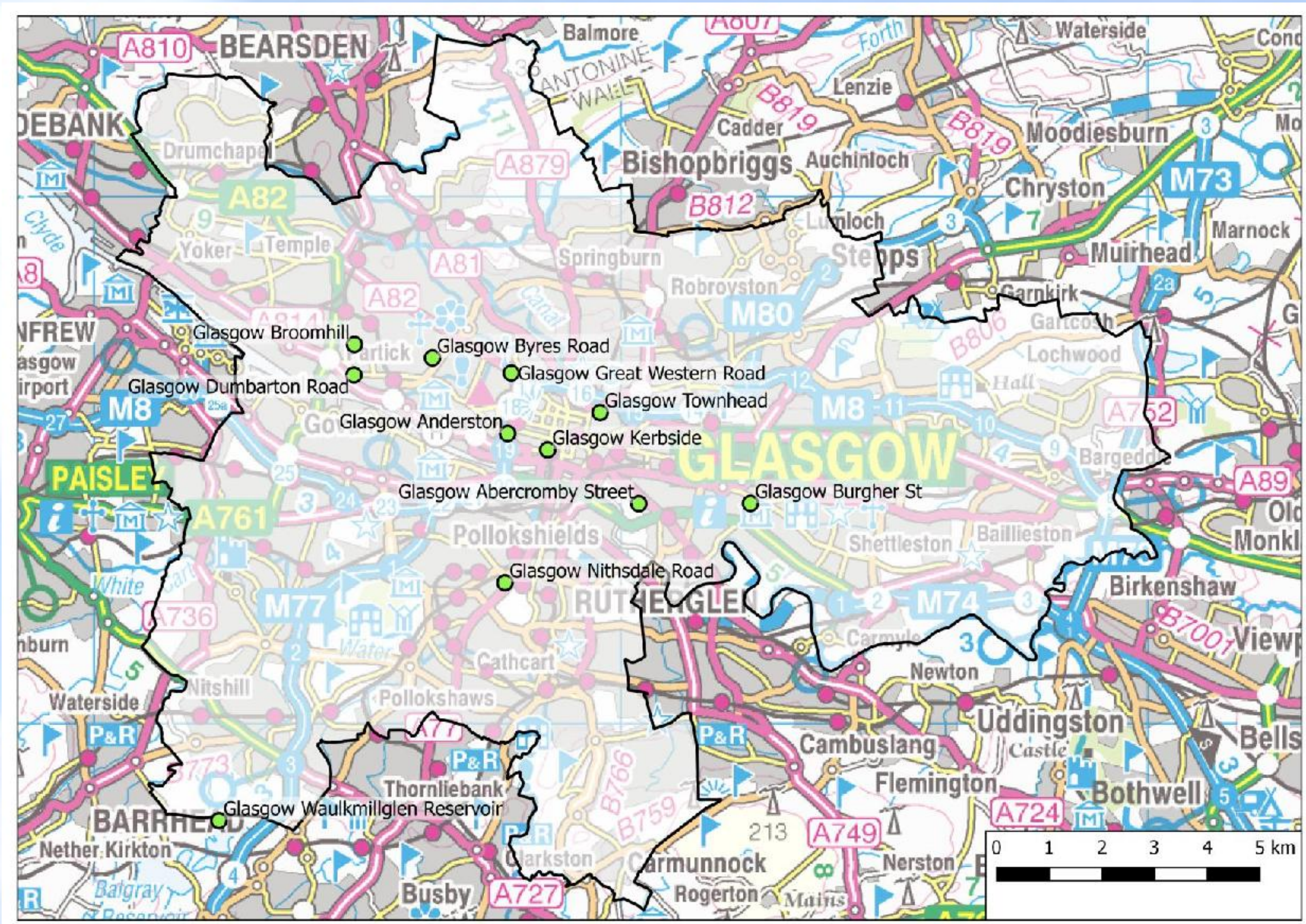
- Emissions sources modelled with ADMS-Urban for 2009-2014
- Traffic flows: DfT, Transport Scotland, Glasgow City Council
- Tunnel and advanced street canyon modelling
- Met Office BADC met observations (Bishopton)
- Measured background data: NO_x and NO_2 from Bush Estate, PM_{10} from Waulkmillglen Reservoir and $PM_{2.5}$ from Auchencorth
- Concentrations of NO_x, NO_2, O_3, PM_{10} and $PM_{2.5}$
  - at monitor site locations
  - Gridded data over Glasgow (25m resolution)

Roads modelled



Road sources modelled. Contains OS OpenData imagery © Crown copyright 2015.

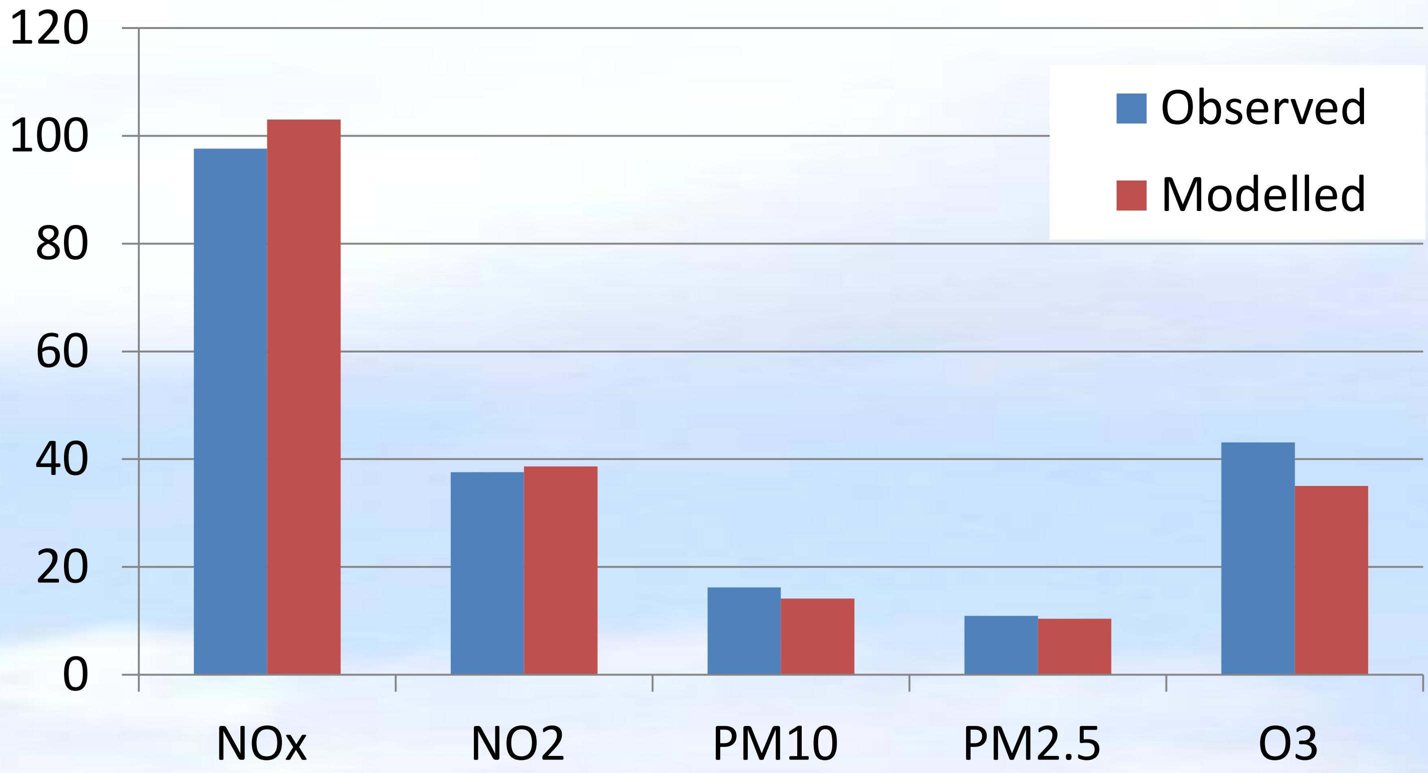
Monitoring sites



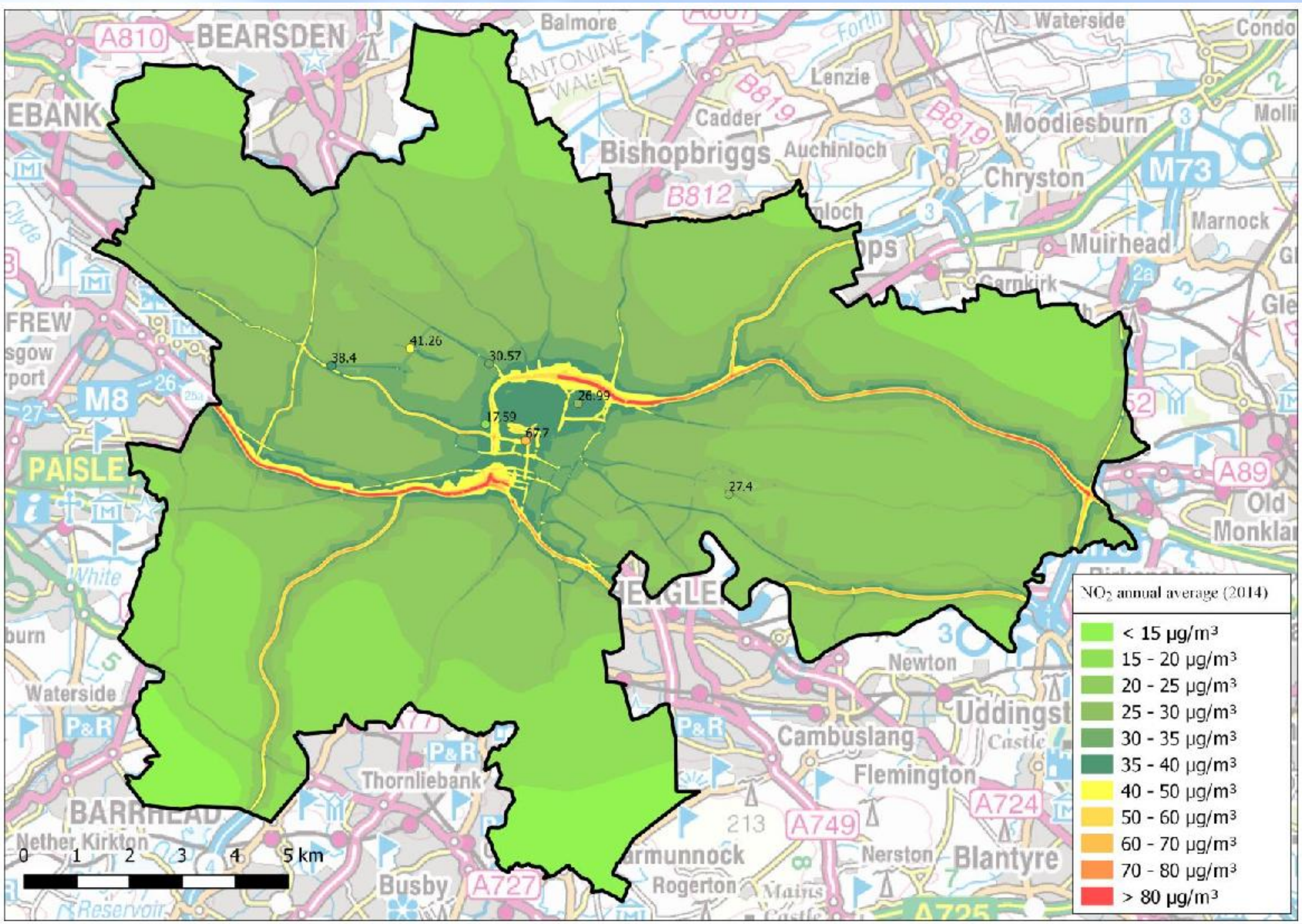
Monitor site locations. Contains OS OpenData imagery © Crown copyright 2015.

Validation results

Annual averages for 2014, all monitoring sites, µg/m³

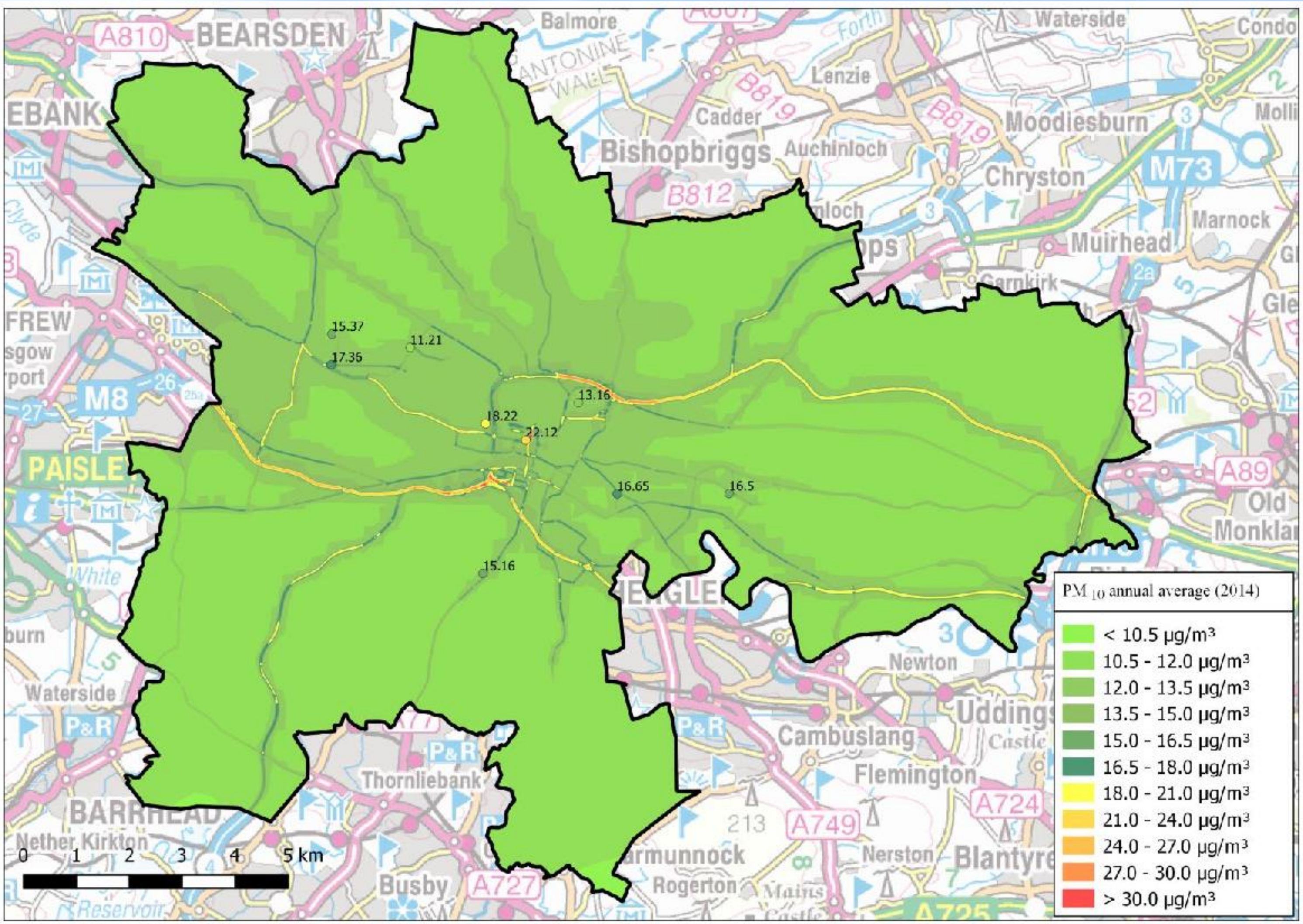


NO_2 annual averages 2014



Modelled annual average NO_2 concentrations at 1.5 metres above ground level. Annual average observed values are also shown at the monitor locations. Contains OS OpenData imagery © Crown copyright 2015.

PM$_{10}$ annual averages 2014



Modelled annual average PM$_{10}$ concentrations at 1.5 metres above ground level. Annual average observed values are also shown at the monitor locations. Contains OS OpenData imagery © Crown copyright 2015.

Development of policy tools

- Our project is improving understanding of links between air quality and health outcomes, specifically for birth weight
  - Used ADMS modelling to produce high resolution air quality concentration datasets for Glasgow
  - Linked these to confidential NHS health records
  - Modelled health risk to assess links between exposure (concentrations) and health outcomes
  - Findings integrated in platform as policy assessment tools.
  - The tools have been applied to the policy scenarios.
- The research methods can be used for other health outcomes.

Transport route tool

Enabling the public to choose low pollution routes

1. User selects start point, end point and travel mode
2. Platform suggests routes
3. Platform uses annual average NO2 concentrations to calculate measures of exposure along the routes
4. Platform displays the exposure measures, estimated travel time, and shows routes on map against concentration visualisation. User can choose their preferred route.

Platform demonstration

Conclusion

- QCumber
- Data for Glasgow
- Air quality modelling for Glasgow
- Transport routing tool
- Demonstration

Thanks for your attention

Mark Jackson, CERC
Chris Johnson, CERC

Work Packages 3 and 4: Health Risk modelling and synthetic data

Tom Clemens[1]; Duncan Lee[2]; Beata Nowok[1]; Chris Dibben[1]

[1]School of Geosciences, University of Edinburgh
[2]School of Mathematics and Statistics, University of Glasgow

"Qcumber EnvHealth" Stakeholder Workshop
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Aims

Work Package 4:

- Develop epidemiological risk models linking environmental exposures to health outcomes using individual routine health records

Work Package 3:

- Improving accessibility of powerful routine health datasets for policy making and scenario planning

WP 4: Health risk modelling

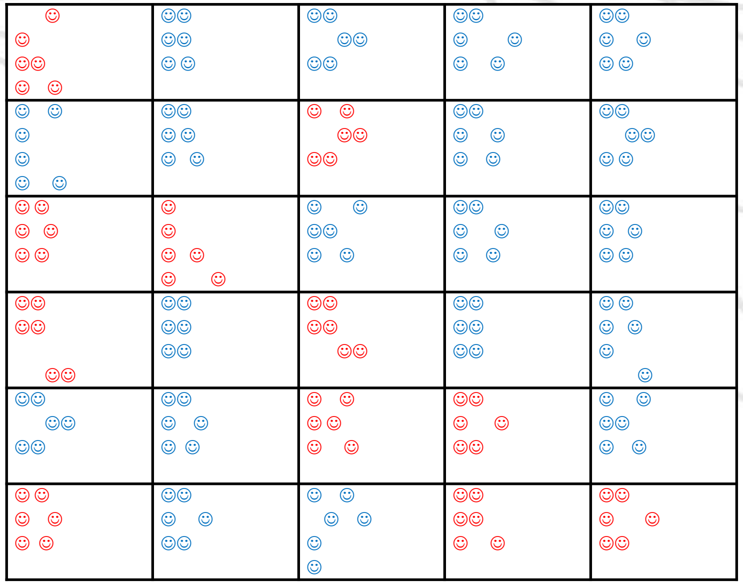
- Using exemplar of birth-weight and air pollution:
  - Developed an approach for modelling health risks of air pollution
  - Method appropriate for wide range of exposures and outcomes

- Why birth outcomes?
  - Important determinant of future outcomes e.g.:
    - Educational attainment, health outcomes in both childhood and older ages

- Utilised the power of routine data:
  - All births to mothers resident in Glasgow City(2009-2014) totalling ~35000 births
  - Outcome: Birthweight (grams)
  - Also included:
    - Age (single year)
    - Age squared
    - Parity (nullip/multip – nullip as reference)
    - Smoker during pregnancy (yes/no – no as reference)
    - Birth year (single year, as continuous variable)

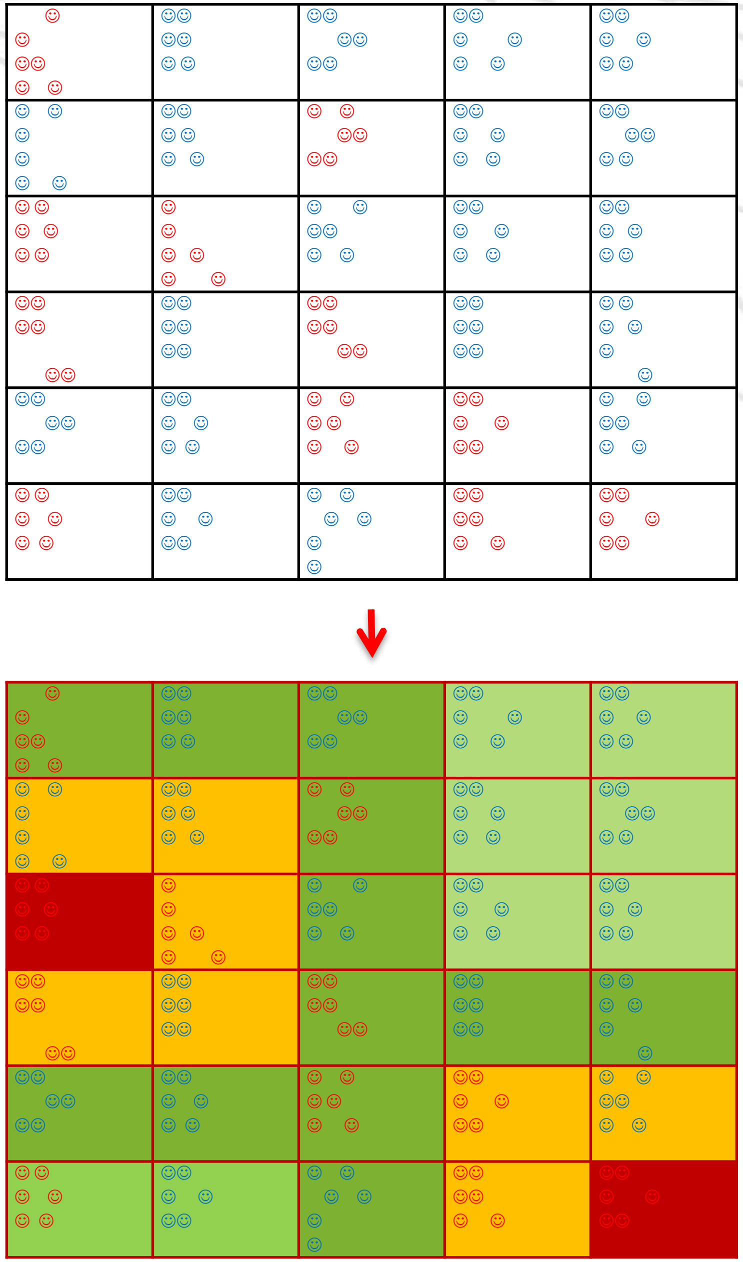
Individual versus ecological studies

- Typically individual studies assign pollution exposure based on area average concentration



Individual versus ecological studies

- Typically individual studies assign pollution exposure based on area average concentration
- **But** many do not take account of spatial dependence in the outcome ***between*** areas
- Ecological approaches (with purely ecological data) explicitly model this dependence
- We combine these approaches borrowing from an ecological spatial modelling approach but incorporating individual level data



Software program - CARBayes

Package ‘CARBayes’

June 1, 2017

Type Package

Title Spatial Generalised Linear Mixed Models for Areal Unit Data

Version 5.0

Date 2017-06-01

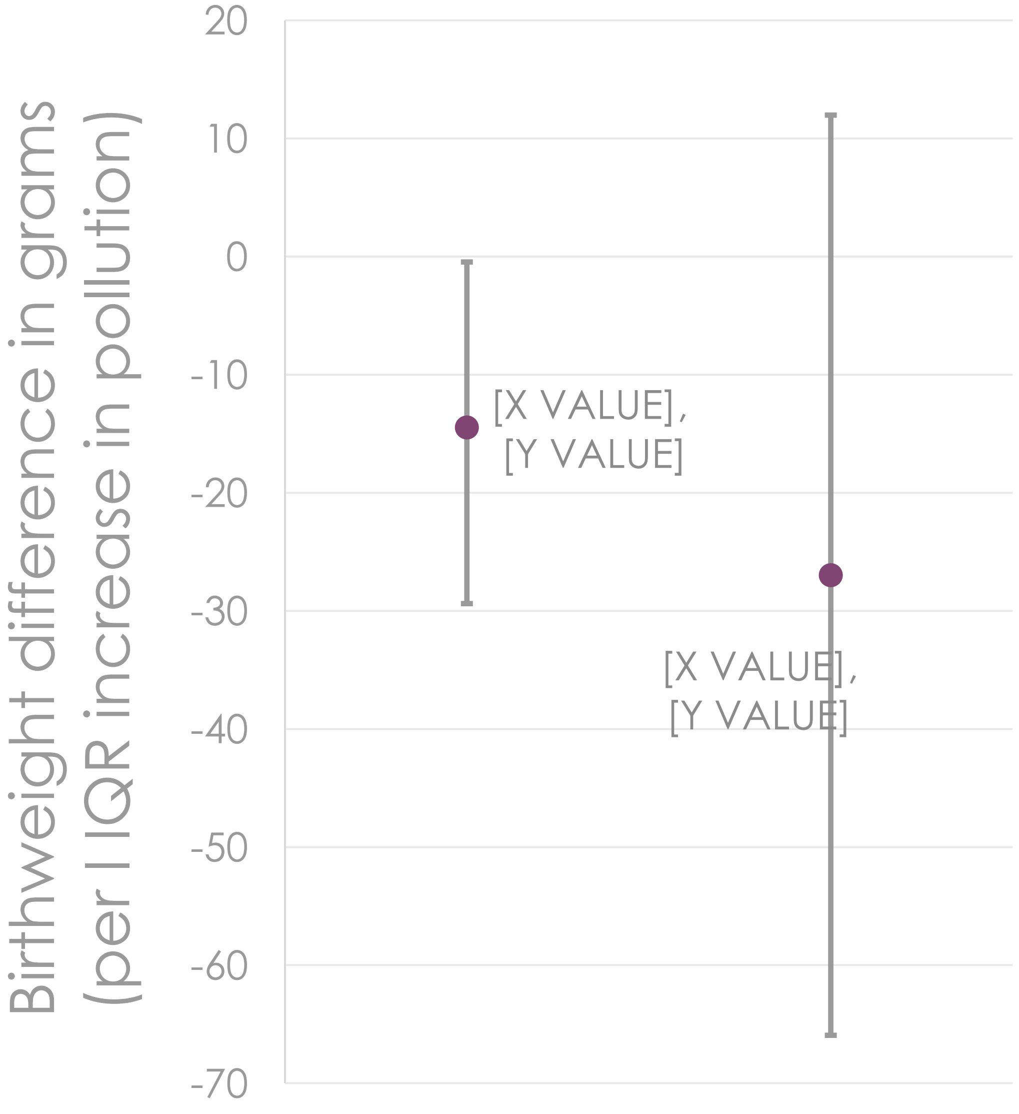
Author Duncan Lee

Maintainer Duncan Lee <Duncan.Lee@glasgow.ac.uk>

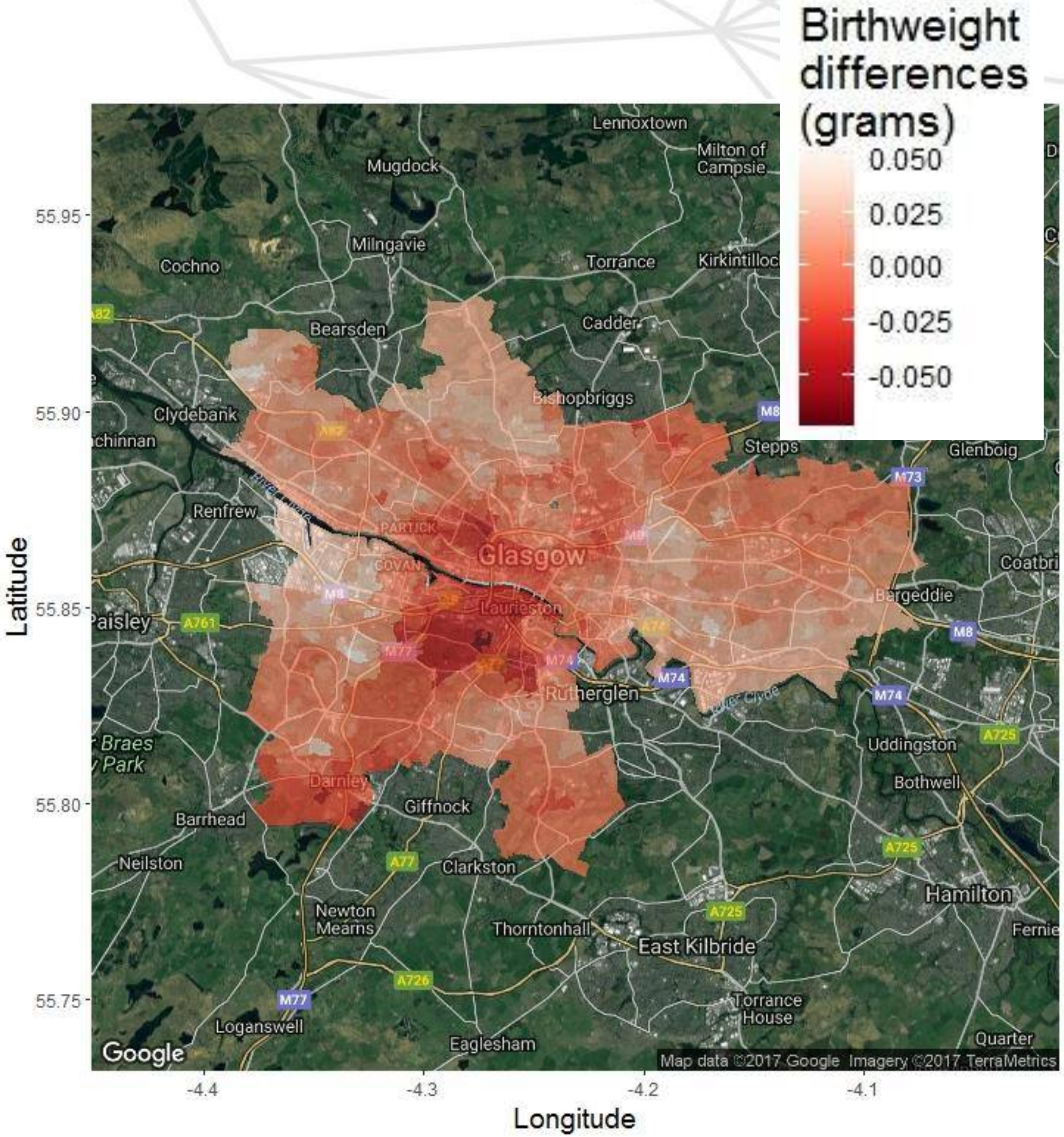
Description Implements a class of univariate and multivariate spatial generalised linear mixed models for areal unit data, with inference in a Bayesian setting using Markov chain Monte Carlo (MCMC) simulation. The response variable can be binomial, Gaussian or Poisson, and spatial autocorrelation is modelled by a set of random effects that are assigned a conditional autoregressive (CAR) prior distribution. A number of different models are available for univariate spatial data, including models with no random effects as well as random effects modelled by different types of CAR prior. Additionally, a multivariate CAR (MCAR) model for multivariate spatial data is available, as is a two-level hierarchical model for individuals within areas. Full details are given in the vignette accompanying this package. The initial creation of this package was supported by the Economic and Social Research Council (ESRC) grant RES-000-22-4256, and on-going development has / is supported by the Engineering and Physical Science Research Council (EPSRC) grant EP/J017442/1, ESRC grant ES/K006460/1, and Innovate UK / Natural Environment Research Council (NERC) grant NE/N007352/1.

Freely available: https://cran.r-project.org/web/packages/CARBayes/index.html

Results



Birthweight differece in grams
(per I IQR increase in pollution)
20
10
0
-10
-20
-30
-40
-50
-60
-70
[X VALUE],
[Y VALUE]
[X VALUE],
[Y VALUE]



Birthweight
differences
(grams)
0.050
0.025
0.000
-0.025
-0.050
Latitude
55.95
55.90
55.85
55.80
55.75
Longitude
-4.4
-4.3
-4.2
-4.1
Glasgow
Lennoxtown
Milton of Campsie
Mugdock
Milngavie
Cochno
Torrance
Kirkintilloc
Bearsden
Cadder
Bishopbriggs
Clydebank
Stepps
Glenboig
Renfrew
Paisley
Laurieston
Rutherglen
Bargeddie
Coatbri
Uddingston
Bothwell
Darnley
Giffnock
Barrhead
Neilston
Clarkston
Newton Mearns
Thorntonhall
East Kilbride
Hamilton
Fernie
Torrance House
Loganswell
Eaglesham
Quarter
Google
Map data ©2017 Google Imagery ©2017 TerraMetrics

WP 3: Accessible health data using synthetic data

- Personal health records are uniquely valuable for health risk modelling.
- But privacy concerns inhibit the use of personal records for policy assessment.
- Solution: create ‘synthetic data’ from the original data.

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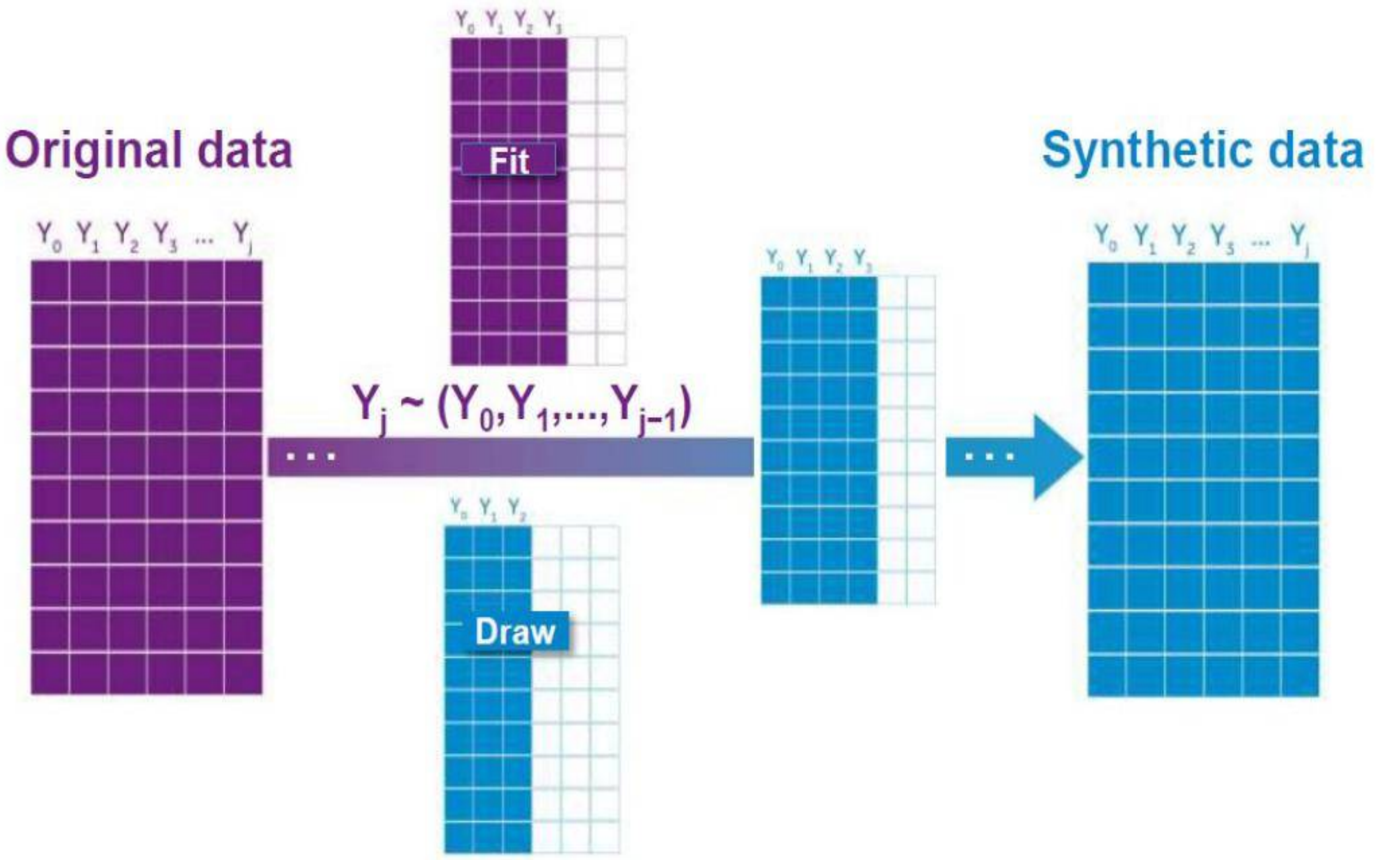
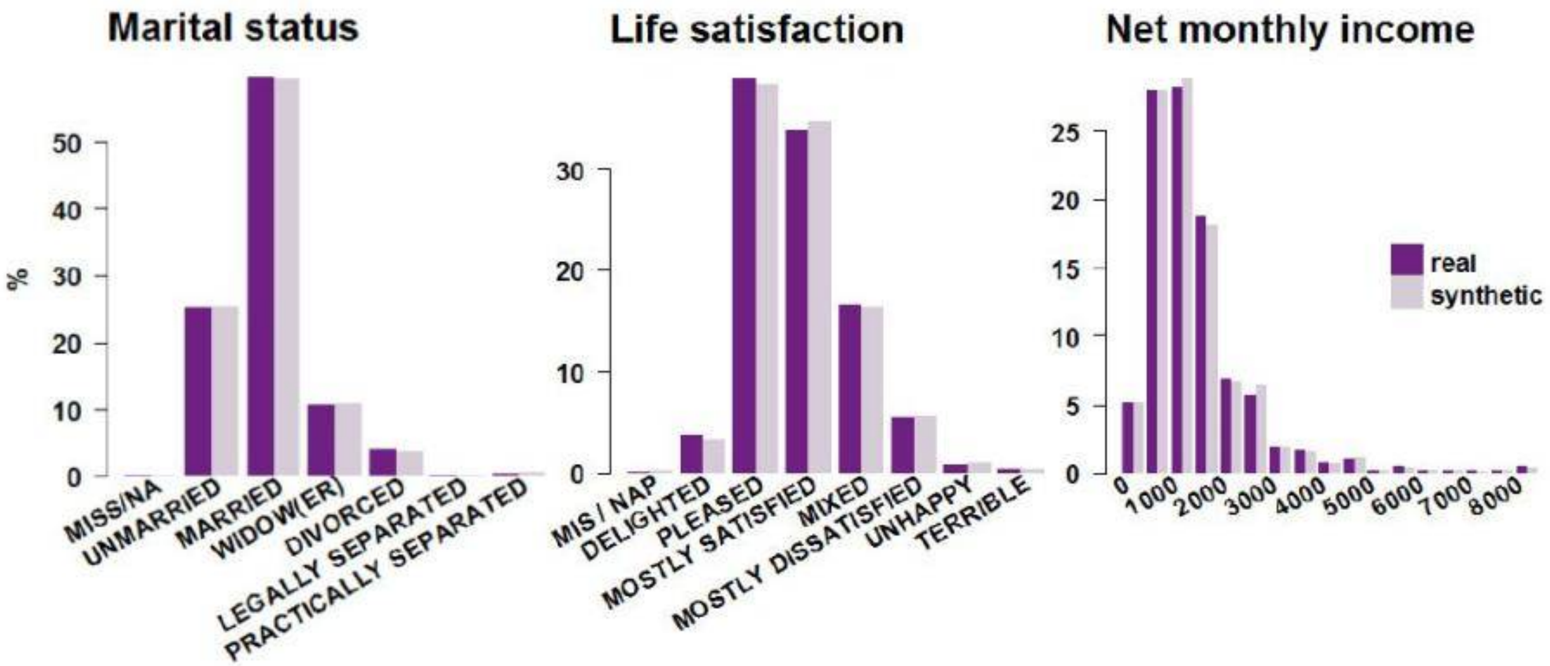


Nowok, B., Raab, G.M., Dibben, C., 2017. Providing bespoke synthetic data for the UK Longitudinal Studies and other sensitive data with the synthpop package for R1. Statistical Journal of the IAOS 33, 785–796. doi:10.3233/SJI-150153
Nowok, B., Raab, G.M., Dibben, C., 2015. synthpop: Bespoke creation of synthetic data in R. Journal of Statistical Software.

Accessible health data: synthetic data

- This resembles the original data and maintains statistical relationships between variables but does not correspond to real individuals.



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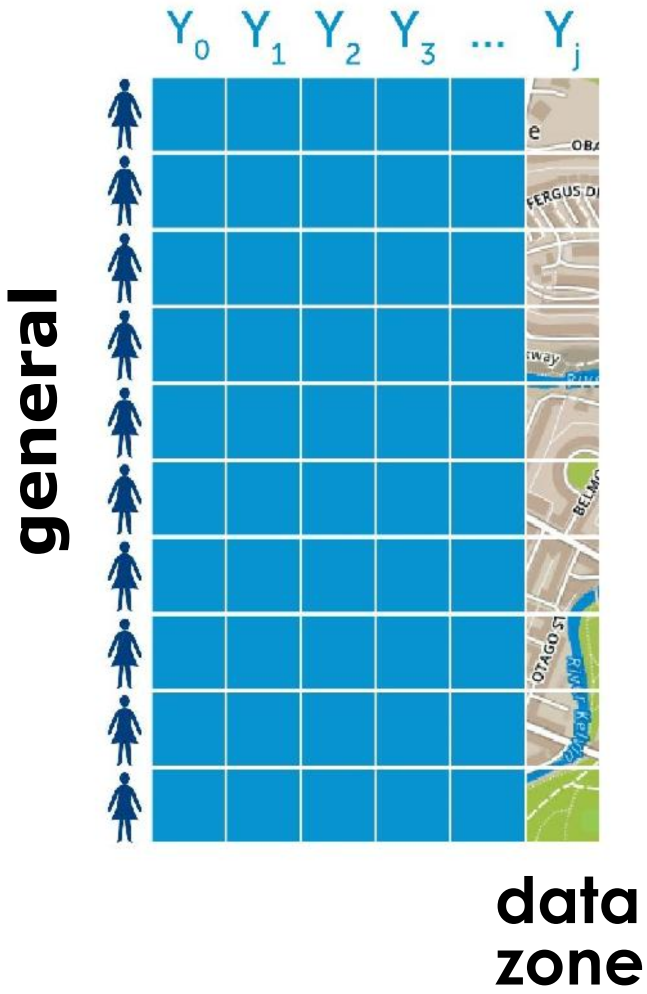
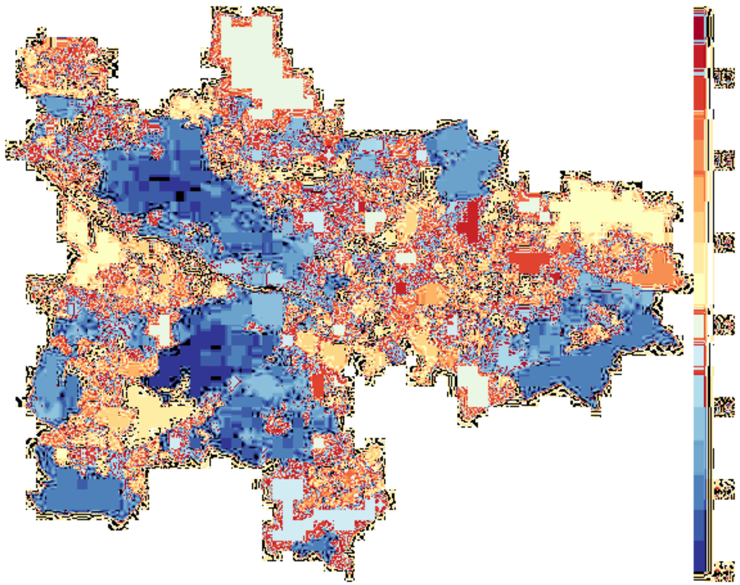
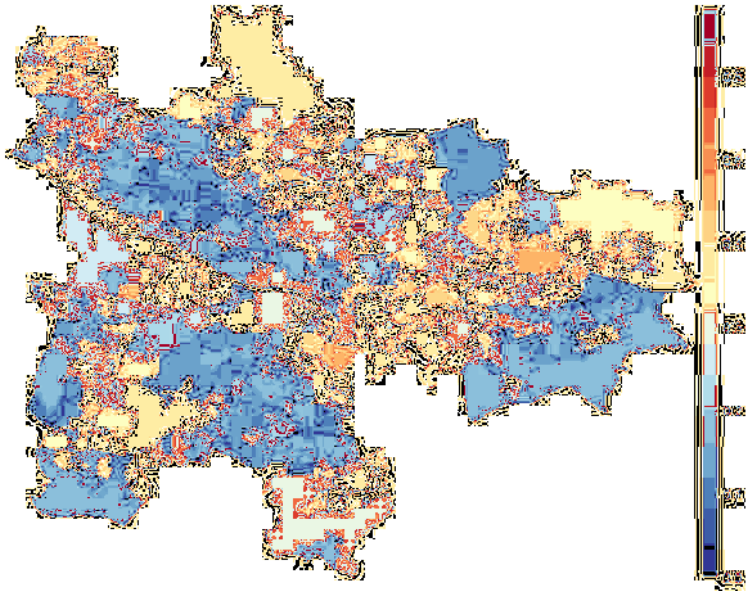
Generating synthetic data for small areas

real data – pregnancy smoking

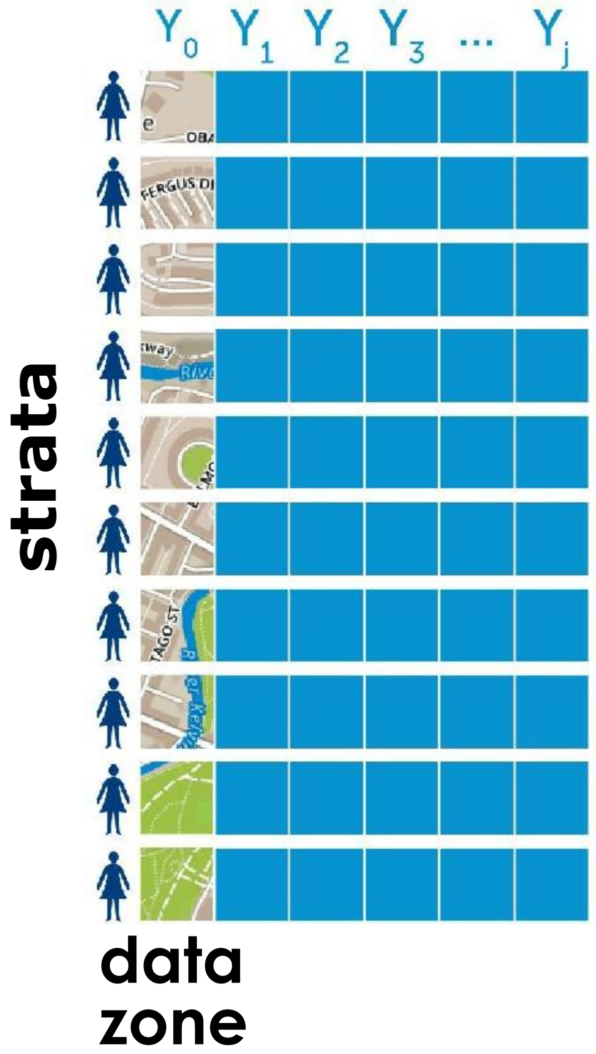




synthetic – general approach



Generating synthetic data for small areas



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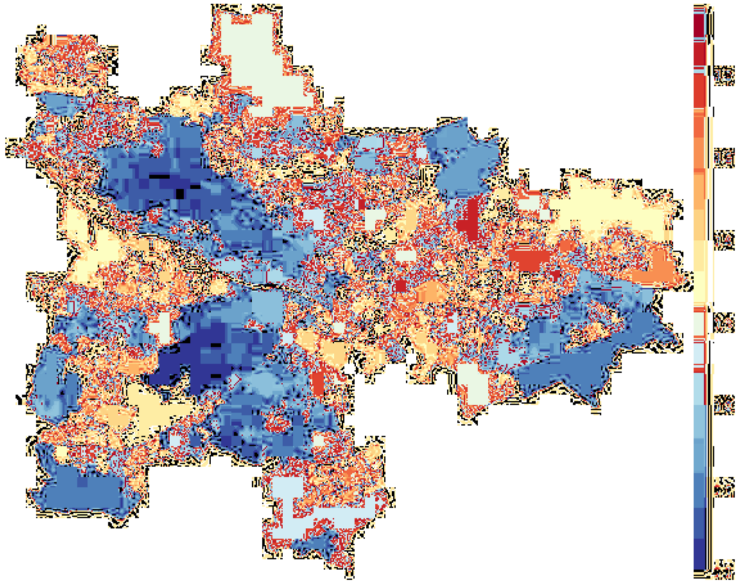
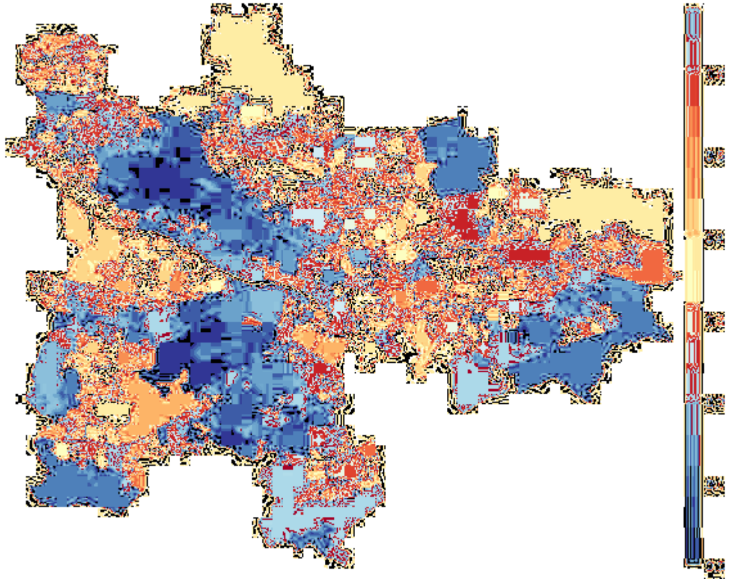
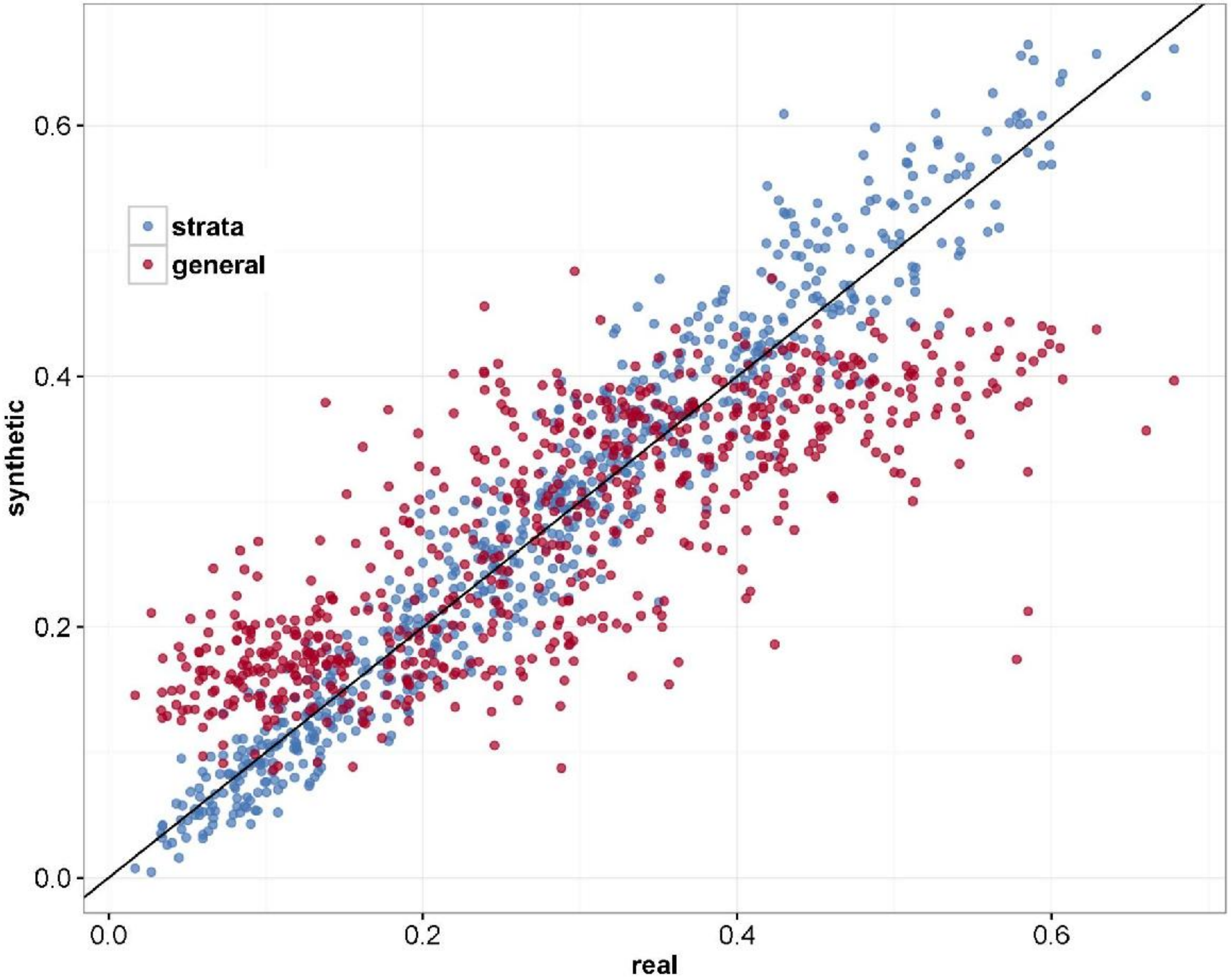


synthetic – strata approach

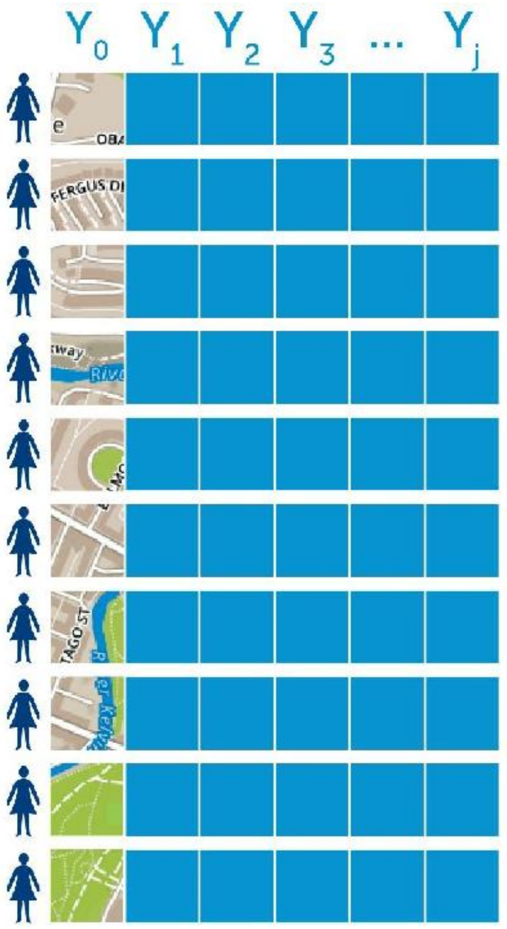


Smoking during pregnancy



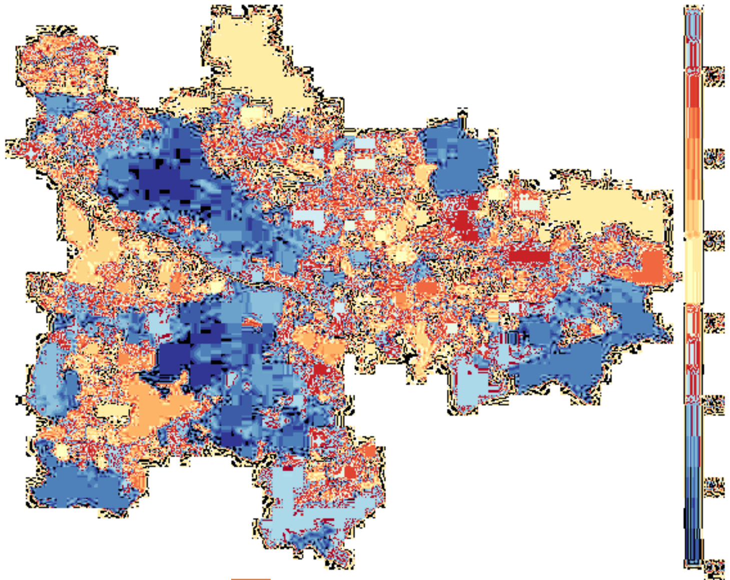
Generating synthetic data for small areas

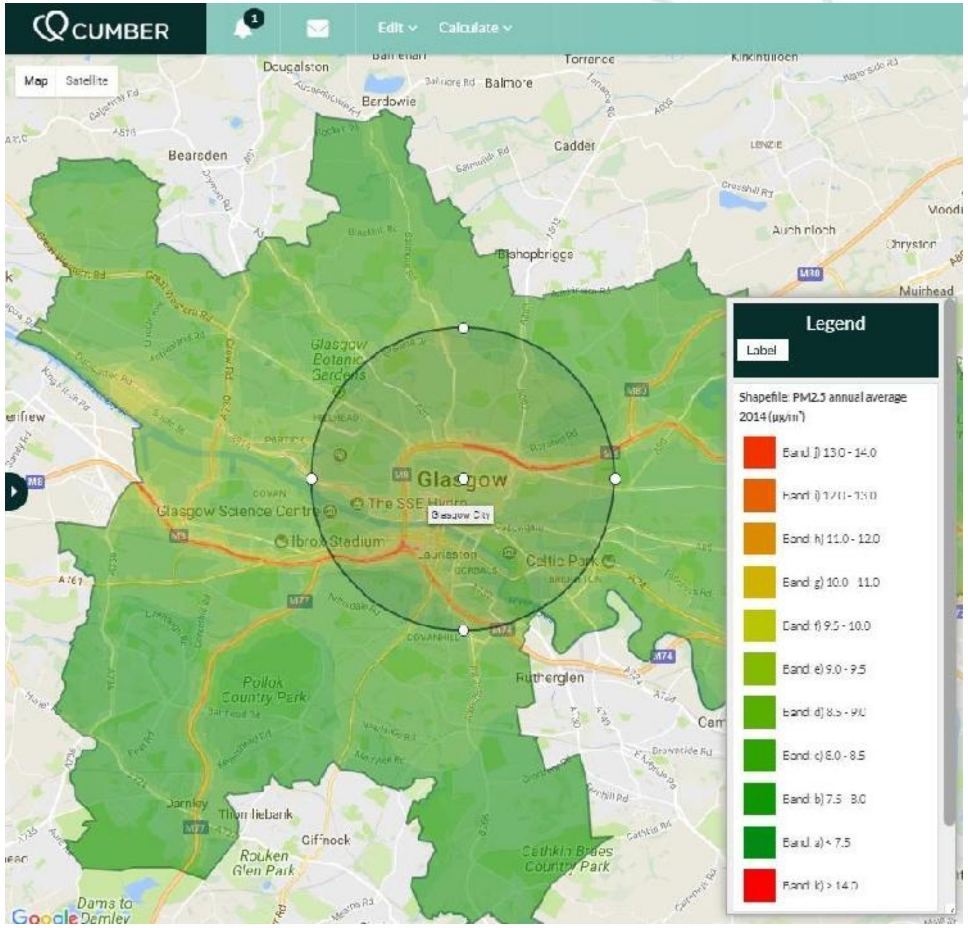
strata



data zone

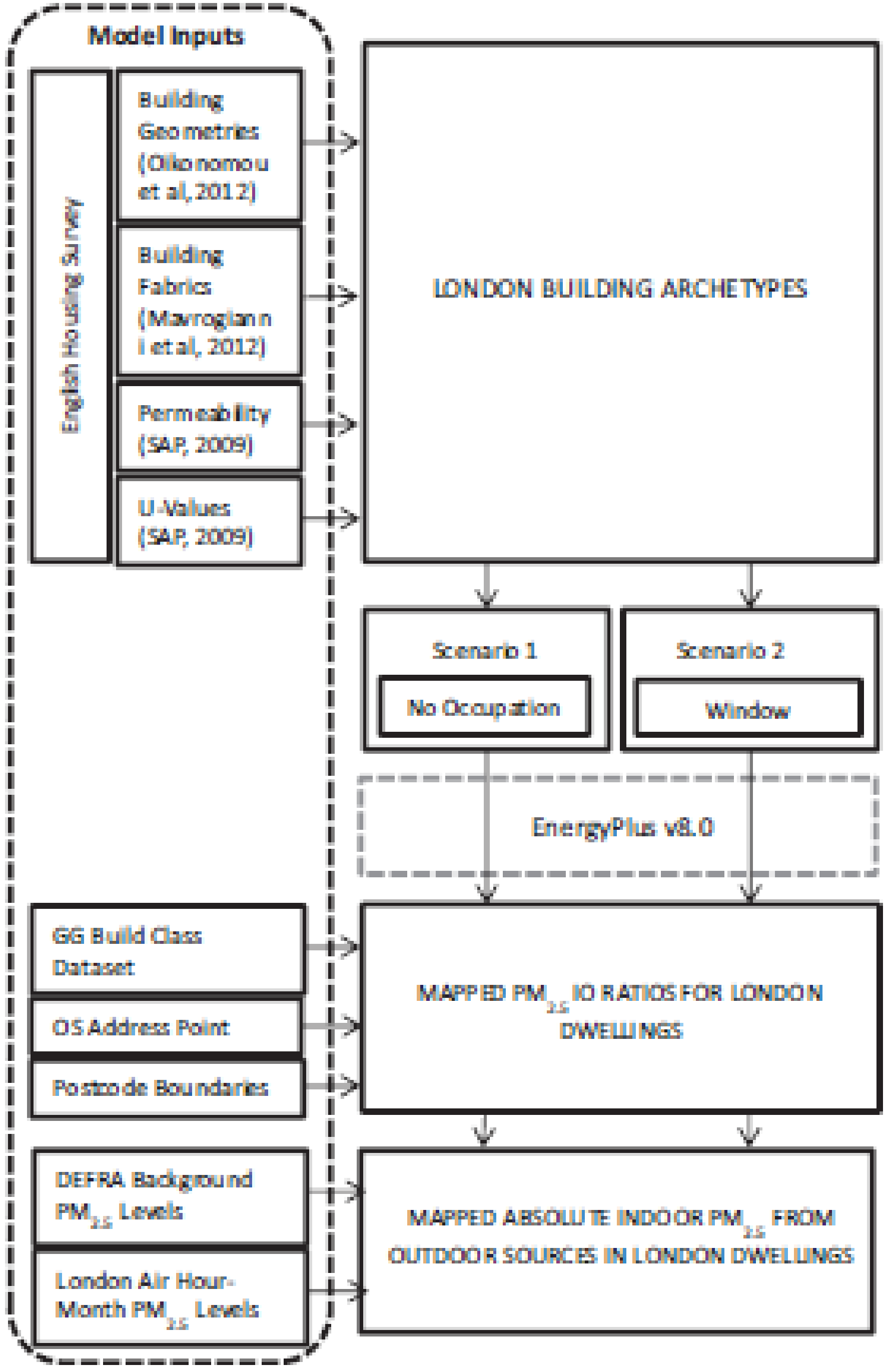
Synthetic data

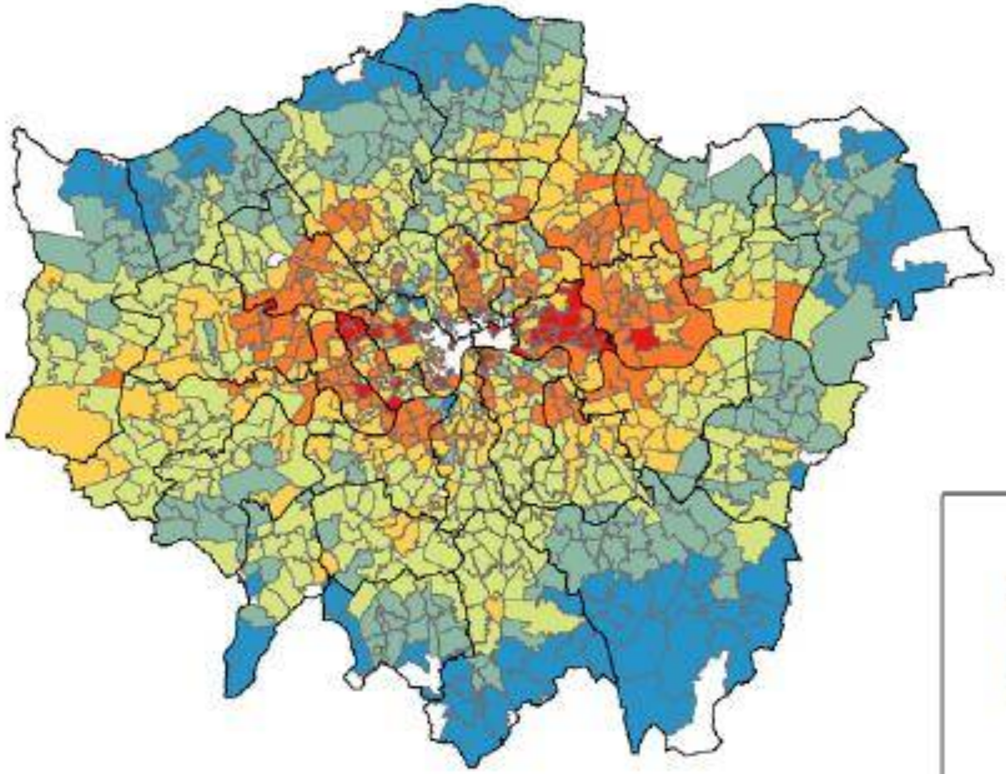




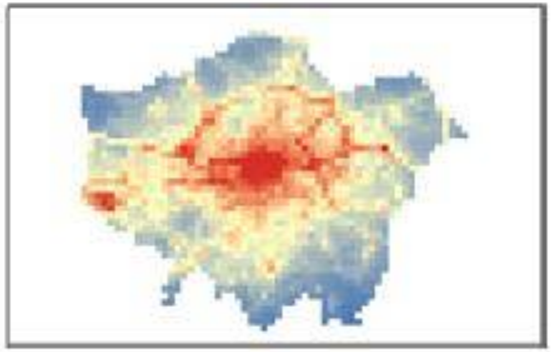
Host on web platform (with appropriate safeguards and security arrangements)

Indoor exposure to outdoor air pollution



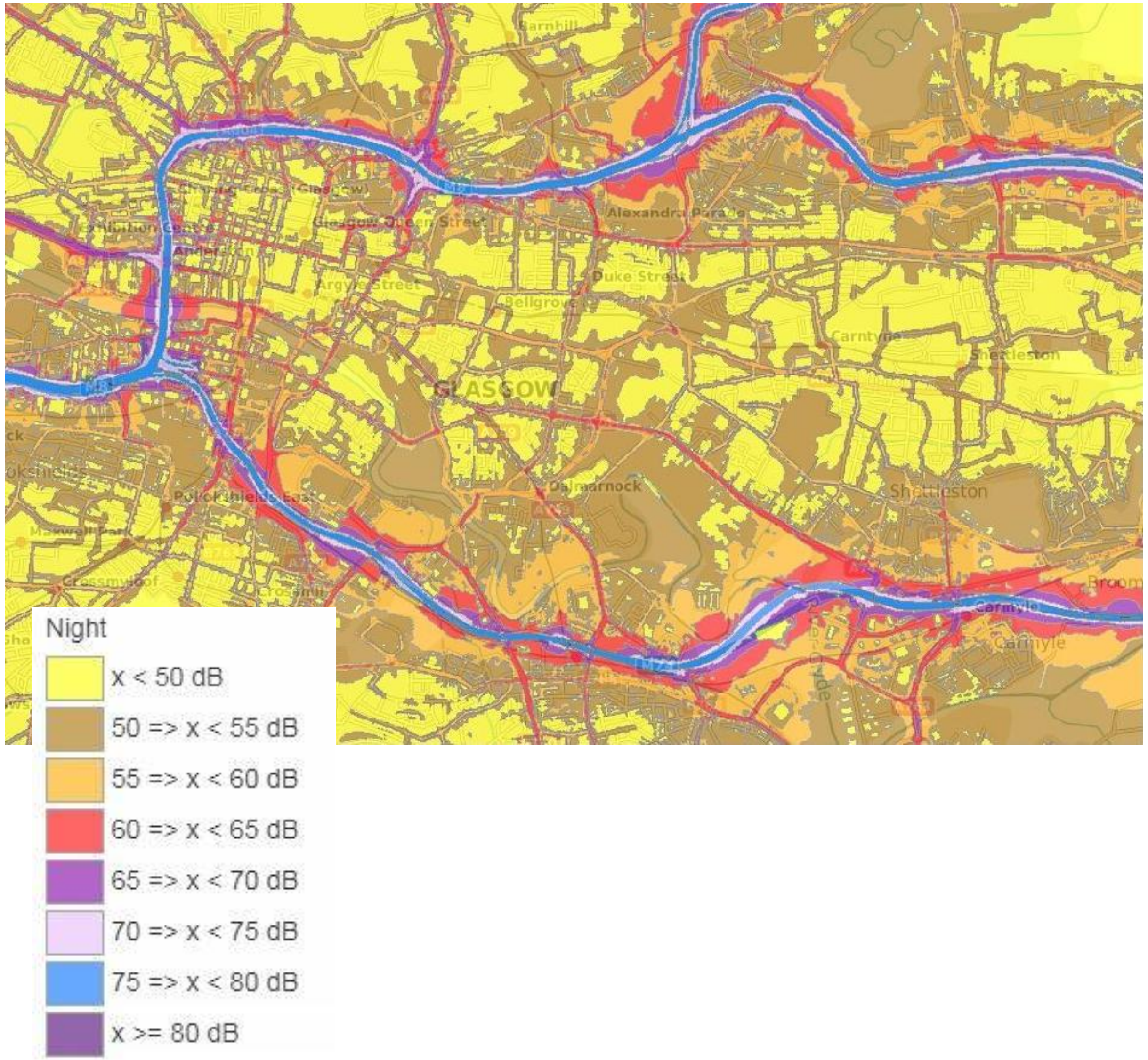


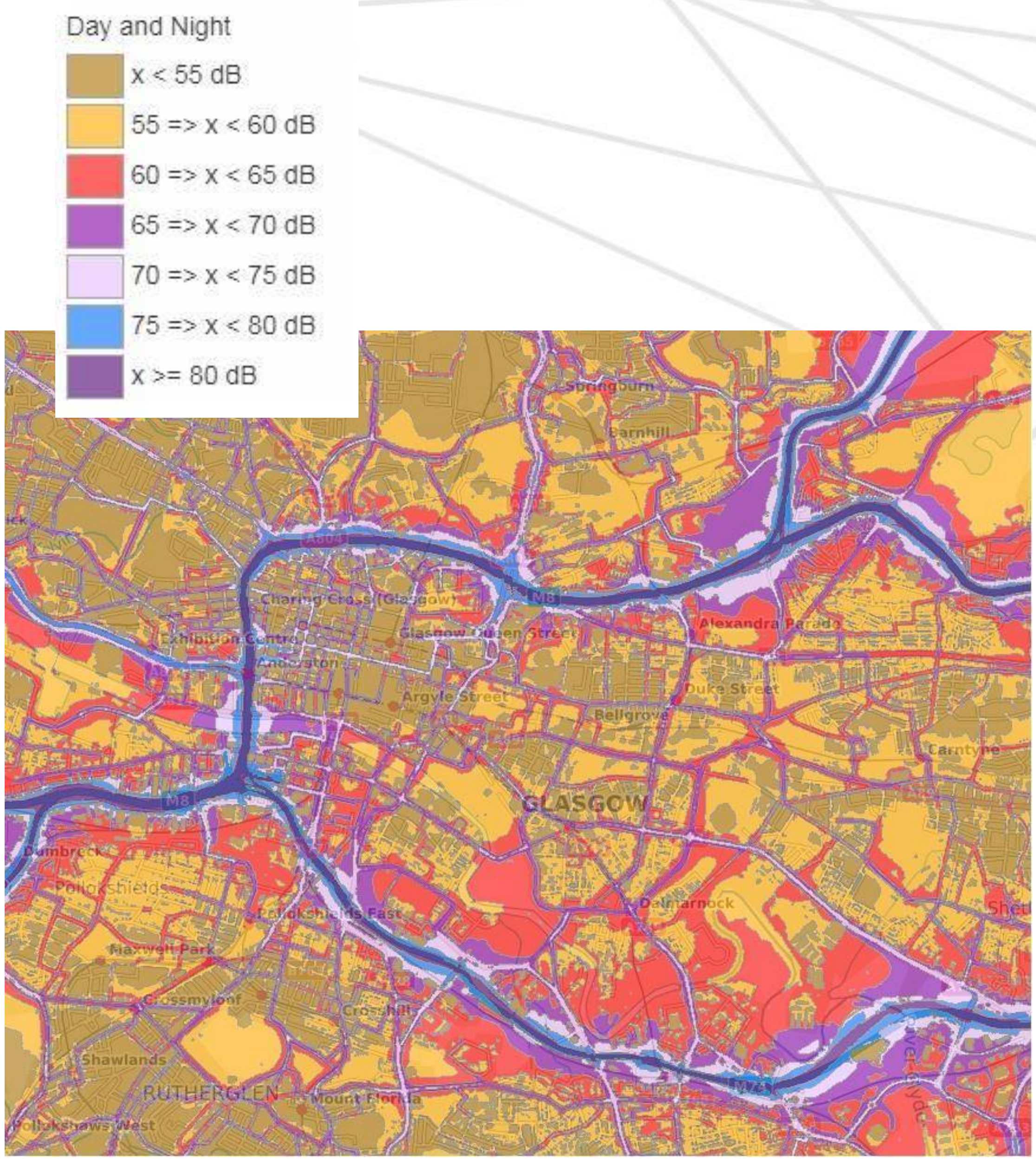
Taylor J, Shrubsole C, Davies M, Biddulph P, Das P, Hamilton I, et al. 2014. The modifying effect of the building envelope on population exposure to PM2.5 from outdoor sources. Indoor Air 24:639–651



Modelled outdoor background concentrations for comparison

Noise exposure





City to City barcelona fad award 2013 Edition

Stalled Spaces

Zeba Aziz
Glasgow City Council

The City

- **Glasgow then…**

- **Glasgow now…**

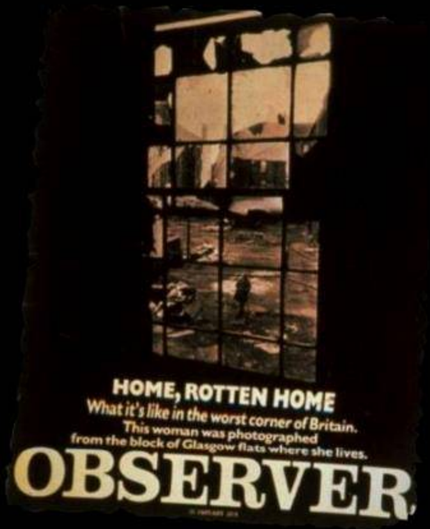
- **Glasgow to be…**

The Press : Early 1980's

" Glasgow… a hellish mix of drink poverty and violence"

" Glasgow's miles worse – a second class city"

" No vision in the face of urban devastation"



Glasgow : More Recently

" a fantastic world class city" (conde nast)

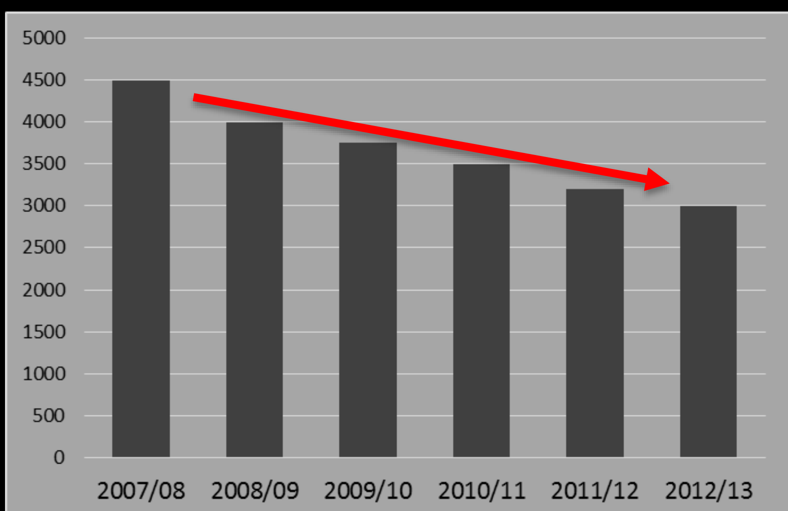
" Brimming with style and culture" (Time)

" Britain's Best Business Location" (Growing Business)

Stalled Spaces Initiative

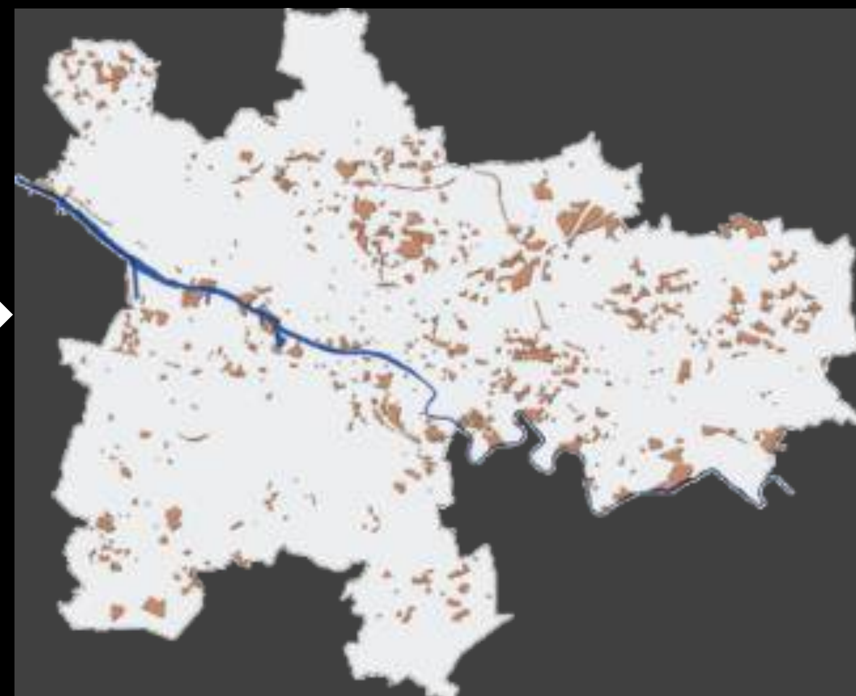
Challenges

Glasgow's Industrial Legacy



Economic Slowdown

Vacant & Derelict Land
+
Stalled Sites



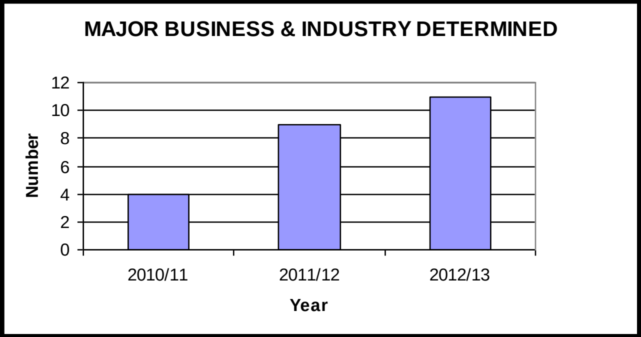
- **60%** of the city’s population lives within **500m / 5 min walk** of a derelict site, one of the **highest** across Scotland.
- Vacant sites often become **prime targets for** fly tipping, vandalism and other **anti-social activities**
- Studies indicate a correlation between **‘areas of deprivation’** in Glasgow and **‘location of vacant and derelict land’**

Opportunities

Commonwealth Games 2014
Legacy Project

GLASGOW 2014
XX COMMONWEALTH GAMES

Join us on the journey
www.gameslegacyglasgow.com
LEGACY 2014



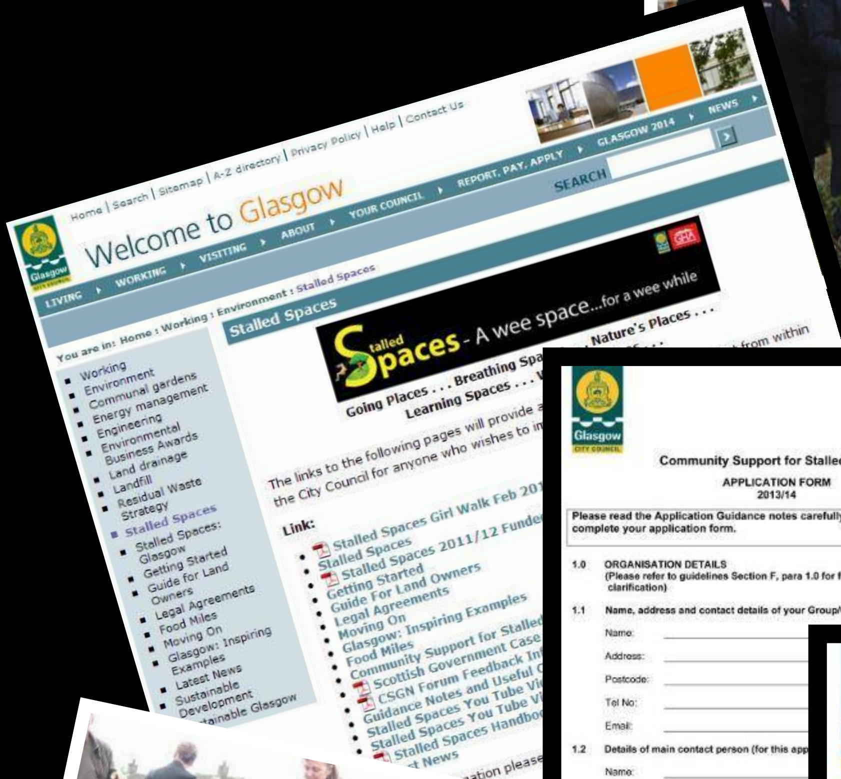
Initiation

Council Motion

At its Meeting of 30 October 2008 the Council approved a motion recognising the impact of the economic downturn on its development ambitions and stating that**,**

“the Council therefore resolves to work with site and property owners to temporarily landscape vacant sites to create simple, but well maintained grassed areas open to the public,”

Making it happen




Application reference

Glasgow CITY COUNCIL

Community Support for Stalled Spaces

APPLICATION FORM
2013/14

Please read the Application Guidance notes carefully and in full before you complete your application form.

1.0 ORGANISATION DETAILS
(Please refer to guidelines Section F, para 1.0 for further information and clarification)

1.1 Name, address and contact details of your Group/Organisation/Initiative

Name:
Address:
Postcode:
Tel No:
Email:

1.2 Details of main contact person (for this app

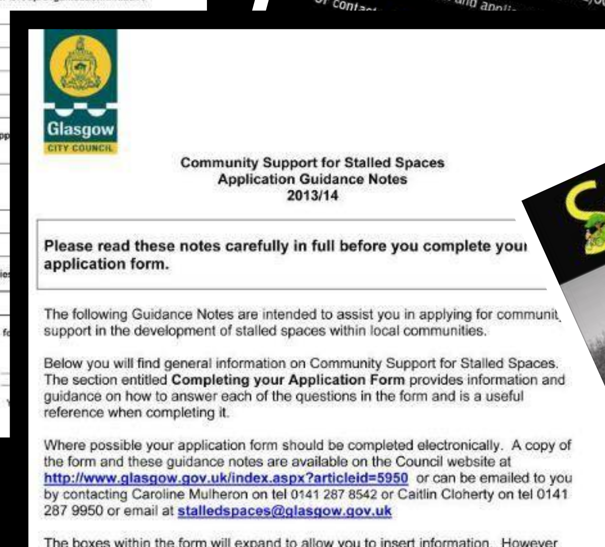
Name:
Position in organisation (e.g. Chairperson):
Address (if different from above):
Tel No:
Email:

What are the main aims/objectives/activitie

1.4 Registration Details: Please provide the fo
N/A if not applicable

Charity Registration No:
Care Commission Registration No

Member of Protection of Vulnerable Groups Scheme?


Glasgow CITY COUNCIL

Community Support for Stalled Spaces
Application Guidance Notes
2013/14

Please read these notes carefully in full before you complete youı application form.

The following Guidance Notes are intended to assist you in applying for communit support in the development of stalled spaces within local communities.

Below you will find general information on Community Support for Stalled Spaces. The section entitled **Completing your Application Form** provides information and guidance on how to answer each of the questions in the form and is a useful reference when completing it.

Where possible your application form should be completed electronically. A copy of the form and these guidance notes are available on the Council website at http://www.glasgow.gov.uk/index.aspx?articleid=5950 or can be emailed to you by contacting Caroline Mulheron on tel 0141 287 8542 or Caitlin Cloherty on tel 0141 287 9950 or email at stalledspaces@glasgow.gov.uk

The boxes within the form will expand to allow you to insert information. However

Making it happen in the Council

- **Development Plan**
  - Lead Officers
  - LDP
  - Open Space Strategy
- **Development Management**
  - Planning applications
  - Integrating into masterplans
- **Legal Services**
  - Lease Agreements
- **Other Teams**
  - Surveying, ownership checks, monitoring, evaluation
- **Other Services**
  - Education, LES, Glasgow Life, Glasgow Community Safety Services

Partnerships

CREATIVE SCOTLAND
ALBA | CHRUTHACHAIL

GHA

planning aid for Scotland

gcv green network
connecting our quality spaces

PAR+RS Public Art Scotland +

THE GLASGOW SCHOOL OF ART

GLASGOW COMMUNITY & SAFETY SERVICES

Get the most out of Glasgow Life

The Scottish Government

NHS SCOTLAND

CSGN
Central Scotland Green Network

Scottish Enterprise

Mactaggart & Mickel
SINCE 1925

RBS
The Royal Bank of Scotland

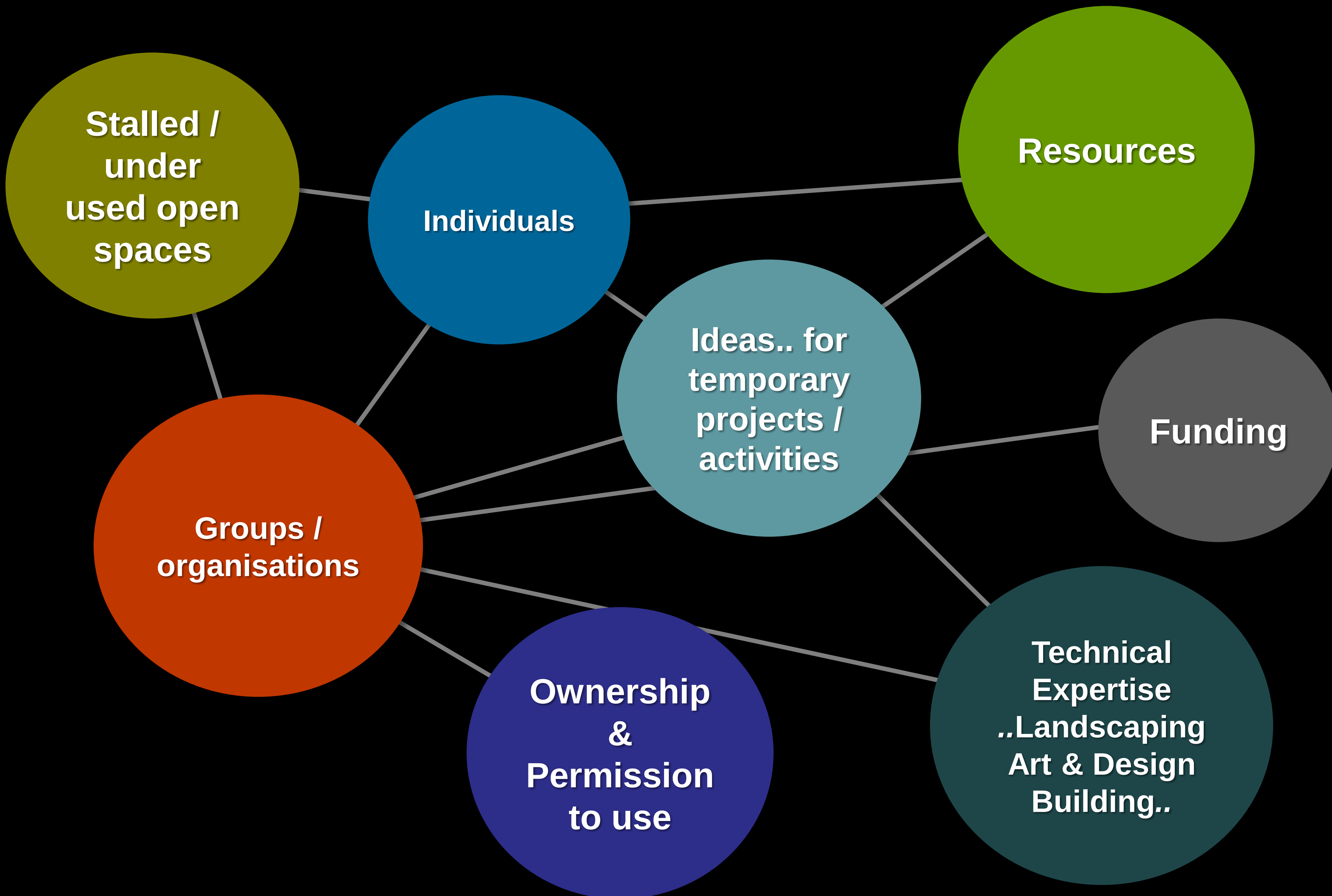
CLYDE GATEWAY

ogilvie

British Waterways

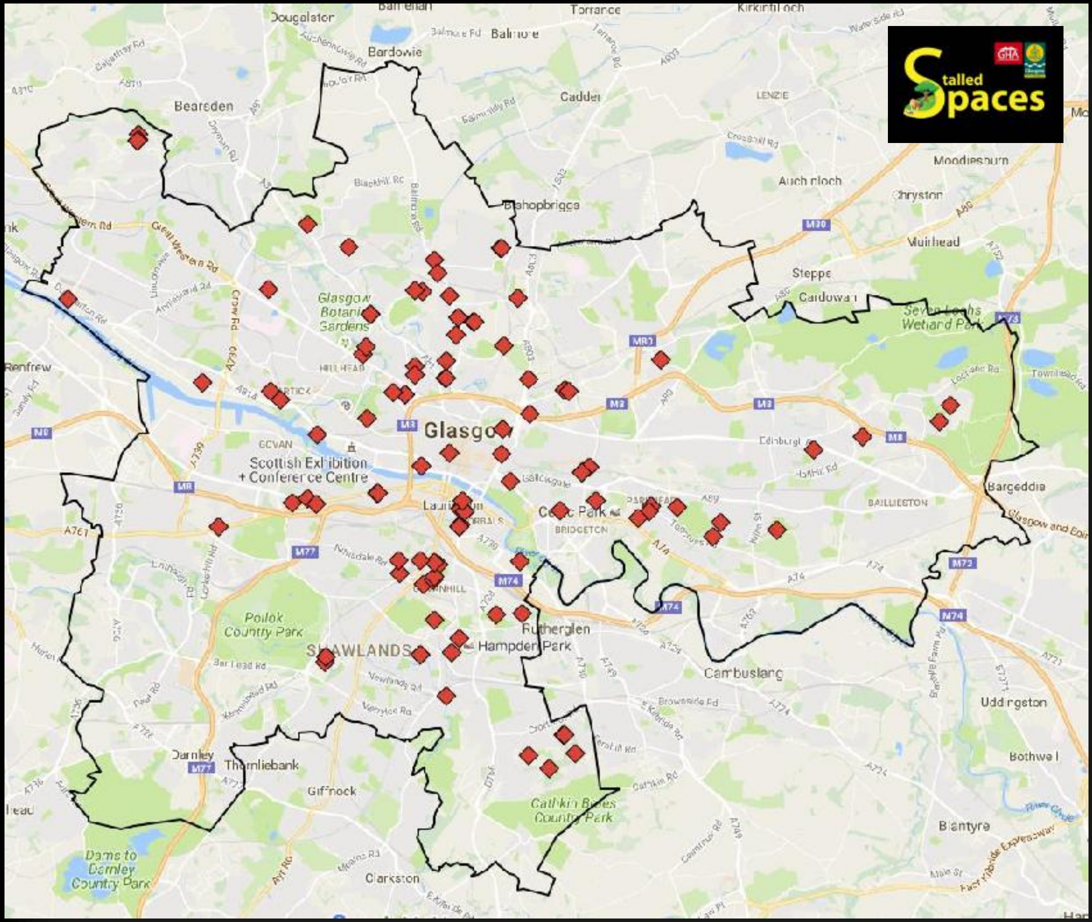
CLYDEPORT

Connecting the dots



Outcomes 2011- 2016

- **>130** - Projects supported
- **100** - Community groups supported
- **>25Ha** - Vacant land brought under active community use
- **53%** - Share of projects in most deprived areas (worst SIMD)
- **£3** - External funding leveraged for every **£1** of Seed Funding
- **>25K** - Volunteer hours spent on projects



Themes

Outdoor Arts

Urban Growing

Environmental Education

Natural Play

Green Networks / Wildlife Diversity

Urban Growing

Community Garden - Friends of Maryhill Park

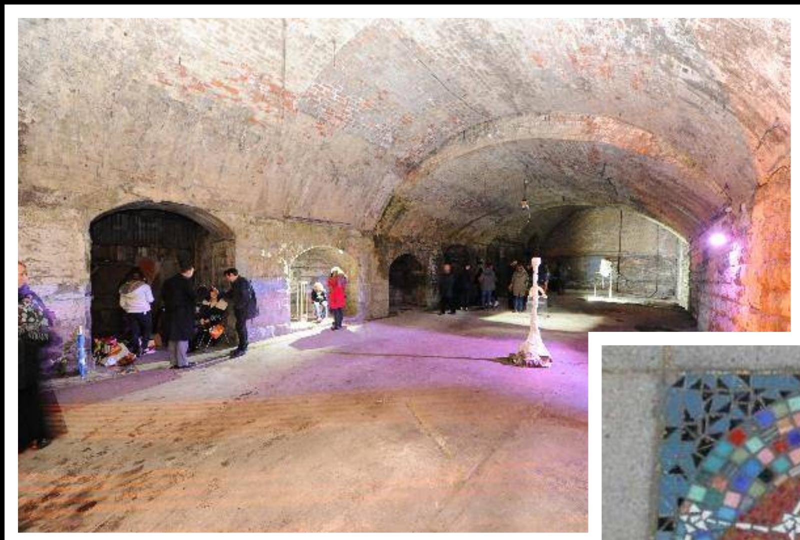

Stalled Spaces - A wee space...for a wee while
GHA

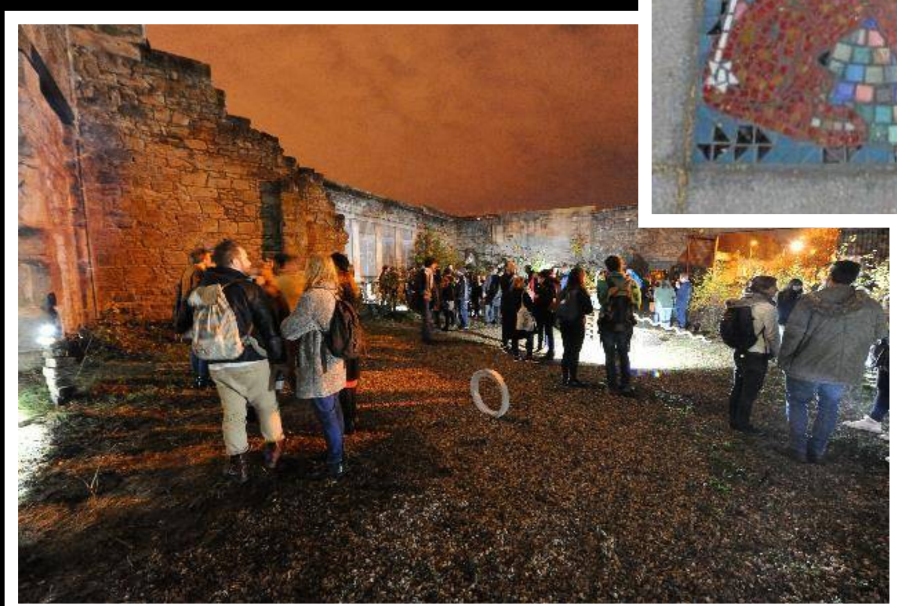
Square Yard Garden on Ledard Rd, Langside






Outdoor Arts





The Secret Garden, David Dale Gallery, Bridgeton


PIZZ

Art & Living Laurieston, Caledonia Road Church, WAVEparticle

Outdoor Recreation

Pollokshields Playhouse – Pollokshields Community Council





PLAYHOUSE
?
5
4
3
2
1



PLAYHOUSE
OPENING TIMES
MON
TUES
WED 12-16
THURS
FRI
SAT 11-16
SUN

PLAYHOUSE



HOT FOODS MENU
CURRY TUB - CHOICE OF CURRIES - ONION SALAD / CUCUMBER RAITA + BREADS £5
SAMOSA OR BHAJI WITH SALAD + DIP £2
PAKORAS WITH SALAD / DIP £3

Environmental Education

Outcomes

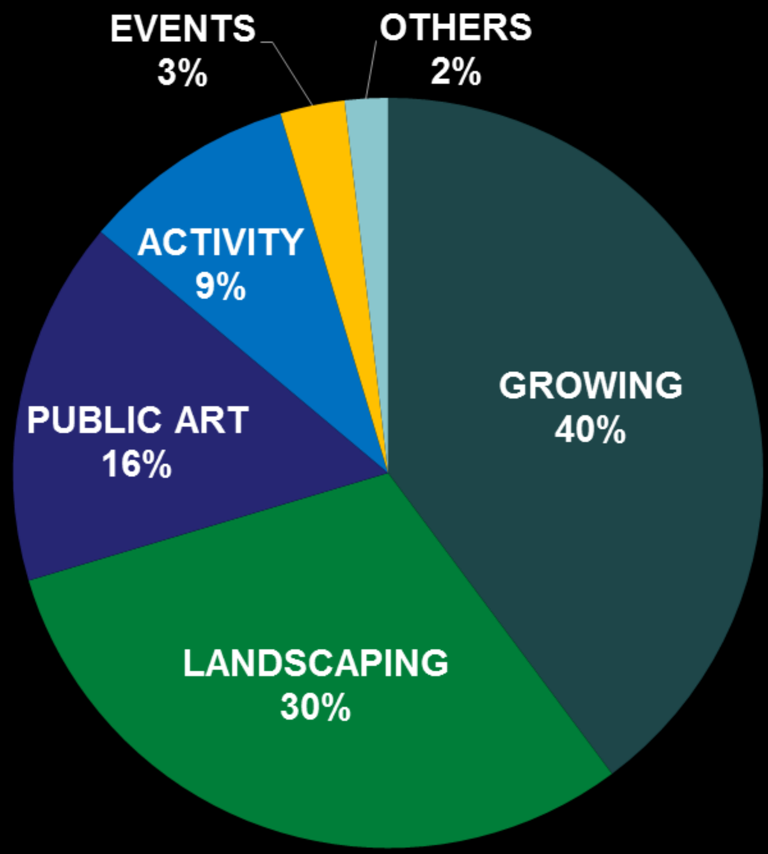
Regeneration

Placemaking

Food Poverty

Reducing Food Miles

Wildlife Conservation



Community Engagement

Social Isolation

Education

Skills & Training

Health & Well-being

Landowner Benefits

- The improvement of unused open space in a way that doesn’t jeopardising future development plans;
- Sites are looked after, well maintained and left in a better condition;
- Sites are made safe and secure through community involvement and use;
- Improvement in the value, quality and image of the local area as well as the site's attractiveness for future development

Community Benefits

- ‘Improving the neighbourhood’ and ‘giving something back to their community’
  - Community becomes more socially integrated
  - Projects lead to subsequent activity intended to benefit the community
- Involvement in such projects has a positive influence on overall well-being
  - People become more active
  - Gain new skills through involvement
  - Opportunity to meet new people, reduction in social isolation through greater socialisation

Assessing the individual and community impacts of Stalled Spaces-funded projects in Glasgow

Glasgow Centre for Population Health, October 2015

Testimonials

"The Stalled Spaces initiative has provided an excellent opportunity for us to give something back to the local community through our involvement with Cleveden Community Club at Dorchester Avenue."
Andrew Mickel, director of Mactaggart & Mickel Group

"Over 4,000 people visited the site and experienced an inspiring outdoor space" *Giant*

"We have transformed an area of neglect and re-kindled a pride in our area" *Craigton Residents Action Group*

"The volunteers increased their physical activity and have taken ownership of the space.
Cassiltoun Housing Association

"A derelict space has now been transformed into and attractive community area where children can learn about and access the natural outdoors in a safe way" *Beechwood Nursery*

"It has made a terrific difference to how we feel about living in the area and has generated a sense of community" *Friends of Kelvingrove Square*

'The project has assisted by reducing the additional maintenance burden placed on the service while also providing an opportunity for our staff to contribute to environmental enhancement and real life change projects within communities'
Thomas McMenamin
Assistant Parks Operations Manager (South)

National Roll Out

Policy Support - City Development Plan & Open Space Strategy

IPG 1: (SG 1) Placemaking Part 1 and Part 2

SMALL SCALE VACANT & DERELICT LAND: THINK ABOUT...

1. Animation of Blank Gables

Inanimate spaces can be made more vibrant and achieve a sense of community ownership through simple creative treatments of blank gables and the refurbishment of site boundaries.

2. Reaffirm and Reinvent Character

Celebrate important social and historic features of the area. Creative responses which reinvent stalled spaces and buildings will help to rebuild confidence in blighted areas.

3. Integrated Networks:

Vacant and derelict land can often form large barriers separating communities. Integrated infrastructure networks should be considered as a first phase of development on derelict land. Consider starting with safe and pleasant walking & cycling routes and the green network (including SUDs).

4. Temporary Community Uses

Consider the wider benefits of assisting with basic maintenance and management of nearby vacant and derelict sites. Investigate animating derelict spaces through temporary community uses and events, such as markets, gardens and growing spaces.

5. Safety

Derelict land can often feel unsafe and unwelcoming. Help alleviate these concerns through improved lighting , passive surveillance management of vegetation and the animation of spaces.

6. Embedded Future Urban Features

When implementing a temporary solution consider embedding urban design features which can later be adopted by the final uses of the site, such as routes, lighting or public artwork.

7. The Involvement of the Local Community

The involvement of the local community will help with understanding of social character and context., whilst also creating a sense of shared custodianship.

8. Repairing Urban Form

Vacant sites often suffer from poor edge conditions. Consider reinforcing street edges and ensure that open spaces are activated and have a clear identity and sense of custodianship.

Stalled Spaces

Glasgow City Council

QCumber-EnvHealth
Stakeholder Workshop

27 September 2017
The Lighthouse, Glasgow

Greenspace policy scenario

Mark Jackson, CERC
Chris Johnson, CERC

Overview

- The value of greenspace
- Scenario: convert vacant/derelict land to greenspace throughout Glasgow
- Scenario assessment: National Indicator for Greenspace, mental wellbeing, inequality
- Research findings on greenspace and mental wellbeing
- Demonstrate policy assessment tool in platform
- Scenario assessment results

The value of greenspace

- It is increasingly evident that good quality greenspaces contribute strongly to physical activity and mental wellbeing
- Scottish Government National Performance Framework sets out a vision of national wellbeing with indicators. For example
  - Greenspace indicator: percentage of adults within 5 minutes walking distance of nearest local greenspace

Greenspace policy scenario

- **Convert all vacant and derelict land in Glasgow to high quality greenspace**
- Inspired by ‘stalled spaces’ projects to support communities to bring stalled spaces or derelict and vacant land into temporary use

Greenspace scenario assessment

- Use readily available open data for a simple and quick analysis
- Estimate benefits of the increased availability of greenspace under the scenario
  - Improvements in National Indicator on greenspace
  - Improvements in mental wellbeing and reductions in inequality

Greenspace scenario assessment: data

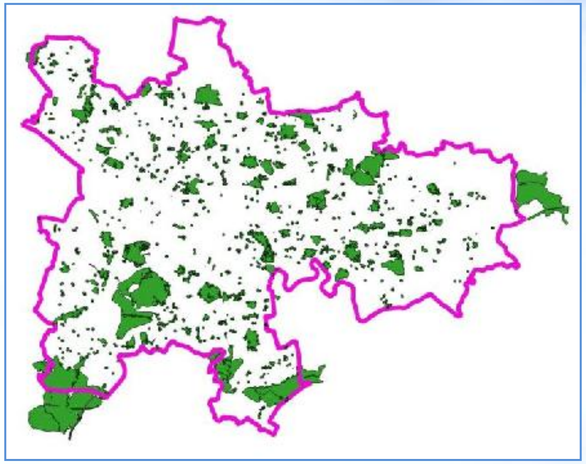
- Used open data for the assessment

Dataset	Data used
OS Open Greenspace	Existing greenspace
Scottish Vacant and Derelict Land Survey 2016	Vacant and derelict sites
Scottish Index of Multiple Deprivation	Income deprivation and population

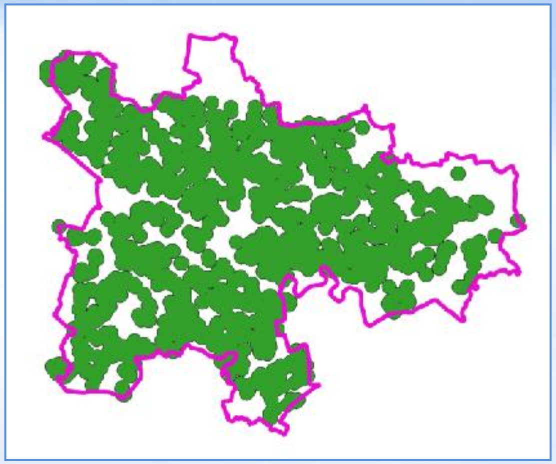
National Indicator: current situation

- Greenspace indicator: percentage of adults within 5 minutes walk of nearest greenspace
- For a simple assessment a 300m distance can approximate a 5 minute walk
- Estimate how many people in Glasgow are within 300m of greenspace

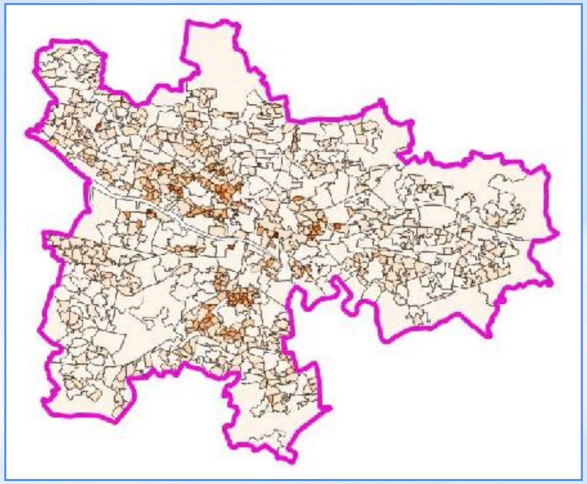
National Indicator: current situation



(1) OS Greenspace: existing greenspace



(2) Areas within 300m of existing greenspace

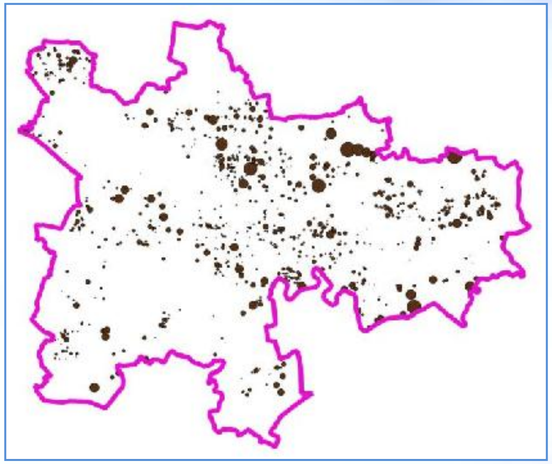


(3) SIMD population data

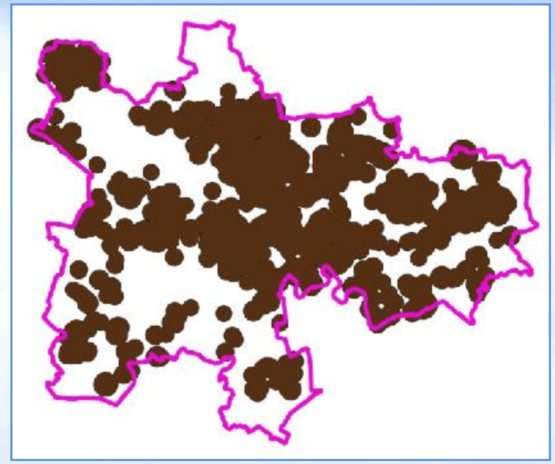
Results

- 83% of the population live within 300m of greenspace.
- Scottish Household Survey national average is 67%

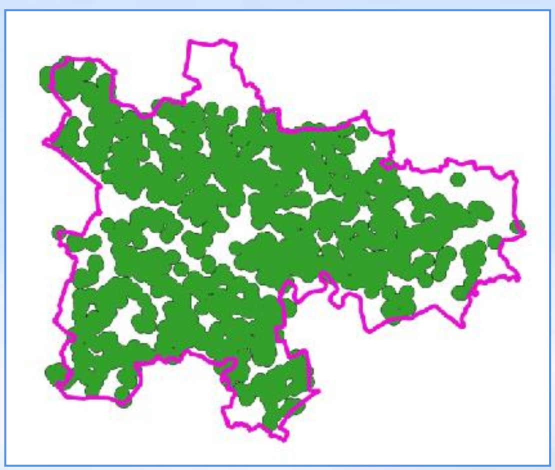
National Indicator: with measure



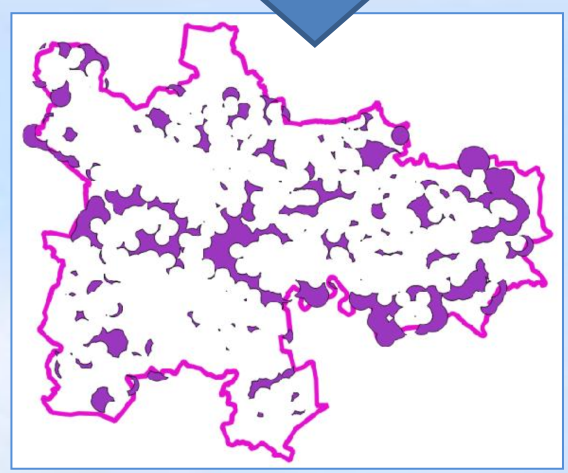
(1) National Vacant/Derelict Land Survey



(2) Within 300m of vacant/derelict land



(3) Within 300m of existing greenspace



(4) Measure brings people within 300m of new greenspace

Impact of measure: National Greenspace Indicator

- Converting all vacant/derelict land in Glasgow to greenspace increases the percentage of adults within 5 minutes walking distance of greenspace from 83% to 92% (increase of 57,000 people)
- Next step: estimate impact on mental wellbeing and inequality

Research findings on greenspace and mental wellbeing

- Links between greenspace and mental wellbeing
  - Based on European Quality of Life Survey 2012
  - Assessed links between mental well-being, neighbourhood environments and socioeconomic inequalities
  - Wellbeing measured using WHO-5 questionnaire (a 100 point scale)
  - Found that socioeconomic inequality in mental well-being was 40% narrower among respondents reporting good access to green/recreational areas

Neighborhood Environments and Socioeconomic Inequalities in Mental Well-Being

Richard J. Mitchell, PhD, Elizabeth A. Richardson, PhD, Niamh K. Shortt, PhD, Jamie R. Pearce, PhD

(Am J Prev Med 2015;49(1):80–84) © 2015 American Journal of Preventive Medicine

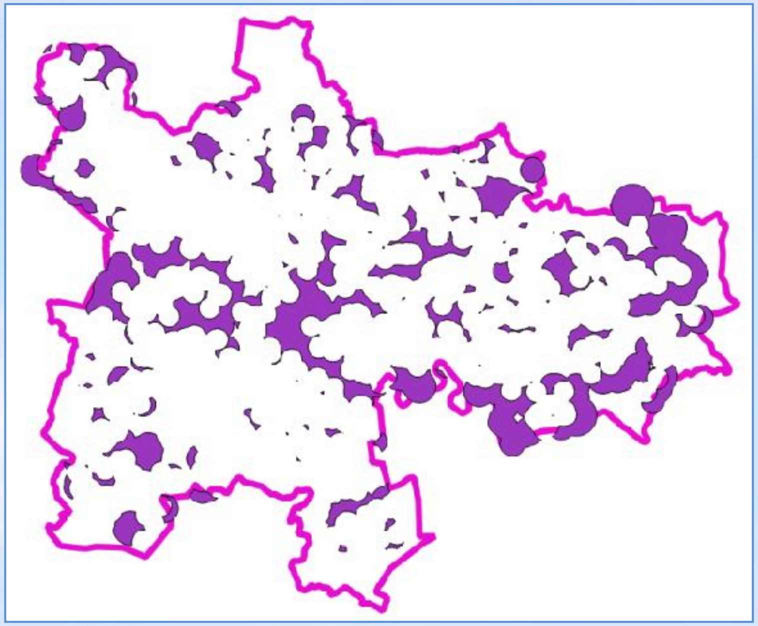
Integrating the findings as an assessment tool

- Assumptions:
  - European Quality of Life Survey results applicable in Scotland
  - ‘Good access to greenspace’ ⇔within 300m of greenspace
  - ‘Financial strain’⇔ SIMD measure of people who are income deprived
- Integrated the findings in the platform as a policy assessment tool

Greenspace Scenario
Platform demonstrations

Scenario assessment results

- Greenspace Indicator: 83% to 92%
- Improves mental wellbeing for 12,000 income deprived people
- Geographical locations where action produces most impact



Greenspace policy scenario assessment: conclusion

- Demonstrated a simple and quick analysis using readily available open data
- Estimated benefits of the increased availability of greenspace: National Indicator for Greenspace, mental wellbeing and inequality
- Showed policy assessment tool in the platform

Thank you: any questions?

Mark Jackson, CERC
Chris Johnson, CERC

QCumber-EnvHealth Stakeholder Workshop

Policy Context
Decision Making
Requirements

Drew Hill

Drew.Hill@transport.gov.scot

Transport Scotland



1 Transport Scotland

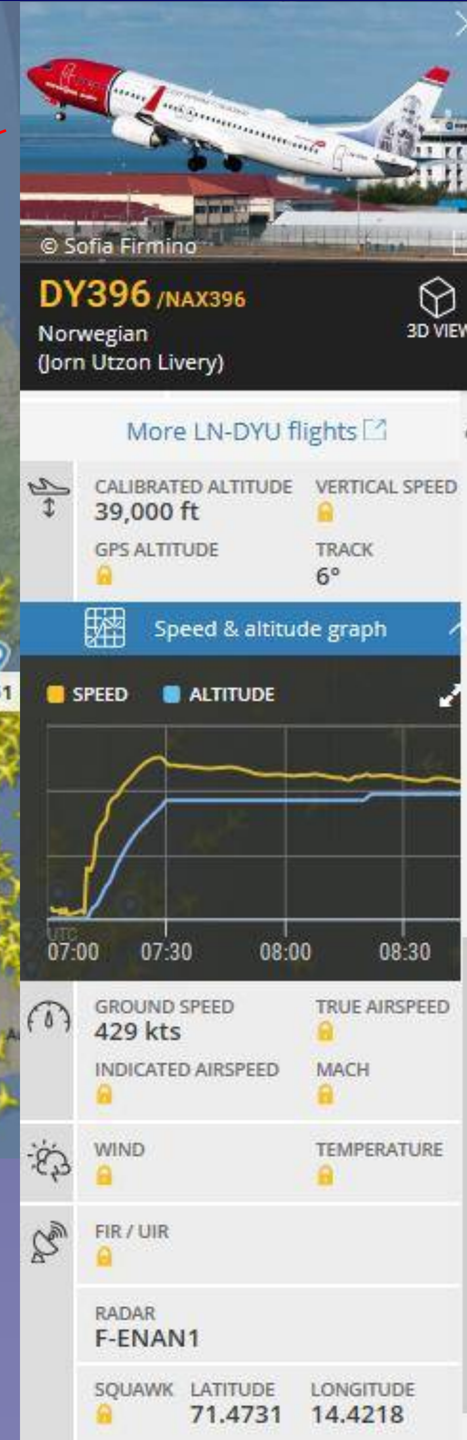
2 Our journey on air quality

3 Cleaner Air for Scotland

4 Programme for Government

5 Next Steps


NAX396
HDA951
Greenland
Iceland
Finland
Sweden
Russia
Canada
Ukraine
Kazakhstan
Mongolia
Algeria
Libya
Mali
Niger
Chad
Colombia
Peru
Angola
Namibia
Madagascar
South Africa
Argentina
South Atlantic Ocean
Indian Ocean
South Pacific Ocean


© Sofia Firmino
DY396 /NAX396
3D VIEW
Norwegian
(Jorn Utzon Livery)
More LN-DYU flights
CALIBRATED ALTITUDE
39,000 ft
VERTICAL SPEED
GPS ALTITUDE
TRACK
6°
Speed & altitude graph
SPEED
ALTITUDE
UTC
07:00
07:30
08:00
08:30
GROUND SPEED
429 kts
TRUE AIRSPEED
INDICATED AIRSPEED
MACH
WIND
TEMPERATURE
FIR / UIR
RADAR
F-ENAN1
SQUAWK
LATITUDE
71.4731
LONGITUDE
14.4218

Paradox message

Transport is a principle cause of poor air quality

Transport can contribute significantly towards cleaner air quality

Role of Transport Scotland

Role

Support and advise the Government on the strategy and policy options for transport in Scotland, deliver major transport projects, and maintain essential infrastructure.

National Transport Strategy

Full assessment of NTS following refresh last year.

Transport policy actions

LOW CARBON VEHICLES

Electric vehicle charging infrastructure in place by 2020.

Widespread adoption of low carbon vehicles by 2030, with almost complete decarbonisation of road journeys by 2050.

TAXI

60 delegates at EST taxi stakeholder event on licencing and operating electric taxi and private hire vehicles

Reviewed legislation and approach to electric taxis, with an evaluation of future actions.

Transport policy actions

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

FREIGHT

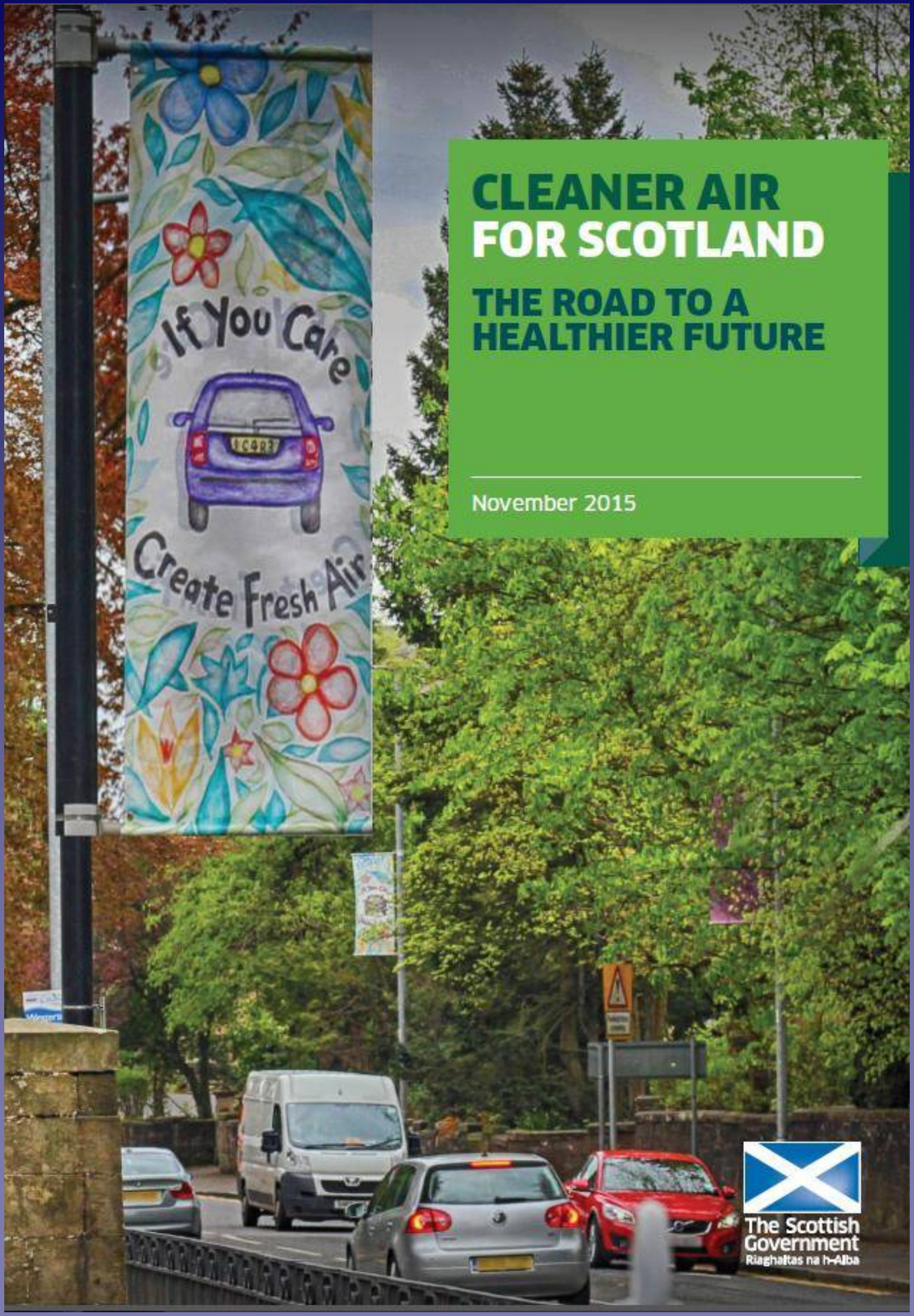
Scottish Freight and Logistics Advisory Group (ScotFLAG) set up to increase sustainable economic growth in Scotland, recognising the importance of freight in the transport sector.

PUBLIC TRANSPORT

Green Bus Fund, BSOG and Quality Bus Partnerships

Cleaner Air For Scotland

- 6 Themes (Climate Change, Communication, Health, Legislation and Policy, Placemaking, Transport)
- New Legislation and Policy on National Modelling Framework and National Low Emission Framework

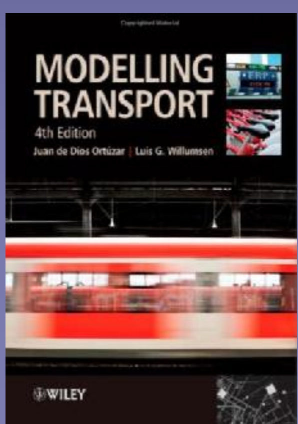


Transport Modelling

What is it for

Economic and Transport Models are clever but they can't predict what's not been invented yet. (Rachel Smith, Author, Speaker, Transport Planner, Smart Cities Task Force

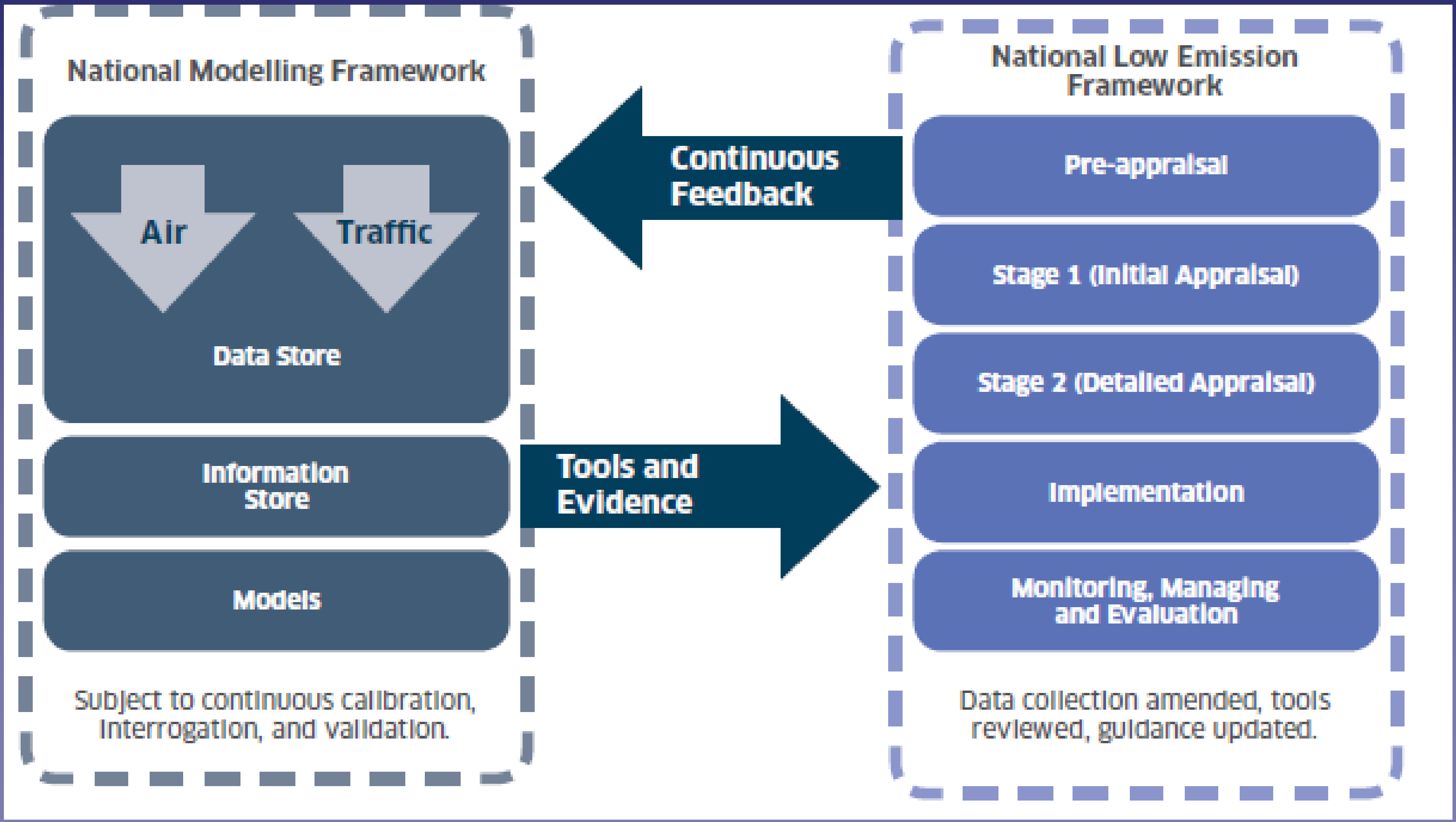
Focus on building communities through transportation, instead of transportation through communities. (Dan Burden, Director of Innovation and Inspiration at Blue Zones)



A *model* is a simplified representation of a part of the real world–the system of interest–which focuses on certain elements considered important from a particular point of view. Models are, therefore, problem and viewpoint specific.

NMF and NLEF …………

Continuous feedback loop, and development of tools



- A transport-focused science-led, evidence based appraisal process to enable local authorities and partners to justify the business case for, and implement, a range of air quality improvement options related to transport (and associated land use).

National Low Emission Framework (NLEF)

Appraisal Guidance

1 Introduction ....

2 Objectives Aims Roles and Responsibilities .....

3 Assessment Procedures Criteria and Measures

4 Mitigation Options and Emission Criteria ....

5 Enforcement ....

6 Legislation..

7 Funding and Costs..

8 Cost Benefit Analysis Tools ....

NLEF supported by NMF evidence

DATA GATHERING
Data gathering and modelling will be undertaken by the Scottish Government to provide an initial clear understanding of the air quality problem.

ANALYSE AND VISUALISE
Data and modelling will be presented and analysed to refine the evidence in order to inform decision making.

ADDRESS UNCERTAINTY
We are aware modelling can be uncertain, with key sensitivities, and this will be quantified and managed to improve the quality of the evidence.

TRANSFORM INTO EVIDENCE
We will provide tools and access to shared data to allow the NME to be used to inform decision making.

NMF process is 'science driven'

Twin track Approach

- Encourage early adopters and partnerships
- Develop robust guidance and funding process

2018

Scottish Government
Riaghaltas na h-Alba
gov.scot

A PLAN FOR SCOTLAND

THE GOVERNMENT'S PROGRAMME FOR SCOTLAND

2016-17

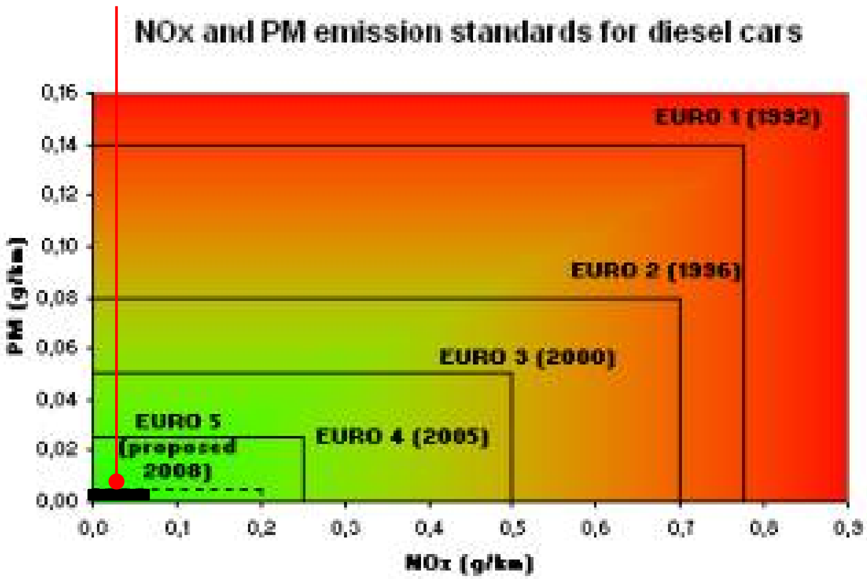
WE MUST WORK TO MAXIMISE THE POTENTIAL OF SCOTLAND'S NATURAL ENVIRONMENT IF WE ARE TO BUILD A STRONG AND SUSTAINABLE LOW CARBON ECONOMY

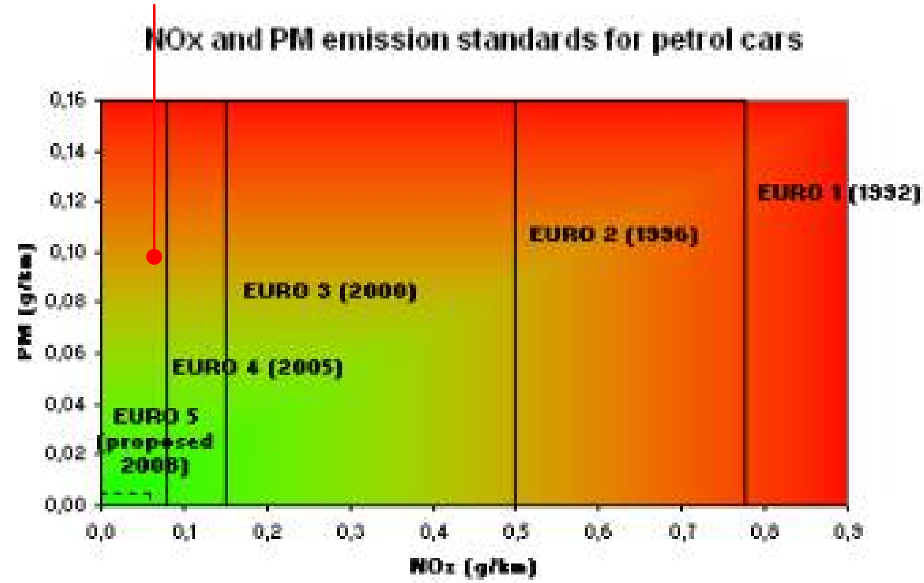
A cleaner, greener Scotland
We must maximise the potential of Scotland's natural environment if we are to build a strong and sustainable low carbon economy.

We will take forward the actions set out in 'Cleaner Air for Scotland' – Scotland's first distinct air quality strategy – to reduce air pollution further. With the help of local authorities, we will identify and put in place the first low emission zone by 2018, creating a legacy on which other areas can build.

Aberdeen	Dundee	Edinburgh	Glasgow
Hydrogen Bus Strong focus on renewable energy	EV capital of Scotland with more EVs in the council fleet than anywhere else in the UK. Largest fleet of EV taxis, more rapid chargers per head than anywhere else. Bid to OLEV for the Go-Ultra Low City	Lothian Buses, Transport for Edinburgh, Edinburgh Trams, SEStran, and City of Edinburgh Council working on Integrated Transport approach. Council Pledge 51“ Investigate the possible introduction of low emission zones"	Introduced a simple LEZ during the 2014 Commonwealth Games. Strong opportunities on City Deal for a Quality Bus Partnership. Lead city in Scotland on big data and sensors.

Euro 6 Diesel – Sept 2014










Over 2 years old

Over

How will we travel – the plan

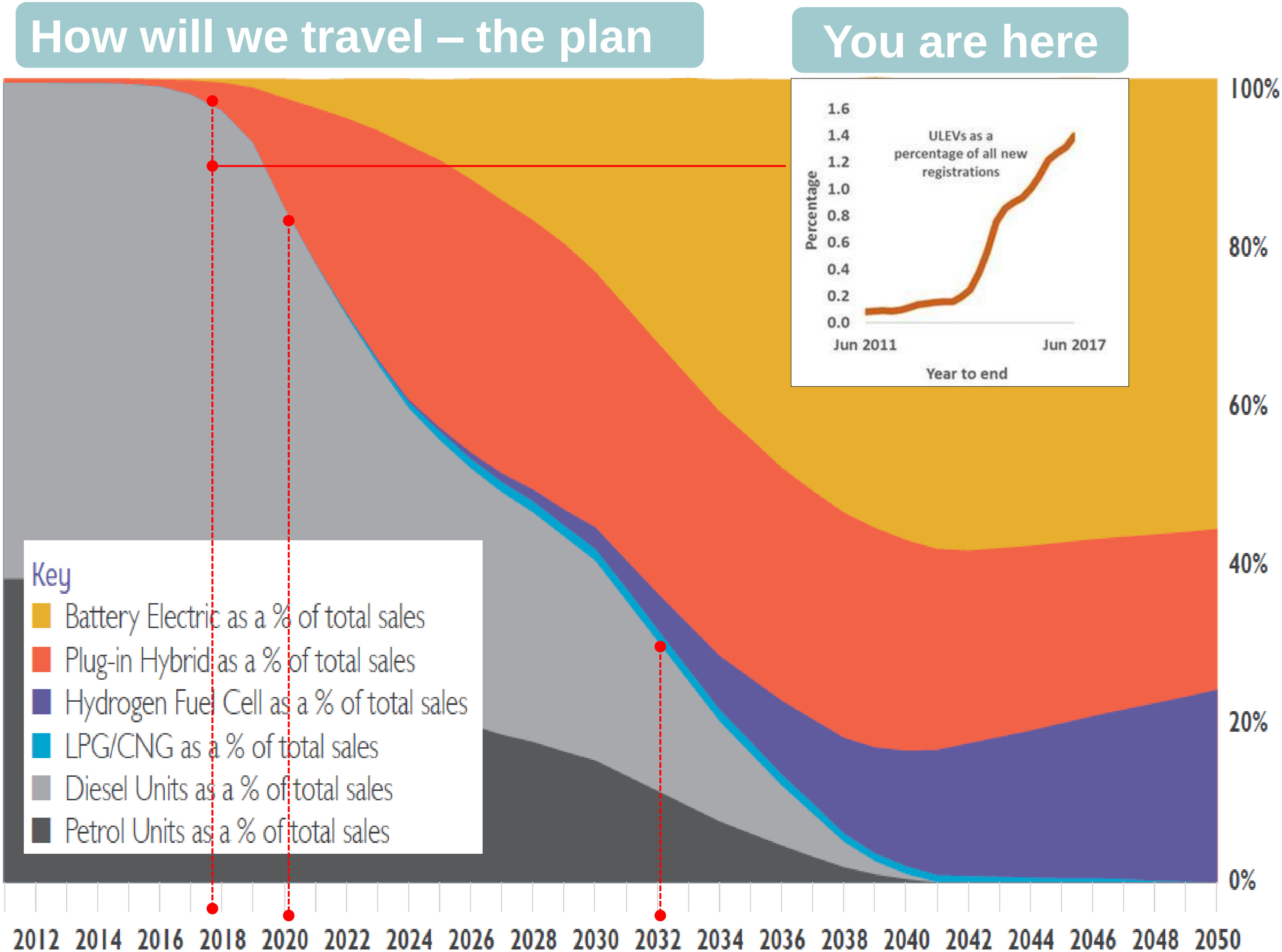
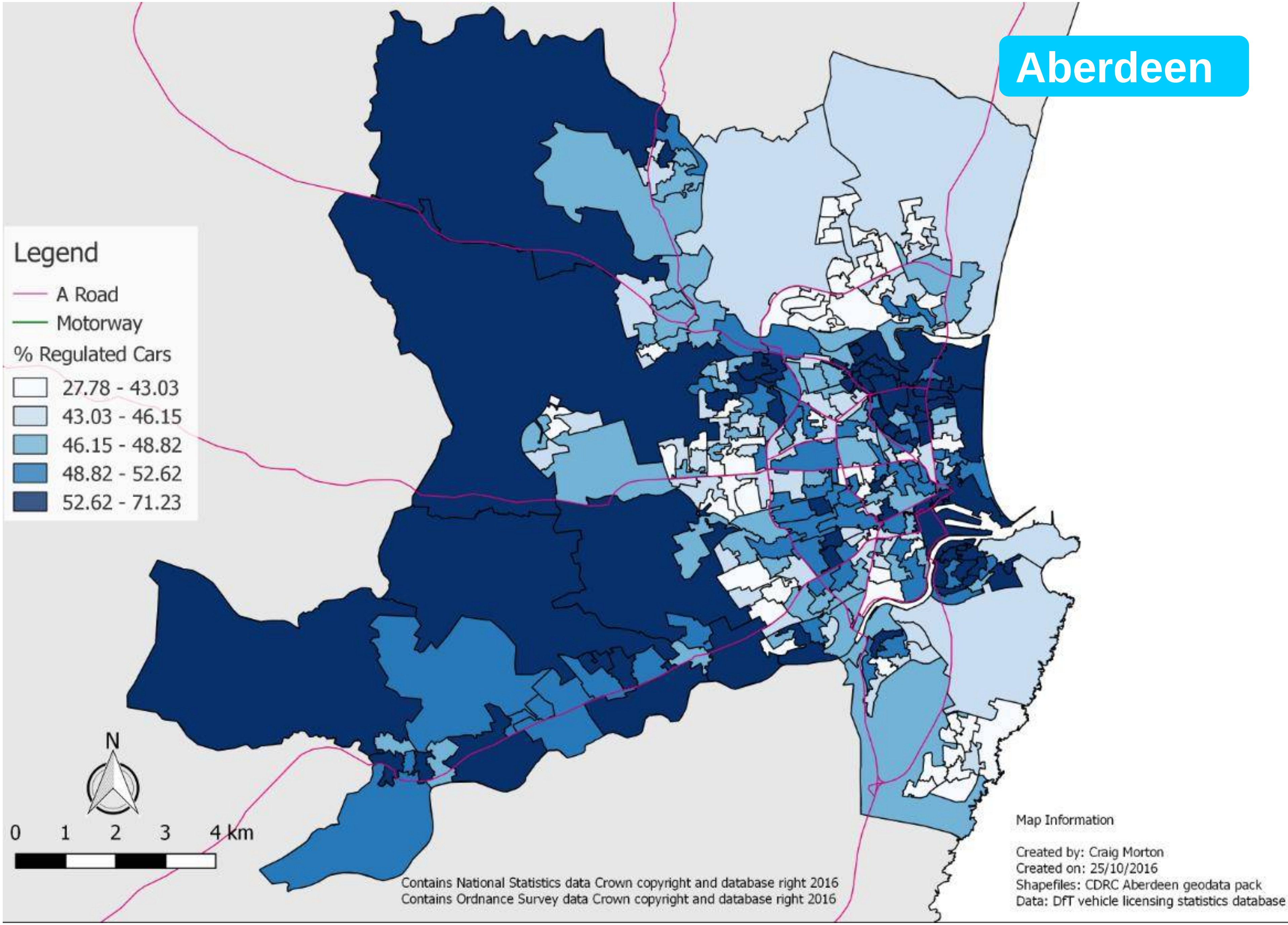
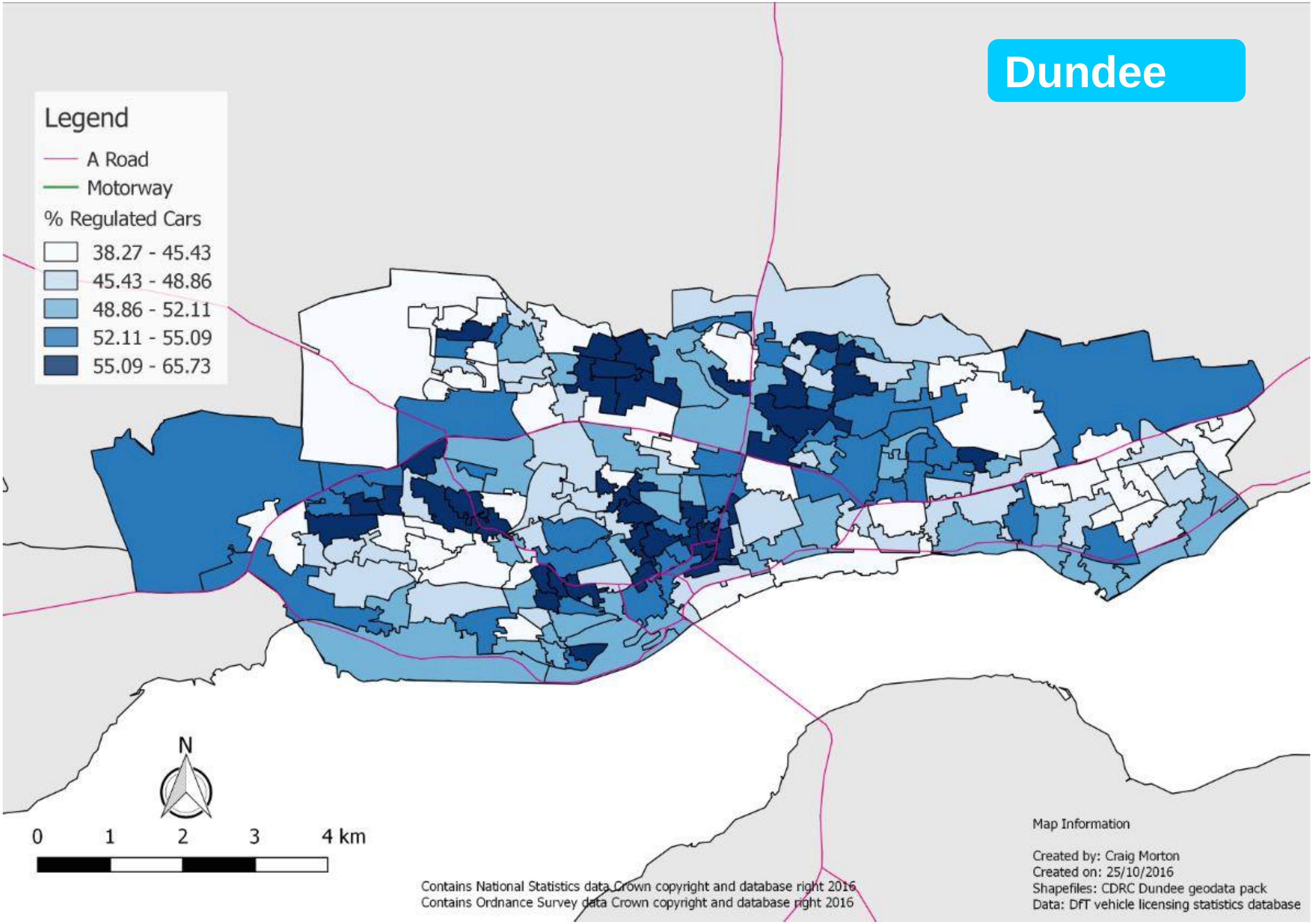
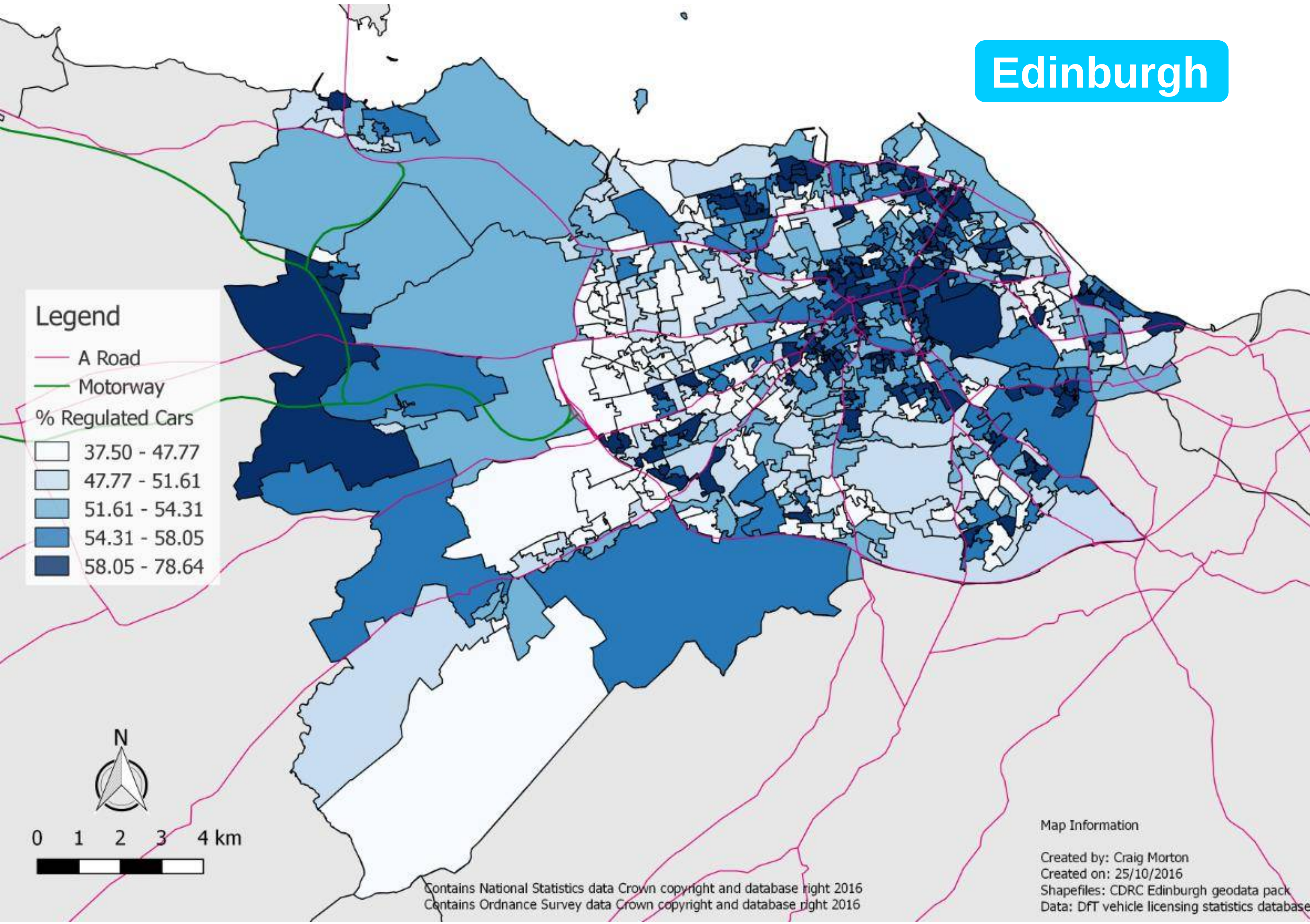


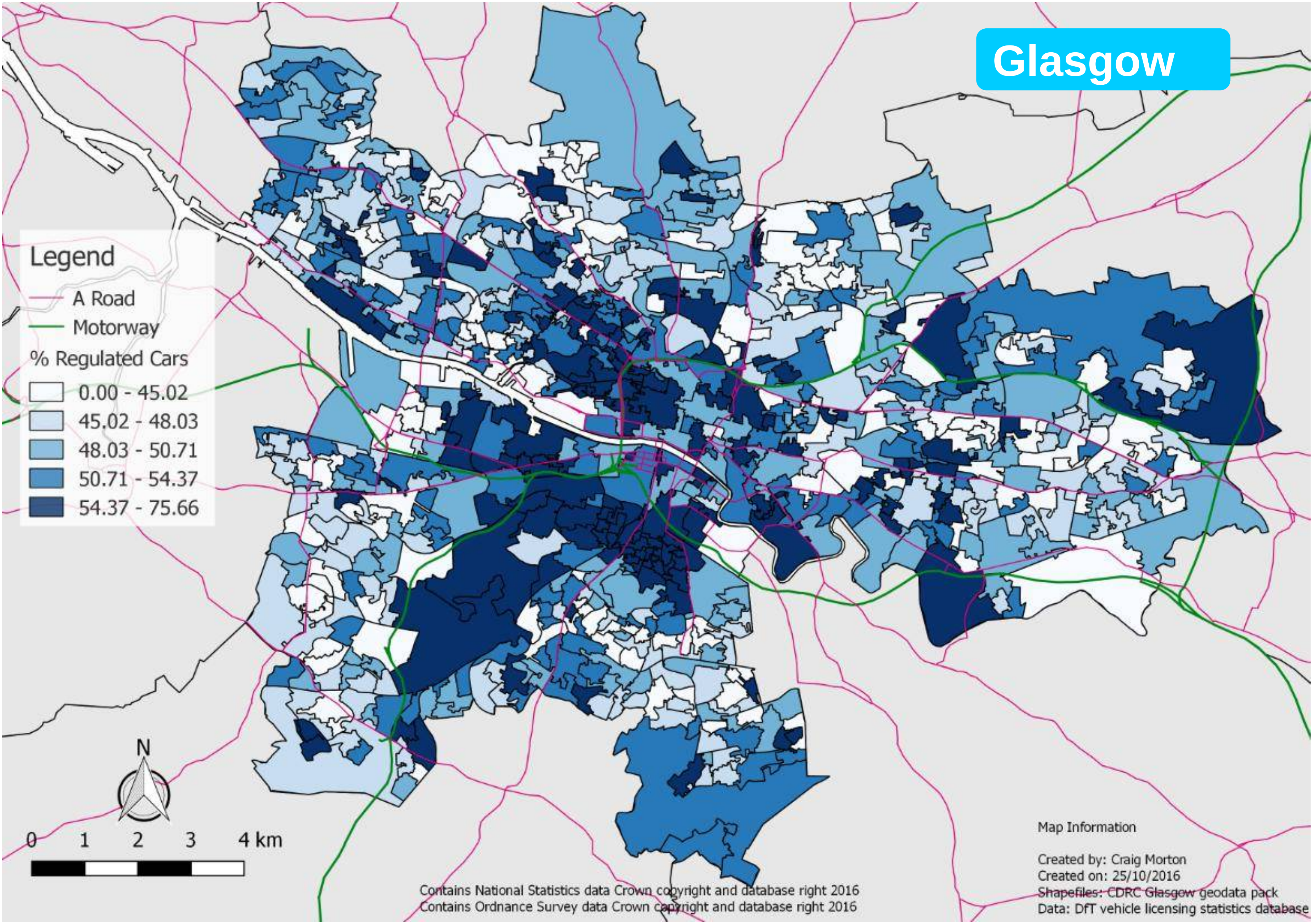
Figure 5: Outlook for new car sales in Scotland[5]



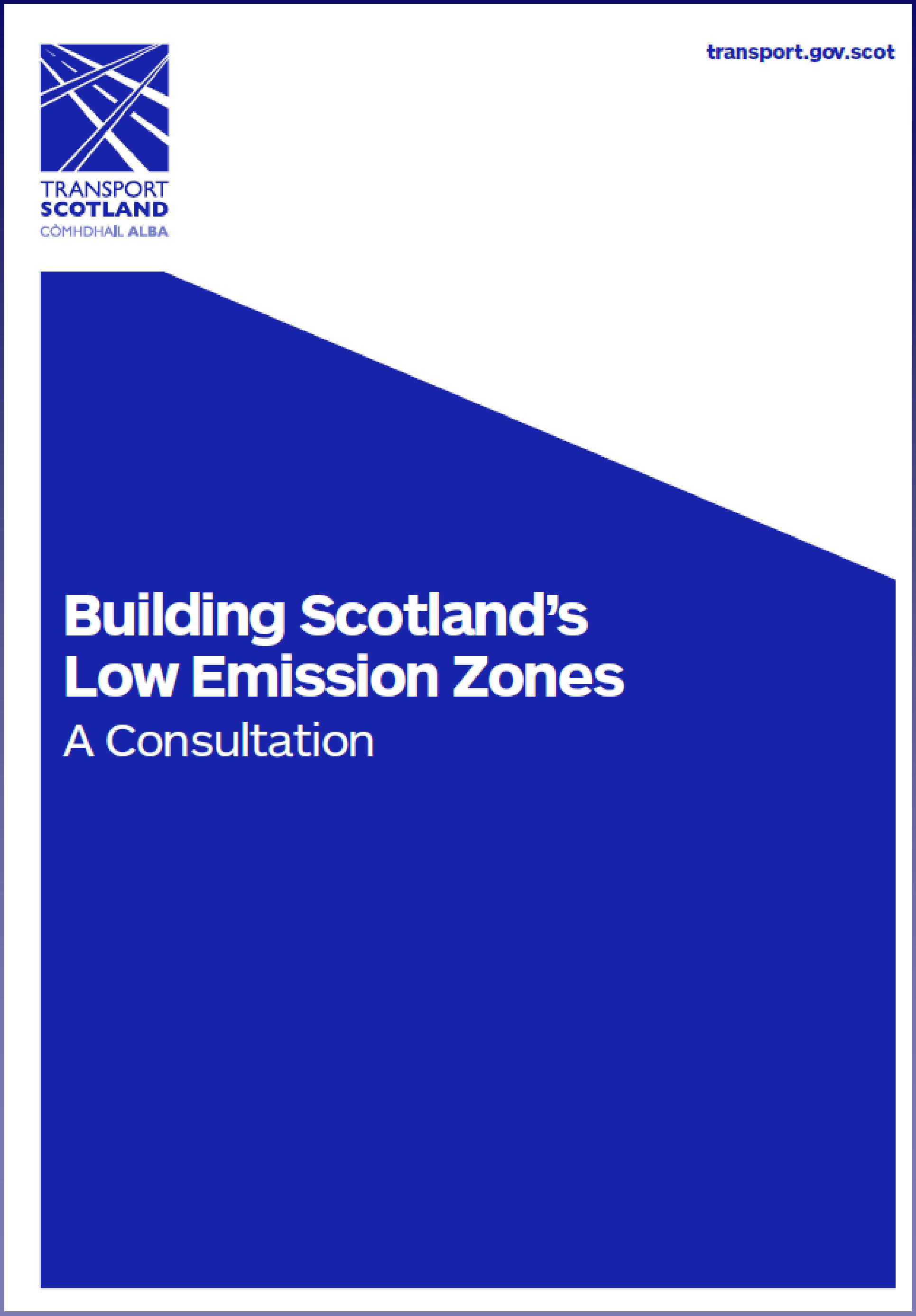
Aberdeen
Legend
A Road
Motorway
% Regulated Cars
27.78 - 43.03
43.03 - 46.15
46.15 - 48.82
48.82 - 52.62
52.62 - 71.23
N
0 1 2 3 4 km
Contains National Statistics data Crown copyright and database right 2016
Contains Ordnance Survey data Crown copyright and database right 2016
Map Information
Created by: Craig Morton
Created on: 25/10/2016
Shapefiles: CDRC Aberdeen geodata pack
Data: DfT vehicle licensing statistics database


Dundee
Legend
A Road
Motorway
% Regulated Cars
38.27 - 45.43
45.43 - 48.86
48.86 - 52.11
52.11 - 55.09
55.09 - 65.73
N
0
1
2
3
4 km
Contains National Statistics data Crown copyright and database right 2016
Contains Ordnance Survey data Crown copyright and database right 2016
Map Information
Created by: Craig Morton
Created on: 25/10/2016
Shapefiles: CDRC Dundee geodata pack
Data: DfT vehicle licensing statistics database


Edinburgh
Legend
A Road
Motorway
% Regulated Cars
37.50 - 47.77
47.77 - 51.61
51.61 - 54.31
54.31 - 58.05
58.05 - 78.64
N
0 1 2 3 4 km
Contains National Statistics data Crown copyright and database right 2016
Contains Ordnance Survey data Crown copyright and database right 2016
Map Information
Created by: Craig Morton
Created on: 25/10/2016
Shapefiles: CDRC Edinburgh geodata pack
Data: DfT vehicle licensing statistics database


Glasgow
Legend
A Road
Motorway
% Regulated Cars
0.00 - 45.02
45.02 - 48.03
48.03 - 50.71
50.71 - 54.37
54.37 - 75.66
N
0 1 2 3 4 km
Contains National Statistics data Crown copyright and database right 2016
Contains Ordnance Survey data Crown copyright and database right 2016
Map Information
Created by: Craig Morton
Created on: 25/10/2016
Shapefiles: CDRC Glasgow geodata pack
Data: DfT vehicle licensing statistics database

- 20 Questions on the proposed shape and form of LEZs.
- Introduce an Air Quality Fund to support local authorities with Air Quality Management Areas to deliver transport based mitigation
- Work with the commercial and bus sectors, the Energy Saving Trust and the Low Carbon Vehicle Partnership to introduce an Engine Retrofitting Centre in Scotland


TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

transport.gov.scot

Building Scotland's Low Emission Zones

A Consultation

Creating a Low Emissions Zone (LEZ) in one of our cities by the end of next year – and working with local authorities to introduce LEZs into our four biggest cities by 2020 and to all Air Quality Management Areas by 2023.

A bold new ambition on ultra-low emission vehicles, including electric cars and vans, with a target to phase out the need for petrol and diesel vehicles by 2032, underpinned by a range of actions to expand the charging network, support innovative approaches and encourage the public sector to lead the way

NLEF Next Steps

November 2017 to April 2018

- Summarise consultation findings
- Set up delivery groups
- Finalise the shape and form of first LEZ
- Agree funding and implementation plan

2018 to 2019

- Work with the stakeholders to support adaptation
- Raise public awareness
- Build LEZ infrastructure and enforcement regime
- Support delivery of other LEZs

QCumber-envHealth
End User Workshop

SMART(ER) EXPOSURE MONITORING

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27 September 2017

Intro

Conventional exposure monitoring is not sufficient

+

Fixed site measurement may not represent true exposure

Time-averaged personal sampling loses temporal resolution

Intro

New ideas look exciting, but… lack scientific evidence

Publicity and hype replace facts about the nature of the data and its limitations

https://plumelabs.com

theguardian

Pigeon patrol takes flight to tackle London's air pollution crisis

Flock of racing pigeons equipped with pollution sensor and Twitter account take to the skies in bid to raise awareness of capital's illegally dirty air

One of the 'pigeon air patrol', a publicity stunt on 14-16 March, equipping racing pigeons with pollution sensors to highlight London's air quality problem. Photograph: DigitasLBi

No technical specs or test data on website

Many similar websites (that come and go)

QCumber-envHealth WP2
Towards smarter exposure monitoring

QCumber-envHealth

- To develop a new integrated decision-making tool for urban health and policy evaluation

WP2

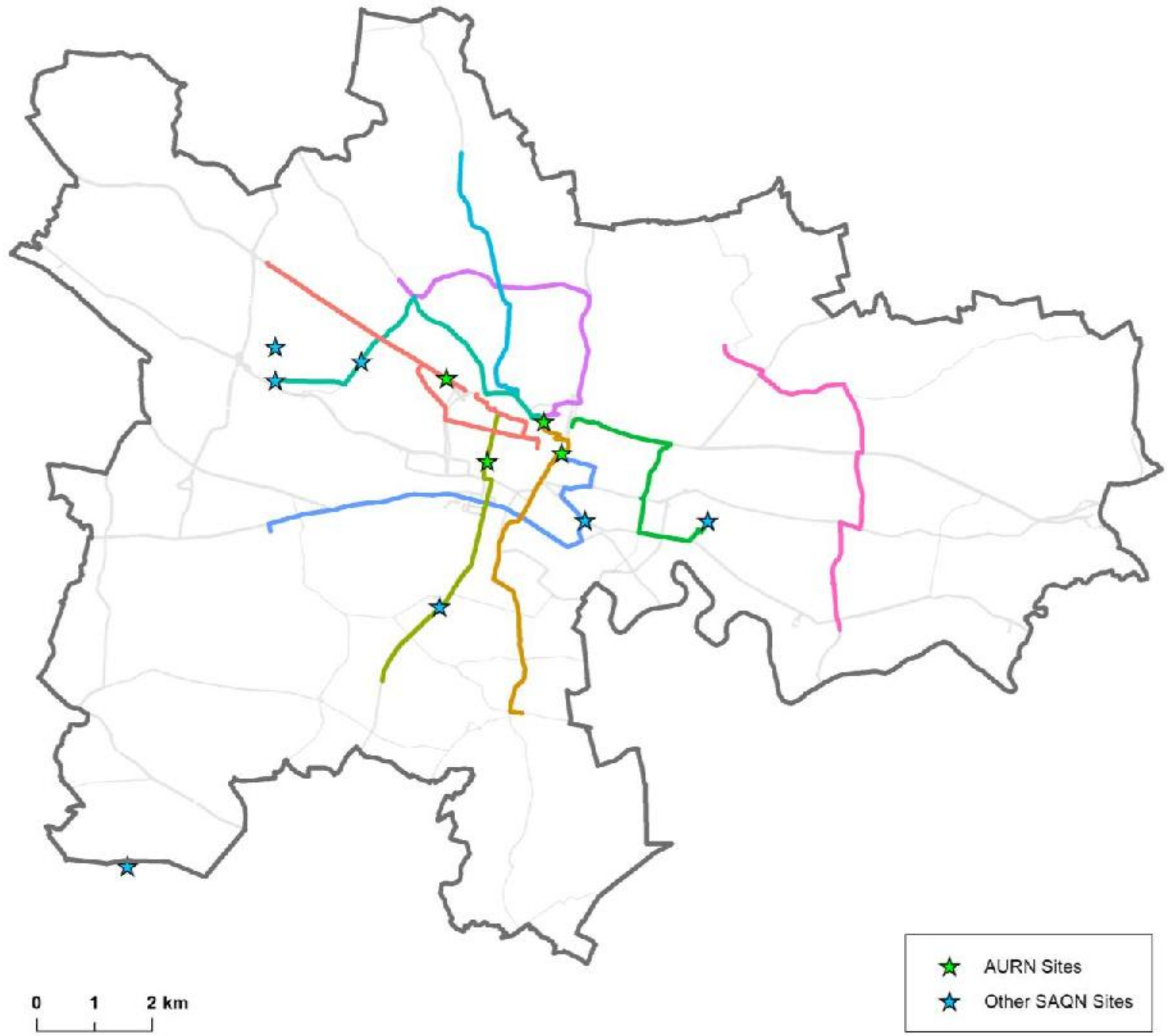
- To test **usability** and **performance** of selected commercial sensor-based AQ portable monitors **in practical usage**
  - Ease of use
  - Comparison with reference analysers
  - Ability to capture spatio-temporal variability in pollution
  - Stability over repeated cycles of idling – calibration – measurement

- To collect high-res pollution data in Glasgow for
  - NO_2
  - O_3
  - $PM_{2.5}$ (mass and number)
  - BC

QCumber-envHealth WP2
Study design

Mobile measurements

- Feb – Aug 2016, Glasgow
- Walking with sensors on 9 routes on A- and B-roads
- Each route covers both **city centre** and **suburban**
- Reps at **peak** and **off-peak** in a day, on 2 **different days**



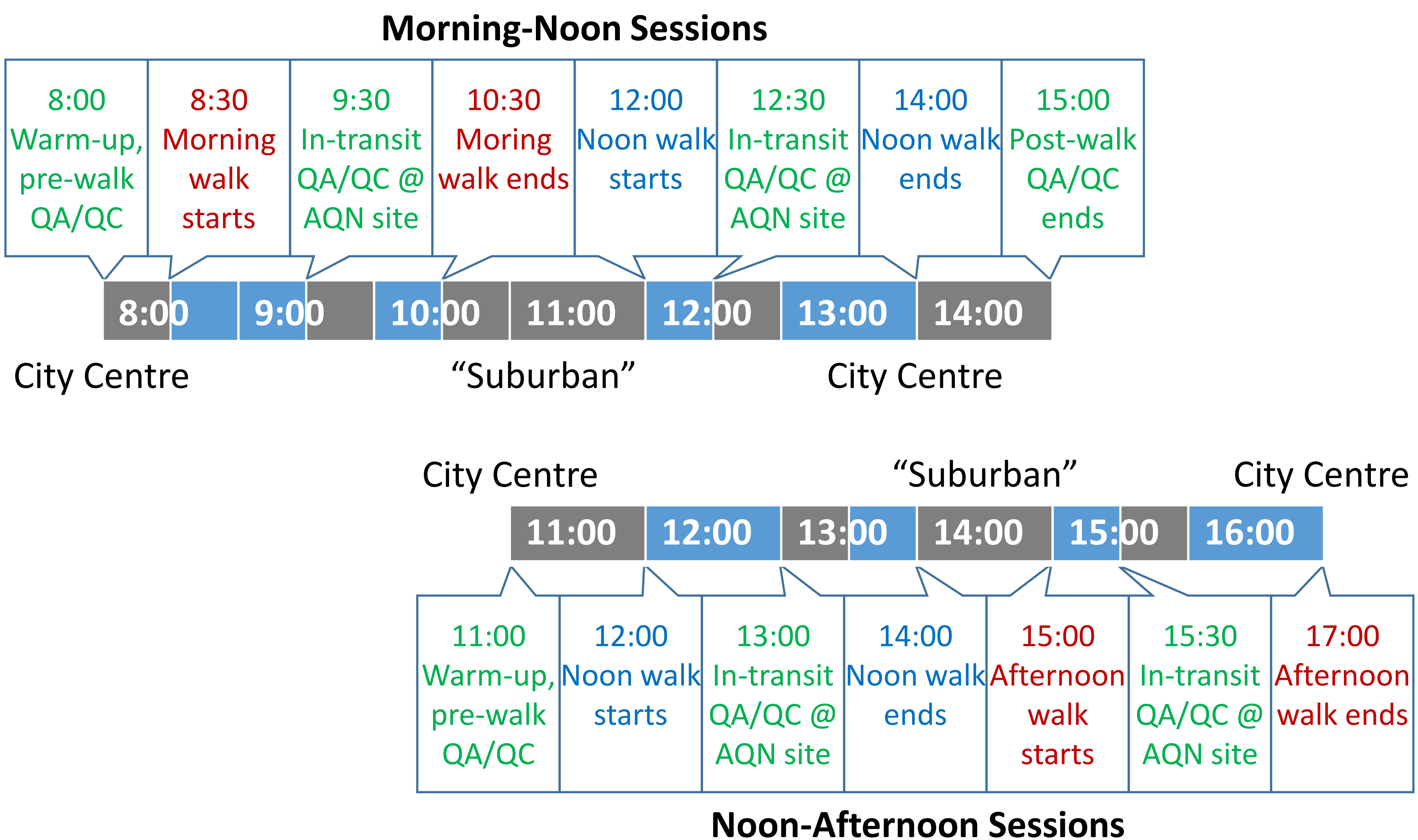
2-stage QA/QC

- Fixed-site co-locations at Townhead **between** field measurement days for **calibration**
- In-transit co-locations at AURN stations **on** measurement days for **validation**

QCumber-envHealth WP2

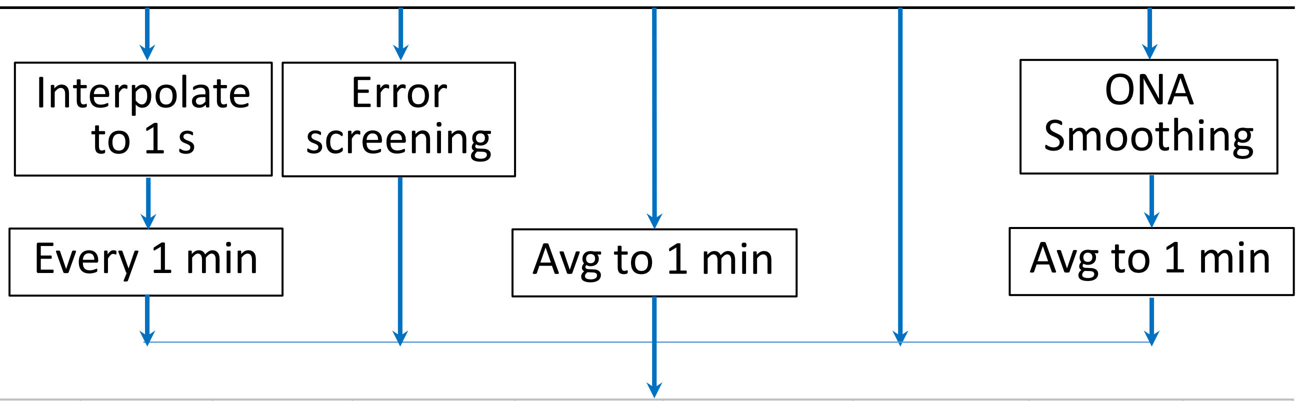
Fieldwork day schedule

- Repeated measurements to capture (and confirm) spatio-temporal pollution variation
- In-transit co-locations to collect QA/QC data



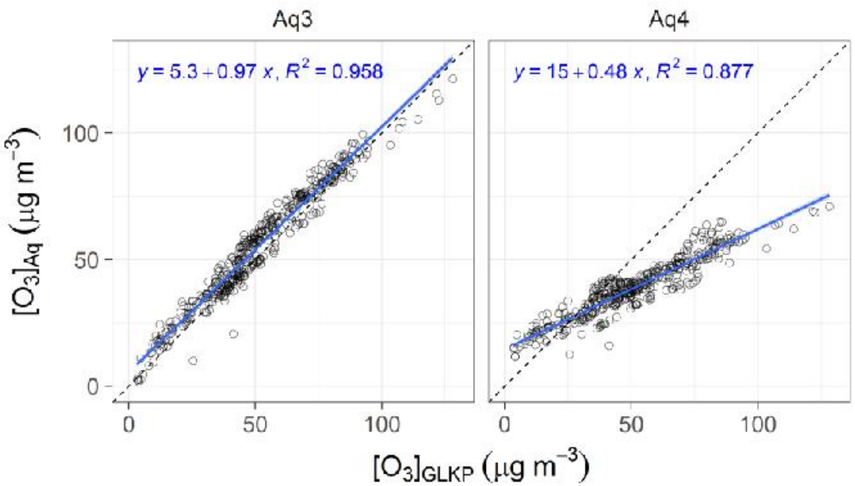
Data acquisition and post-trip **synchronisation**

Instrument	Google Nexus 6	Aeroqual S500	RTI MicroPEM	Dylos DC1700	AethLabs microAeth
Measures	Location	NO_2, O_3	$PM_{2.5}$ (mass)	$PM_{0.5\text{-}2.5}$ (number)	Black carbon
Sensor technology	GPS	Elec-chem; MO semicon.	Particle optical scattering		Optical absorption
Recording Interval	2 m	1 min	5 s	1 min	1 s



date	lat	lon	alt.m	no2.ugm3	o3.ugm3	pm2.5.ugm3	pm2.5.pm3	bc.ngm3	sess
2016-04-19 07:38:00	55.86556	-4.243710	102.57143	71	21	15.416667	8358982	1408.1177	Morning
2016-04-19 07:39:00	55.86564	-4.243476	109.00000	77	22	12.250000	8920485	1525.2745	Morning
2016-04-19 07:40:00	55.86571	-4.244358	89.50000	79	22	12.583333	7935206	1692.5964	Morning

… and data **calibration, correction** and **validation**



Calibration strategy comparison:

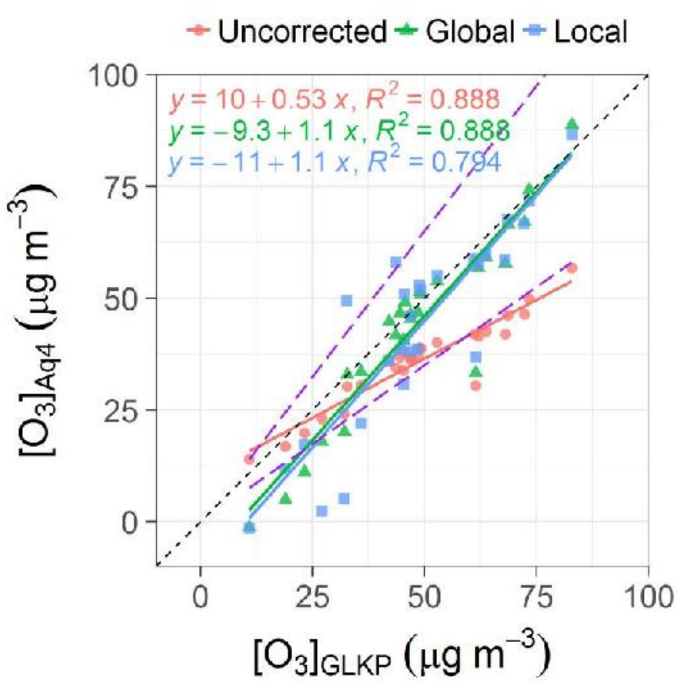
◀ **Global** calibration

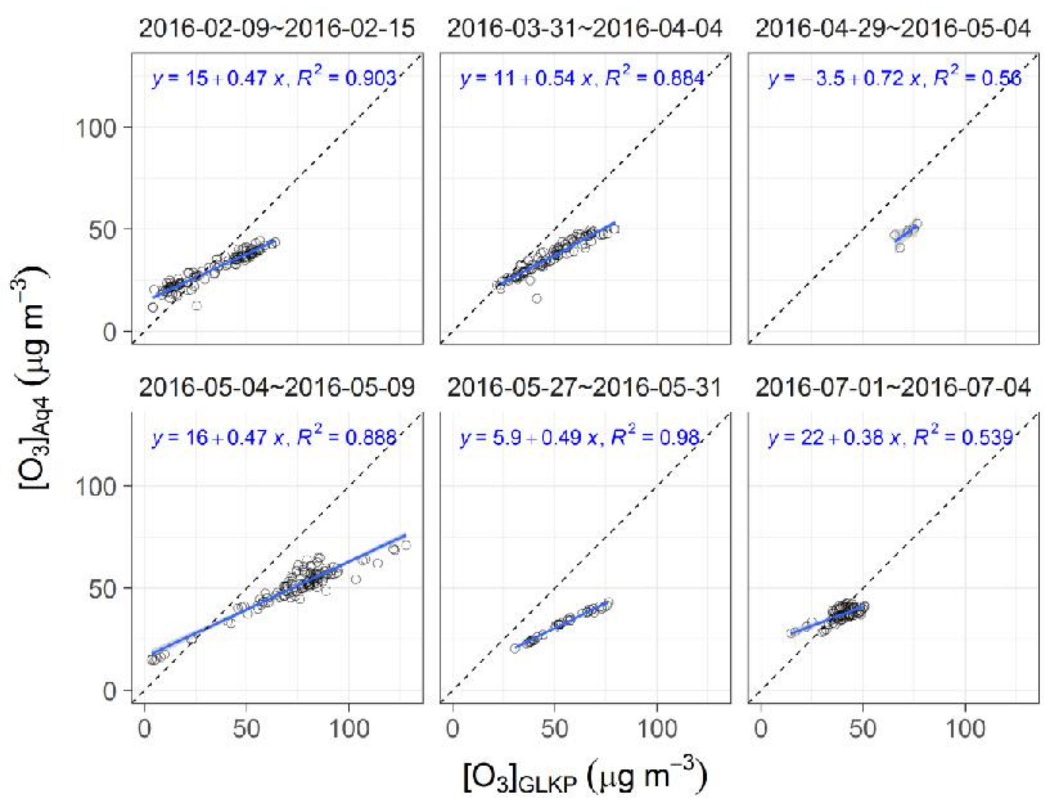
Use **all** calibration data

▼ **Local** calibration

Use **nearest** calibration period

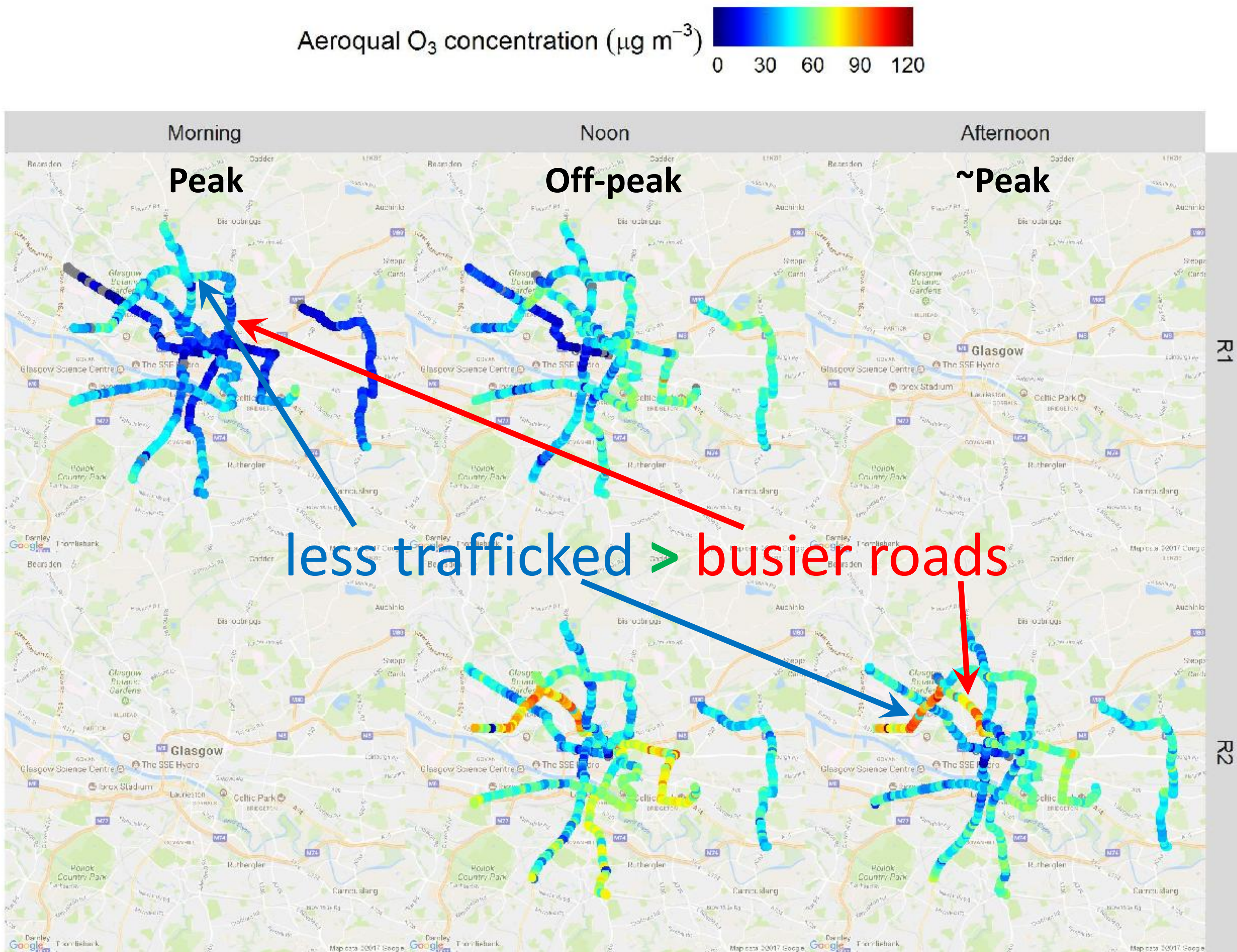
▼ Validation of correction using **in-transit co-location** data





O_3 concentration (corrected against Ref but not adjusted across days)

peak-time < off-peak



QCumber-envHealth WP2

Lessons learnt

- Smart(er) exposure monitoring has great potential, but is much more complicated than it looks
- Portable monitors appeared easy to operate, but many factors could affect their outputs: *T*, RH, wind, cross-sensitivity…
- After data post-processing a few tested monitors provided useful qualitative/indicative measurement of short-term variability of air quality; but others struggled with robust measurements in the long term
- Ongoing quantitative calibration **in relevant environments** is critical
- Considerable user expertise and time is needed for meaningful data interpretation
- It may be more feasible with rapid technology advancement

Acknowledgements

CEH Edinburgh

Stefan Reis

University of Strathclyde

Nicola Masey; **Jonathan Gillespie**; **Nor Eliani Binti Ezani**

University of Edinburgh

Brian Shaw; **Nuoxi Zhang**; **Hao Wu**

Thank you

QCumber-EnvHealth
Stakeholder Workshop

27 September 2017
The Lighthouse, Glasgow

Transport and air quality policy scenarios

Mark Jackson, CERC
Chris Johnson, CERC

Transport and air quality policy scenarios: overview

- Scenario 1: hypothetical Glasgow LEZ
  – SEPA modelling output integrated into QCumber and used to predict health impacts
- Demonstrate platform ADMS modelling
- Scenario 2: phase out diesel/petrol cars/vans
  – Assessment of phasing out diesel and petrol cars and vans using QCumber, showing progress towards National Air Quality Objectives and health impacts.

Scenario 1: Low Emissions Zone

Scenario 1: Glasgow LEZ

- The Scottish Government and Glasgow City Council plan to introduce an LEZ in Glasgow between 2018 and 2020.
- Transport Scotland and SEPA are developing a National Modelling Framework and National Low Emission Framework to assess LEZs in Scotland.
- The Scottish Government is currently consulting on arrangements and options for this.
- In the meantime, SEPA have provided **illustrative** NMF output for a **hypothetical** Glasgow LEZ.
- We have used this output to test QCumber-EnvHealth.

Hypothetical Glasgow LEZ

Vehicle	Restrictions
HGVs	EURO VI
Buses and coaches	EURO VI
LGVs	EURO 6 (diesel); EURO 4 (petrol)
Taxis and private hire	EURO 6 (diesel); EURO 4 (petrol)
Cars	EURO 6 (diesel); EURO 4 (petrol)
Motorcycles	EURO 3

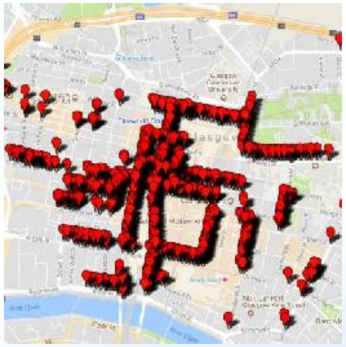
SEPA modelling output in SPOTFIRE and QCumber

- The SEPA NMF output has been integrated into QCumber and SPOTFIRE (SEPA's tool for presenting data on Scotland's environment).
- This demonstrates interoperability between the platforms.
- The output shows roadside locations where the Scottish National Objective for NO2 is exceeded, in a 'do nothing' scenario and with the hypothetical LEZ.

Output in SPOTFIRE and QCumber

QCumber **SPOTFIRE**

'Do nothing'



Hypothetical LEZ

Roadside locations where the Scottish National Objective for NO2 is exceeded are shown in red

Birth weight change in QCumber

QCumber-EnvHealth predictions of increases in average birth weight with the hypothetical LEZ

Platform demonstration
ADMS modelling


Scenario 2:
Phasing out diesel
and petrol cars and vans

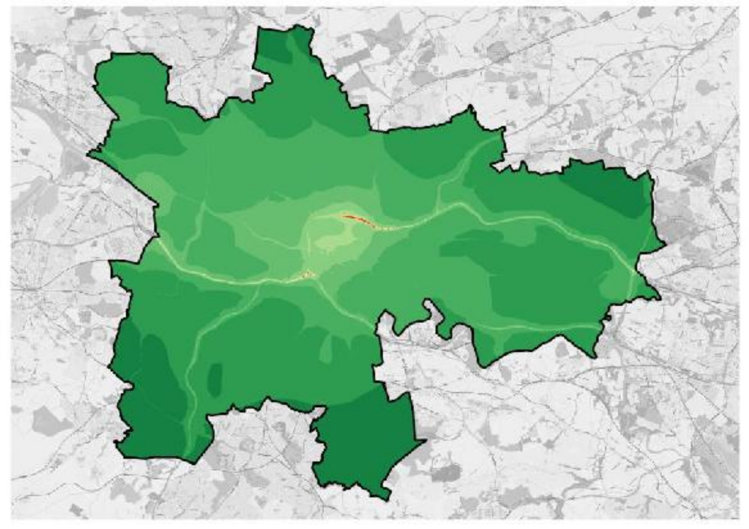
Scenario 2: Phasing out diesel and petrol cars and vans

- Demonstration assessment illustrating how the impact would be modelled
- CERC has modelled Glasgow in future assuming:
  - 'Do nothing'
  - 'Phase out'

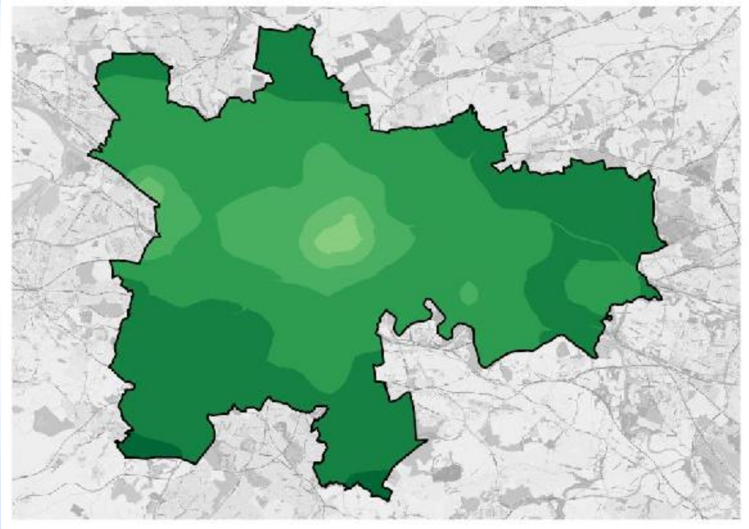
Air quality modelling

- Emissions sources modelled with ADMS-Urban
- Traffic flows constant
- Met data for 2014
- ‘Do nothing’: Defra emission factors & fleet for 2030
- ‘Phase out’: replace diesel/petrol cars/vans with electric vehicles
- No LEZ in either scenario
- PM emissions include brake, tyre and road wear and resuspension
- Background concentrations: Defra predictions for 2030

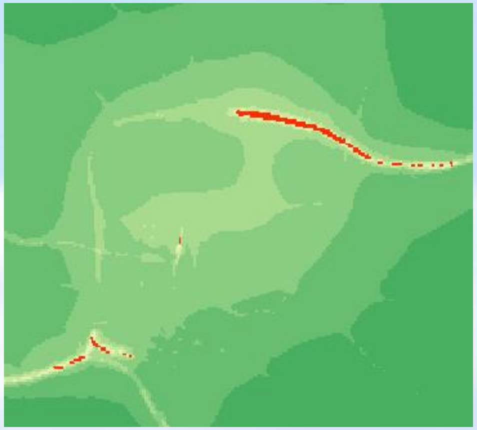
Results compared to NO2 objective



‘Do nothing’ – some NO2 exceedences (red)



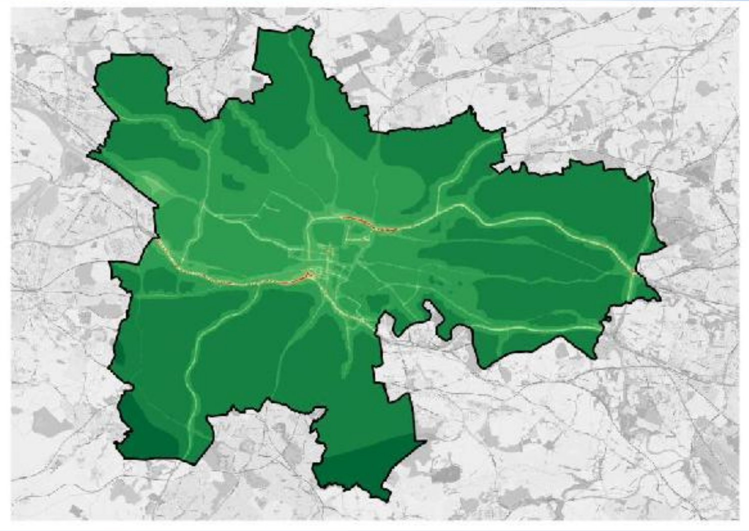
‘Phase out’ – no NO2 exceedences



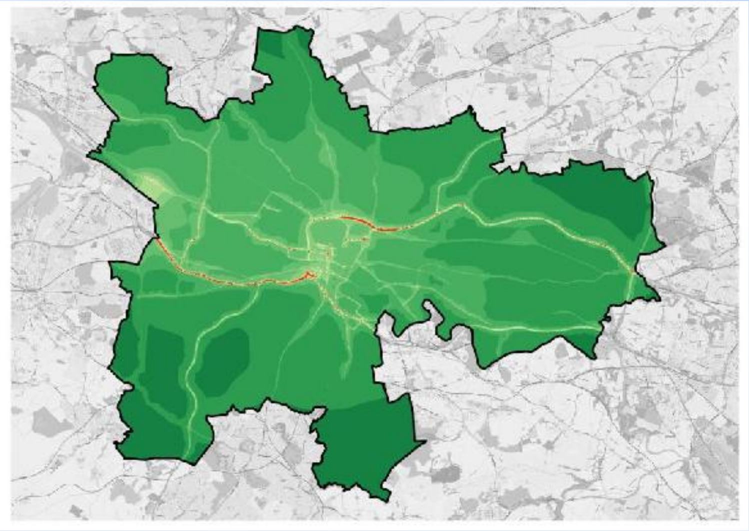
‘Do nothing’ – enlarged view of central area

Phasing out petrol/diesel cars/vans has removed exceedences of NO2 40µg/m³ annual average

Results compared to PM objectives



‘Phase out’ – PM10 annual average, red where above 18 µg/m³



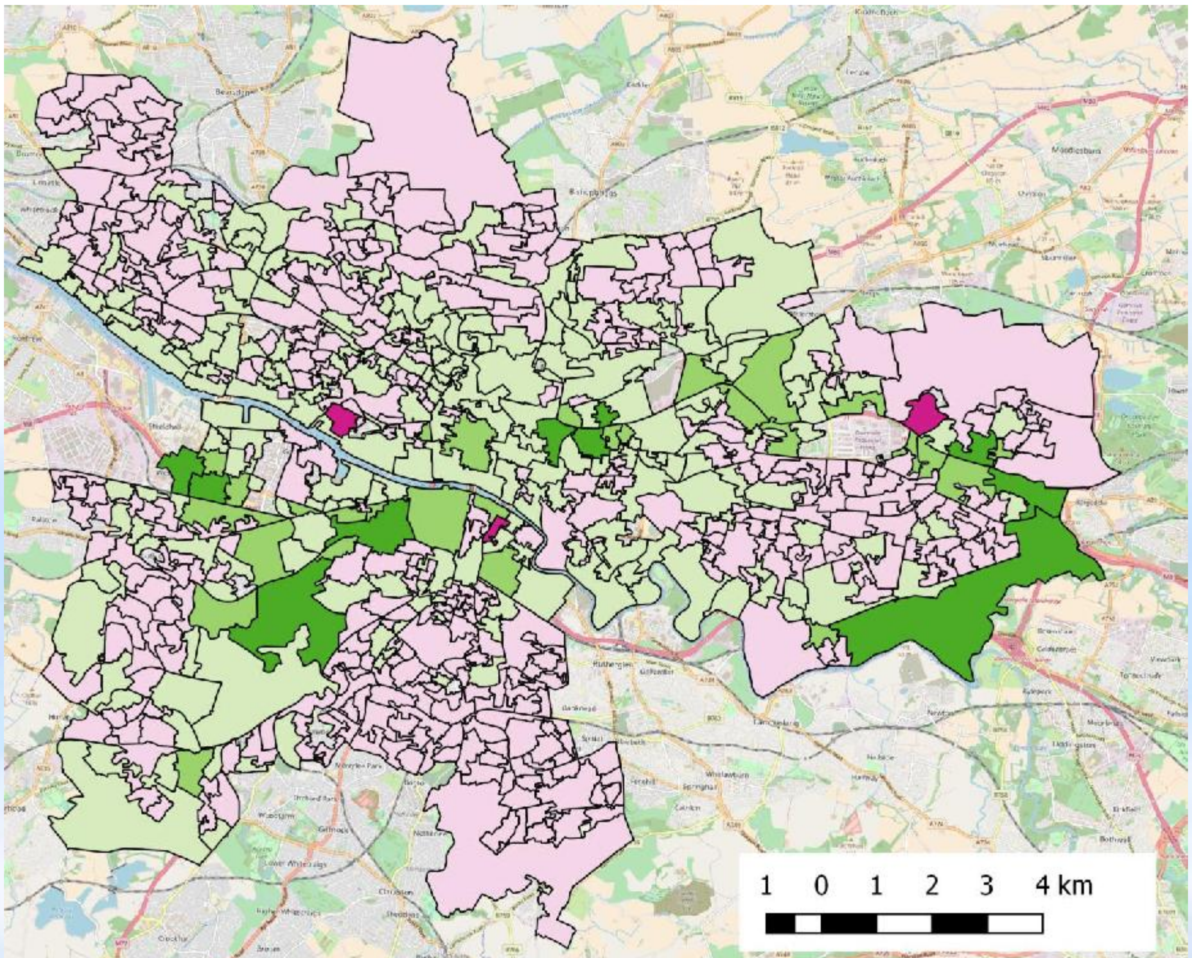
‘Phase out’ – PM2.5 annual average, red where above 10 µg/m³

- Phasing out diesel/petrol cars/vans has little impact on PM objectives: exceedences along major roads
- Other measures needed (e.g. bus fleet improvements)

Proof of concept: air pollution, smoking and birth weight

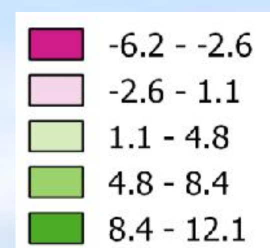
- Our research partners found that maternal smoking reduces birth weight, as does air pollution. But they found an interaction: air pollution has less impact on birth weight where the mother smokes.
- These findings could be used in impact assessment by using synthetic data to provide data on maternal smoking
- We have used dummy synthetic data to illustrate how this could be used in an impact assessment.

Air pollution, smoking and birth weight: interaction



USING 'DUMMY' SYNTHETIC DATA – NOT REAL PREDICTIONS

Difference in birth weight (g) due to smoking interaction, compared to NO2 alone



Transport and air quality policy scenarios: Conclusion

- Scenario 1: hypothetical Glasgow LEZ
  - SEPA NMF output integrated into QCumber and used to predict health impacts
- Scenario 2: phase out diesel/petrol cars/vans
  - Assessment of phasing out diesel/petrol cars/vans using QCumber, showing progress towards National Air Quality Objectives and health impacts.
- Data and health risk tools integrated in platform

Thanks for data:

- Transport Scotland

- Glasgow City Council

- SEPA

Any questions?

Mark Jackson, CERC

Chris Johnson, CERC

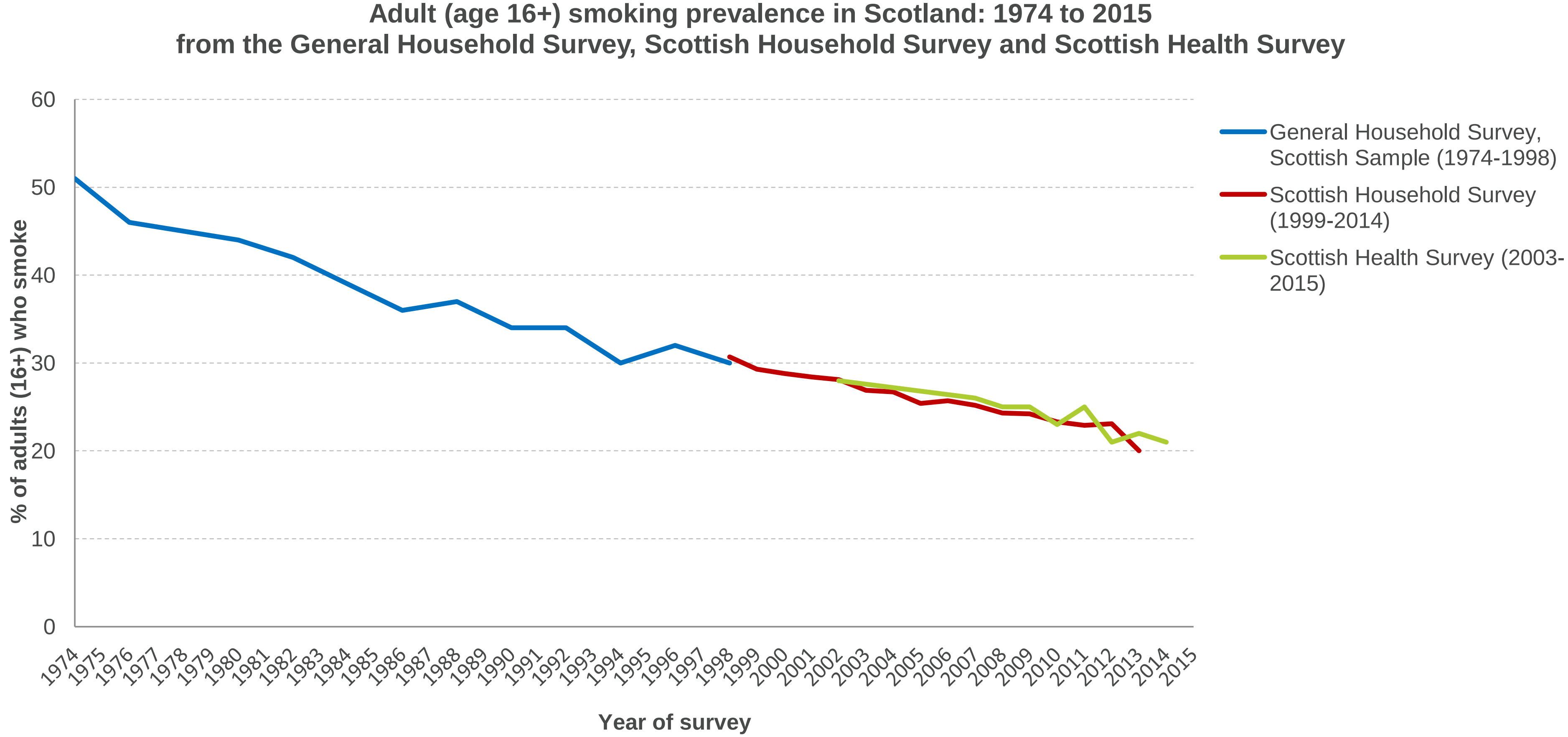
Our work

Ruaraidh Dobson
Policy & Communications Officer

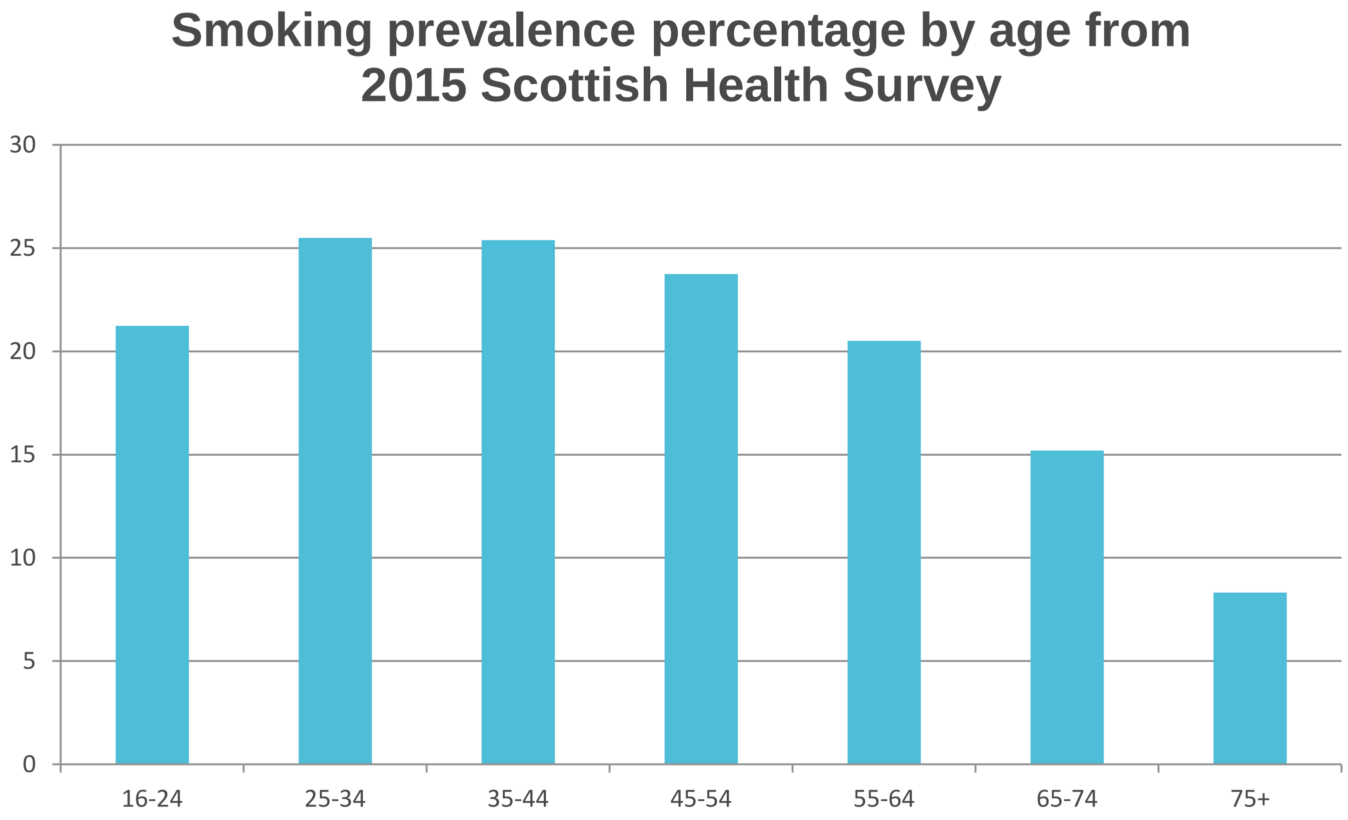
About us

- ASH Scotland is the only national charity dedicated to the fight against smoking

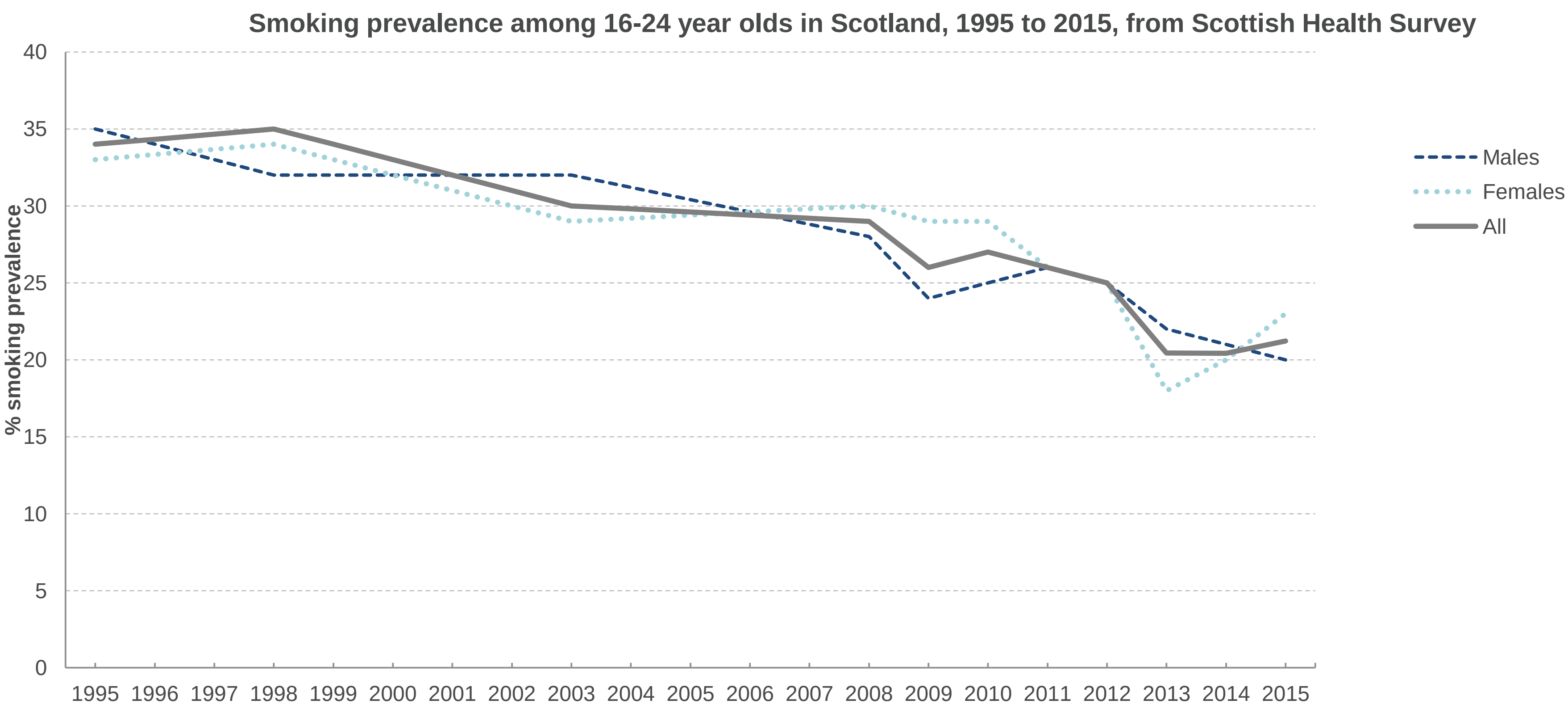
Smoking Prevalence in Scotland



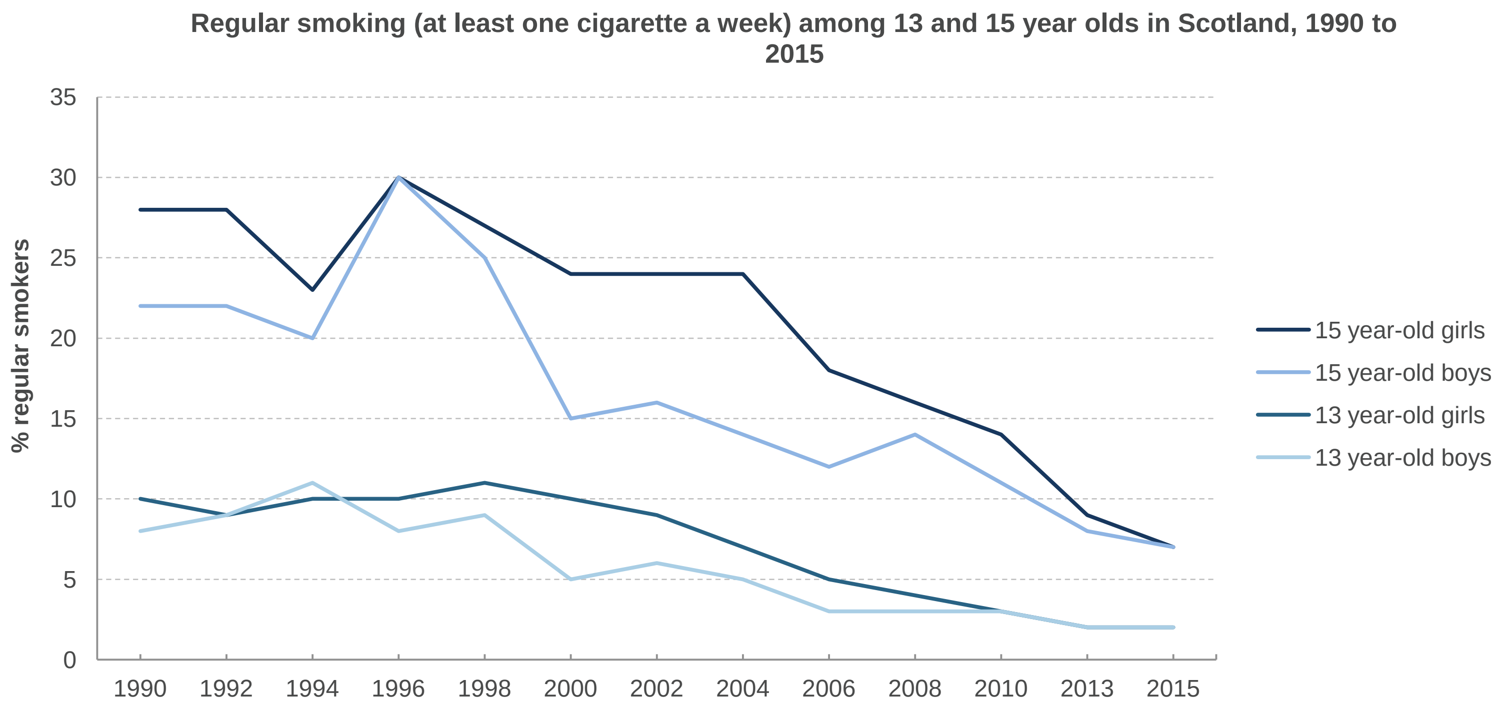
Prevalence by age in Scotland



Tobacco use amongst 16-24 year olds

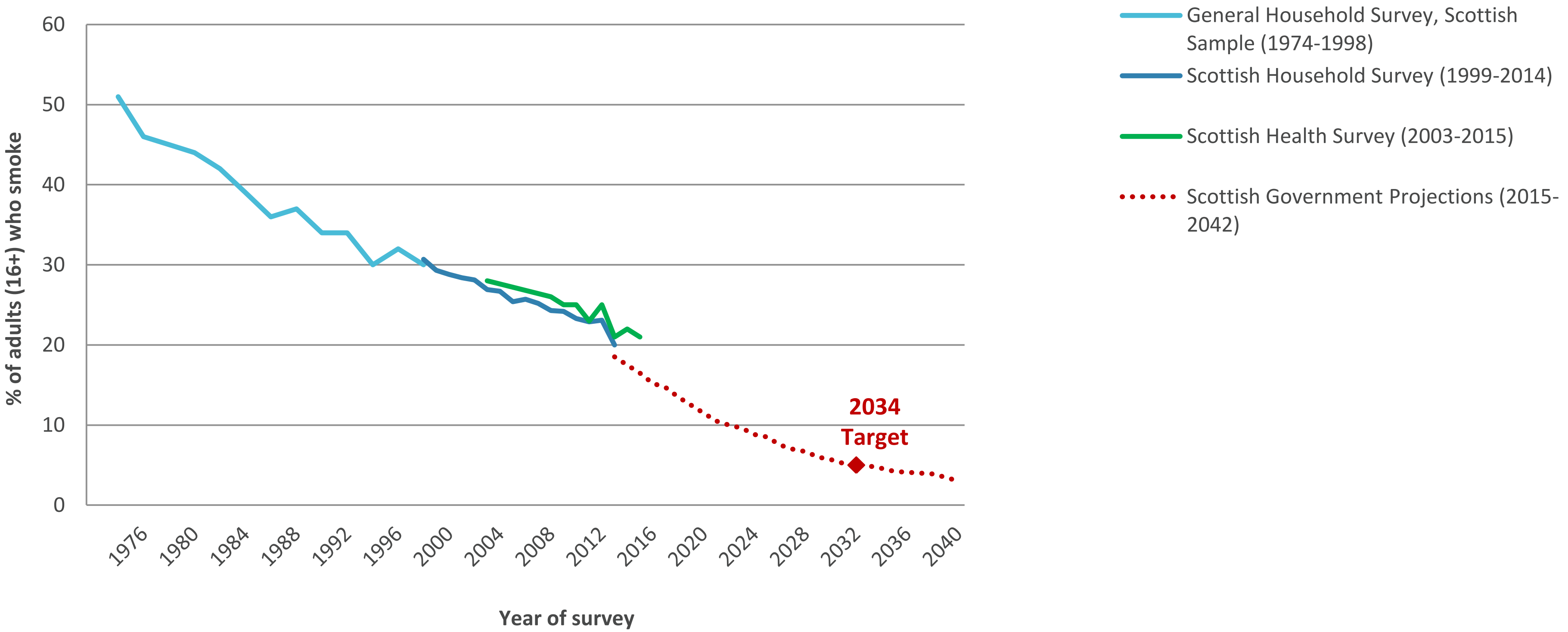


Tobacco use amongst younger teenagers

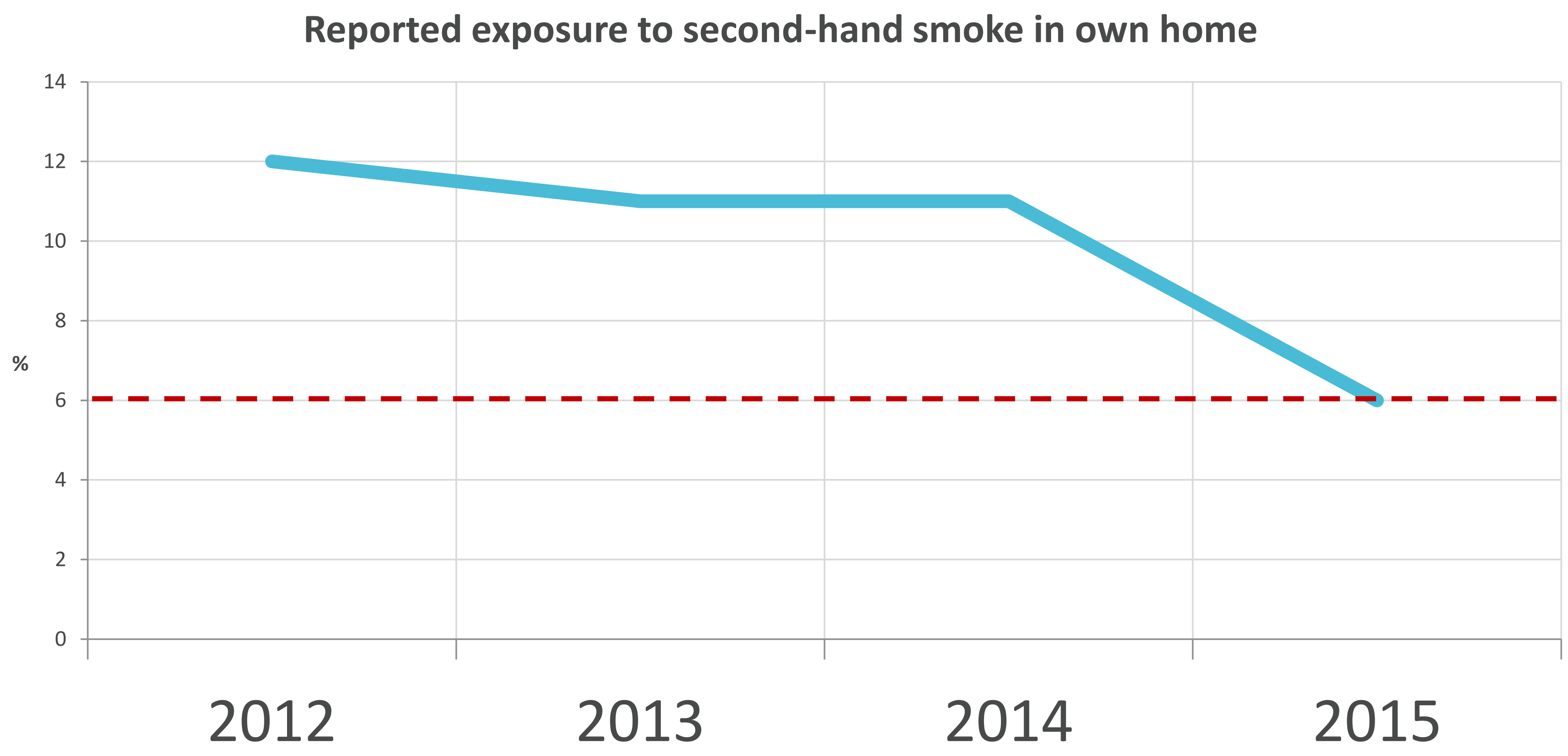


2034 Target

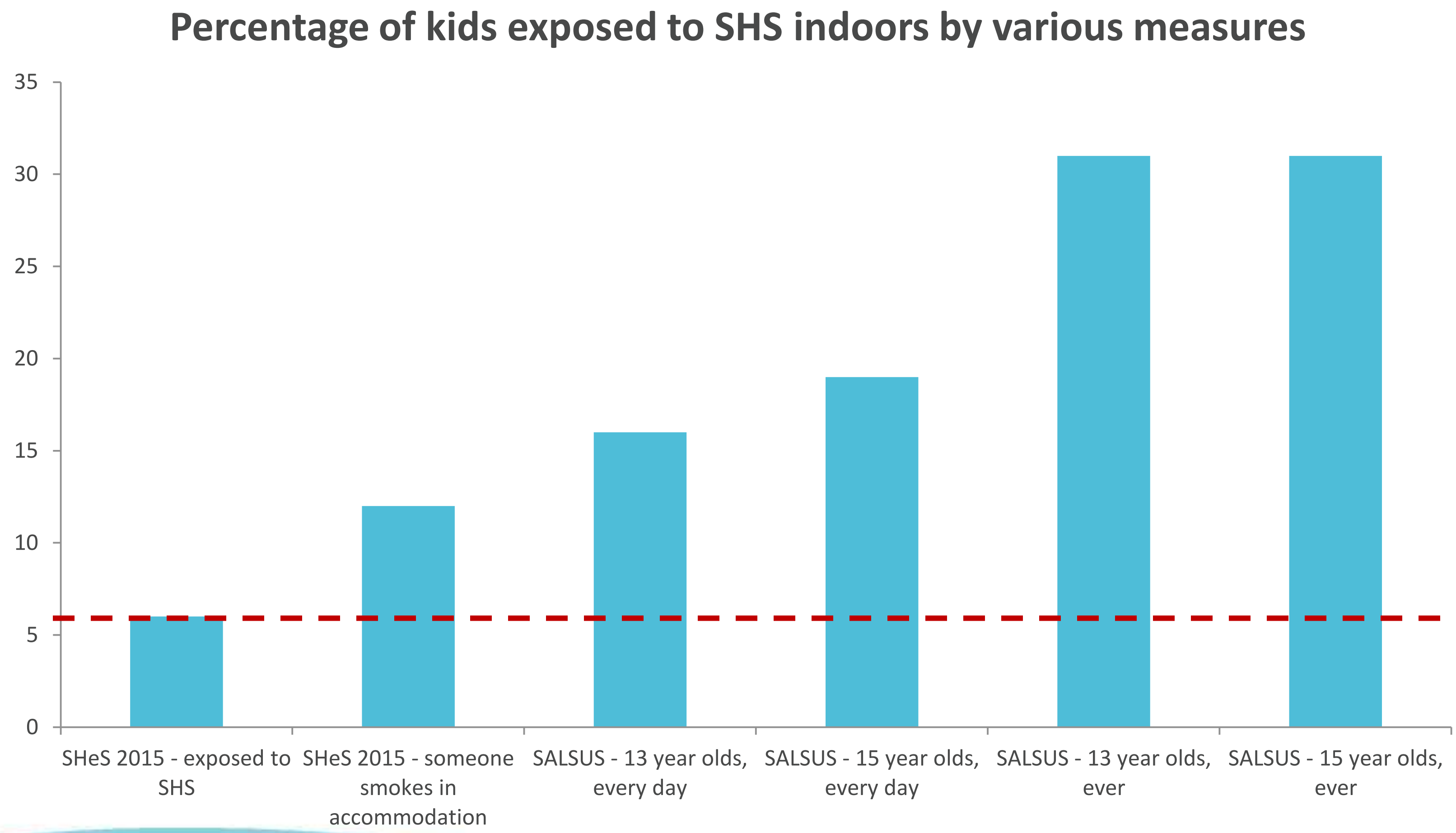
Adult (age 16+) smoking prevalence in Scotland: 1974 to 2042 from the General Household Survey, Scottish Household Survey , Scottish Health Survey and Scottish Government projections



Second-hand smoke

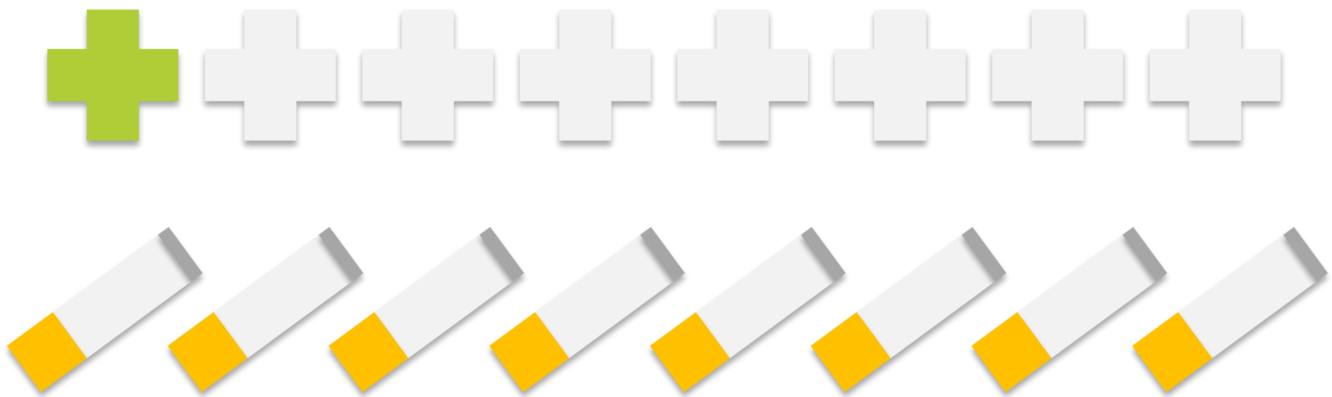


Second-hand smoke



Sales of tobacco in Scotland

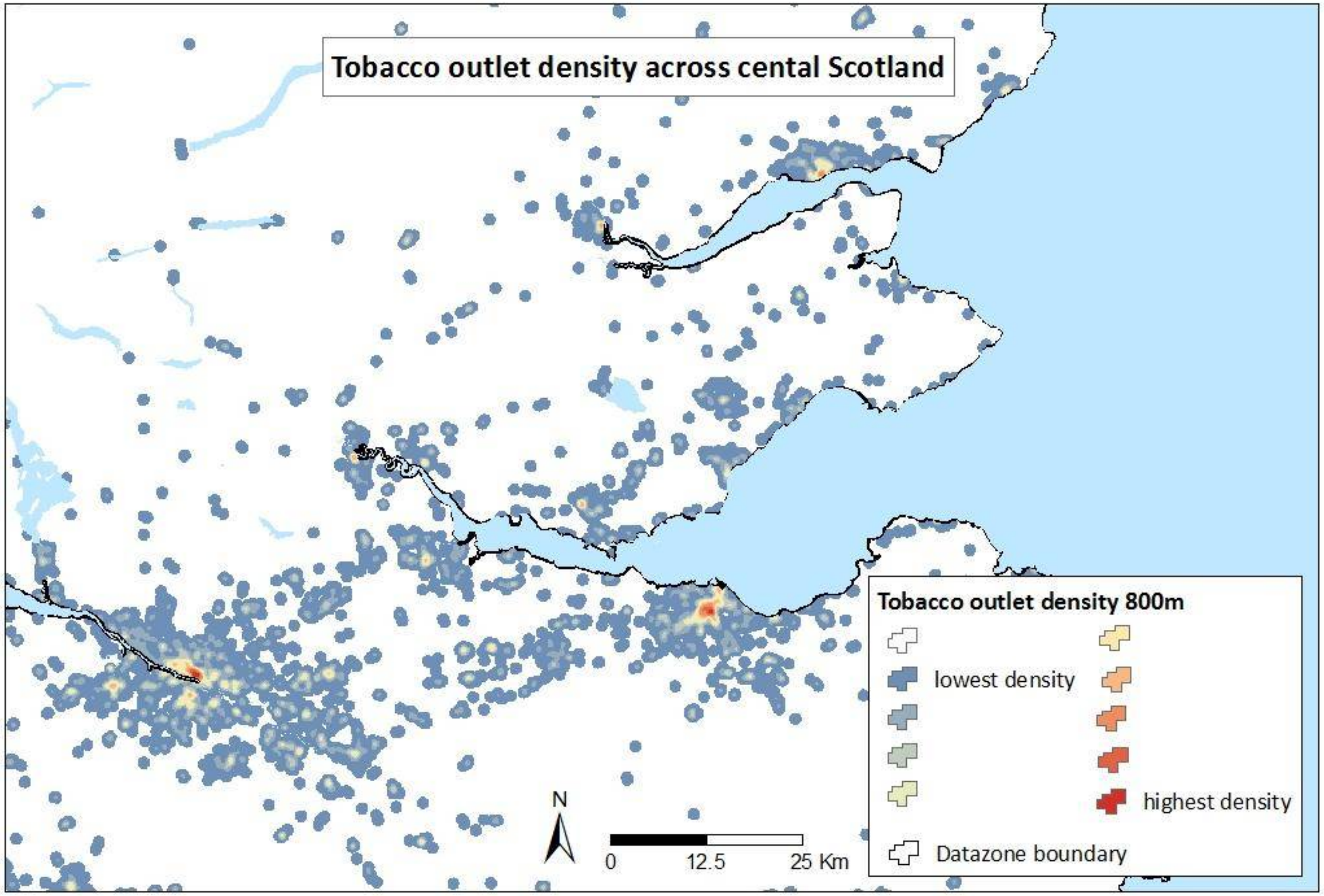
10,000 shops sell tobacco



8 times as many as pharmacies

Supply of tobacco

Retail density



Policies to reduce retail density

Thanks!

Ruaraidh Dobson
rdobson@ashscotland.org.uk

Tobacco policy scenario

Mark Jackson, CERC
Chris Johnson, CERC

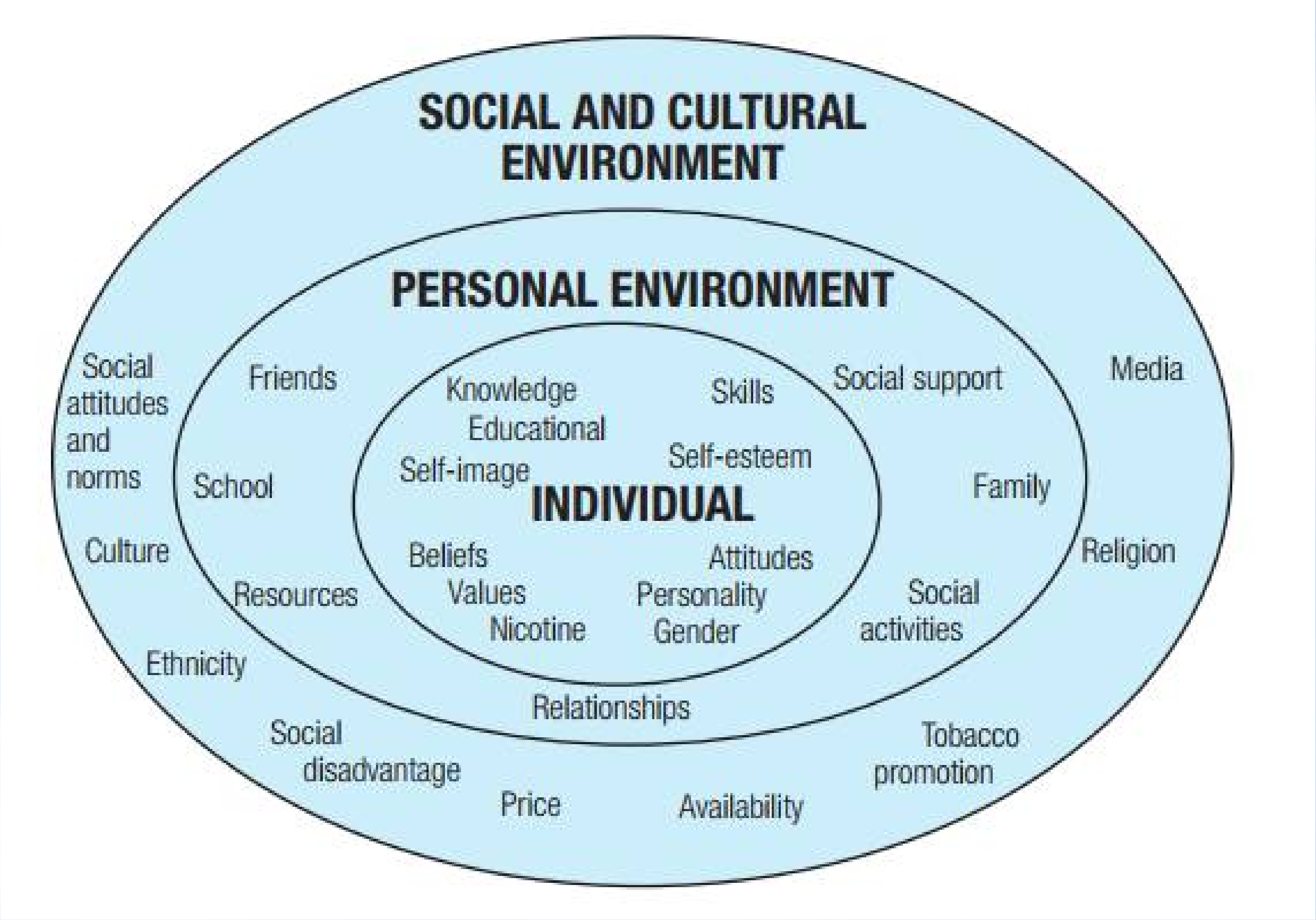
Overview

- Tobacco and smoking policy
- Influences on smoking
- Scenario: reduce tobacco outlet density
- Research on tobacco density in Scotland
- Scenario assessment results and limitations

Tobacco and smoking policy

- Smoking is the primary preventable cause of ill-health and premature death. Each year tobacco:
  - Kills around 10,000 Scots (one fifth of all deaths)
  - Is linked to 128,000 hospital admissions
  - Costs NHS Scotland more than £300 million
- Scottish Government target to reduce smoking prevalence in Scotland to 5% or less by 2034.
- Policy actions so far include implementation of a tobacco retail register in 2011, a ban on self-service sales from vending machines in 2013, and a tobacco display ban in shops from 2013.

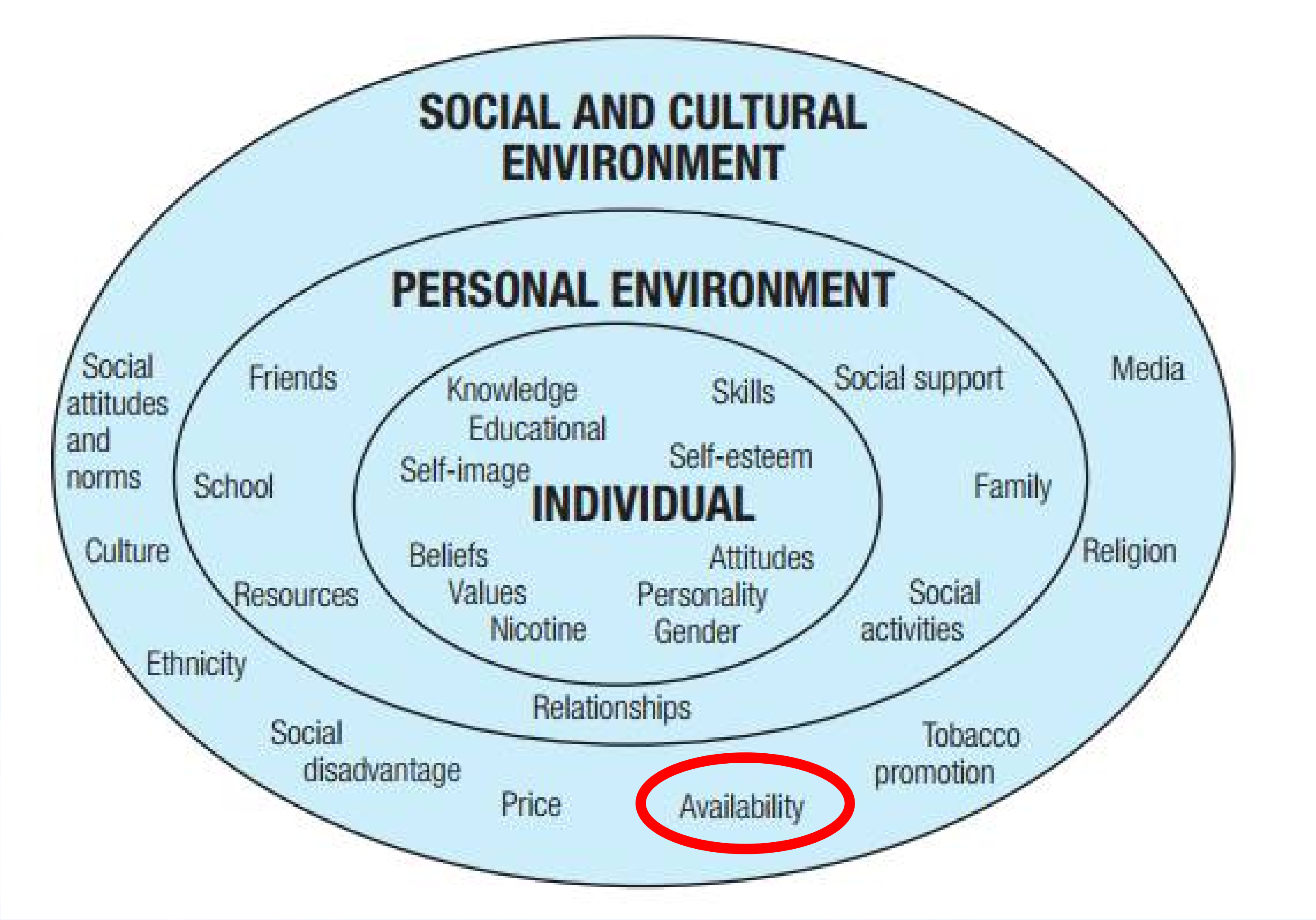
Influences on smoking



The tobacco policy scenario

- There is increasing interest internationally in restrictions on tobacco retail density. For example in Spain the minimum distance between tobacco outlets has been set to 150m.
- Tobacco retail policy scenario: **reduce density of tobacco retailers.**

Influences on smoking



Policy levers

- Extend the tobacco retailer register into a licensing scheme?
  - Limit minimum distance between retailers?
  - Set maximum number of retailers in a particular area?
  - Gradually tighten the restrictions?

Tobacco density and smoking in Scotland – research findings

- Studying links between tobacco outlet density and adult smoking in Scotland, adjusting for confounders.
- Retail outlet density by each postcode was calculated from the Scottish Tobacco Retailers Register (2012).
- Tobacco outlet density linked to the Scottish Health Surveys.
- Findings suggest that residents of environments with greater availability of tobacco outlets are more likely to start/sustain smoking, and less likely to quit.

Nicotine & Tobacco Research, 2016, 138–146
doi:10.1093/ntr/ntv089
Original investigation
Advance Access publication April 20, 2015

SRNT

OXF

Original investigation

Tobacco Retail Environments and Social Inequalities in Individual-Level Smoking and Cessation Among Scottish Adults

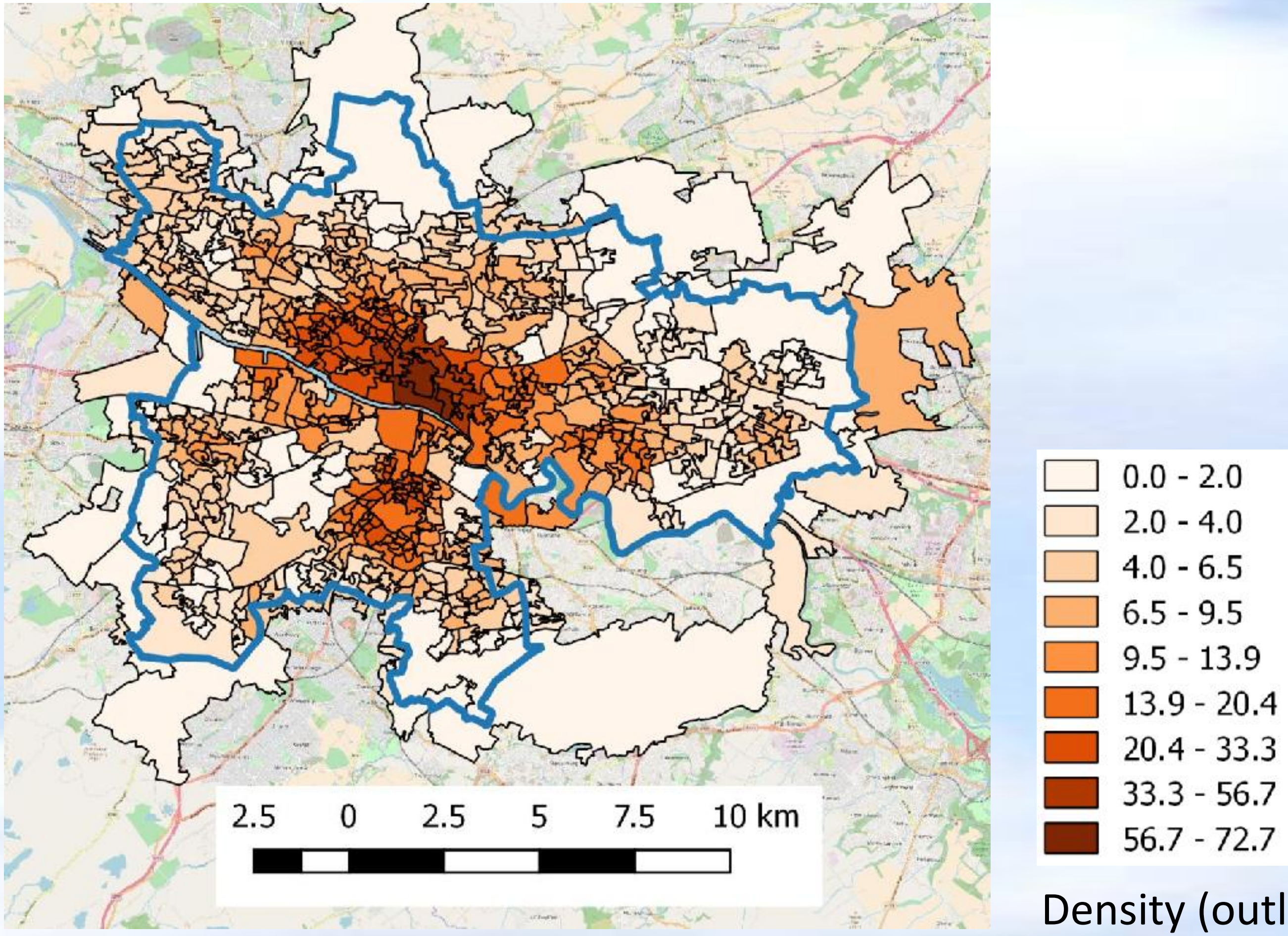
Jamie Pearce PhD[1], Esther Rind PhD[1], Niamh Shortt PhD[1], Catherine Tisch MSc[1], Richard Mitchell PhD[2]

Tobacco outlet density

- CRESH data for Tobacco Outlet Density by datazone in Glasgow City Council area.
- The data are grouped into four bands, to to minimize disclosure risk.

Tobacco Outlet Density Band	Median density (/km2)	Number of datazones
1	0.3	40
2	3.2	185
3	6.1	276
4	15.3	193

Current distribution of tobacco retailers

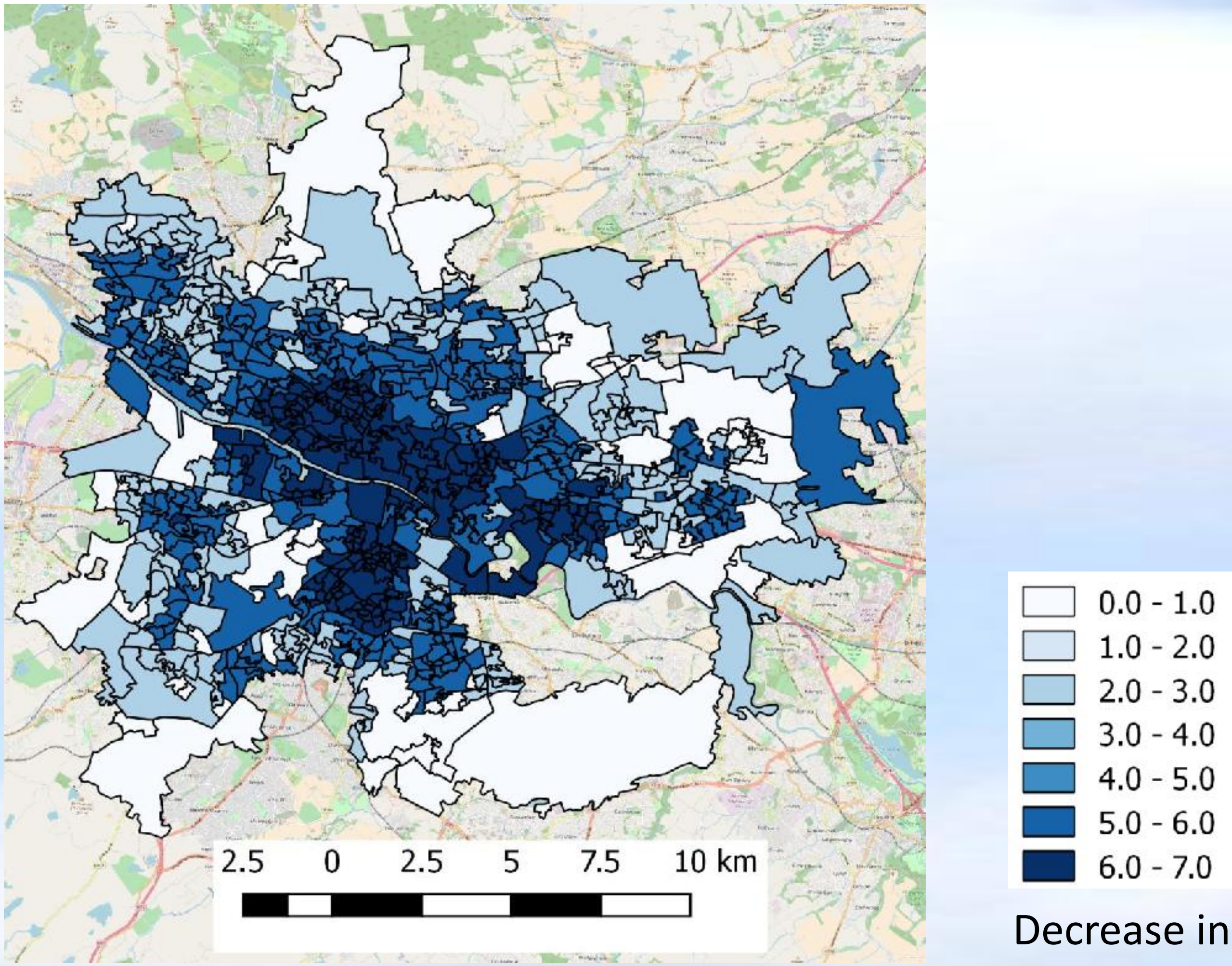


Density (outlets/km²)

Applying the findings as an assessment tool

- What might the effect be of reducing the tobacco outlet density throughout Glasgow to the lowest density band?
  - Ambitious: reduce to 1.75 outlets/km^2
- Results
  - Smoking prevalence reduced by up to 7 percentage points; on average 5 percentage points

Spatial pattern of changes in prevalence

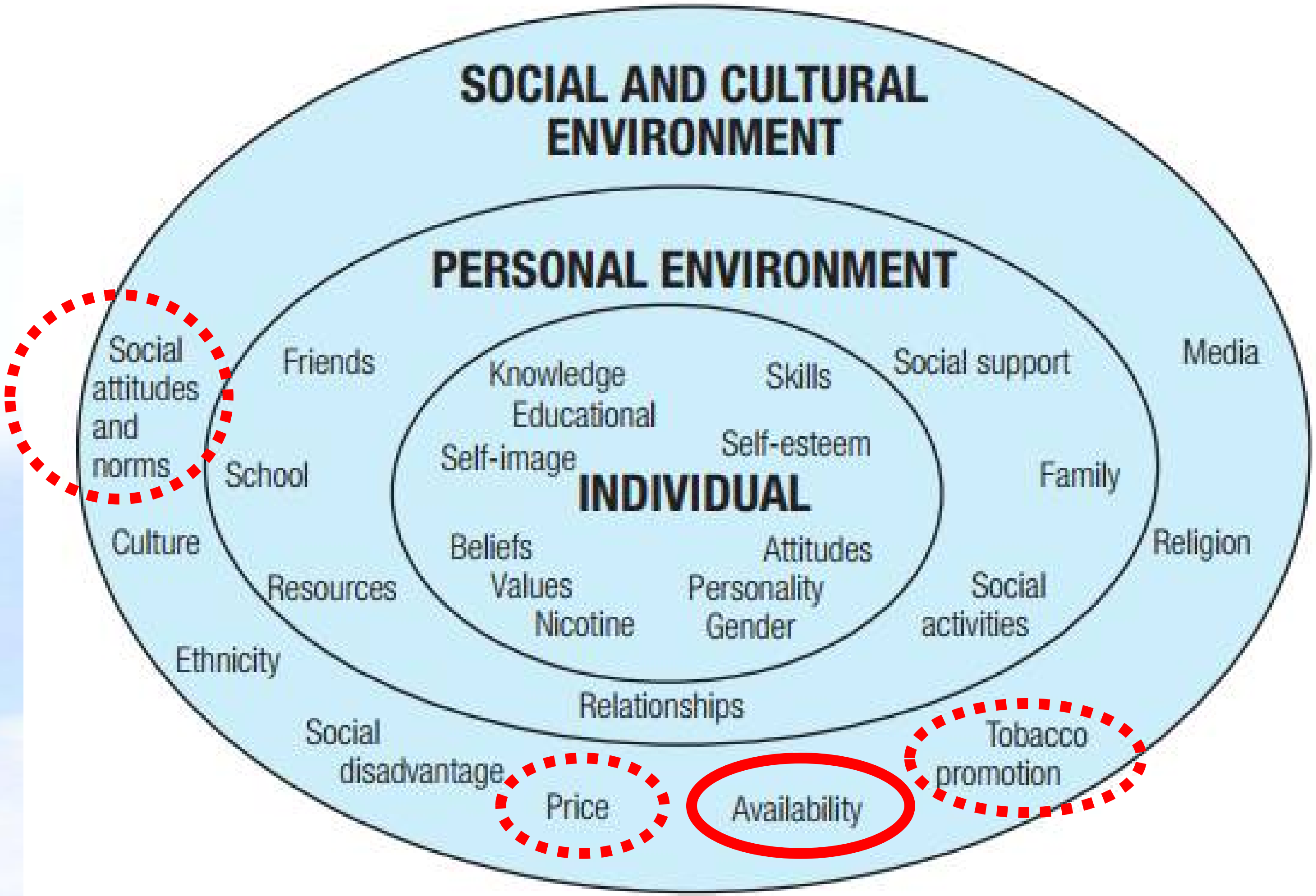


Decrease in smoking (%)

Would recent policy changes change the results?

- The research is based on data from before the point-of-sale advertising ban (2015) and the introduction of plain tobacco packaging (2017).
- It may be that these measures will dilute any causal link between retailing and smoking.

Influences on smoking



Secondary effects – price effects, denormalisation

- Reducing tobacco retail availability would be likely to drive up the cost of tobacco (through less competition and higher effort to procure tobacco).
- Smokers are known to be price-sensitive
- If it was possible to estimate the increase in cost due to the reduction in tobacco availability, price-elasticity models could be used to calculate the effects on prevalence.
- There may be other effects such as denormalisation of smoking: this is harder to model

Conclusion

- Tobacco and smoking policy
- Influences on smoking
- Scenario: reduce tobacco outlet density
- Relevant research findings
- Scenario assessment results and limitations
- Data and health risk tool are integrated in platform

Thank you: any questions?

Mark Jackson, CERC
Chris Johnson, CERC

QCumber-envHealth
Stakeholder Workshop

13 June 2016
The Lighthouse, Glasgow

Project Overview

David Carruthers, CERC
Ruth Doherty, University of Edinburgh

Project background

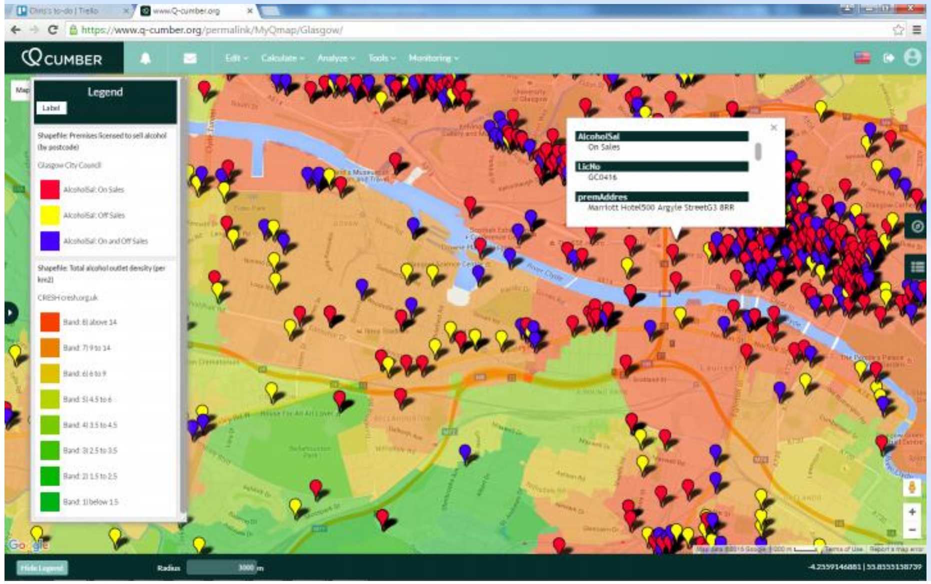
A new integrated decision-making tool for urban health and policy evaluation: 'QCumber-envHealth'

- Innovate UK collaborative research and development project under their competition *Solving urban challenges with data*
- Project runs November 2015 to October 2017

Innovate UK
Technology Strategy Board

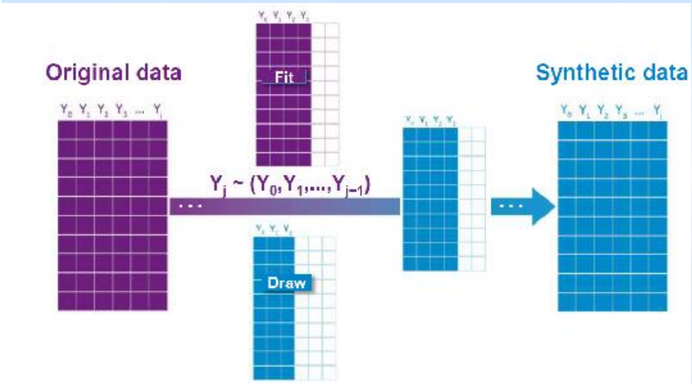
Project Goal

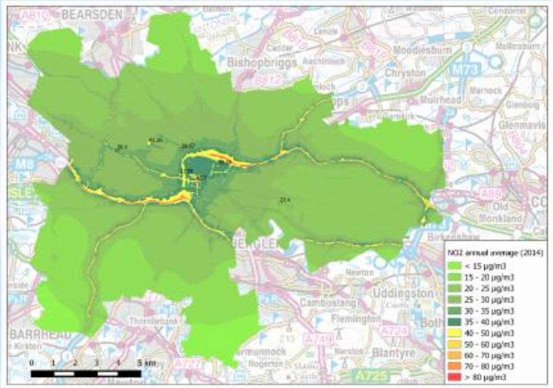
- In the context of Glasgow with its wealth of data, build on the QCumber system with state-of-the-art research and end-user participation to create an integrated platform for environmental health policy and well-being/inequality related decision making.

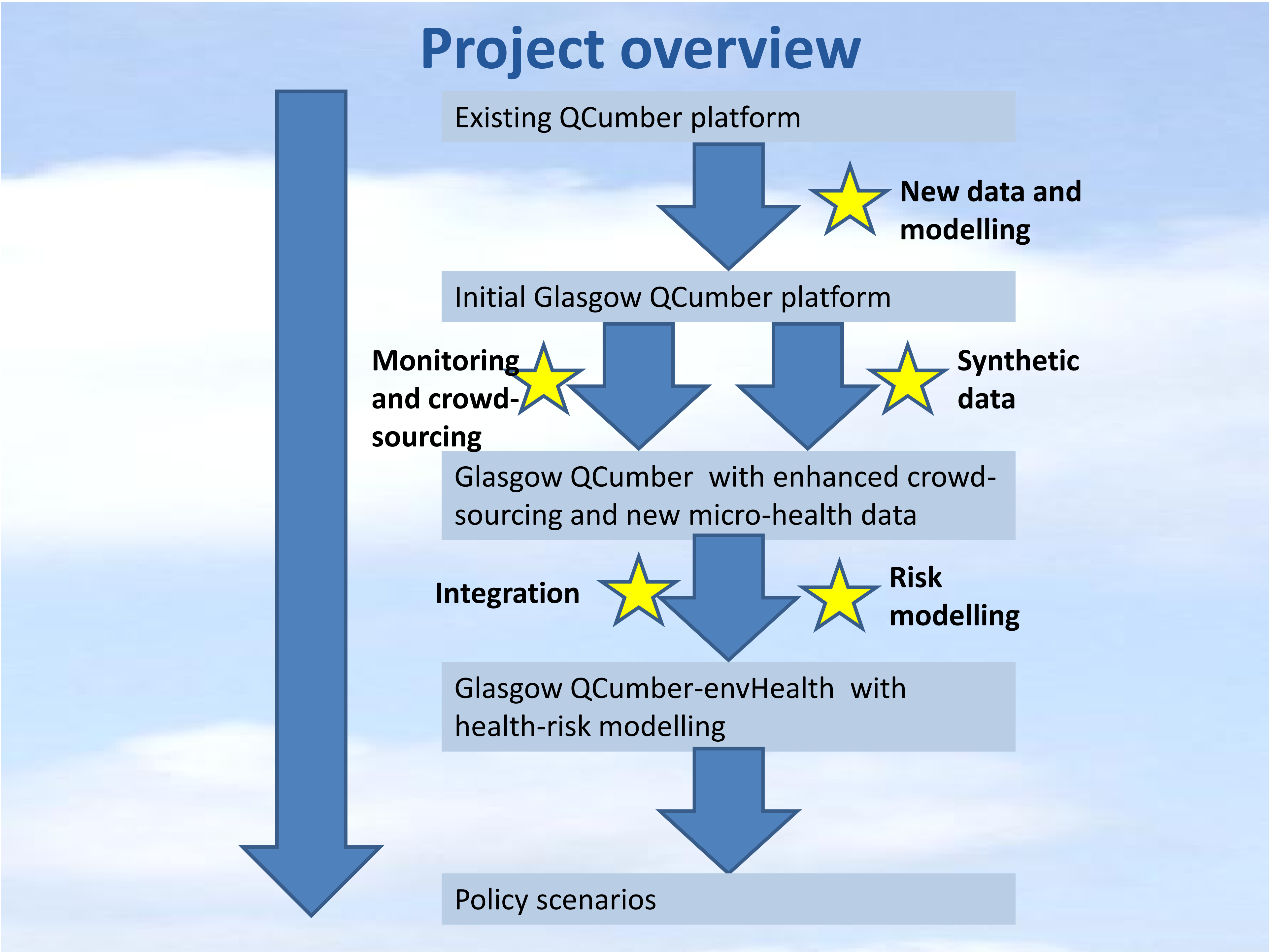


Innovations

- New health related behaviour data and exposure modelling
- Integration of crowd-sourcing and monitoring
- Creation and integration of accessible personal data (synthetic data)
- End-user led health risk modelling and policy scenarios






Project overview
Existing QCumber platform
New data and modelling
Initial Glasgow QCumber platform
Monitoring and crowd-sourcing
Synthetic data
Glasgow QCumber with enhanced crowd-sourcing and new micro-health data
Integration
Risk modelling
Glasgow QCumber-envHealth with health-risk modelling
Policy scenarios

Project partners

- CERC
- University of Edinburgh
- University of Strathclyde
- University of Glasgow
- Transport Scotland

CERC

Formative stakeholders

- Glasgow City Council
- Health Protection Scotland
- NHS Greater Glasgow & Clyde

Workshop objectives

- Brief stakeholders on the project
- Gather stakeholder feedback to help shape the platform
- Select policy case studies to be assessed

Example policy case studies

- Reducing traffic flow
- Alcohol and tobacco retail
- Green space

Thanks for your attention

David Carruthers, CERC
Ruth Doherty, University of Edinburgh

QCumber-envHealth
Stakeholder Workshop

13 June 2016
The Lighthouse, Glasgow

The Glasgow Platform

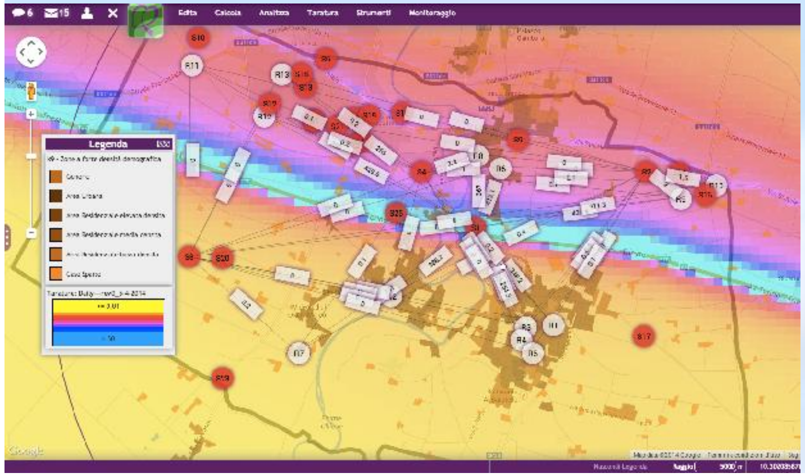
Mark Jackson, CERC
Chris Johnson, CERC

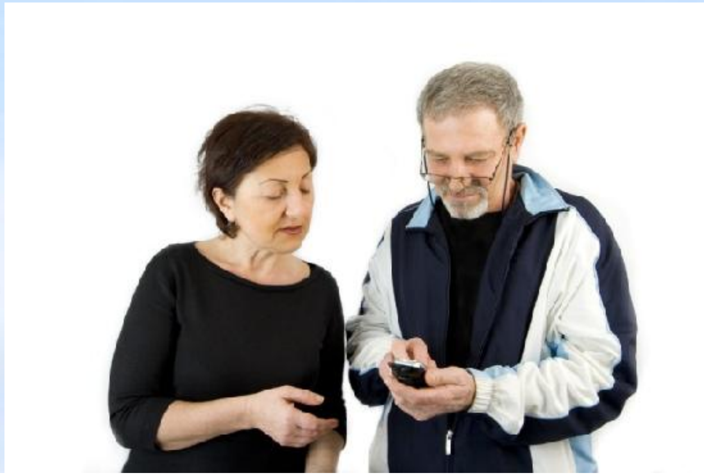
The Glasgow Platform

- QCumber
- Data for Glasgow
- Air quality modelling for Glasgow
- Demonstration
- Future of the platform

QCumber

- QCumber is a usable, fast, city data platform
  - Website and phone app
  - Interactive map visualisation using Google Maps
  - Integrated data and models
  - Social media and crowd-sourcing
  - Adopted by many institutions in Italy





Public Glasgow Platform

- QCumber has been set up for Glasgow
- Public platform produced www.q-cumber.org
- Data and modelling
  - New health-related social behaviour data
  - Open data
  - ADMS-Urban air quality modelling

Data integrated: publishers

Glasgow City Council

Transport Scotland
Còmhdhail Alba

CRESH

DATA.GOV.UK
Opening up Government

Community Safety Glasgow

sustrans
Join the movement

Ordnance Survey

OpenStreetMap
The Free Wiki World Map

Glasgow Data Launchpad

ScotPHO
Public Health Information for Scotland

PREV'AIR

NCR

Scottish Natural Heritage
All of nature for all of Scotland

ISD Scotland

NHS
National Services Scotland

Department for Environment Food & Rural Affairs

National Records of Scotland

SEPA
Scottish Environment Protection Agency

Met Office

Scottish Neighbourhood Statistics

National Atmospheric Emissions Inventory

Department for Transport

Datasets integrated

Transport
- **Cycle**
  - Cycle racks
  - Cycling routes
- **Rail**
  - Train tracks
- **Road**
  - Traffic signals
  - Electric vehicle charging points
  - Reported road accidents
  - Travel time to GP
  - City roads
- **Mode**
  - Travel mode to school

Transport Scotland
- Glasgow traffic model link locations
- Traffic count locations
- Major road sections

Social
- **Social**
  - Community Safety Index
  - Scottish Index of Multiple Deprivation score
  - Health deprivation rank

Exposure
- **Alcohol**
  - Licensed Premises
  - On-Sales outlet density
  - Off-Sales outlet density
  - Total outlet density
- **Green spaces**
  - Multifunctional greenspace
  - Country parks
  - Nature reserves
  - SSSI
  - PAN 65 open space types
  - Greenspace percentage
- **Health services**
  - Patients by GP
- **Physical environment**
  - MEDIx and MEDClass
- **Tobacco**
  - Tobacco outlet density

Environment
- **Air Quality**
  - ADMS model input
  - ADMS model output
  - NO2 diffusion tubes
  - Monitors
  - Air Quality Management Areas
- **Waste**
  - Waste sites
  - Landfill capacity

Health
- **Alcohol**
  - Patients hospitalised
  - Hospital episodes
  - Standardised Mortality Ratio
- **Births**
  - Breastfeeding
  - Teenage pregnancy
  - Low birth weight
  - Smoking status at maternity
- **General health**
  - NRAC Morbidity and Life Circumstances index
  - Long-term health problem or disability
  - General health
- **Life expectancy**
  - Life expectancy
- **Respiratory**
  - Patients hospitalised with asthma
  - Respiratory disease
  - Lung cancer
  - Smoking prevalence
  - Standardised Mortality Ratio

Demography
- **Population**
  - Population count

Air quality modelling for Glasgow

- High resolution air quality modelling
- For comparison with air quality standards
- To provide air quality exposure for health modelling
- To be combined with measurements

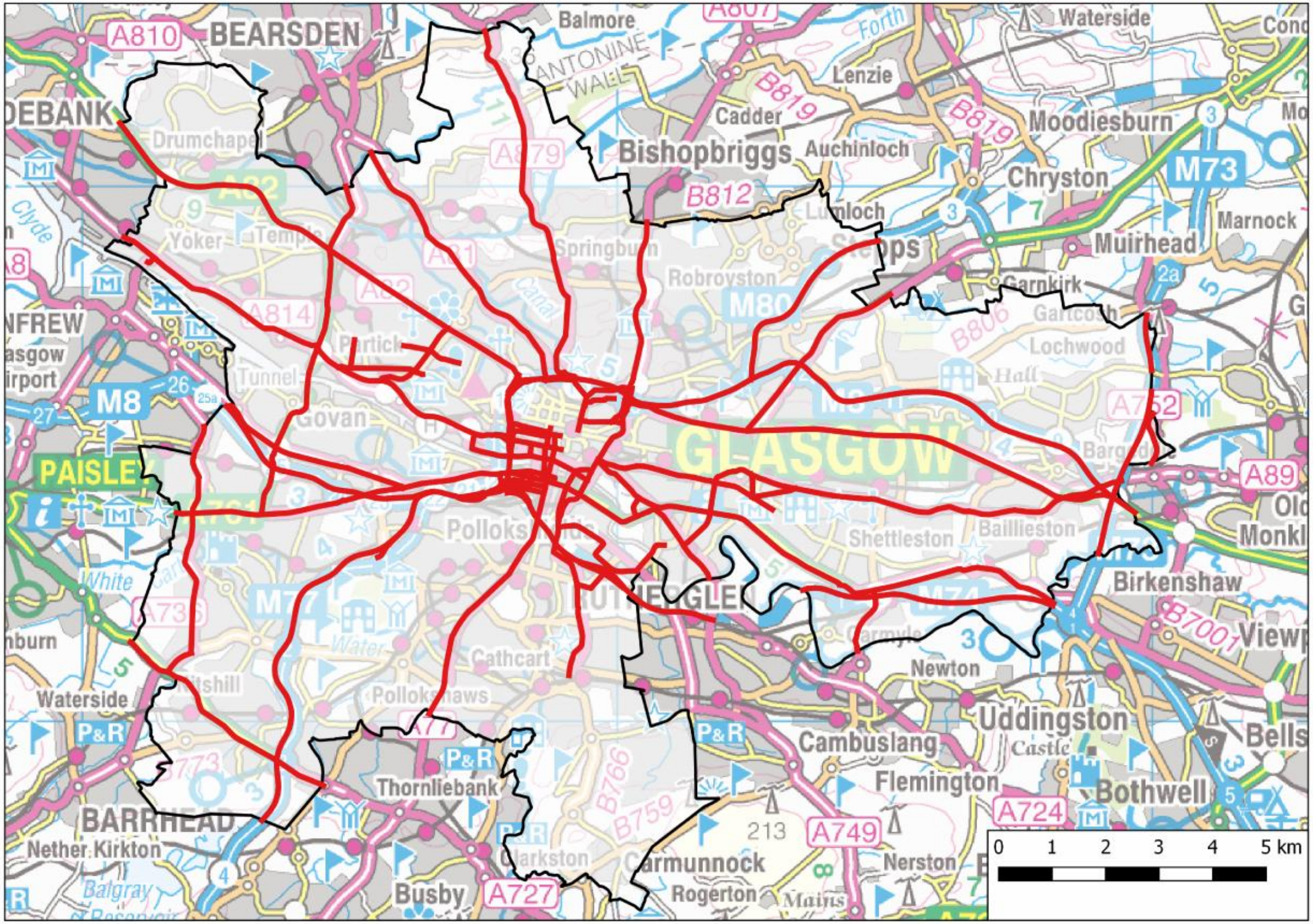
ADMS-Urban air quality modelling

- Emissions sources modelled with ADMS-Urban version 4.0 for the years 2009-2014
- Traffic flows from DfT, Transport Scotland, Glasgow City Council
- Tunnel and advanced street canyon modelling
- Met Office BADC met observations (Bishopton)
- Measured background data: NO_x and NO_2 from Bush Estate, PM_{10} from Waulkmillglen Reservoir and $PM_{2.5}$ from Auchencorth
- Concentrations of NO_x, NO_2, O_3, PM_{10} and $PM_{2.5}$ calculated at monitor site locations
- Contour plots of concentrations over Glasgow (25m resolution)

Emissions totals (tonnes/year)

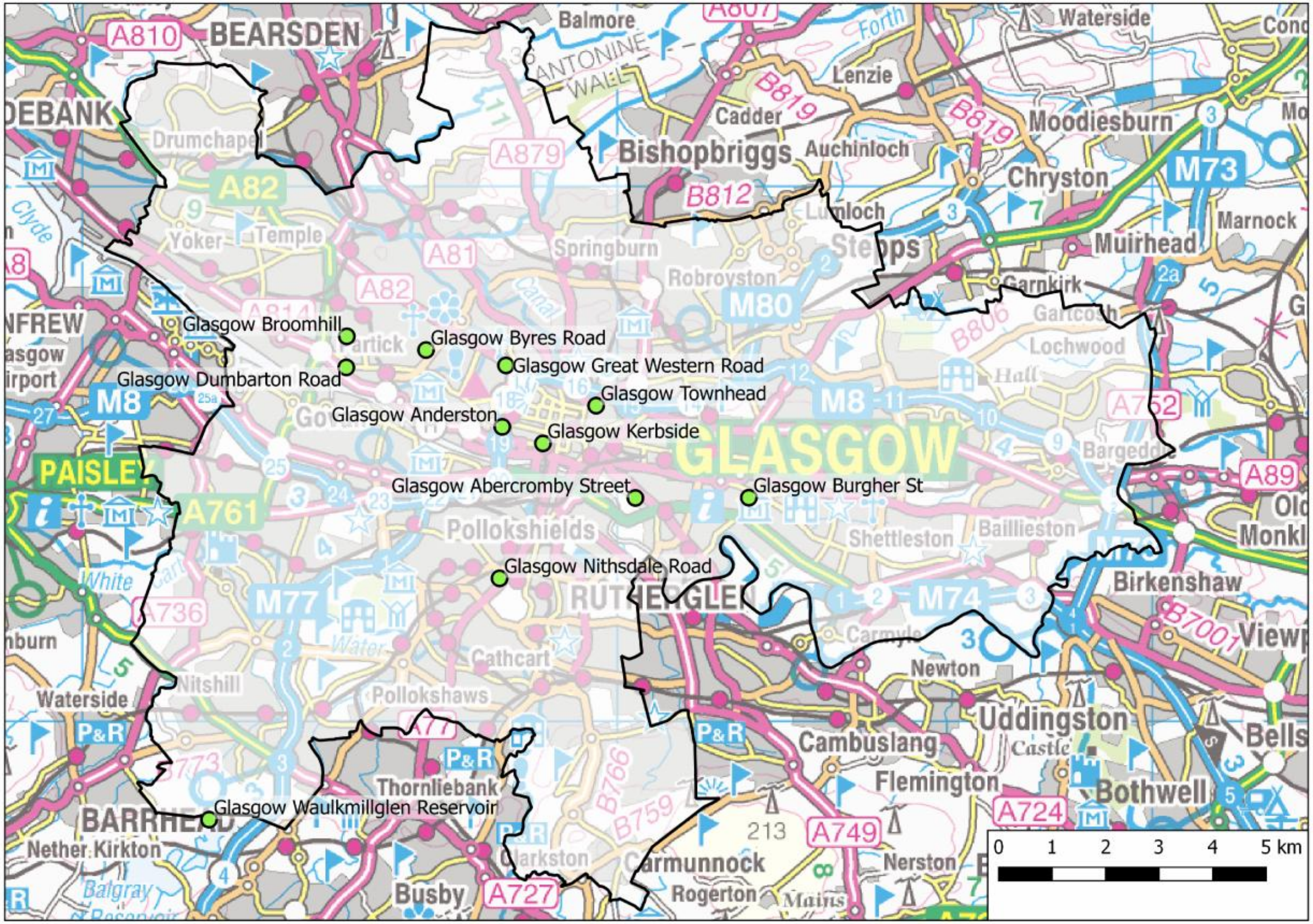
Group	NO2	NOx	PM10	PM2.5
Energy production and transfer	13	252	4	4
Commercial and residential combustion	72	1443	41	40
Industrial combustion	39	779	17	17
Production processes	0	4	40	8
Fossil fuels	0	0	0	0
Solvent	0	0	65	23
Major roads	422	2416	128	67
Other roads	96	1917	35	33
Other transport and machinery	83	1653	89	84
Waste	0	4	32	30
Agriculture	0	0	4	1
Other	0	5	44	42
TOTAL	**725**	**8475**	**499**	**349**

Roads modelled



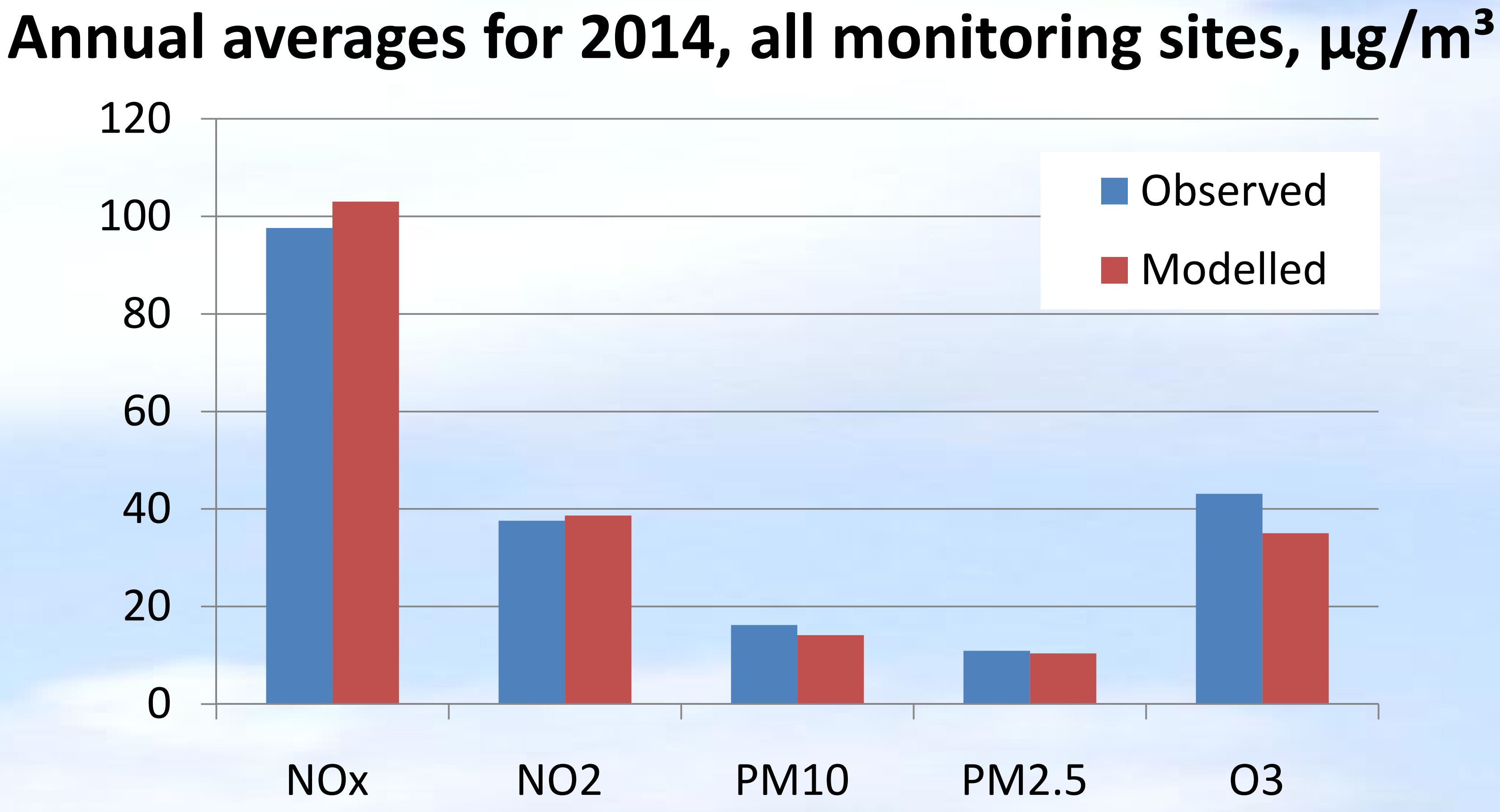
Road sources modelled. Contains OS OpenData imagery © Crown copyright 2015.

Monitoring sites



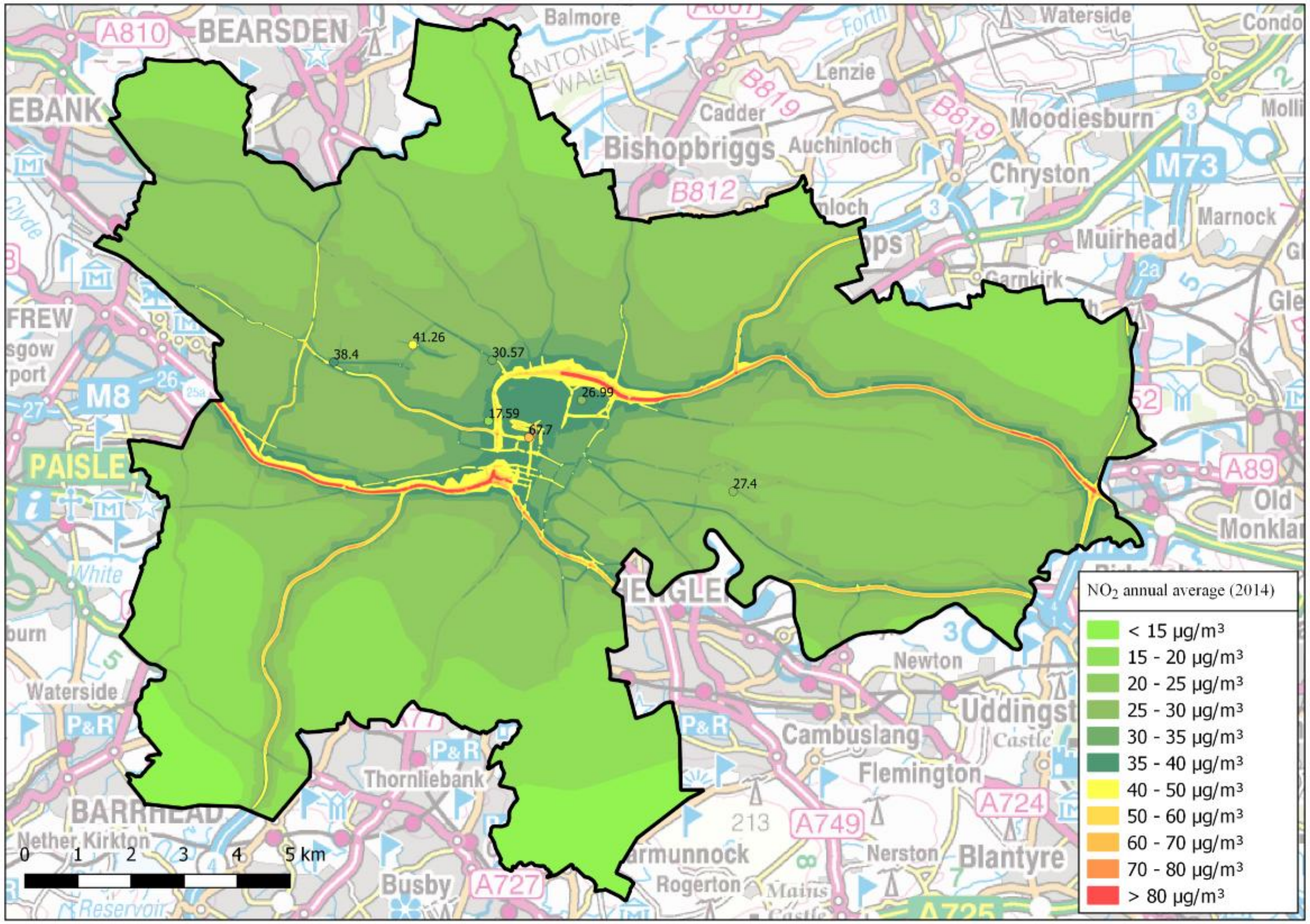
Monitor site locations. Contains OS OpenData imagery © Crown copyright 2015.

Validation results



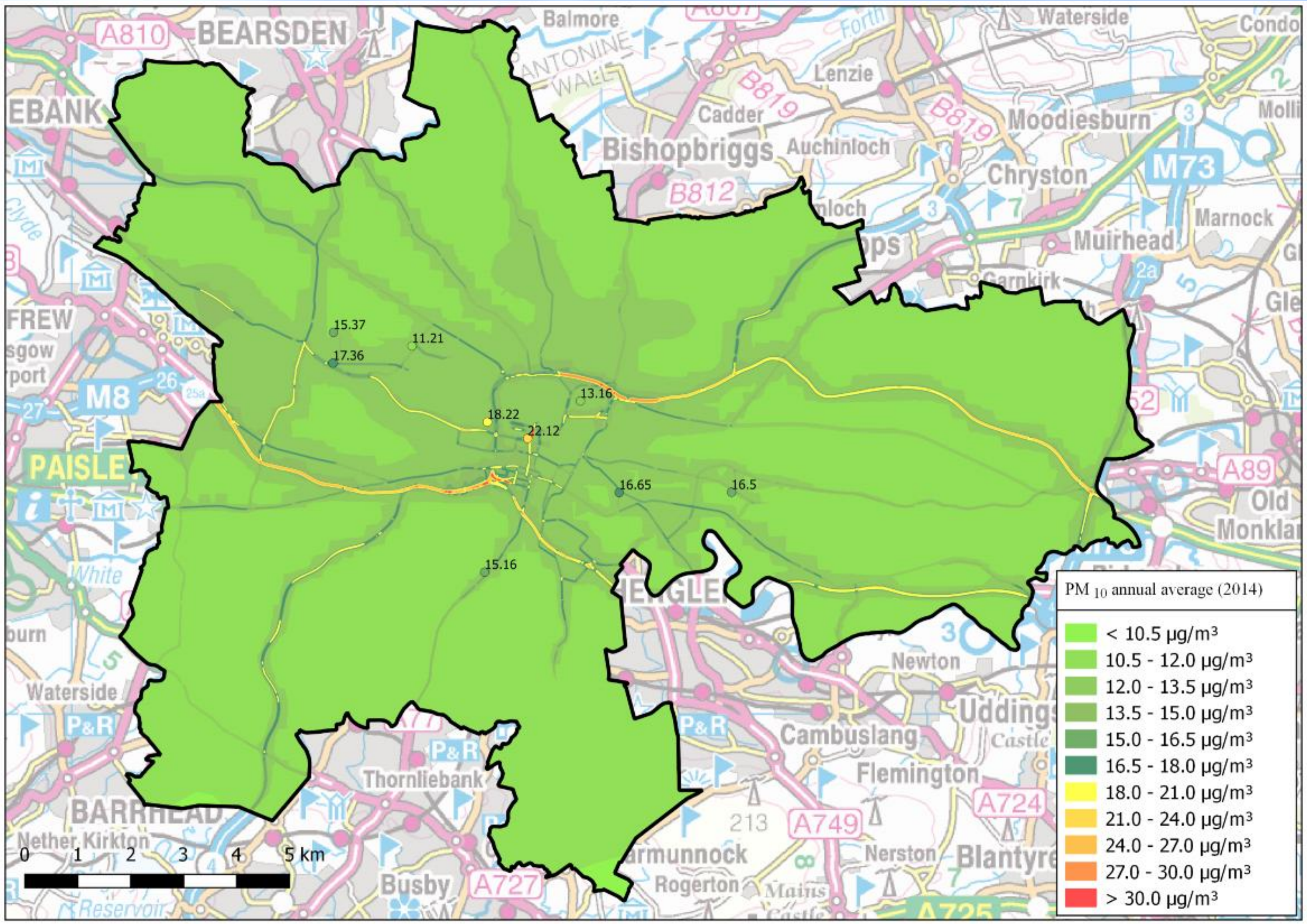
QCumber-envHealth
Stakeholder Workshop

NO_2 annual averages 2014



Modelled annual average NO_2 concentrations at 1.5 metres above ground level. Annual average observed values are also shown at the monitor locations. Contains OS OpenData imagery © Crown copyright 2015.

PM_{10} annual averages 2014



Modelled annual average PM_{10} concentrations at 1.5 metres above ground level. Annual average observed values are also shown at the monitor locations. Contains OS OpenData imagery © Crown copyright 2015.

Platform demonstration

QCumber-envHealth
Stakeholder Workshop

What’s next for the platform

- Transport routing
- Smart measurements
- Noise modelling
- Update data
- Accessible health data (synthetic data)
- Health modelling
- Case studies

Conclusion

- QCumber
- Data for Glasgow
- Air quality modelling for Glasgow
- Demonstration
- Future of the platform

Thanks for your attention

Mark Jackson, CERC
Chris Johnson, CERC

Linking exposure to health

Chris Dibben, Jamie Pearce, Duncan Lee, Tom Clemens, Gillian Raab and Beata Nowok

THE UNIVERSITY of EDINBURGH

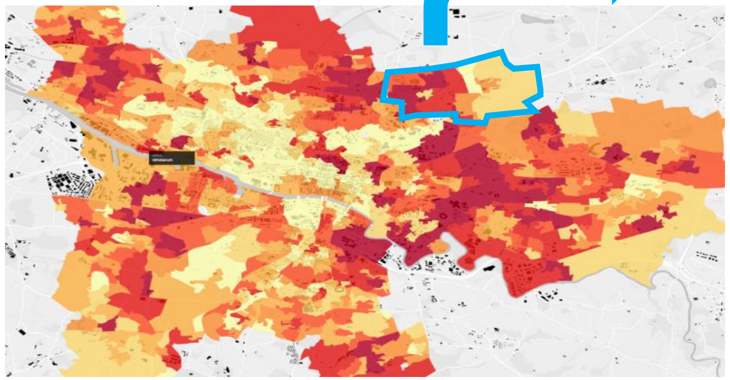
University of Glasgow

Overview

- Aims for this piece of work
- The health case study – outcomes of pregnancy
  - Air pollution and outcomes of pregnancy
  - Other environments effects
- Synthetic micro data - “accessible” health data

Produce synthetic "accessible" health data

- Will consist of small areas (datazones) across Glasgow, each made up of populations of synthetic individuals.
- These individuals mimic distributional properties and characteristics of the "real" population within each datazone
- Estimated from the **real data** (from WP4) and released to QCumber system **(pending approval…)**



Change in birthweight

- Produce determinist models estimating risks of low birth weight associated with exposure to air pollution:
  - Study area: Glasgow (council area, health board)
  - Exposure: Modelled air pollution information from CERC (ADMS), linked via residential postcode.
    - Other exposures available and linked already…
  - Health data (**Real data**): Scottish Morbidity Record 02 (Maternity inpatient record)
    - Sensitive; cannot leave the server on which it is stored.
    - Linked to pollution based on residential postcode at delivery
  - Combine to develop and produce determinist models (parameters) to be released to Qcumber:
    - Incorporate complexity (interactions, smoking, spatial dependency etc)

Why birth outcomes as the exemplar?

JAMA The Journal of the American Medical Association

August 14, 2002, Vol 288, No. 6 >

< Previous Article Next Article >

Review | August 14, 2002

Cognitive and Behavioral Outcomes of School-Aged Children Who Were Born Preterm

Research

Effects of gestational age at birth on health outcomes at 3 and 5 years of age: population based cohort study

BMJ 2012 ; 344 doi: http://dx.doi.org/10.1136/bmj.e896 (Published 01 March 2012)
Cite this as: *BMJ* 2012;344:e896

http://www.sciencedirect.com/science/article/pii/S0013935115001565

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Place of work and residential exposure to ambient air pollution and birth outcomes in Scotland, using geographically fine pollution climate mapping estimates

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School of Geosciences, University of Edinburgh, Drummond Street, Edinburgh, UK

ARTICLE INFO

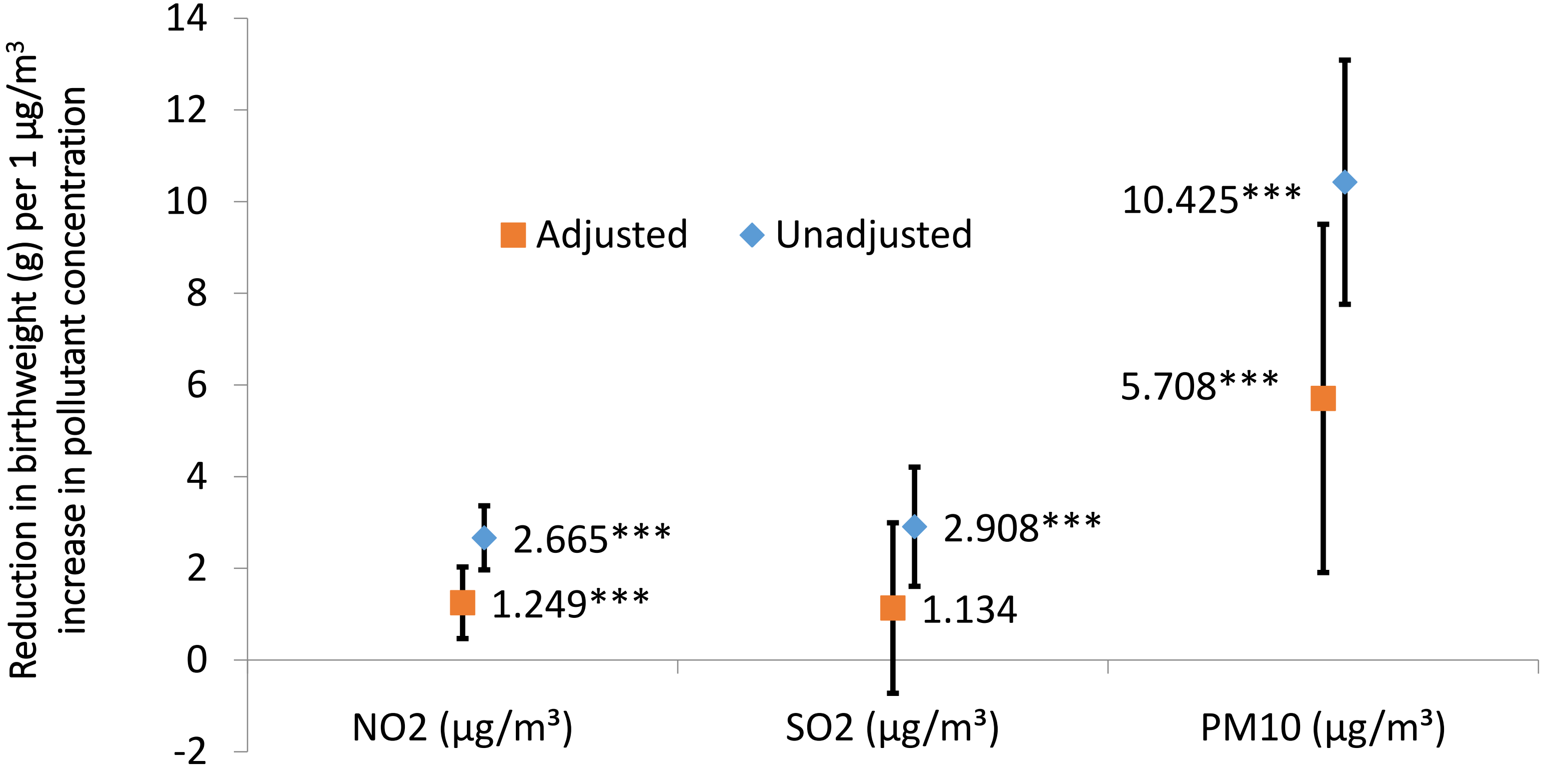
Article history:
Received 19 December 2014
Received in revised form
4 May 2015
Accepted 11 May 2015
Available online 22 May 2015

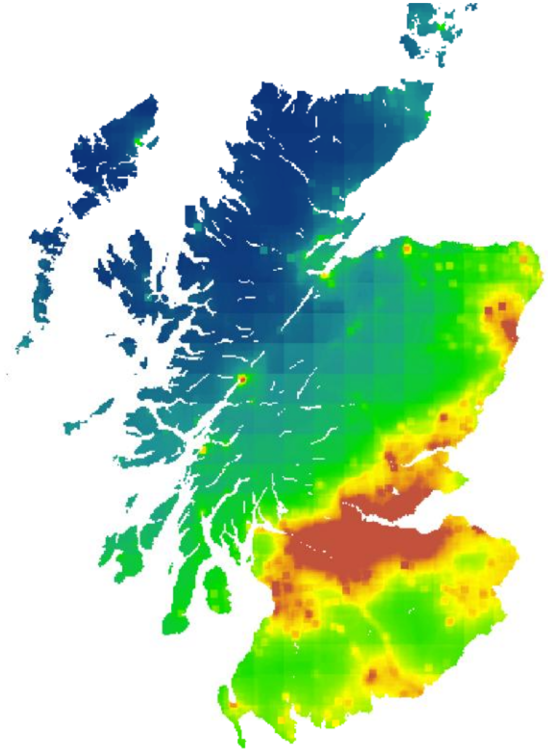
Keywords:
Air pollution
Birth outcomes
Measurement error
Pollution climate mapping

ABSTRACT

Objectives: A relationship between ambient air pollution and adverse birth outcomes has been found in a large number of studies that have mainly used a nearest monitor methodology. Recent research has suggested that the effect size may have been underestimated in these studies. This paper examines associations between birth outcomes and ambient levels of residential and workplace sulphur dioxide, particulates and Nitrogen Dioxide estimated using an alternative method – pollution climate mapping.
Methods: Risk of low birthweight and mean birthweight (for $n=21{,}843$ term births) and risk of preterm birth (for $n=23{,}086$ births) were modelled against small area annual mean ambient air pollution concentrations at work and residence location adjusting for potential confounding factors for singleton live births (1994–2008) across Scotland.
Results: Odds ratios of low birthweight of 1.02 (95% CI, 1.01–1.03) and 1.07 (95% CI, 1.01–1.12) with concentration increases of 1 μg/m^3 for NO_2 and PM_{10} respectively. Raised but insignificant risks of very preterm birth were found with PM_{10} (relative risk ratio=1.08; 95% CI, 1.00 to 1.17 per 1 μg/m^3) and NO_2 (relative risk ratio=1.01; 95% CI, 1.00 to 1.03 per 1 μg/m^3). An inverse association between mean birthweight and mean annual NO_2(−1.24 g; 95% CI, −2.02 to −0.46 per 1 μg/m^3) and PM_{10} (−5.67 g; 95% CI, −9.47 to −1.87 per 1 μg/m^3). SO_2 showed no significant associations.
Conclusions: This study highlights the association between air pollution exposure and reduced newborn size at birth. Together with other recent work it also suggests that exposure estimation based on the nearest monitor method may have led to an under-estimation of the effect size of pollutants on birth outcomes.

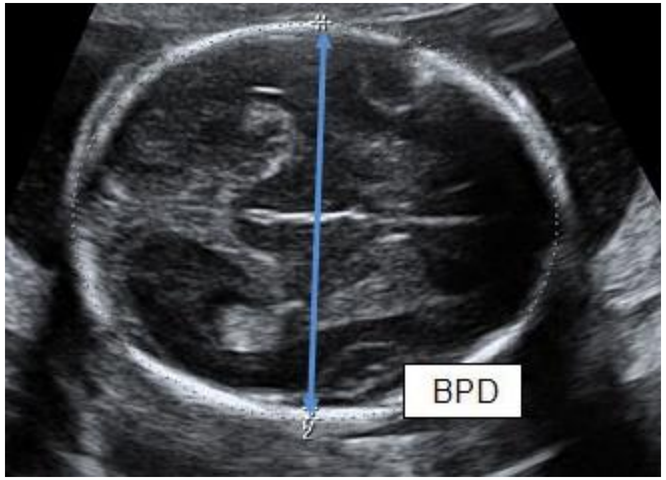
Air pollution and pregnancy outcomes

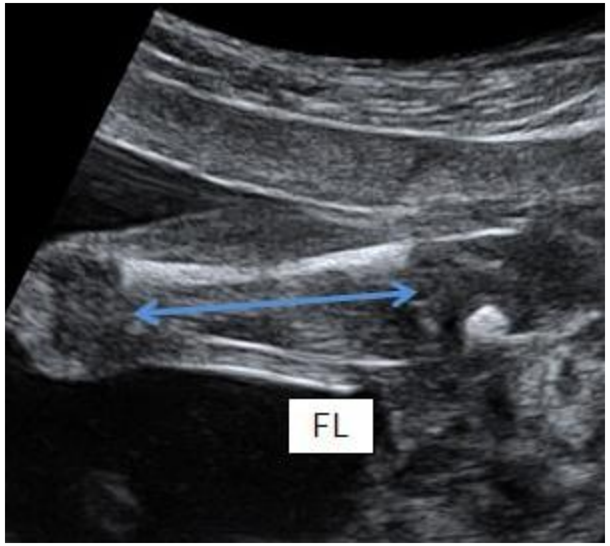


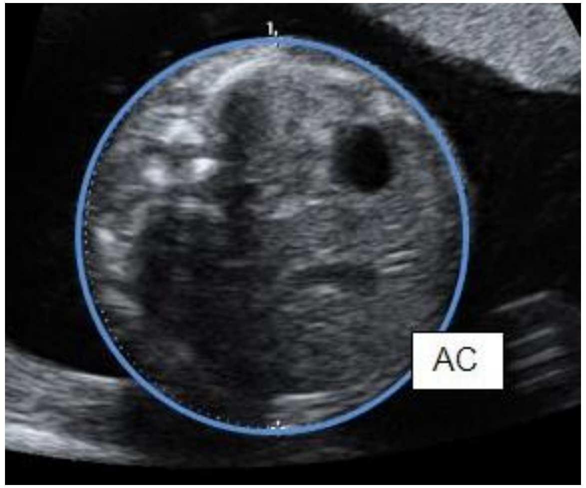


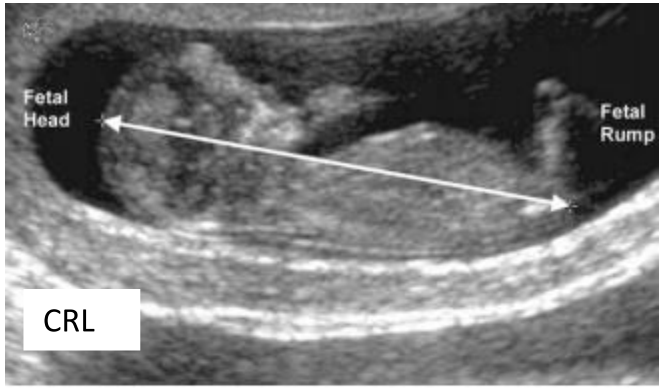
Adjusted coefficients: Adjusted for social class, parity, individual estimated income, ethnicity, smoking, area log crime rate, mother's age, mothers education, season of birth and year of birth. **(p<.10) **(p<.05) *** (p<.01)* Source: Scottish Longitudinal Study

Fetal scan data

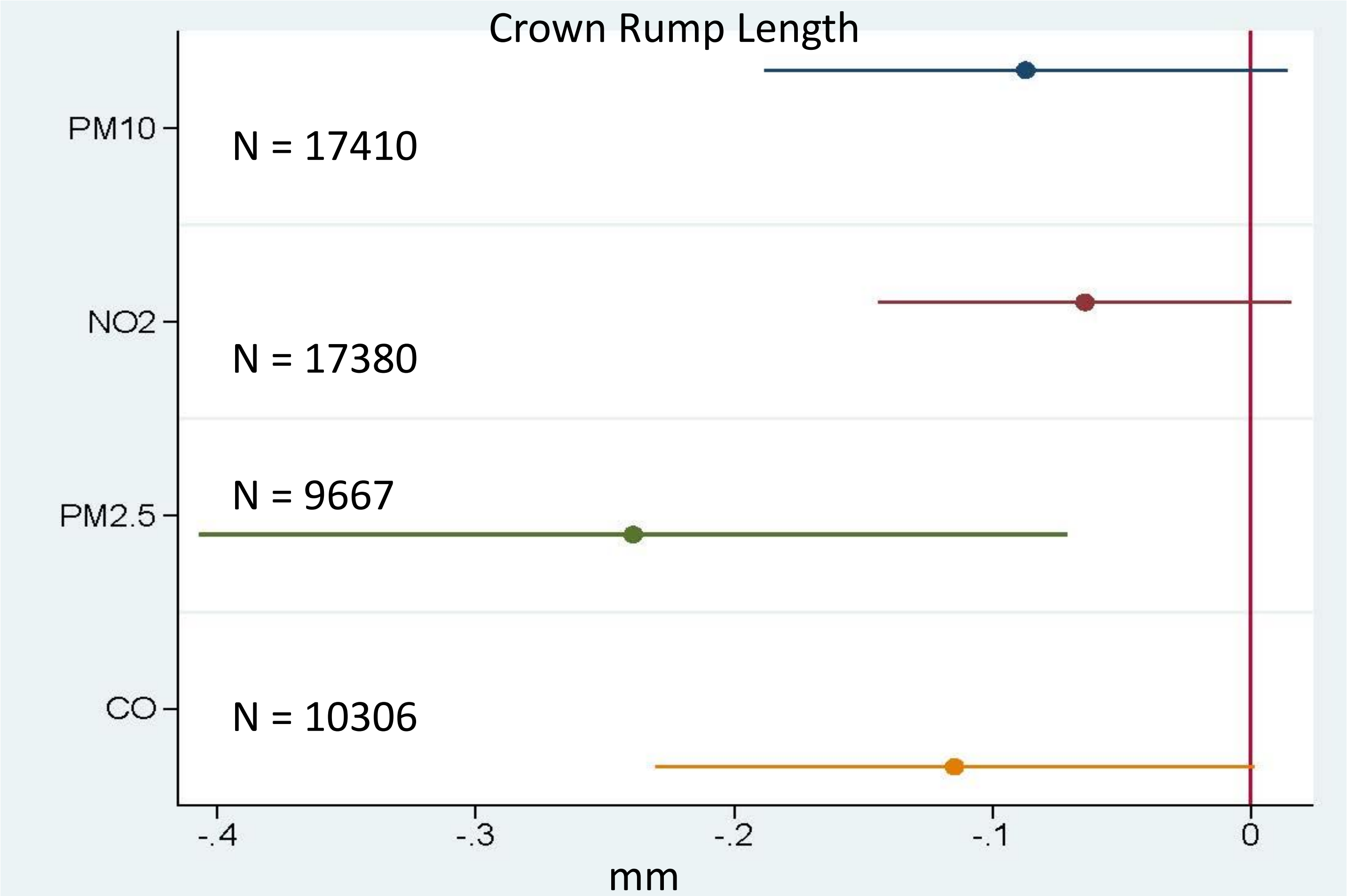






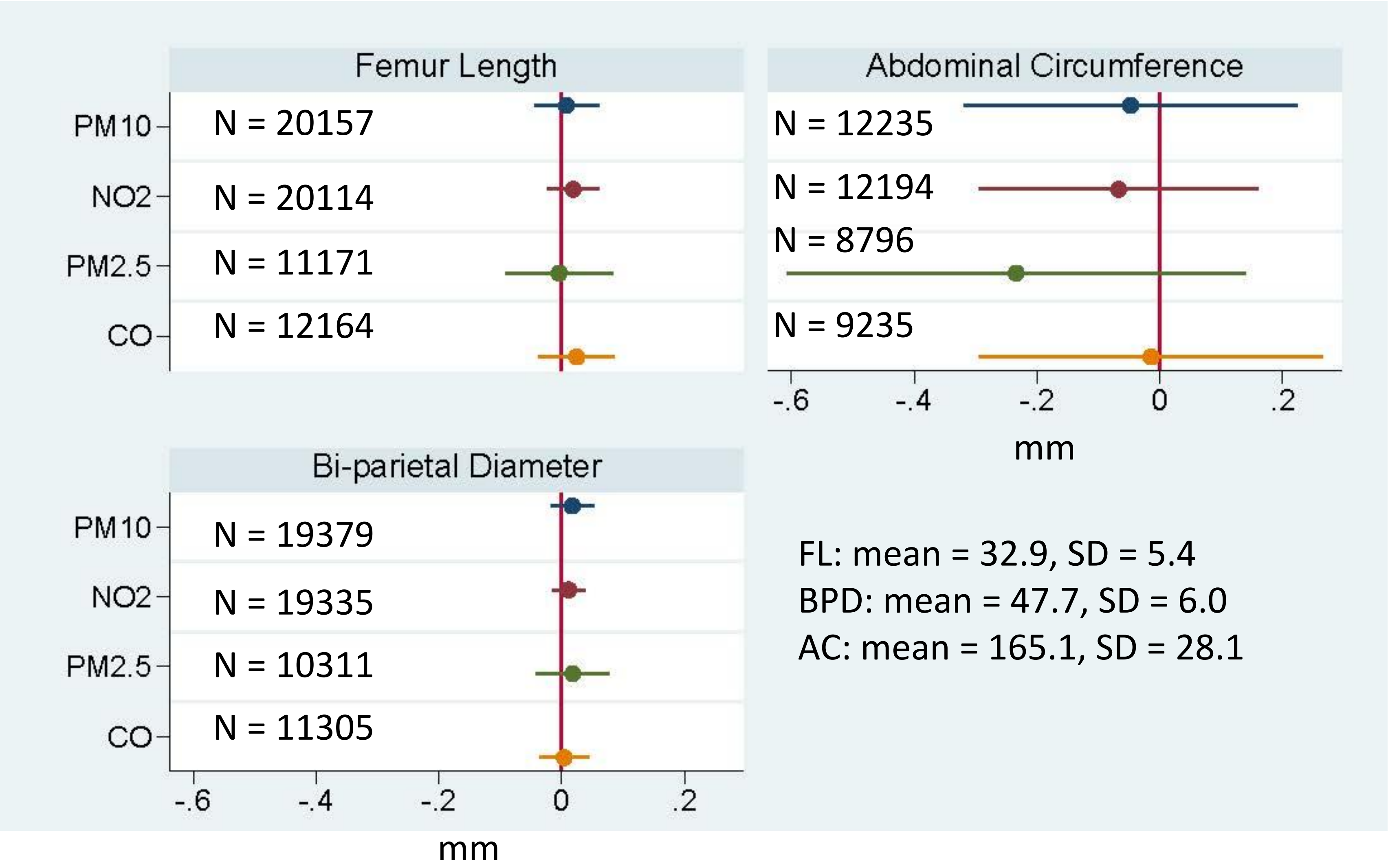


Air pollution and fetal growth – Trimester one



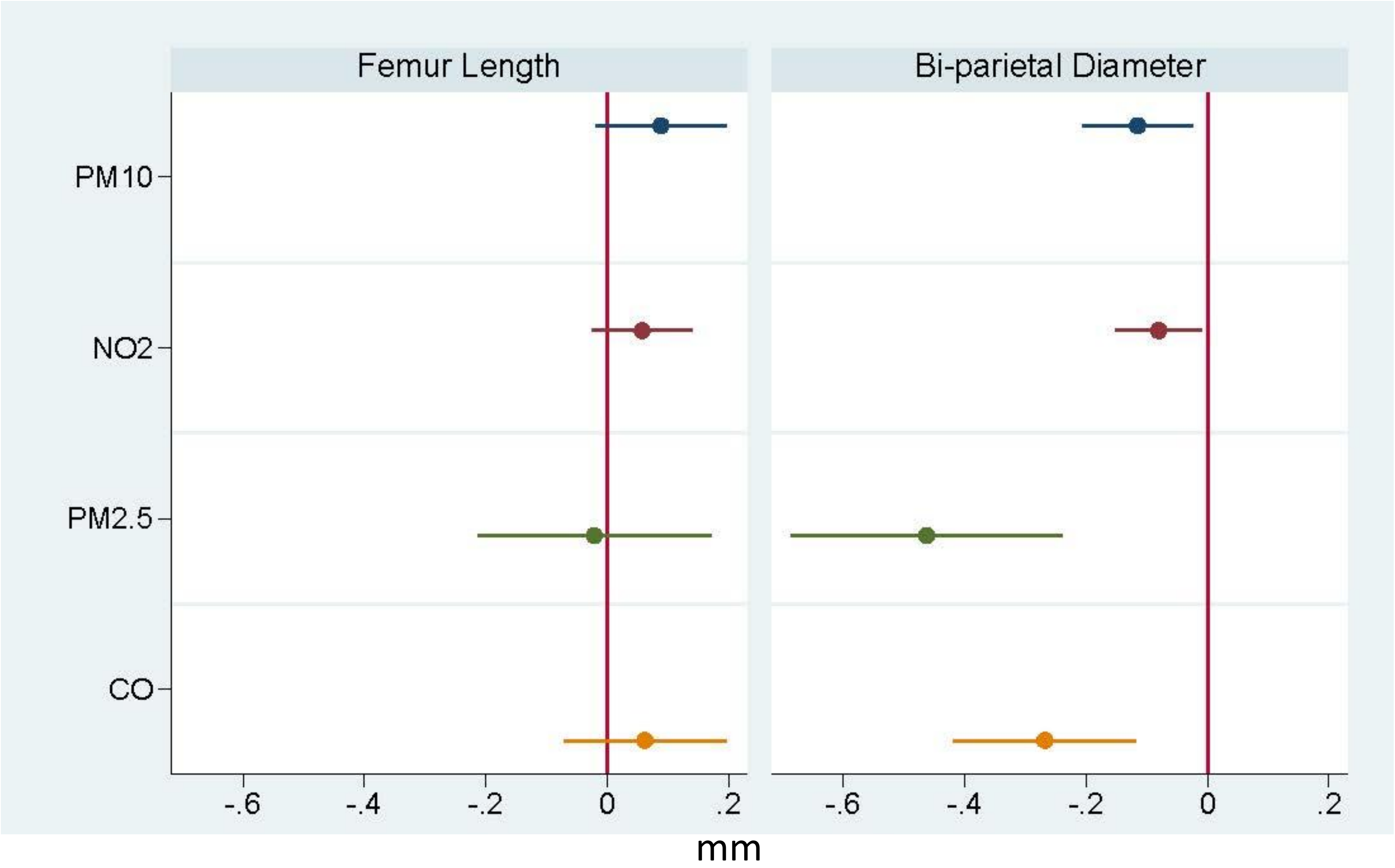
CRL: mean = 51.1, SD = 15.9

Air pollution and fetal growth – Trimester 2

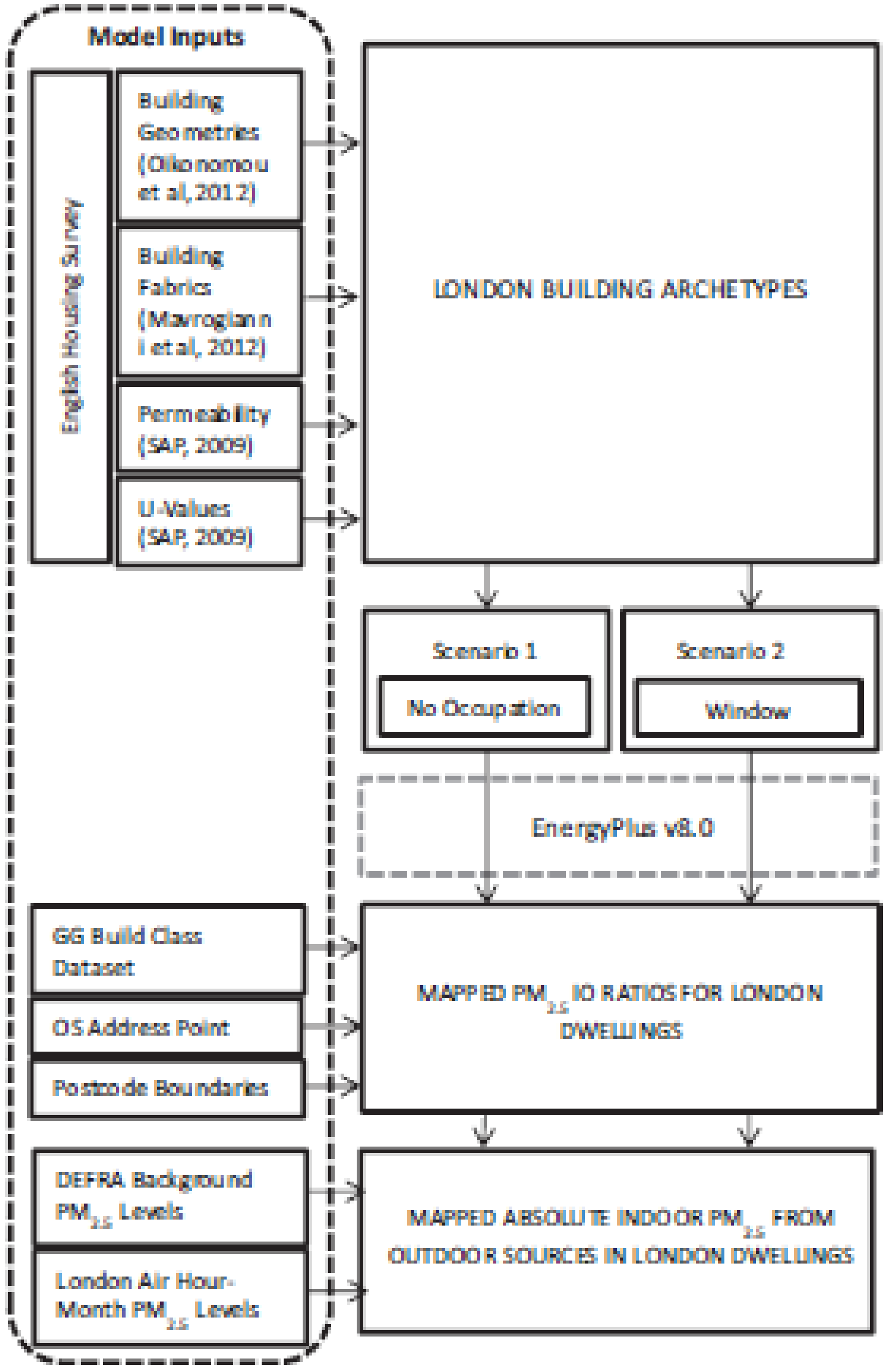


FL: mean = 32.9, SD = 5.4
BPD: mean = 47.7, SD = 6.0
AC: mean = 165.1, SD = 28.1

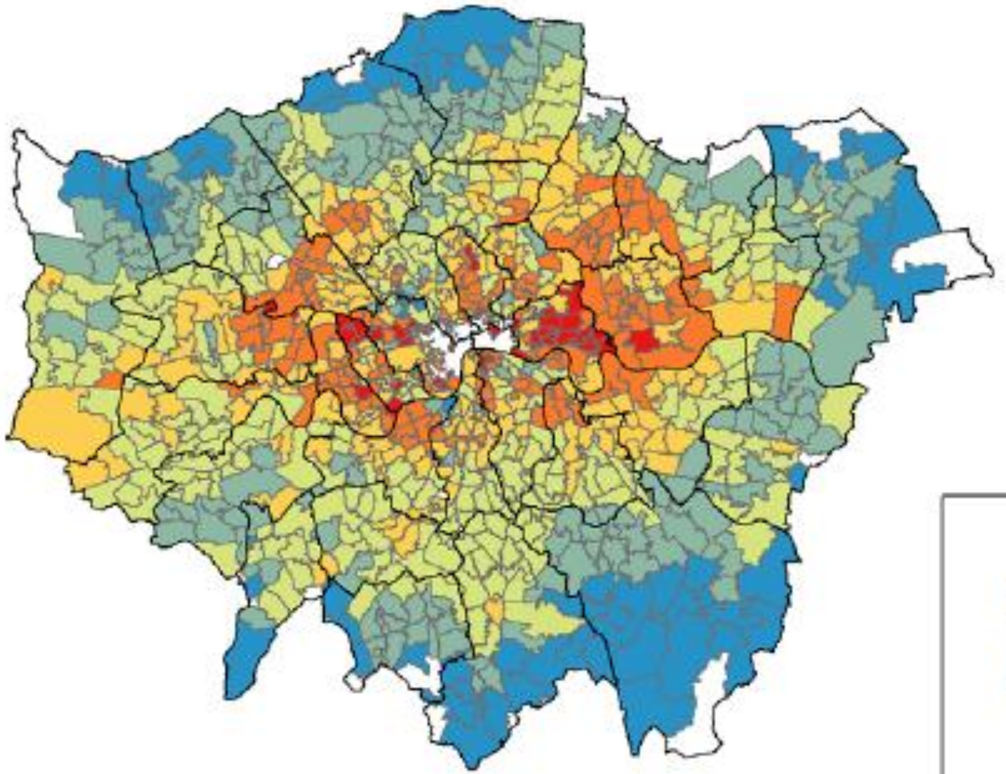
Air pollution and fetal growth – Trimester 3

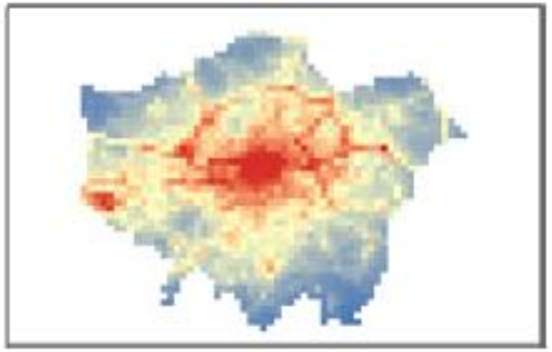


FL: mean = 65.6, SD = 6.0
BPD: mean = 85.8, SD = 6.0



Indoor exposure to outdoor air pollution

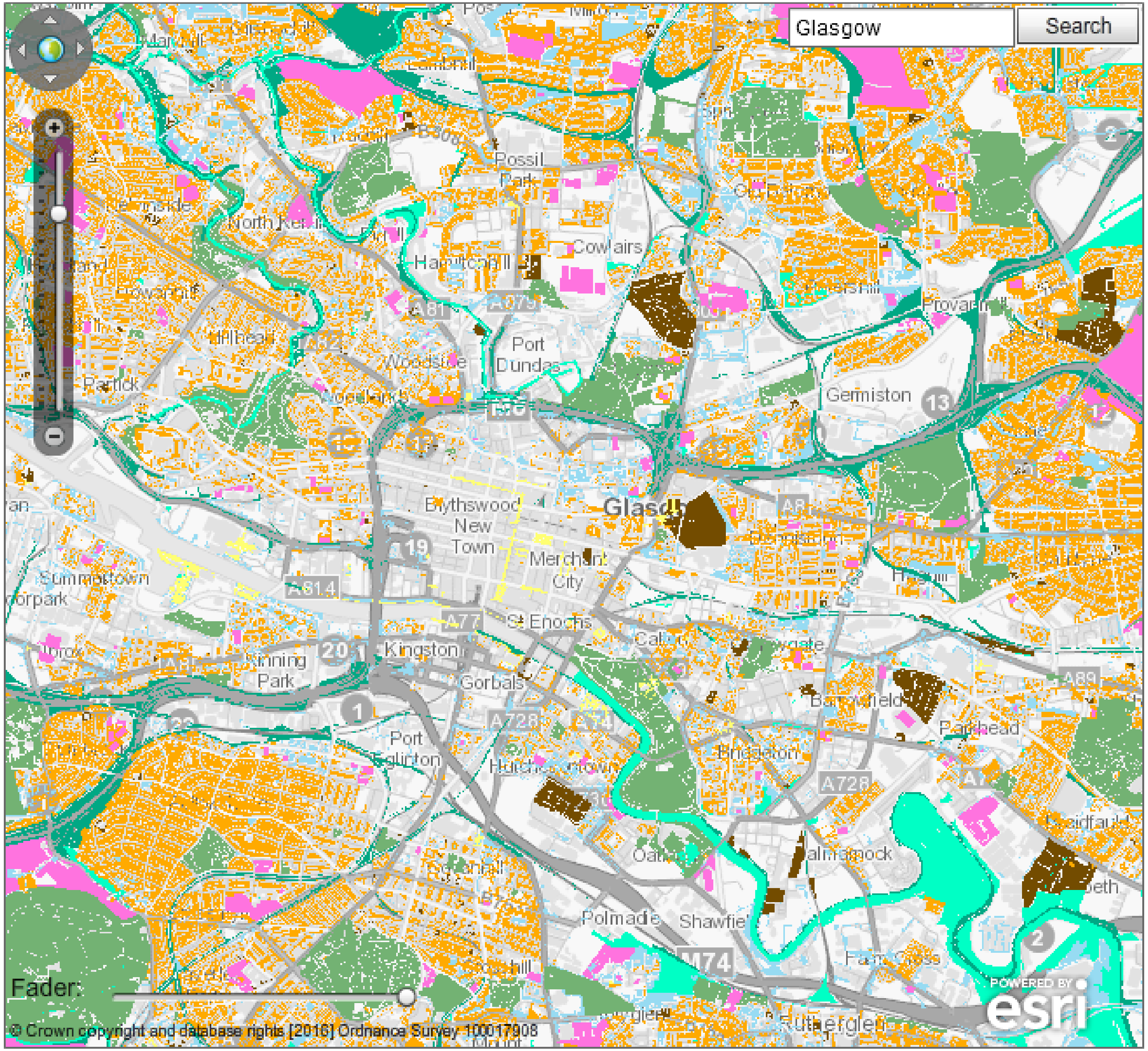




Taylor J, Shrubsole C, Davies M, Biddulph P, Das P, Hamilton I, et al. 2014. The modifying effect of the building envelope on population exposure to PM2.5 from outdoor sources. Indoor Air 24:639–651

Modelled outdoor background concentrations for comparison


WOLSELEY Rd
payzone
JCDecaux
CORNER SHOP
CORNER SHOP
SWEETS - CIGARETTES - GROCERIES
Lycamobile
Lycamobile
Free calls & texts
Free calls & texts
GENERAL STORE
68
STAVELEY ROAD

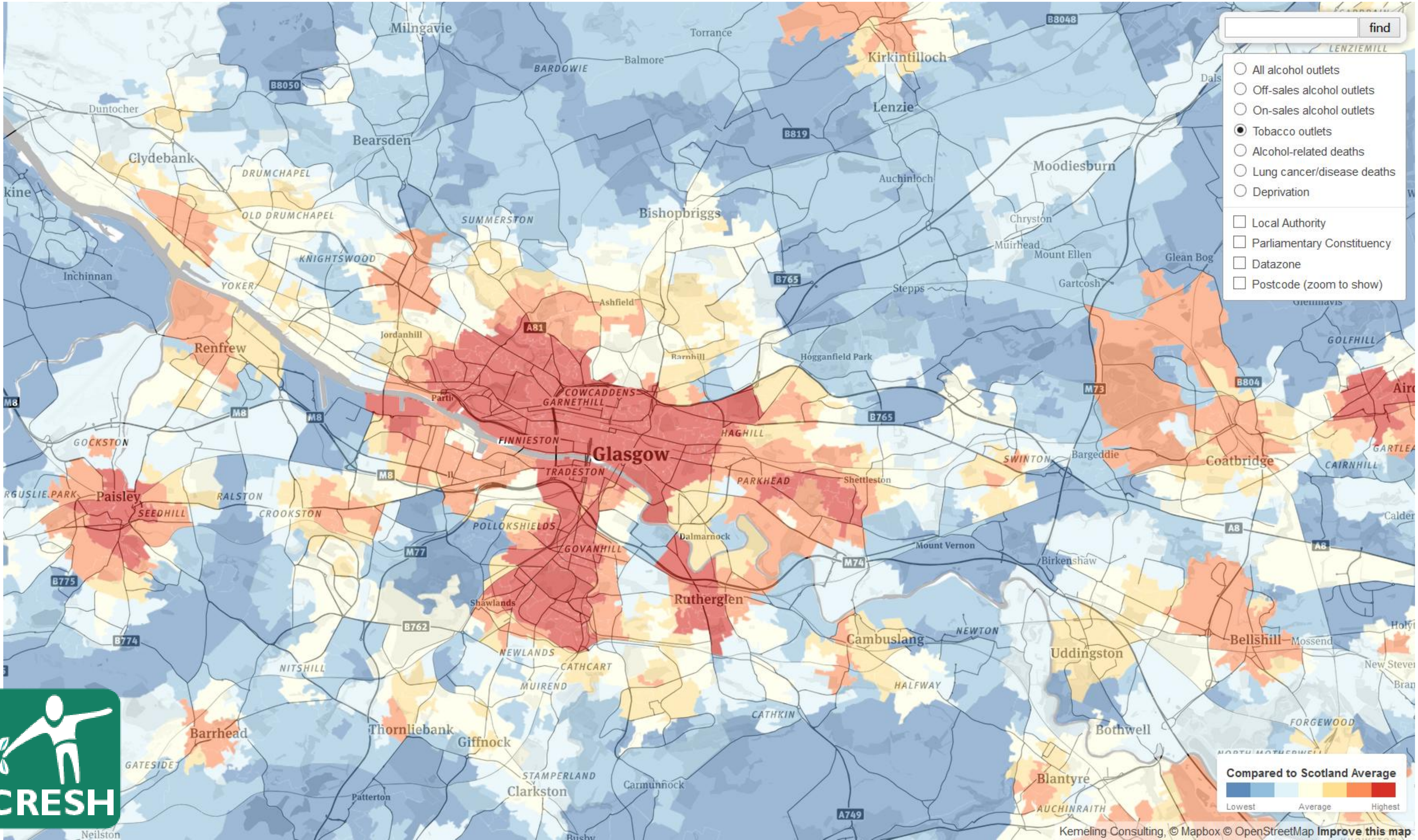


Scotland's Greenspace

Primary Classification

- Public park and garden
- Private gardens or grounds
- Amenity Greenspace
- Playspace for Children & Teenagers
- Sports Areas
- Green corridors
- Natural/Semi-natural greenspaces
- Other Functional Greenspace
- Civic space

CRESH


find
All alcohol outlets
Off-sales alcohol outlets
On-sales alcohol outlets
Tobacco outlets
Alcohol-related deaths
Lung cancer/disease deaths
Deprivation
Local Authority
Parliamentary Constituency
Datazone
Postcode (zoom to show)
Compared to Scotland Average
Lowest
Average
Highest
Milngavie
Torrance
Balmore
Kirkintilloch
Lenzie
Bardowie
Duntocher
Bearsden
Clydebank
Drumchapel
Old Drumchapel
Summerston
Bishopbriggs
Auchinloch
Moodiesburn
Chryston
Muirhead
Mount Ellen
Glean Bog
Gartcosh
Stepps
Inchinnan
Yoker
Knightswood
Ashfield
Jordanhill
Renfrew
Barnhill
Hogganfield Park
Cowcaddens
Garnethill
Finnieston
Glasgow
Tradeston
Haghill
Parkhead
Shettleston
Swinton
Bargeddie
Coatbridge
Cairnhill
Golfhill
Gockston
Paisley
Seedhill
Ralston
Crookston
Pollokshields
Govanhill
Dalmarnock
Mount Vernon
Birkenshaw
Shawlands
Rutherglen
Cambuslang
Newton
Uddingston
Bellshill
Mossend
Newlands
Cathcart
Muirend
Nitshill
Halfway
Cathkin
Barrhead
Thornliebank
Giffnock
Bothwell
Forgewood
Gateside
Stamperland
Clarkston
Carmunnock
Patterton
Blantyre
Auchinraith
Neilston
M8
M77
M74
M73
A81
A8
A749
B8048
B8050
B819
B765
B804
B775
B774
B762
Kemeling Consulting, © Mapbox © OpenStreetMap Improve this map

CRESH

In order to predict impact of spatial change in pollution levels need micro data

Completely synthetic data

What is it?

Data that resembles the original data. But contains no records that correspond to real individuals or other units

History

Originally proposed for disclosure control over 20 years ago

Many theoretical papers from the early 2000's

Real applications US Bureau of the Census Others in Canada, New Zealand, Germany.

Original proposal

Was to use synthetic data in the place of the real data. But applications are more cautious.

Observed (input)

Sex	Age	Education	Marital status	Income	Life satisfaction
FEMALE	57	VOCATIONAL/GRAMMAR	MARRIED	800	PLEASED
MALE	41	SECONDARY	UNMARRIED	1500	MIXED
FEMALE	18	VOCATIONAL/GRAMMAR	UNMARRIED	NA	PLEASED
FEMALE	78	PRIMARY/NO EDUCATION	WIDOWED	900	MIXED
FEMALE	54	VOCATIONAL/GRAMMAR	MARRIED	1500	MOSTLY SATISFIED
MALE	20	SECONDARY	UNMARRIED	-8	PLEASED
FEMALE	39	SECONDARY	MARRIED	2000	MOSTLY SATISFIED
MALE	39	SECONDARY	MARRIED	1197	MIXED
FEMALE	38	VOCATIONAL/GRAMMAR	MARRIED	NA	MOSTLY DISSATISFIED
FEMALE	73	VOCATIONAL/GRAMMAR			
FEMALE	54	SECONDARY			
MALE	30	VOCATIONAL/GRAMMAR			
MALE	68	SECONDARY			
MALE	61	PRIMARY/NO EDUCATION			

Synthetic (output)

Sex	Age	Education	Marital status	Income	Life satisfaction
MALE	81	PRIMARY/NO EDUCATION	MARRIED	2100	PLEASED
MALE	54	VOCATIONAL/GRAMMAR	MARRIED	1700	PLEASED
FEMALE	32	VOCATIONAL/GRAMMAR	DIVORCED	870	MIXED
FEMALE	98	PRIMARY/NO EDUCATION	MARRIED	800	MOSTLY DISSATISFIED
FEMALE	50	PRIMARY/NO EDUCATION	MARRIED	NA	MOSTLY SATISFIED
FEMALE	37	VOCATIONAL/GRAMMAR	MARRIED	158	PLEASED
MALE	28	VOCATIONAL/GRAMMAR	NA	1500	MOSTLY SATISFIED
FEMALE	62	PRIMARY/NO EDUCATION	MARRIED	830	MOSTLY SATISFIED
MALE	78	PRIMARY/NO EDUCATION	MARRIED	NA	PLEASED
FEMALE	29	SECONDARY	MARRIED	580	MOSTLY SATISFIED
MALE	59	PRIMARY/NO EDUCATION	MARRIED	1300	MOSTLY SATISFIED
MALE	41	SECONDARY	UNMARRIED	1500	MIXED
MALE	18	SECONDARY	UNMARRIED	-8	PLEASED
FEMALE	73	PRIMARY/NO EDUCATION	WIDOWED	1350	MOSTLY SATISFIED

Data that look (structurally) like original data but contain artificial units only

How do we make synthetic data

Assume some sort of model fits the data

Fit the model to the data

Generate synthetic data from the fit to the model

In practice for real data

Build up from conditional distributions

Example

Start with first variable – fit a distribution– e.g. age

Generate a sample from this distribution

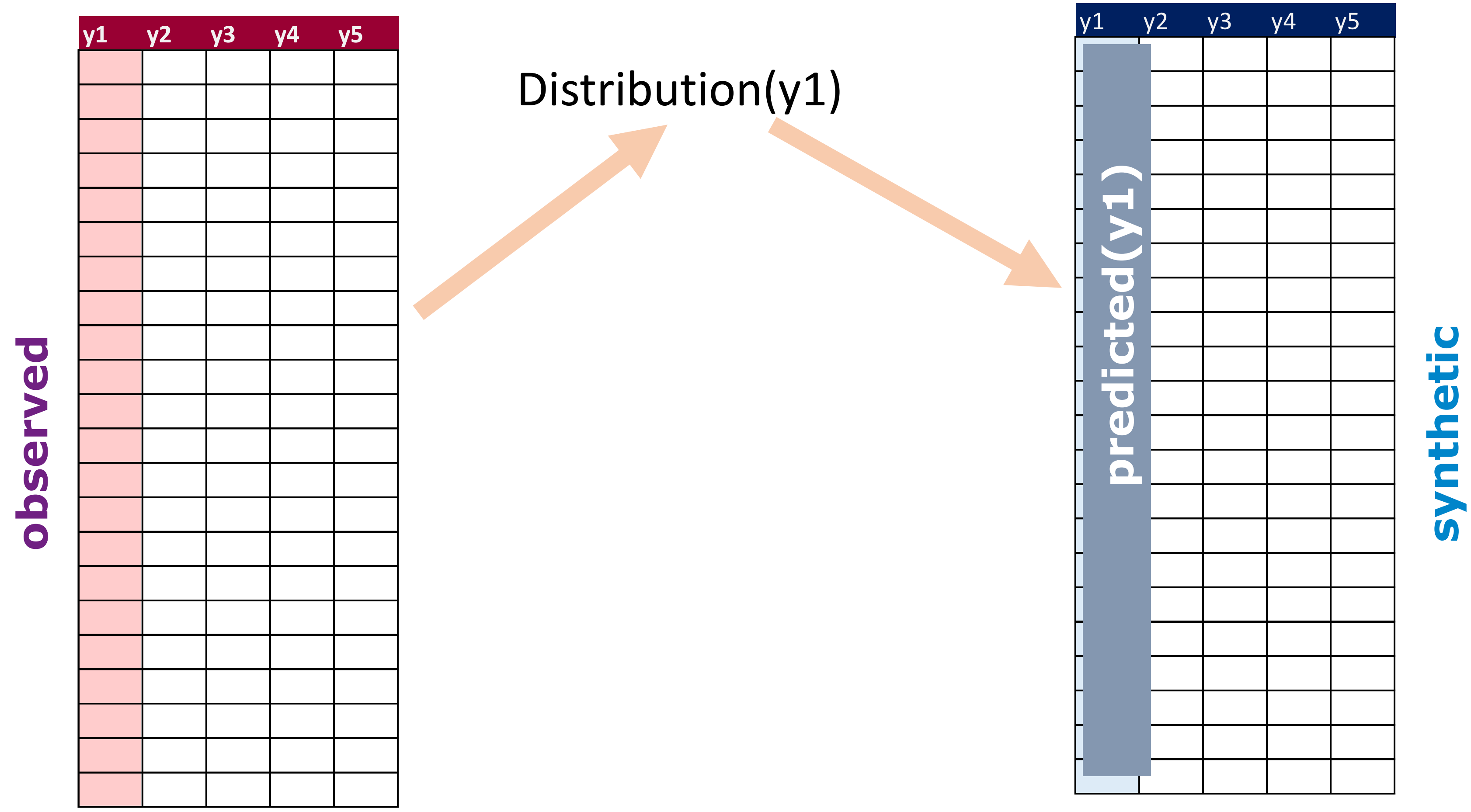
Model next variable e.g. sex predicted from age

Generate simulated data from (sex | age)

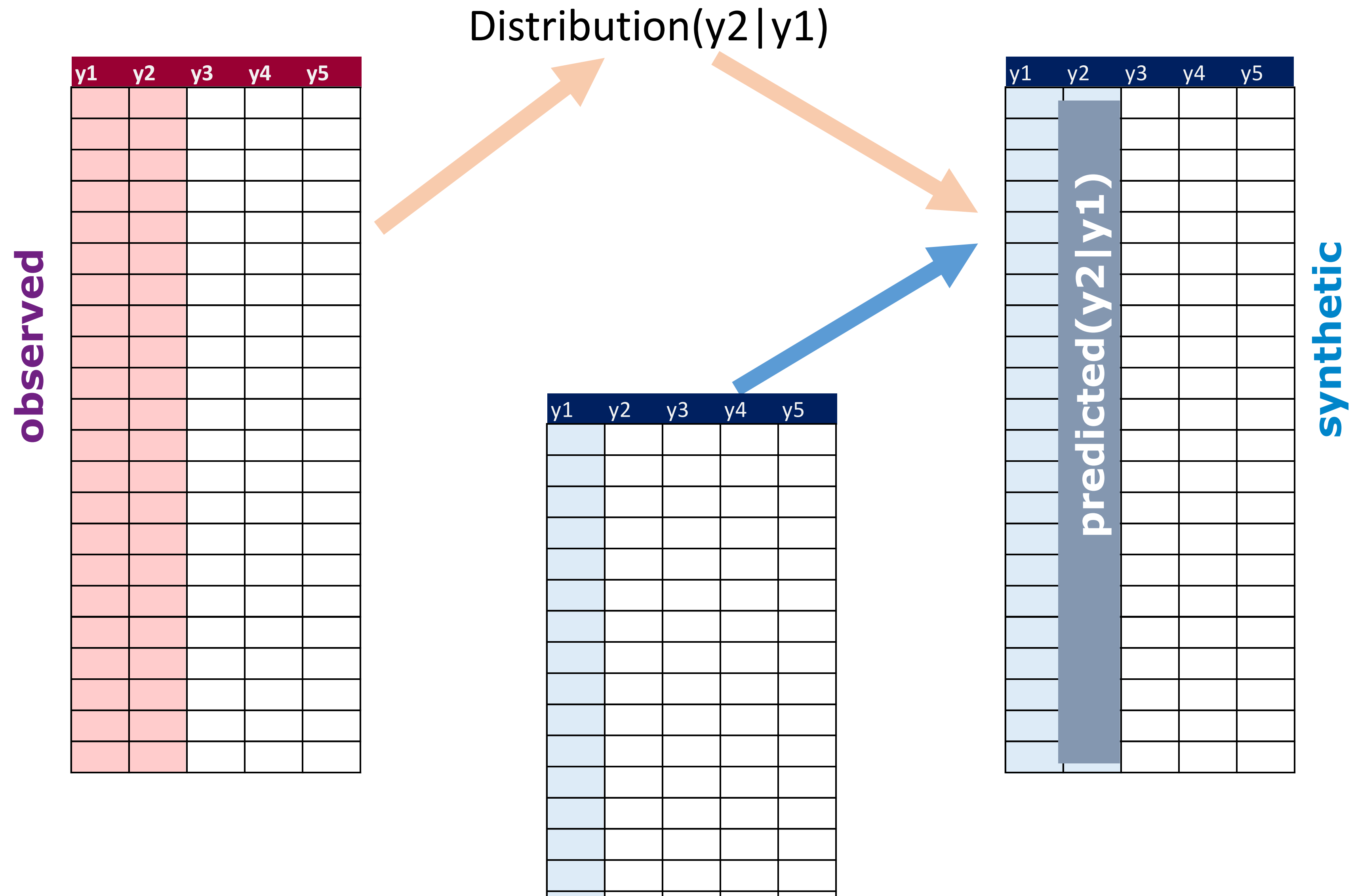
Model education and generate (education| age, sex)

Generate simulated data from (occupation| sex,age)

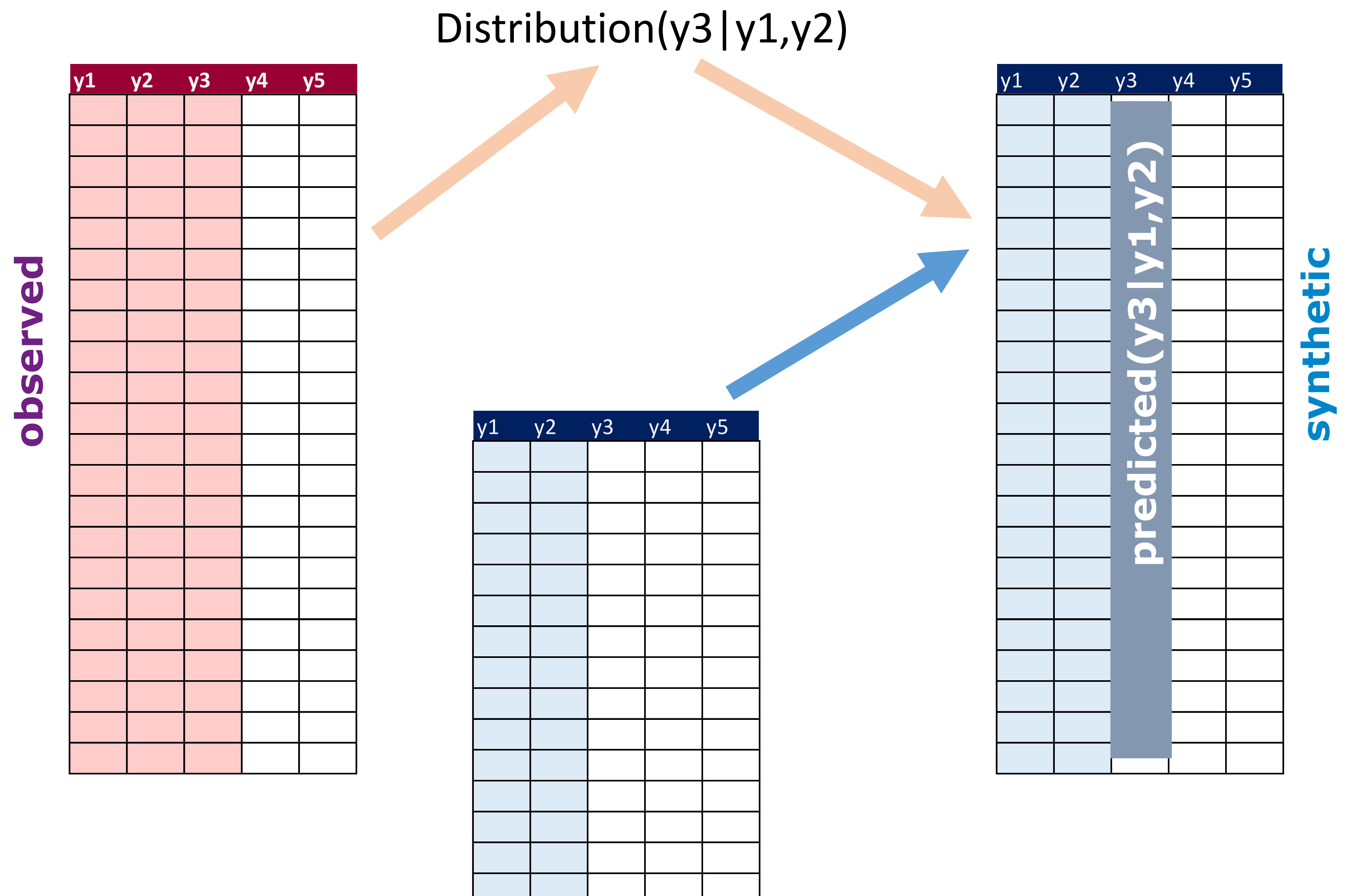
First variable



Second variable

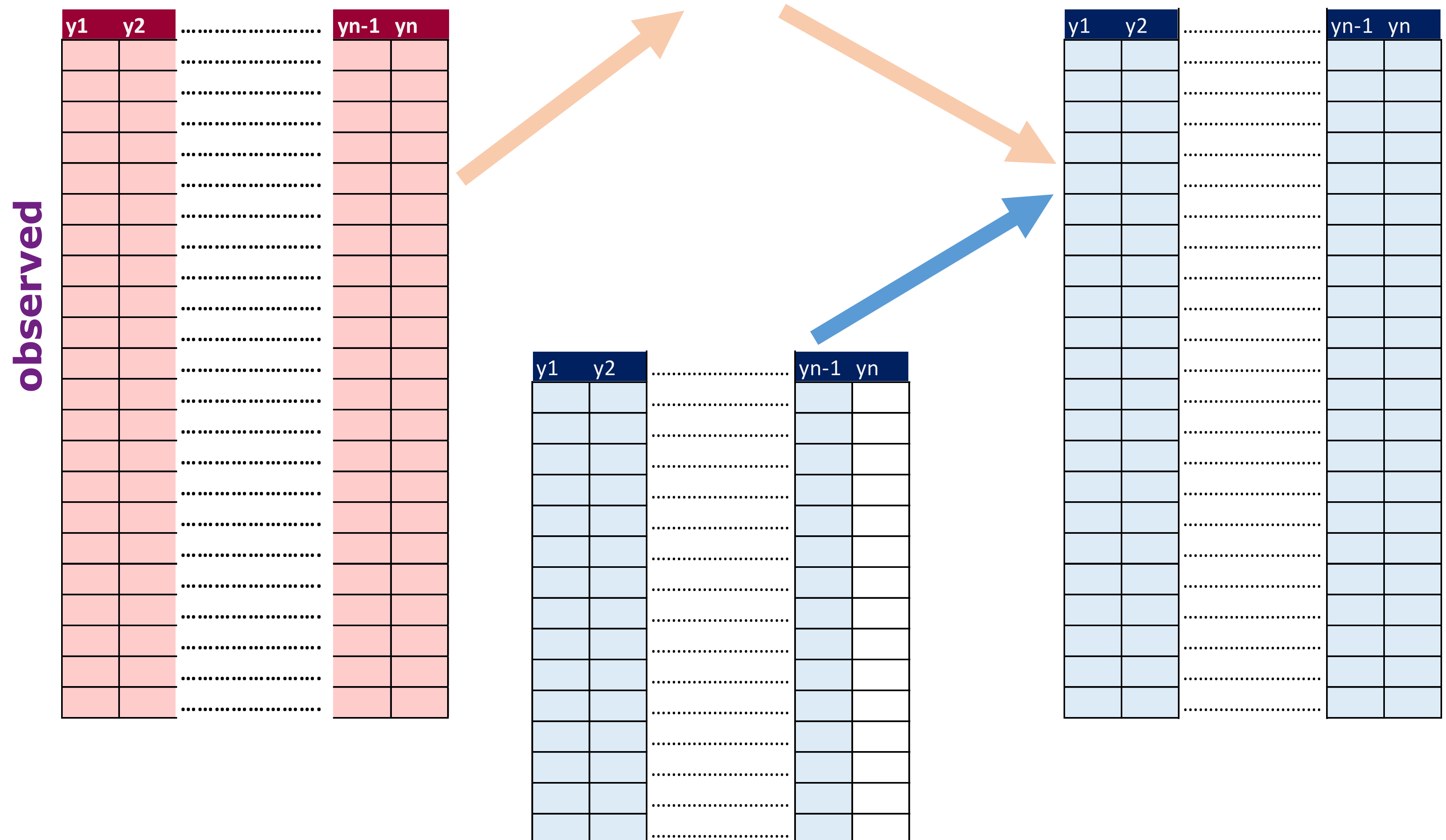


Third variable



Final step

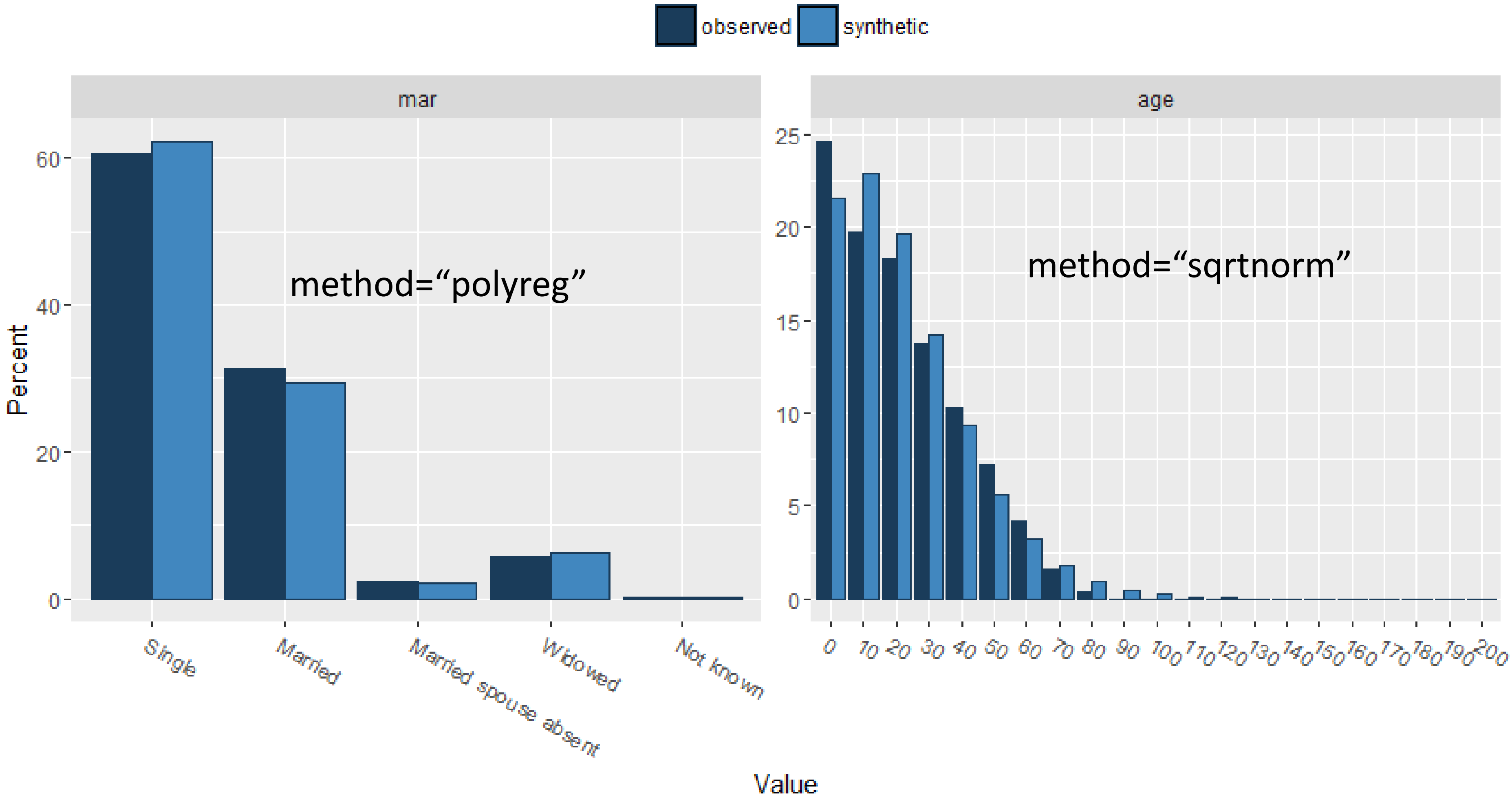
Distribution(yn|y1,y2,y3,y4,y5,y6,y7,y8,y9,y10,y11,...yn-1)



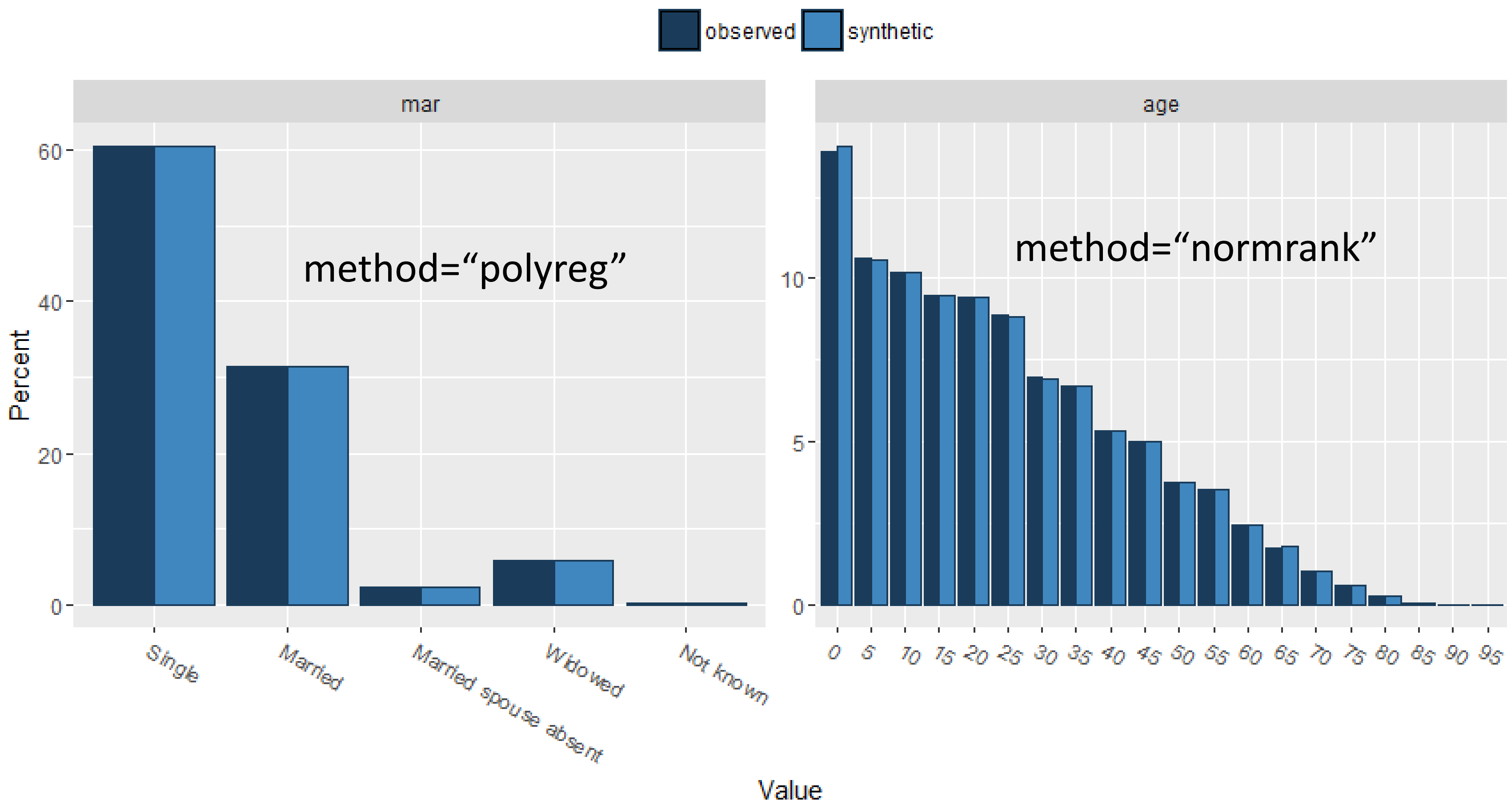
package

http://cran.r-project.org/package=synthpop

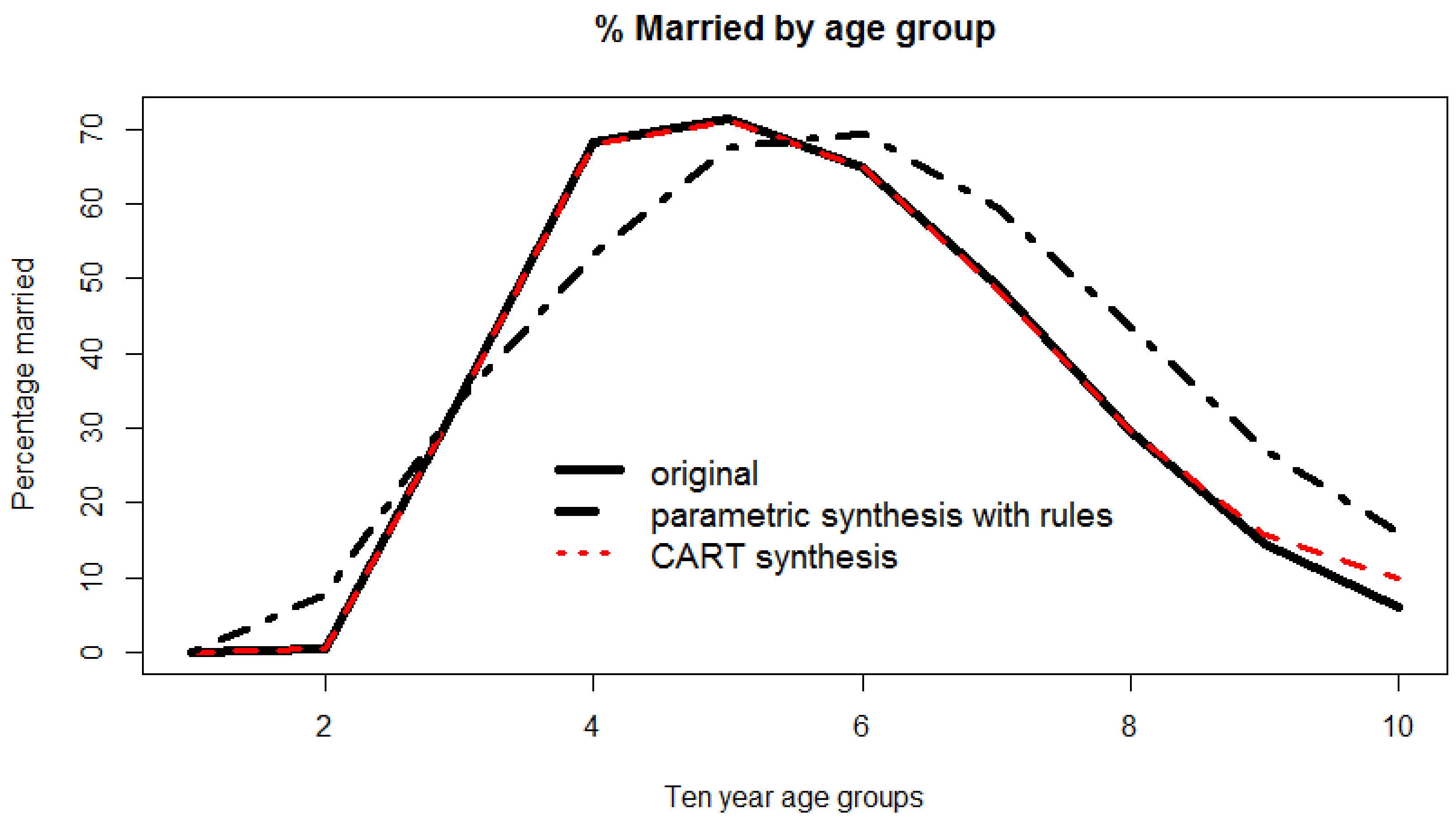
compare(mysynth2,data,var=c("mar","age"))



Changing method for age to regression on Normal scores



CART model worked better



Challenge

- To produce synthetic data for small areas
- Two methods – both work, need to test which works best

Progress

- We have now obtained access to health data:
  - All births (individual level) in Scotland (1981 - 2015)
  - Includes information on:
    - Birthweight, gestational age (prematurity), maternal ethnicity, marital status, height, weight, smoking behaviour, age, occupation etc
  - Access permitted only via physical safe haven at the Bio-quarter, Edinburgh
- Obtained modelled air pollution data from CERC (for 2014):
  - To be linked imminently to the health data based on mothers postcode of residence.
- Synthetic estimation of geographical location:
  - General method to estimate synthetic data is complete
  - Close to finalising the method to create datazone areas containing synthetic populations

Points for discussion

- Reflecting uncertainty in projections-scenarios
- Black box – will it need explanation?
- Which of these scenarios are of most interest to you?

INDEPENDENT News Voices Culture Lifestyle Tech Sport

News › World › Americas

US Environmental Protection Agency tested diesel fumes on children

Advocacy groups question legality of the EPA experiments

Payton Guion | Friday 23 January 2015 | 3 comments

QCumber-envHealth End User Workshop

Smart Exposure Monitoring

Chun Lin[1], Iain Beverland[2], Mathew R Heal[1]

[1]University of Edinburgh

[2]University of Strathclyde

13 June 2016

Intro

Need for high-resolution monitoring

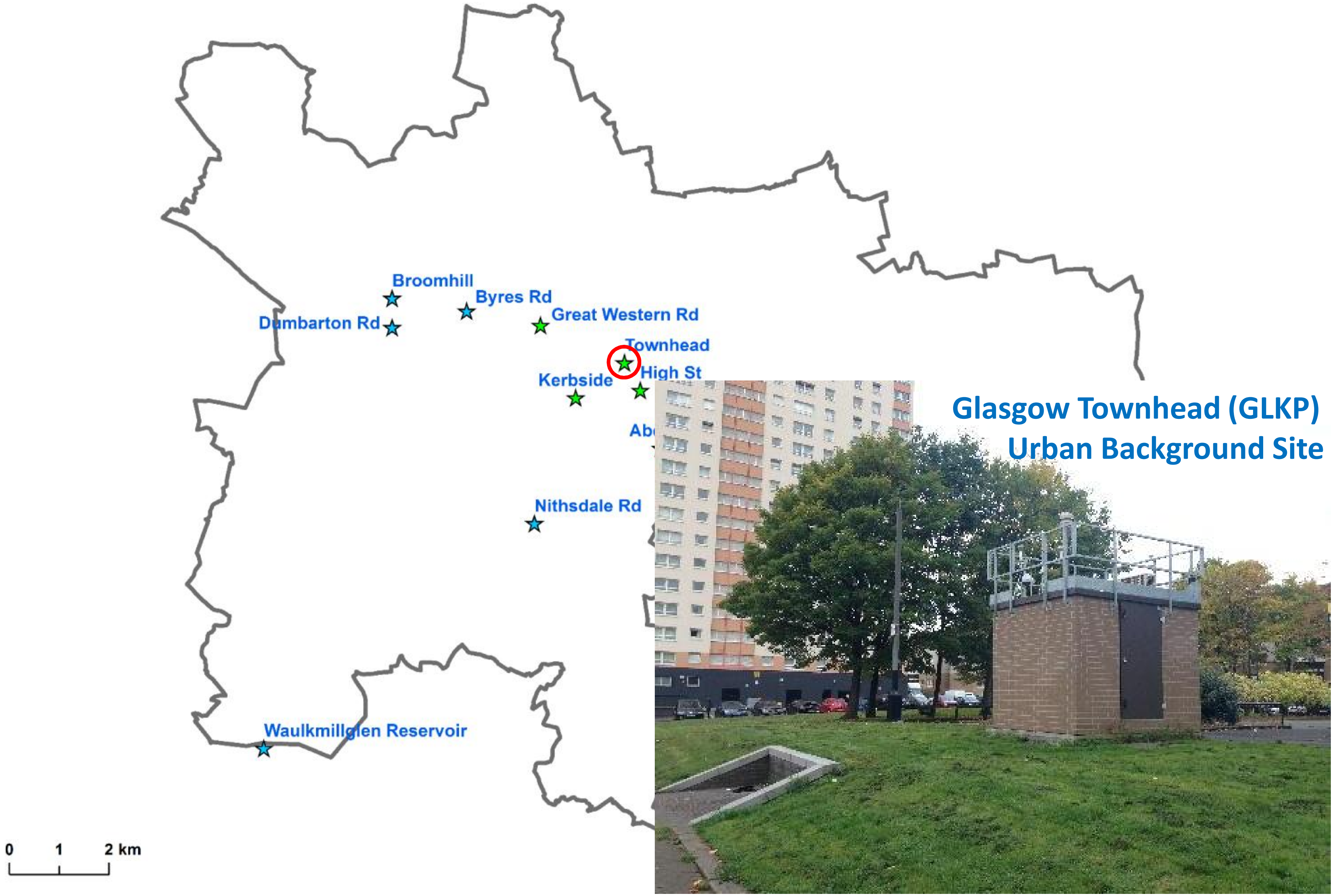
- QCumber-envHealth: an integrated tool to determine impacts on **environmental exposure**, health and inequalities
- **Exposure assessment**: sparse fixed-site monitoring networks vs air pollution spatial variability
  - ➥ Personal monitoring
  - ➥ High-resolution modelling
    - ➥ Model validation & enhancement
- Policy making: better understanding of air pollution mechanism
- Citizen science: use low-cost sensors for education, democratising AQ data, and explore crowd-source AQ monitoring

Intro

Aim of QCumber-envHealth high-res monitoring

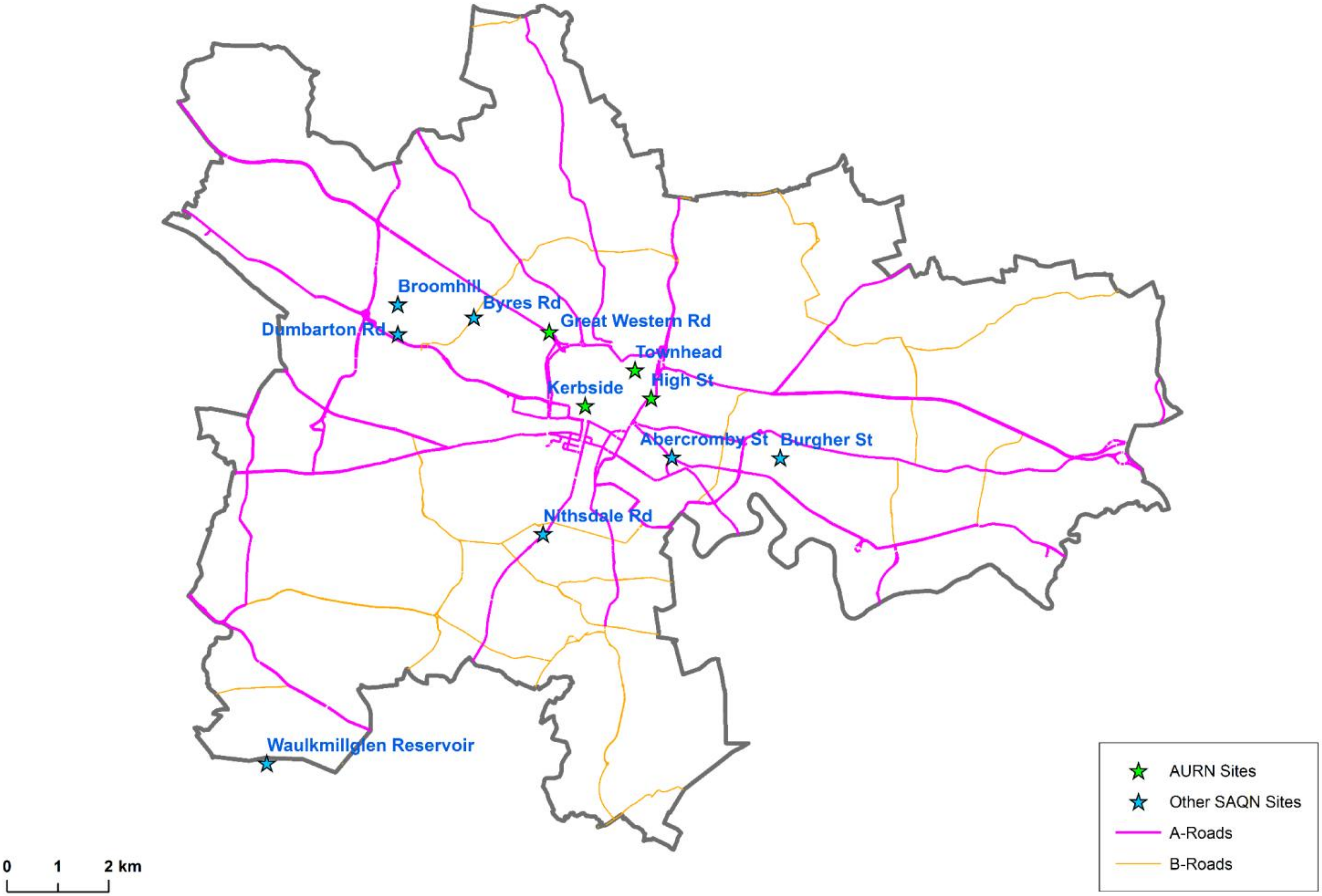
- Complementary real-time, high density monitoring
- Portable sensor-based monitors
- Measuring health-related pollutants
  - NO_2
  - O_3
  - $PM_{2.5}$_mass
  - $PM_{2.5}$_number
  - Black carbon
- Different times of day, days, and locations.
- Proof of concept for crowd-source monitoring
- To aid exposure modelling across wider area
- To support transport routing tool

Staged field campaign

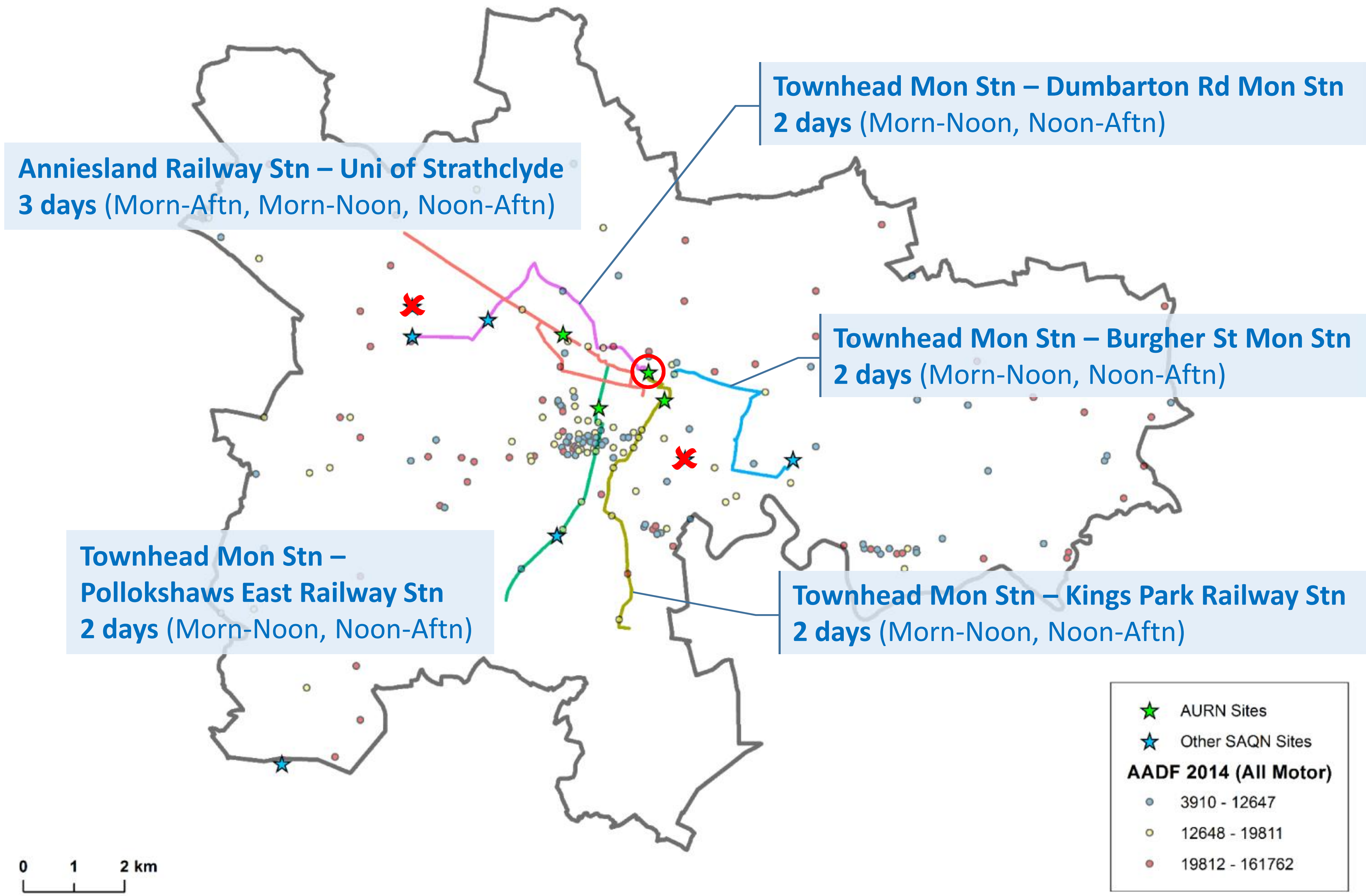


Glasgow Townhead (GLKP)
Urban Background Site

Staged field campaign

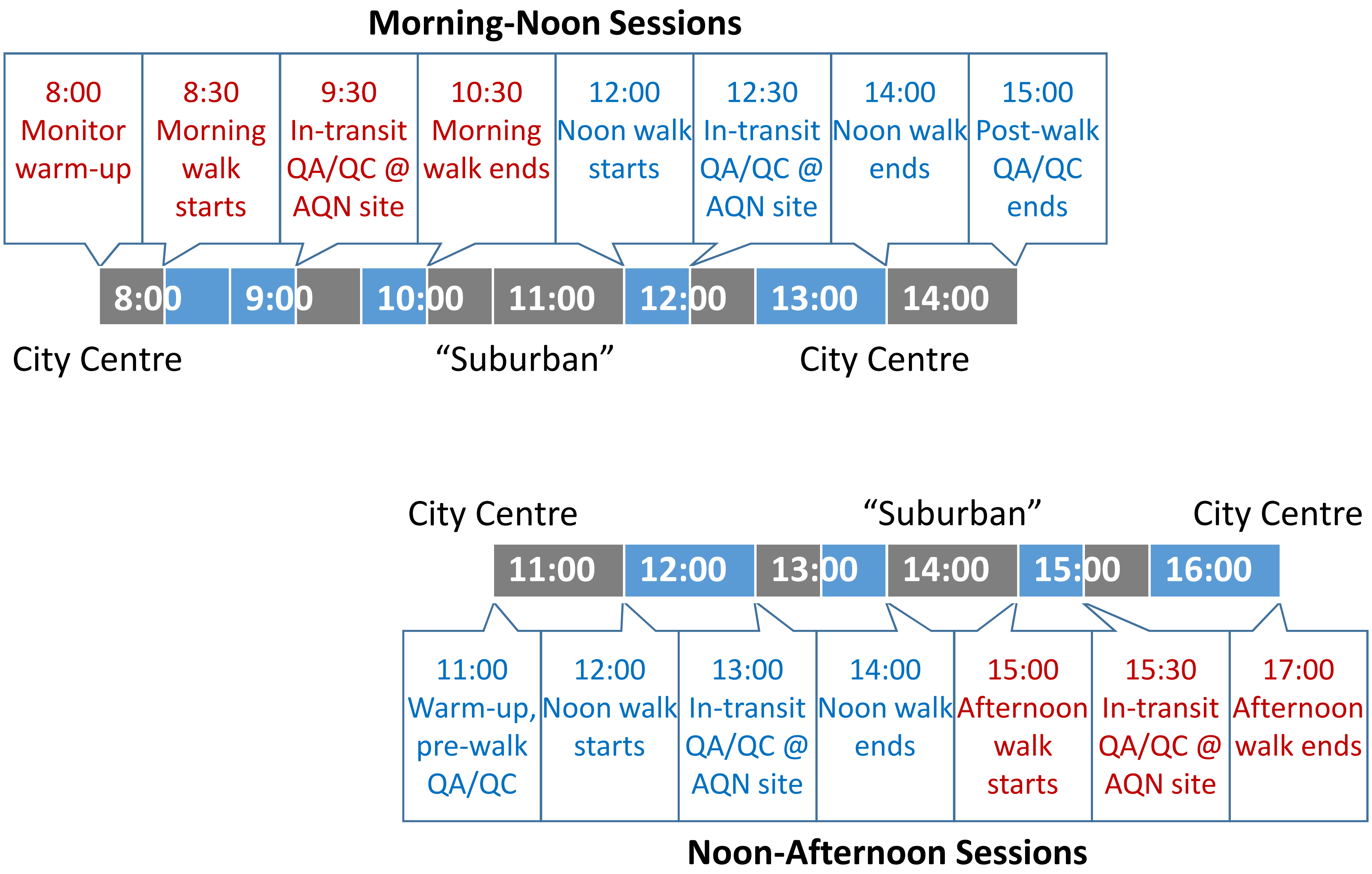


Completed routes in Q2



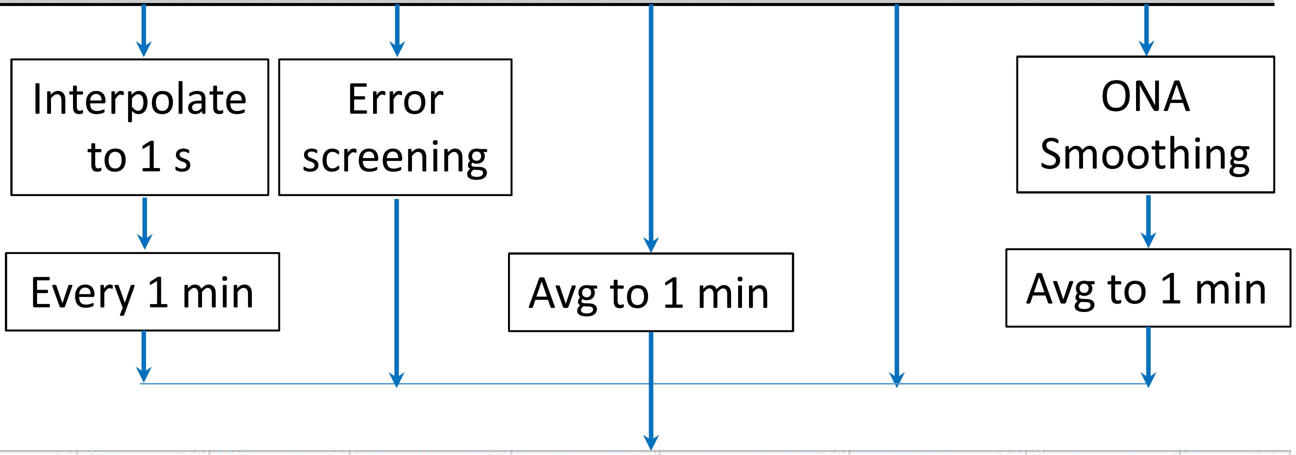
Fieldwork day schedule

Representing spatio-temporal contrast



Data acquisition and post-trip synchronisation

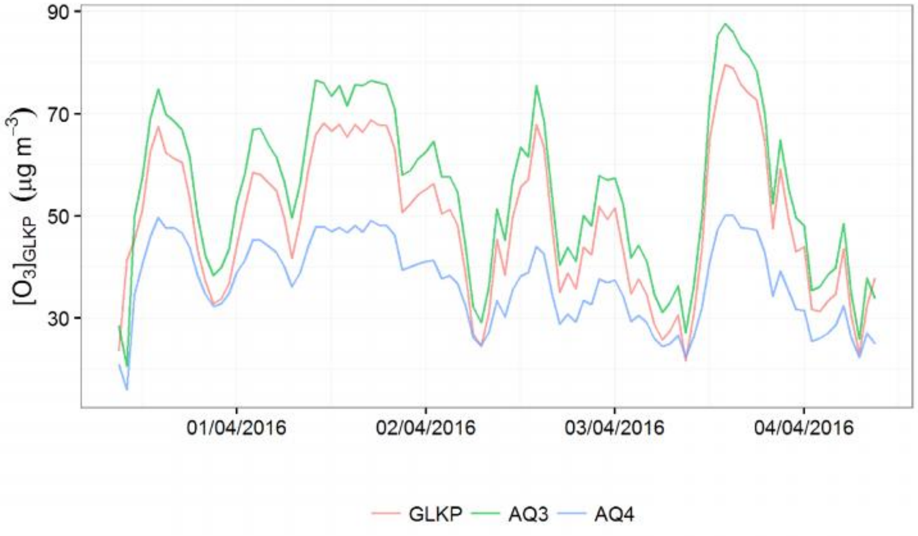
Sensor	Google Nexus 6	Aeroqual S500	RTI MicroPEM	Dylos DC1700	AethLabs microAeth
Measures	Location	NO_2, O_3	$PM_{2.5}$ (mass)	$PM_{0.5\text{-}2.5}$ (number)	Black carbon
Recording Interval	1 s or 2 m	1 min	5 s	1 min	1 s



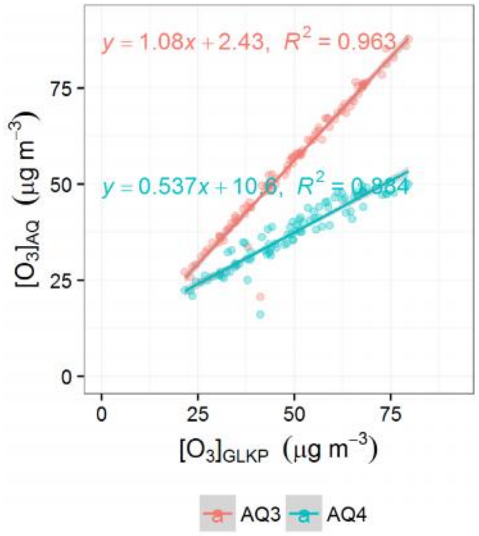
date	lat	lon	alt.m	no2.ugm3	o3.ugm3	pm2.5.ugm3	pm2.5.pm3	bc.ngm3	sess
2016-04-19 07:38:00	55.86556	-4.243710	102.57143	71	21	15.416667	8358982	1408.1177	Morning
2016-04-19 07:39:00	55.86564	-4.243476	109.00000	77	22	12.250000	8920485	1525.2745	Morning
2016-04-19 07:40:00	55.86571	-4.244358	89.50000	79	22	12.583333	7935206	1692.5964	Morning

Example calibration: 31 March – 4 April 2016 @ Glasgow Townhead

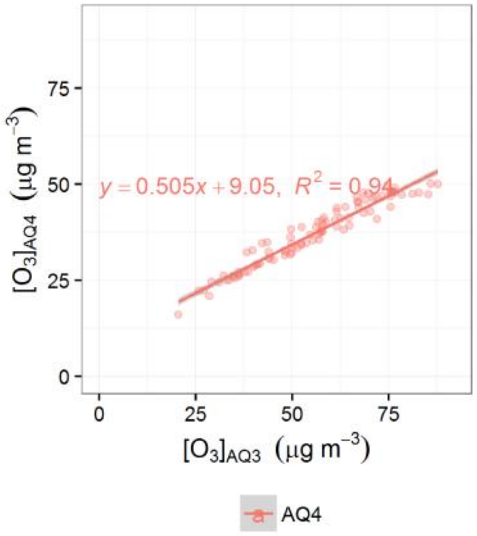
O_3 Aeroquals & ref



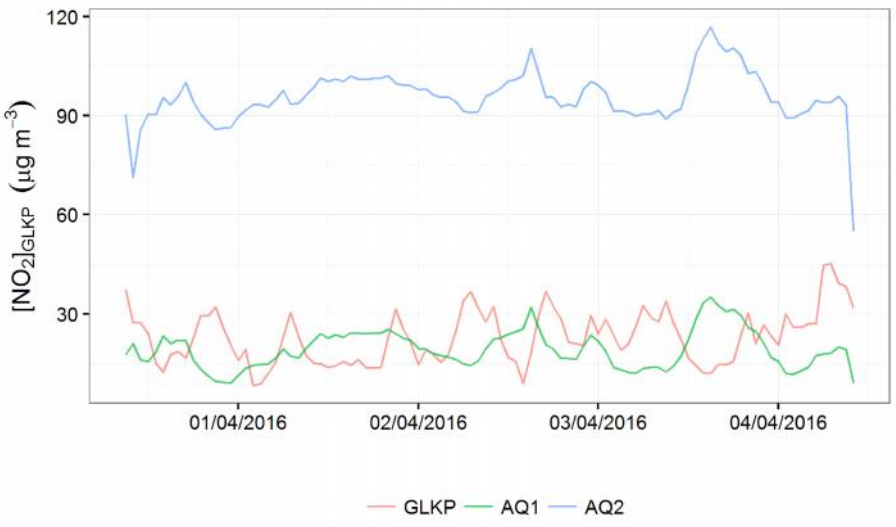
AQs v ref



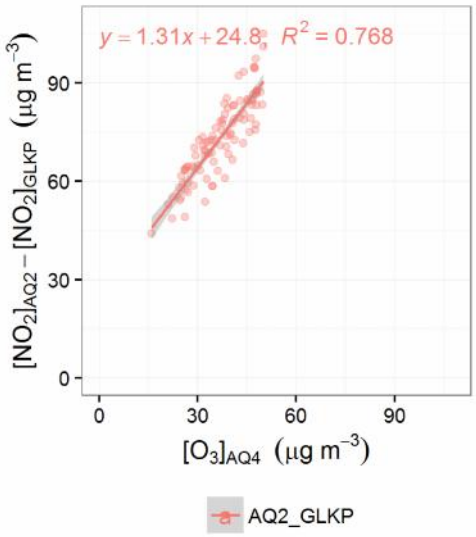
AQ4 v AQ3



NO_2 Aeroquals & ref

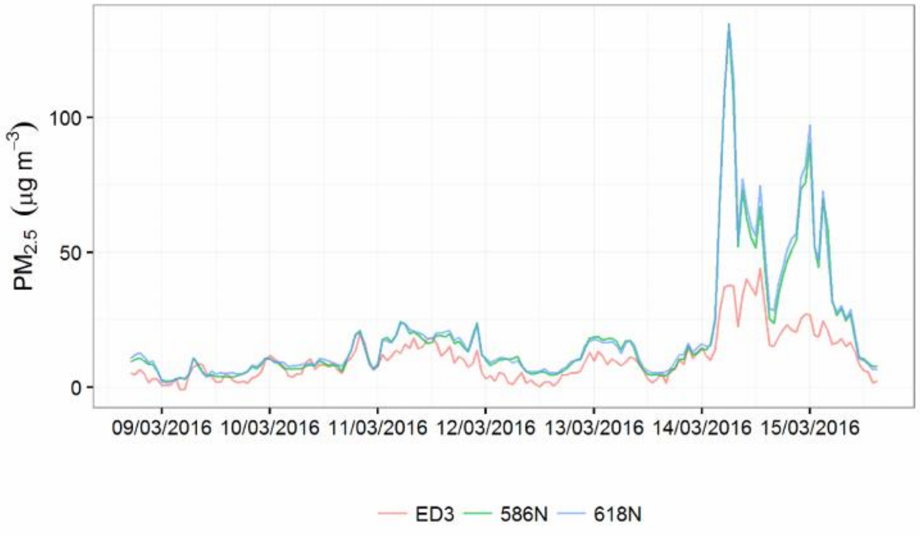


(NO_2 Aeroqual – ref) v O_3 Aeroqual

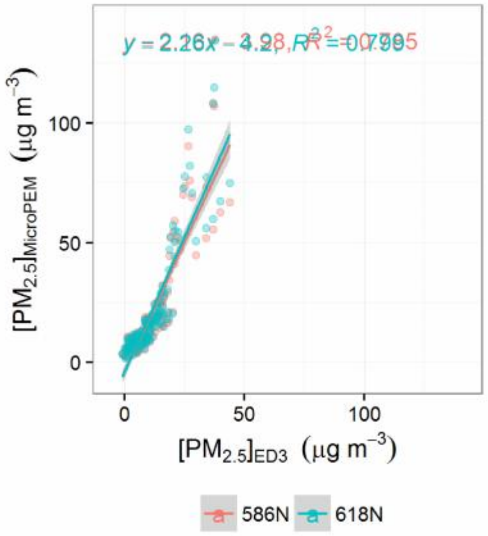


Example calibration: 8-15 March 2016 @ Edinburgh St Leonard's

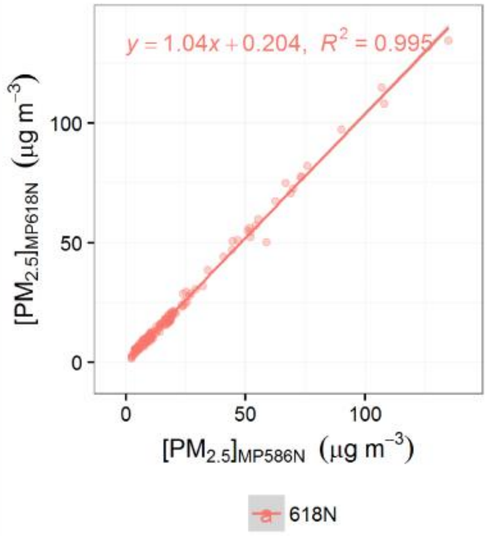
MicroPEMs & ref



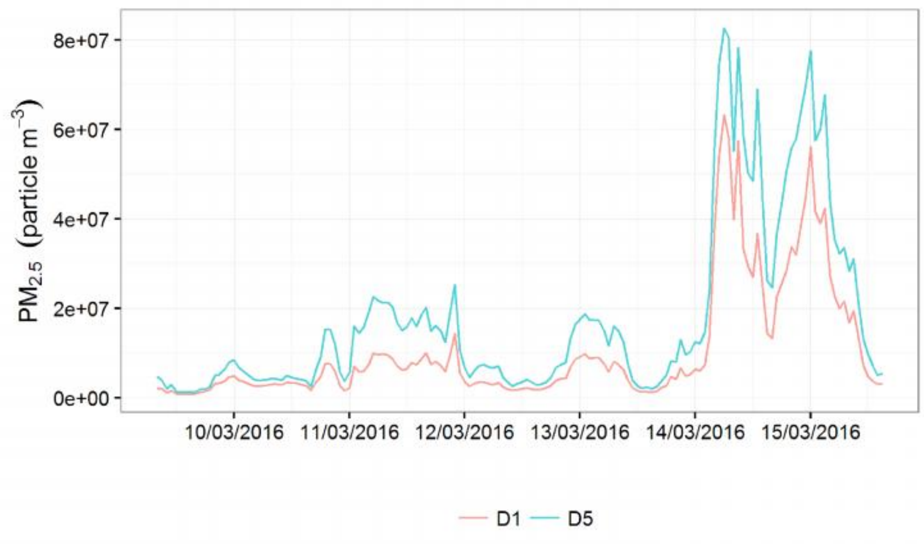
MPs v ref



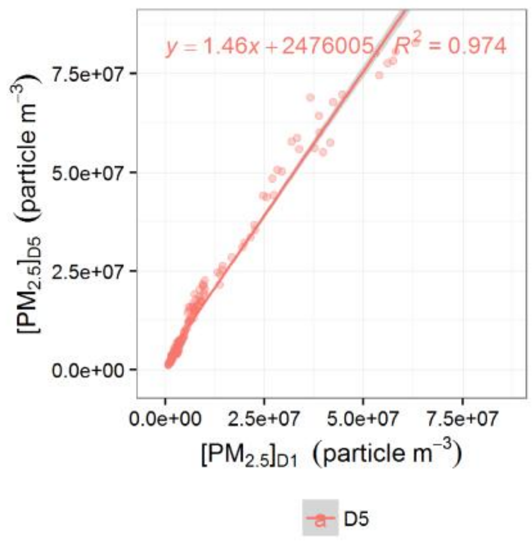
MP618 v MP586



Dyloses



D5 v D1



Results

Calibration of portable monitors at AURN sites

O_3 (n = 327 hr @ Glasgow Townhead)

- AQ_O3_3 = 0.96 × ref + 7.551, $\boxed{R^2 = 0.971}$
- **AQ_O3_4 = 0.50 × ref + 13.56,** $\boxed{\mathbf{R^2 = 0.935}}$

NO_2 (n = 327 hr @ Glasgow Townhead)

- AQ_NO2_1 – ref = 0.80 × AQ_O3_3 – 49.63, $\boxed{R^2 = 0.925}$
- **AQ_NO2_2 – ref = 1.61 × AQ_O3_4 + 10.22,** $\boxed{\mathbf{R^2 = 0.856}}$

$PM_{2.5}$_mass (n = 809 hr @ Edinburgh St Leonard's)

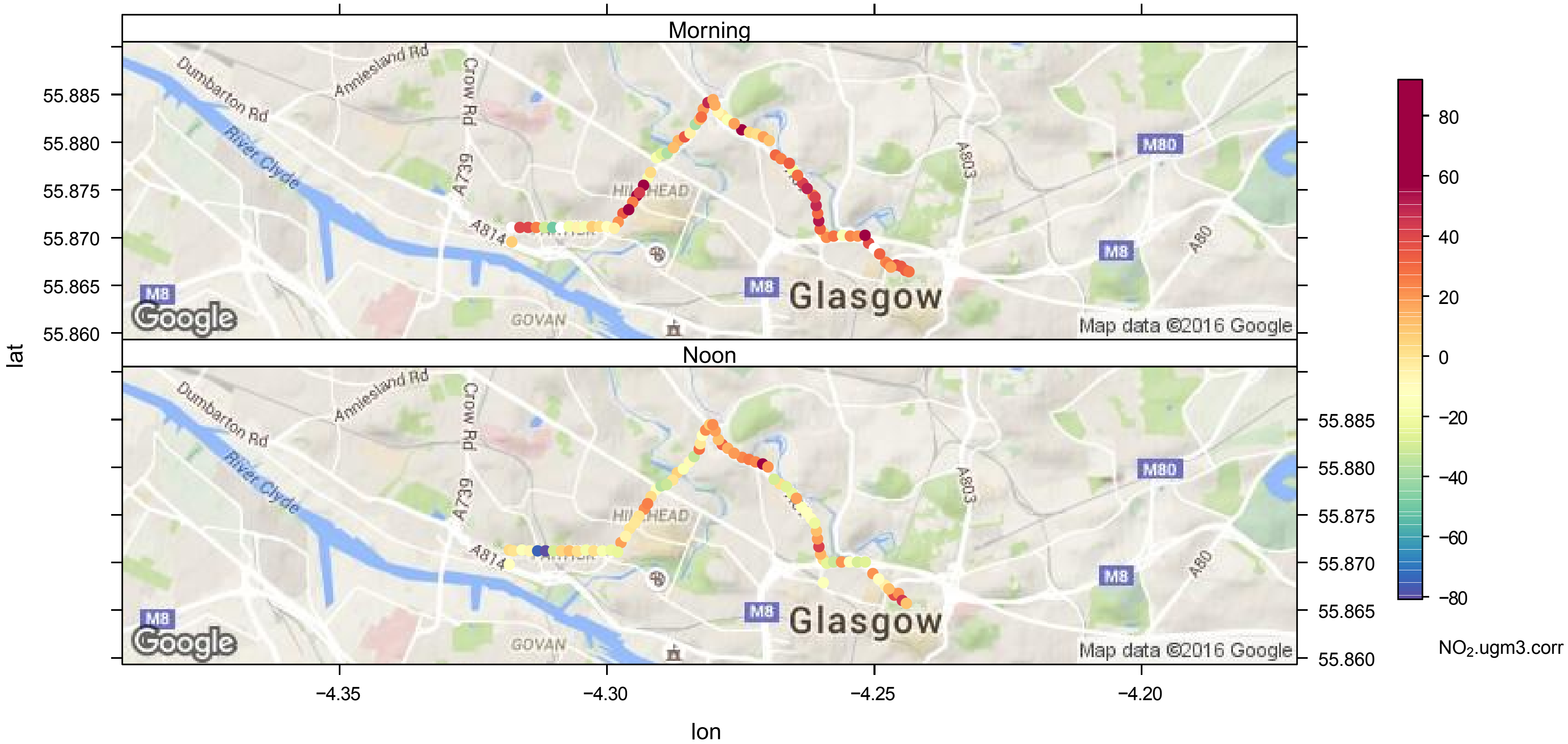
- MP586N = 1.68 × ref + 0.74, $\boxed{R^2 = 0.784}$
- **MP618N = 1.69 × ref + 1.34,** $\boxed{\mathbf{R^2 = 0.766}}$

BC (n = 236 hr @ Glasgow Townhead)

- MA1303 = 1.24 × ref + 0.04, $\boxed{R^2 = 0.752}$
- **MA1204 = 1.18 × ref + 0.04,** $\boxed{\mathbf{R^2 = 0.680}}$

Example high-res monitoring
19 April 2016
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

NO_2 ($\mu g\ m^{-3}$): **Morning > Noon, A-Rd > B-Rd**

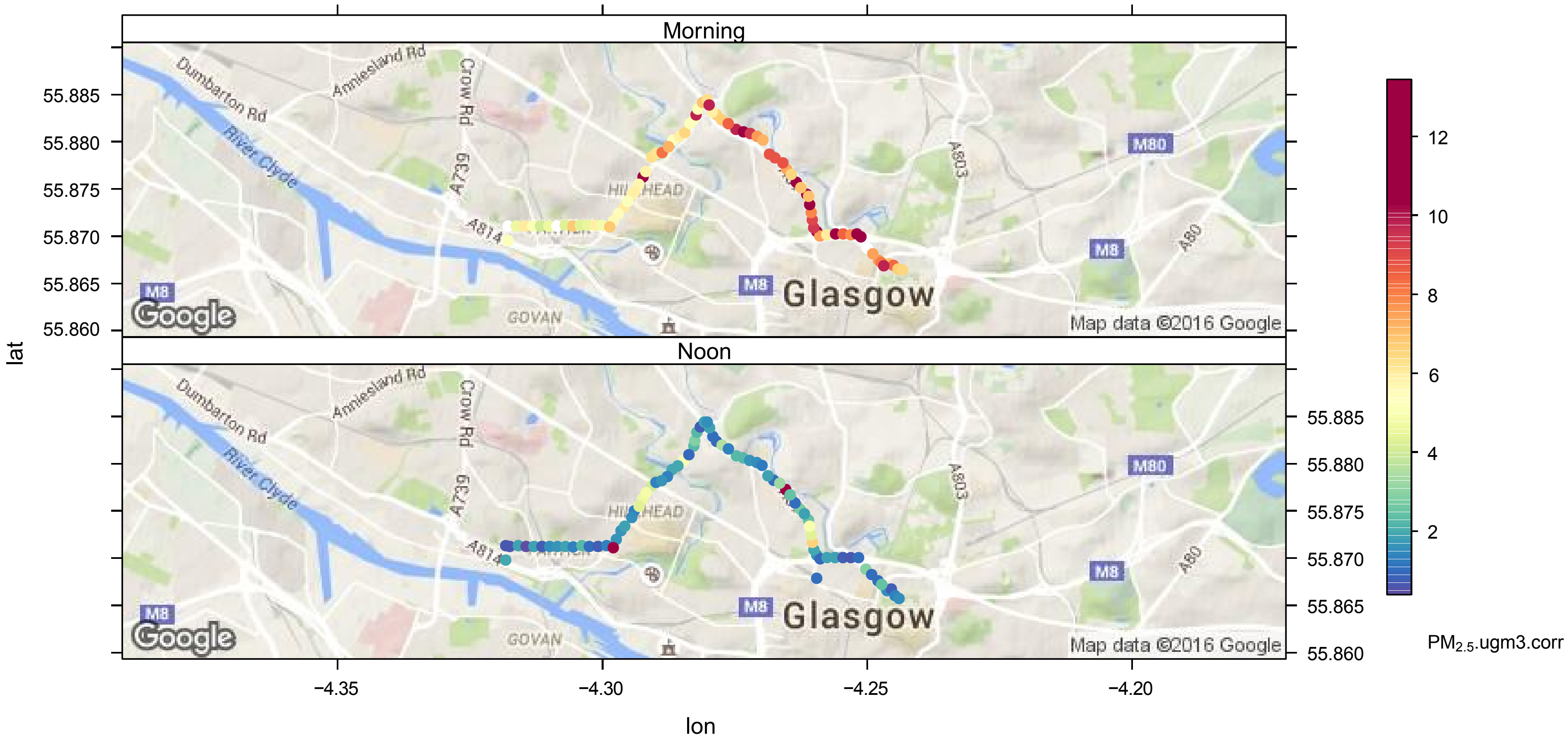


Example high-res monitoring
19 April 2016
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

O_3 ($\mu g\ m^{-3}$): **Morning < Noon, A-Rd < B-Rd**

Example high-res monitoring
19 April 2016
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

PM$_{2.5}$_mass (µg m^{-3}): **Morning > Noon, A-Rd > B-Rd**

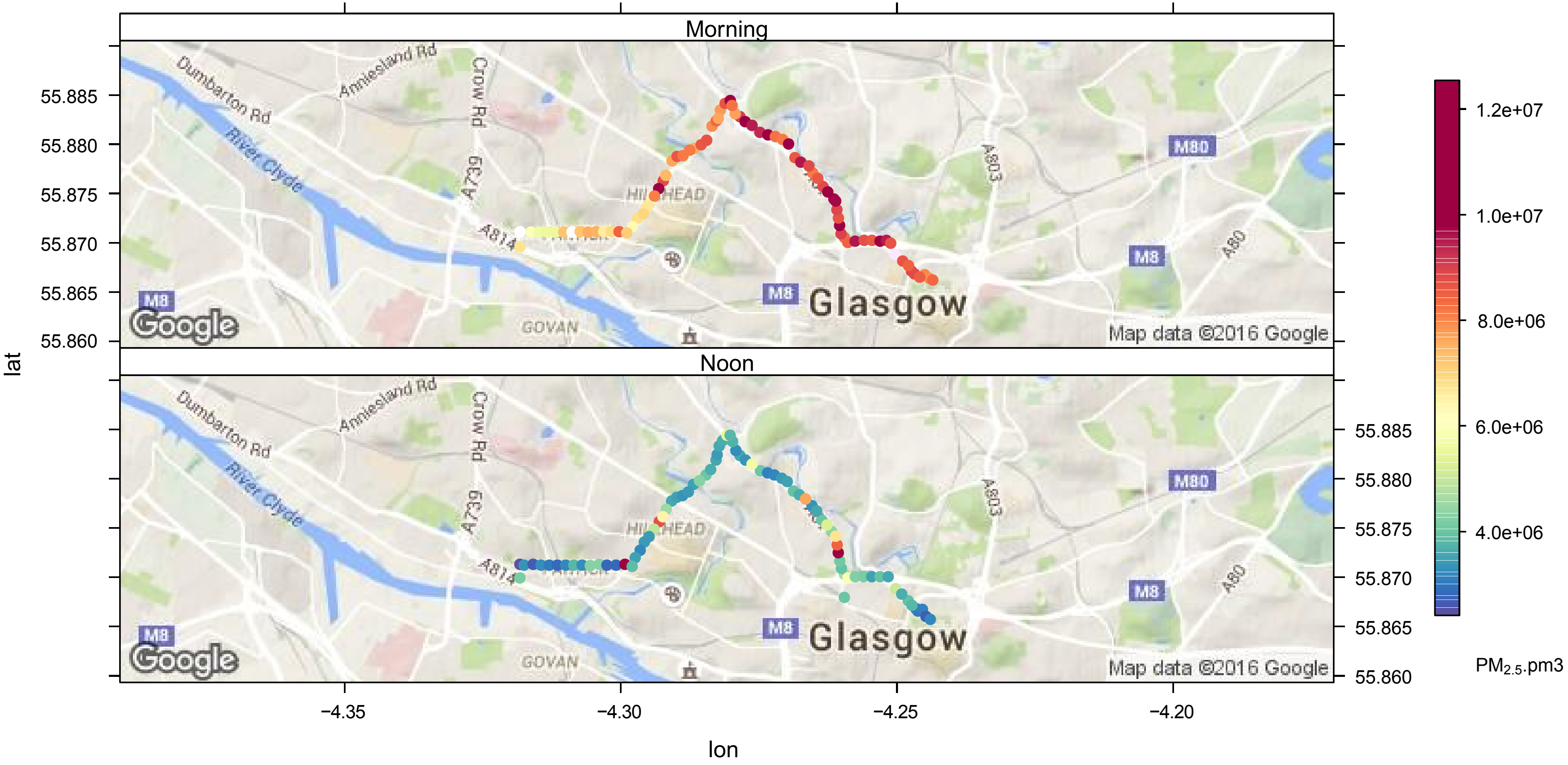


Example high-res monitoring

19 April 2016

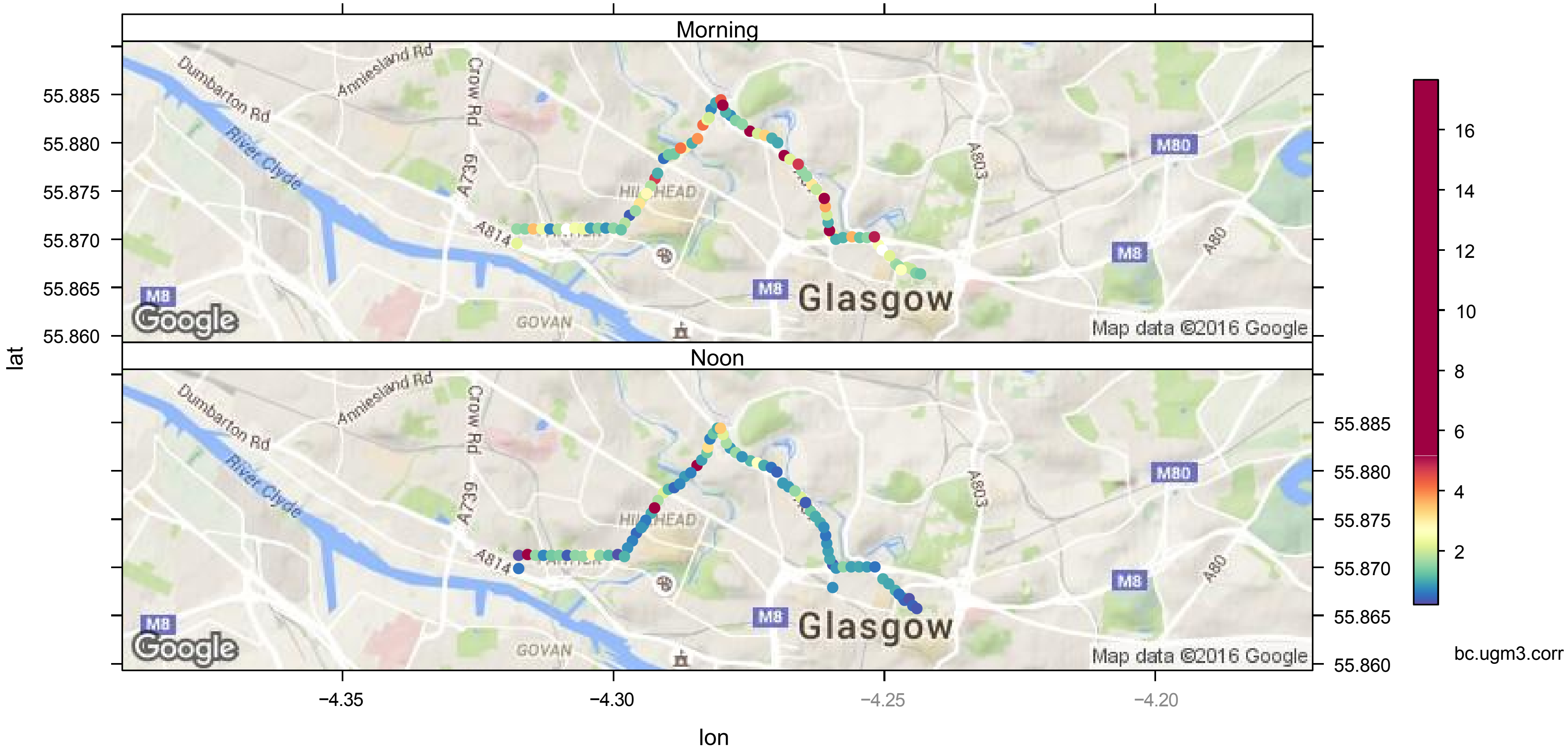
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

$PM_{2.5}$_number (particle m^{-3}): **Morning > Noon, A-Rd > B-Rd**



Example high-res monitoring
19 April 2016
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

BC (µg m^{-3}): **Morning > Noon, highlighting hotspots**



19 April 2016
Townhead Monitoring Stn – Dumbarton Rd Monitoring Stn

Discussion: Uncertainties

- Calibration
  - **1-hr** calibration applied to **1-min** time series
  - **Static** calibration applied to **mobile** measurement
  - **Smaller conc range** calibration applied to **greater conc range**
  - Static calibration varying over periods, esp., Aeroqual NO_2
  - Handling occasional erroneous measurements, e.g. false 0 from Aeroqual O_3
- Weather: strong wind, rain
- Battery life: Aeroqual & Dylos max 6-7 hr

QCumber-envHealth
High-res monitoring Q2 conclusive remarks

- Low-cost sensors vs ref monitors
  - **well correlated** during static co-location
  - Sensors not ref-grade yet (absolute values), but show the same trend

- High-res mobile monitoring along 166 km major roads
  - **Clear, consistent spatio-temporal contrasts**
  - Reveals more details in exposure variation than sparse fixed-site AQN
  - Potential to enhance AQ modelling in complex environment

- Low-cost sensors for citizen science and crowd-source monitoring
  - Potential for education and democratising AQ data
  - **Appropriate calibration (vs ref and between sensors) and post-processing are critical, and need further development**

Acknowledgements

- Stefan Reis @ CEH Edinburgh
- Nicola Masey; Jonathan Gillespie; Nor Eliani Binti Ezani @ UoS
- Brian Shaw; Hao Wu @ UoE

Q-Cumber envHEalth

Transport

Policy context, decision making, requirements

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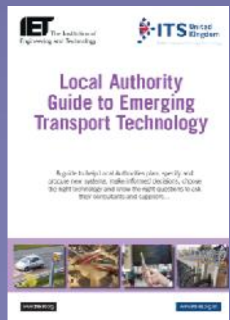
Transport Scotland





Key background, policies, actions, and decision making, tools such as Q-Cumber can support.

An intelligent client perspective

Key paradox message today…

Transport is a principle cause of poor air quality

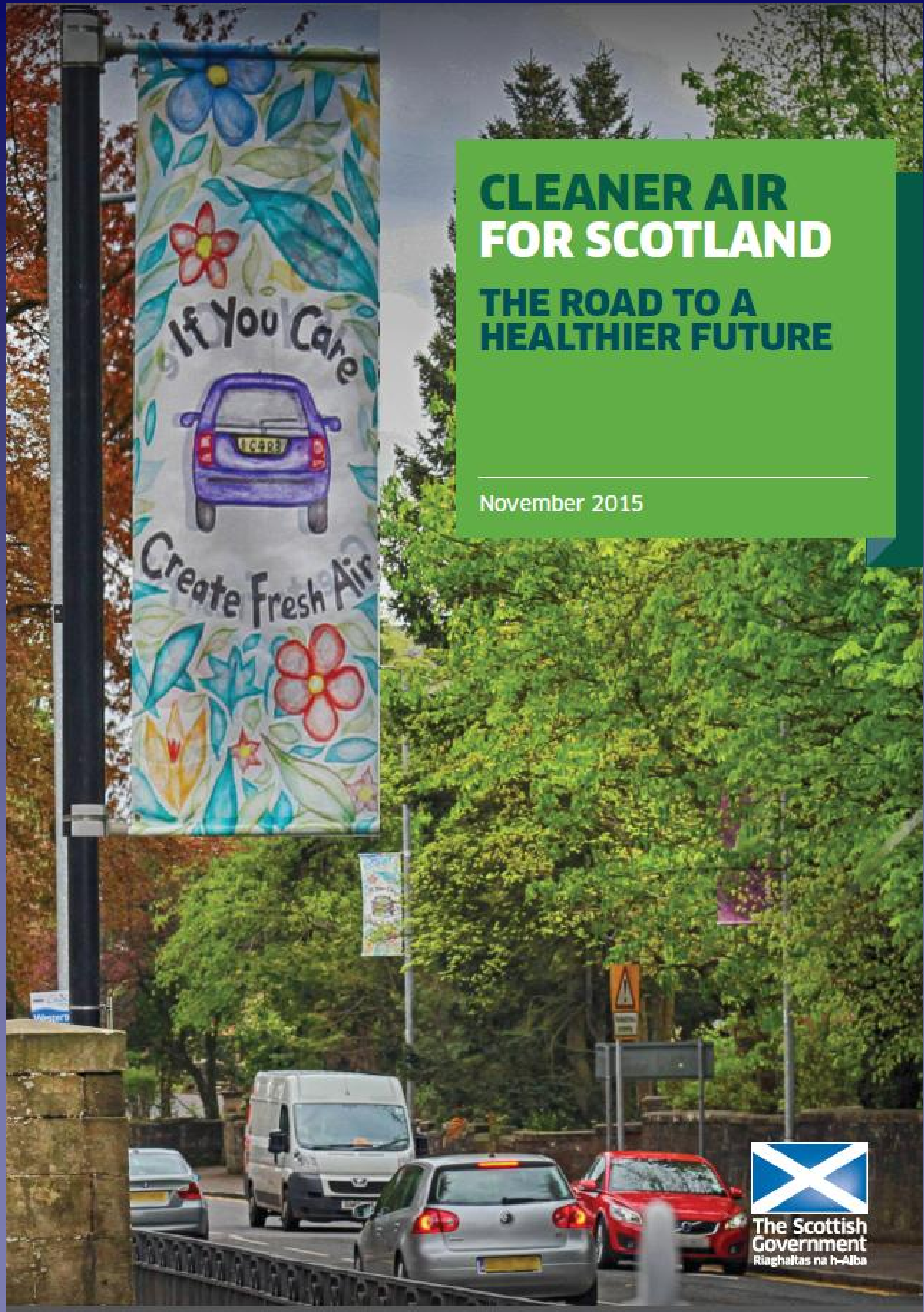
Transport can contribute significantly towards cleaner air quality

Environment - where are we now

c.3.7 Million	Air pollution contribution to worldwide deaths each year, primarily from cardiovascular disease
9th	Global ranking of air pollution in significant population risk factors for morbidity and mortality
20-30% 91-96%	European population exposed to $PM_{2.5}$ levels above EU reference values and World Health Organization Guidelines
6% per 10µg/m3	Increase in chronic impact of PM exposure on cardiovascular mortality rates
3.9% 9.3%	Proportion of all deaths attributable to long-term $PM_{2.5}$ exposure in Scotland and UK

Congestion costs the UK economy €24.5Bn a year in lost production

Nearly 2,100 people are estimated to die every year in Scotland as a result of air pollution



NATIONAL LOW EMISSION FRAMEWORK

11

What is NLEF

Description

A legislation supported, science led, evidence based process, for collaborative assessment of funded transport and planning driven air quality interventions (the NLEF options).

Who is involved

- Transport Scotland leading
- SEPA NMF integration
- Regional Transport Partnerships
- Planning Authorities
- Local Authorities

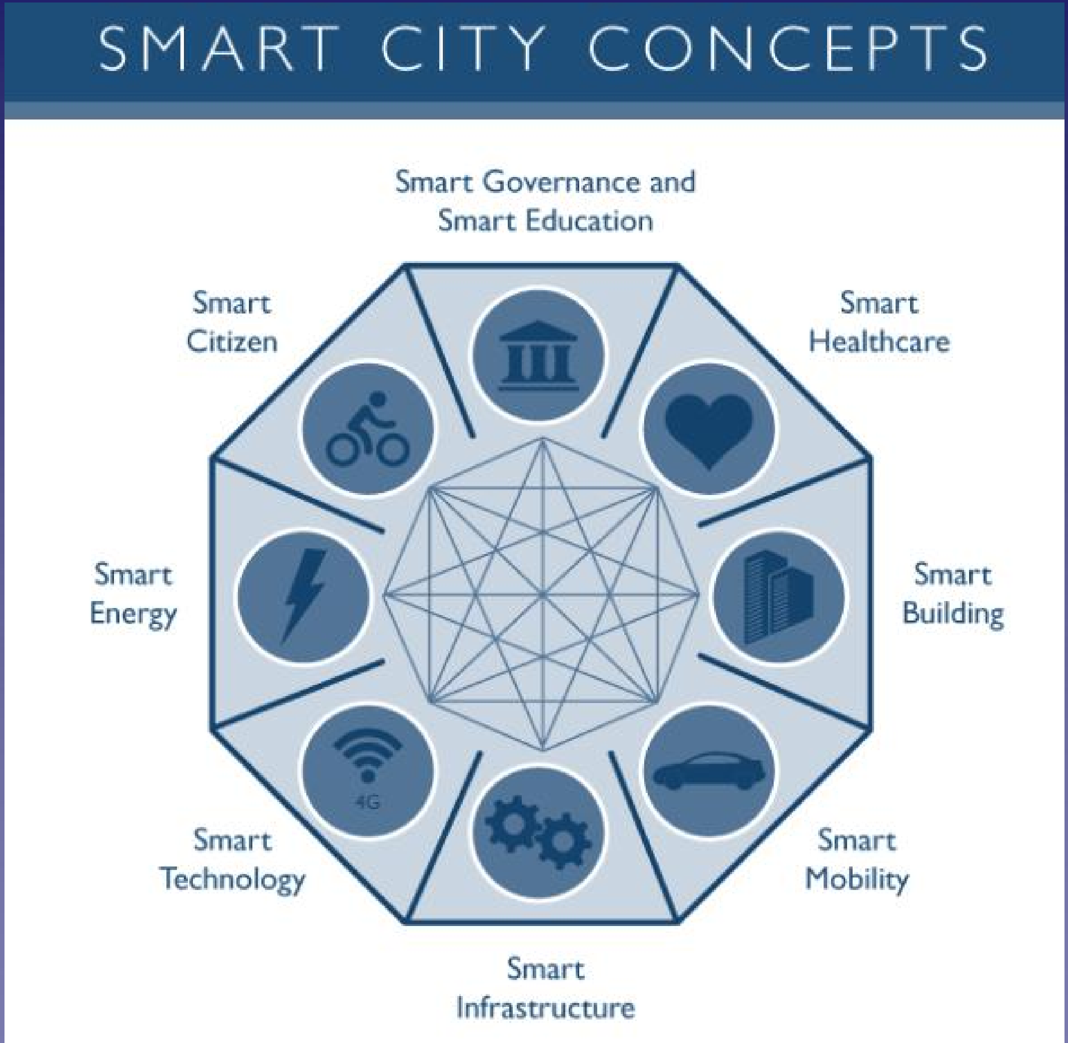
NLEF Options

Option	What it is	Key steps (see Technical Annex for more detail)
1A – Low Emission Zone (LEZ)	Setting minimum emission standards for access to a defined area; either charging vehicles to enter the area or excluding those vehicles that do not meet the standards (such as the example shown in case study 14 from Germany).	• Evaluate the current range of vehicles operating in the specified area. • Define consistent emission standards (or most polluting vehicles), the vehicle types and classes to be excluded and the operation times for the LEZ. • Develop a consistent approach to implementation.
1B – Clean Air Zone (CAZ)	Assessing vehicles operating in a defined area. Targeting implementation of measures, other than exclusion, at the most polluting vehicles that enter a space on a regular basis; note the recent guidance published by City of York Council[97] (as noted in case study 15).	• Identify the vehicles to be targeted, with a focus on setting different entry standards for vehicles based how often a day they enter the CAZ. • Engage with operators and others to identify current management and improvement measures. • Develop additional measures to deliver further improvements.
2 – Other Access Regulation Schemes	Controlling access to a zone based on weight (physical urban access regulation schemes, also known as p-ARS)[98] or at certain times of day (major access regulation schemes, also known as Key-ARS)[99].	• Evaluate the range of such measures across Scotland. • Develop a consistent approach within the NLEF.
3 – Traffic Management	Appraising traffic management in an area and introducing new measures designed to improve air quality.	• Identify existing measures in the specified area. • Define, appraise and, where appropriate, implement a range of additional traffic management measures to improve air quality, including Intelligent Transport Management, road junction upgrades, cycle lanes, cycle corridor lighting prioritisation and public messaging.
4 – Vehicle Licensing Regulations	Requiring compliance with specified air quality objectives through conditions attached to vehicle licences for buses and/or taxis.	• Evaluate the potential effectiveness of this approach for improving air quality. • Develop guidance for vehicle licensing in a specified area.

Work packages – tendering this year

1	Data and consultation	Models, traffic data, fleet status, partners, opportunities
2	Funding	Existing and new
3	Enforcement	Methodology, cost, existing resources
4	Cost Benefit Analysis	Impacts, option costs, scales for each stage
5	Options Refinement	LEZ, CAZ, other options, terminology, detail
6	Process Documents	Define the process, describe the detail, milestone review
7	Engagement	Vehicle Fleet, stakeholders, manage expectations, lead change

What is a SMART city



A digitally integrated city using advanced secure technology to manage its assets to improve quality of life and services

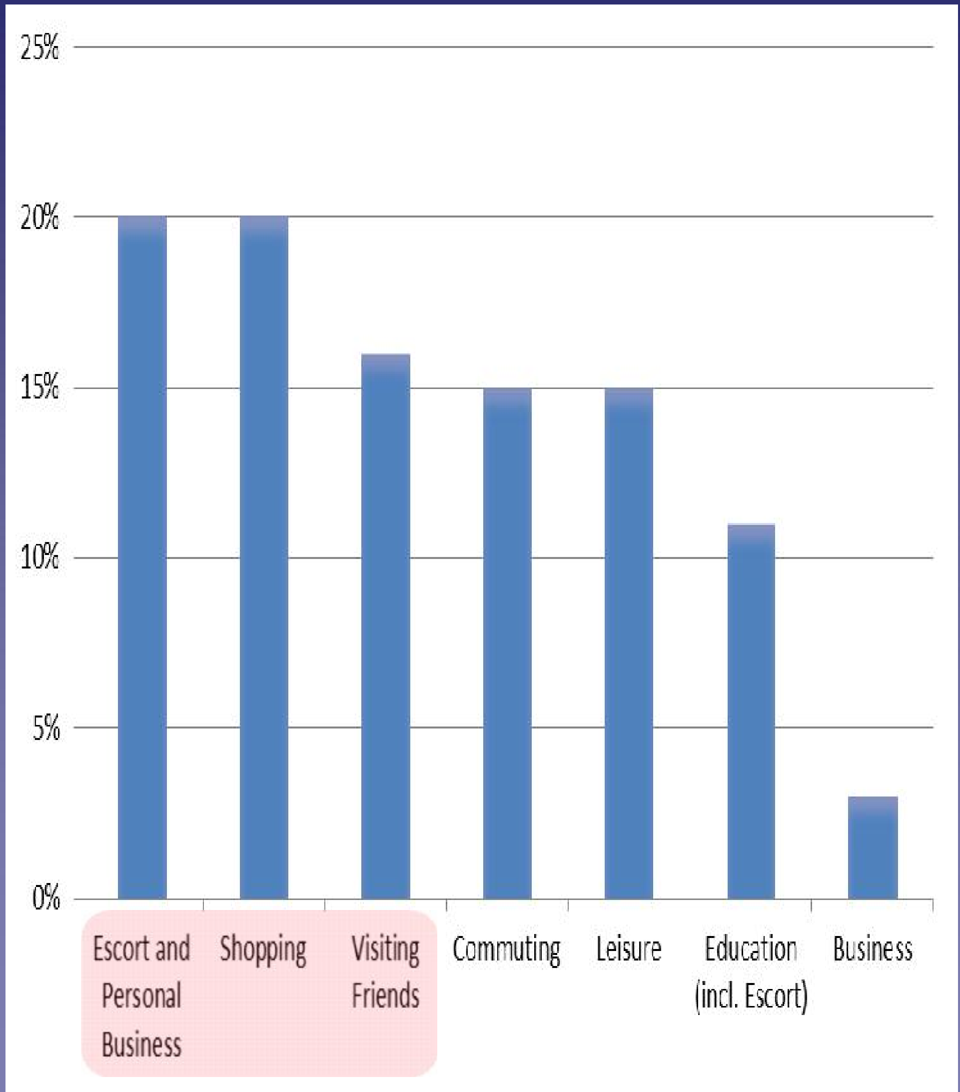
Focussed on creating efficient infrastructure to support urban planning and improving the well-being of the population through data.

With sensor data that gets used to create actions for……

Economy	Environment
Governance	People
Mobility	Living

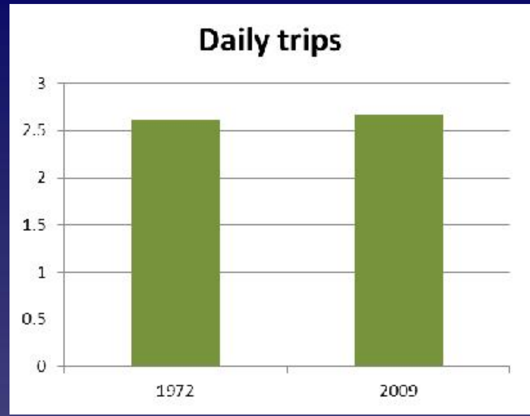
Mobility - why do we travel

UK trips by purpose

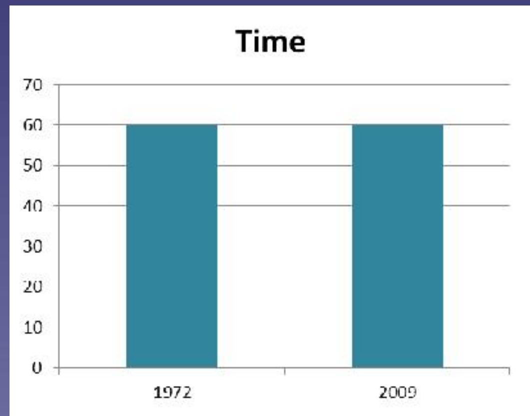


1972 to 2009

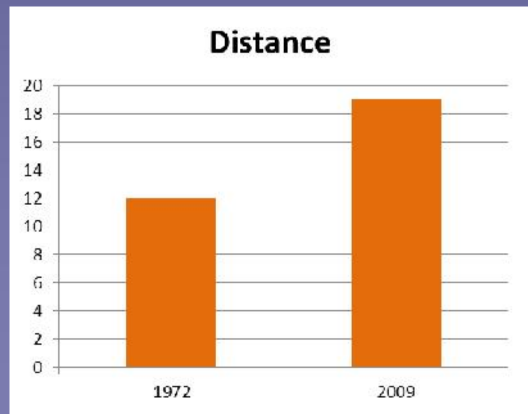
2.7 trips per person



60 minutes per day



Up from 12 miles to 19 miles



How will we travel – the plan

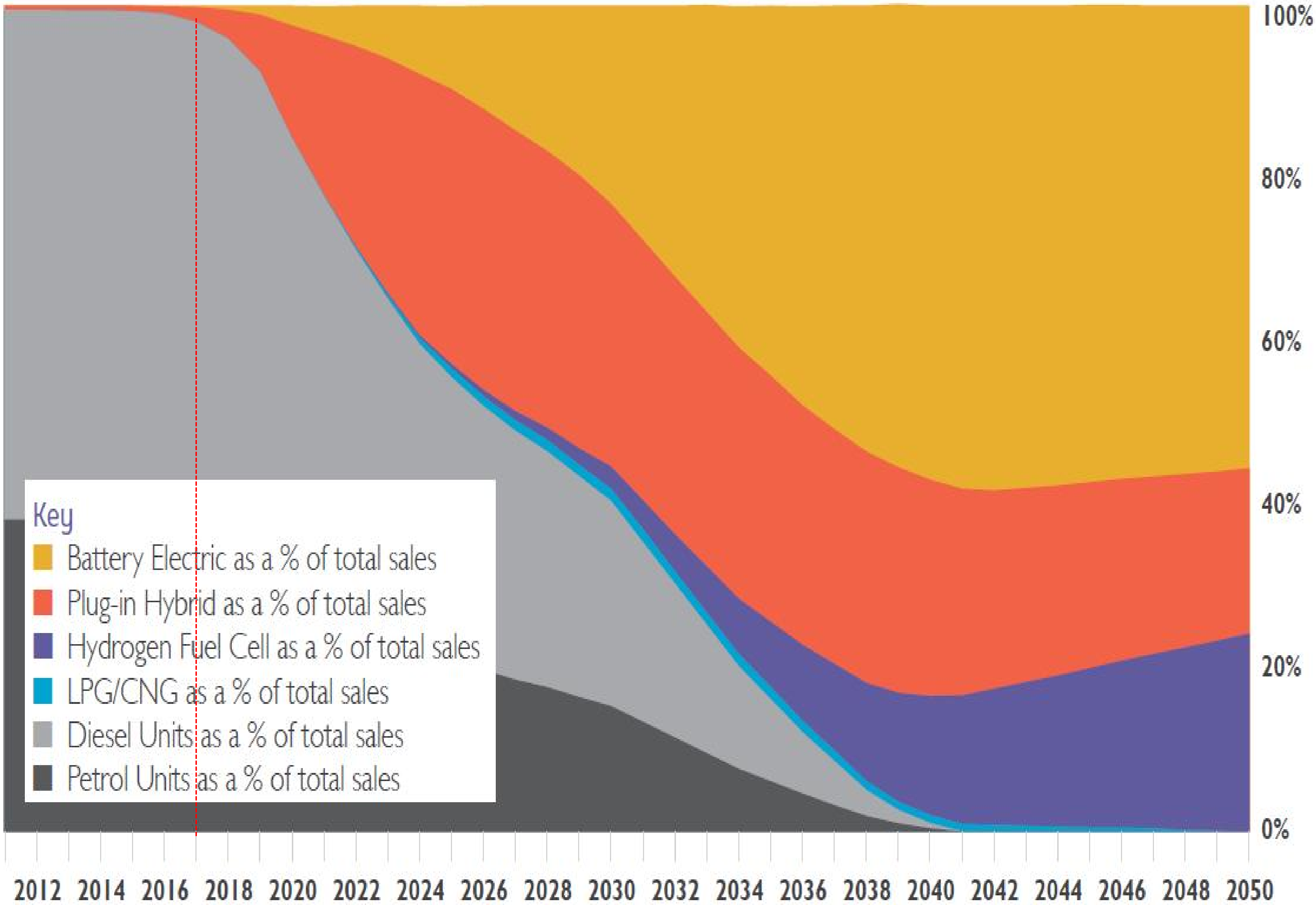


Figure 5: Outlook for new car sales in Scotland[5]

What Q-Cumber can provide

- Evidence
- Visual tools and infographics
- Passive decision making tools
- Active decision making tools

But….behaviour change must be rewarding and fun

Evidence

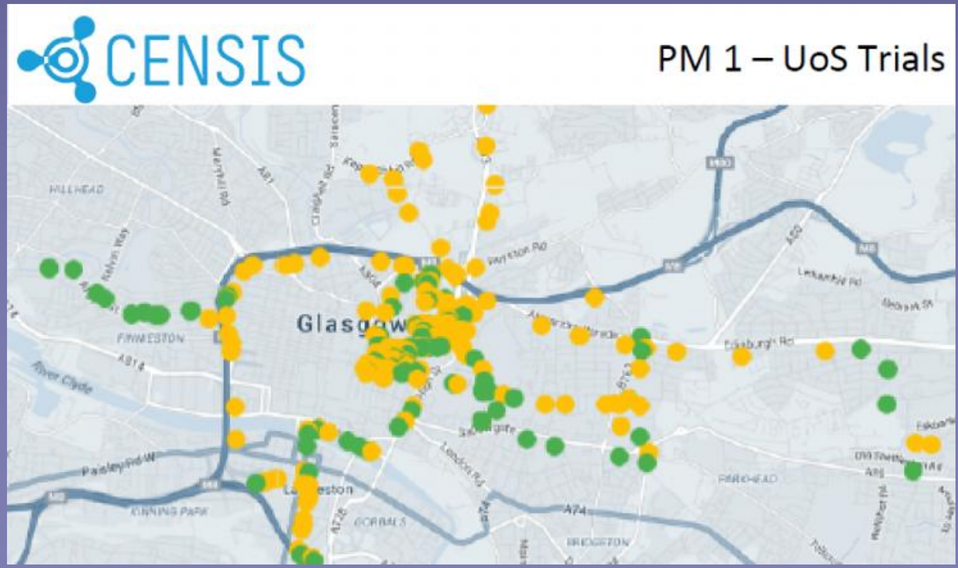
Sensor network and monitoring

EDAR – Infrared scanning tailpipe monitoring

- Improved emission factors
- Behaviour change messages
- Focussing strategy decisions

Mobile monitoring

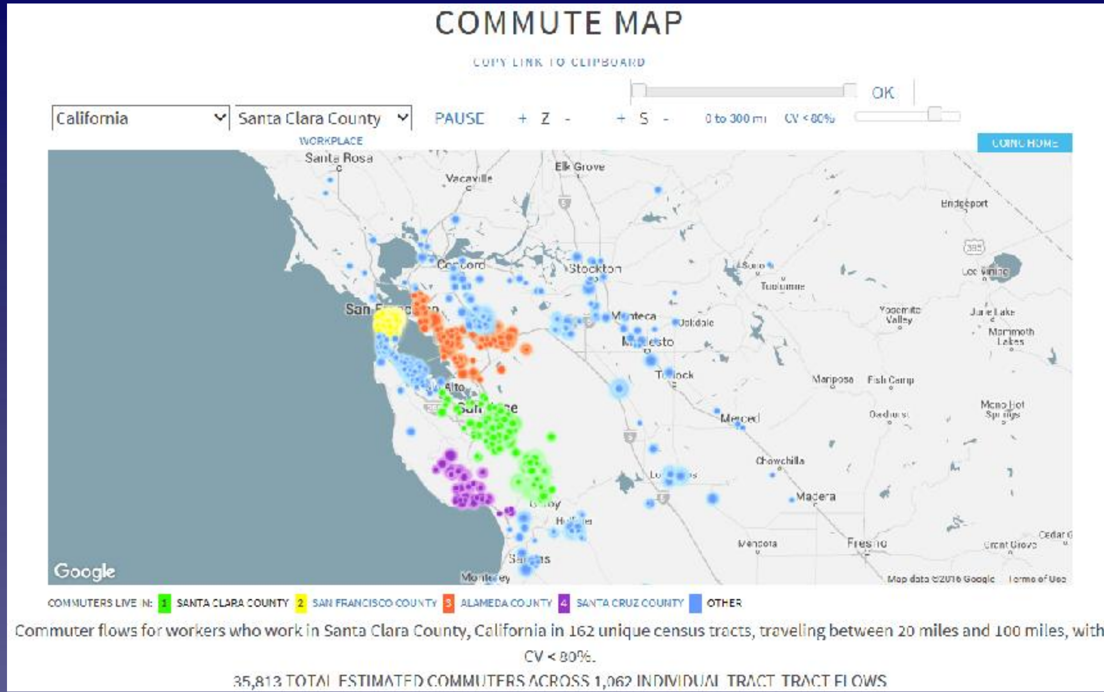
- Improved spatial and temporal coverage
- New algorithms required for decision making



Useful Visual tools

Big Data commute MAPS

- Clarity of area based travel patterns
- Provides insight for strategic transport measures



SEPA Spotfire and Matlab tools for NMF analysis

- Allow scenario testing
- Provides guidance for detailed analysis

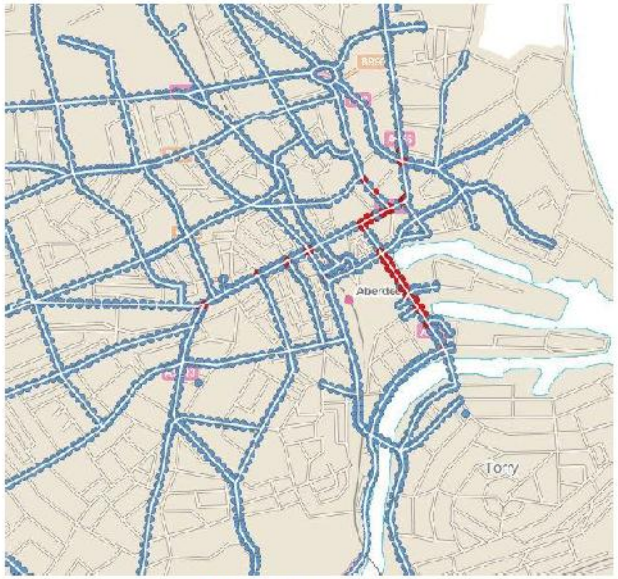
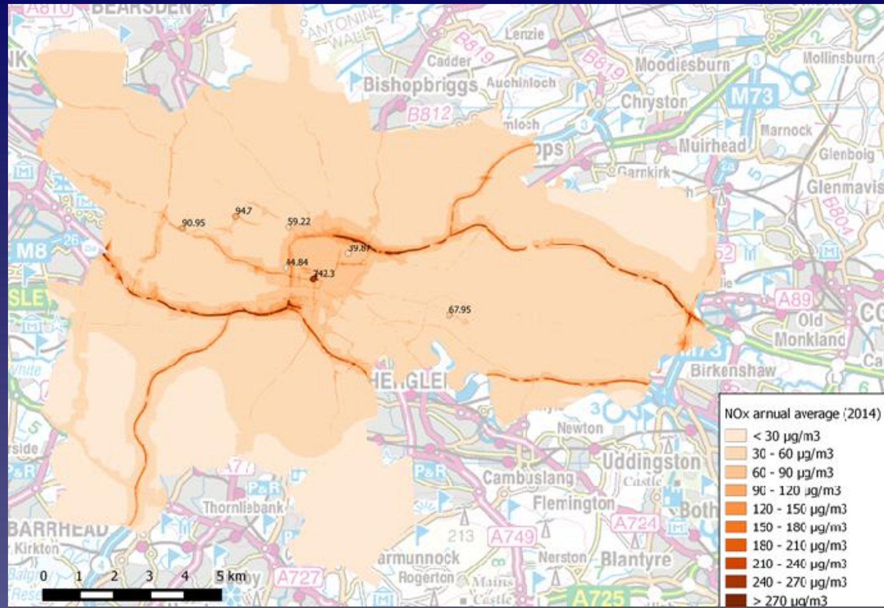


Figure 206: Scenario L7
(All Euro 1, 2 and 3 HGV's and Buses replaced with Euro 6 HGV's and Buses; Diesel cars replaced with Petrol)
(Blue: < 40 µg m^{-3}; Red: > 40 µg m^{-3})

Useful Decision making tools

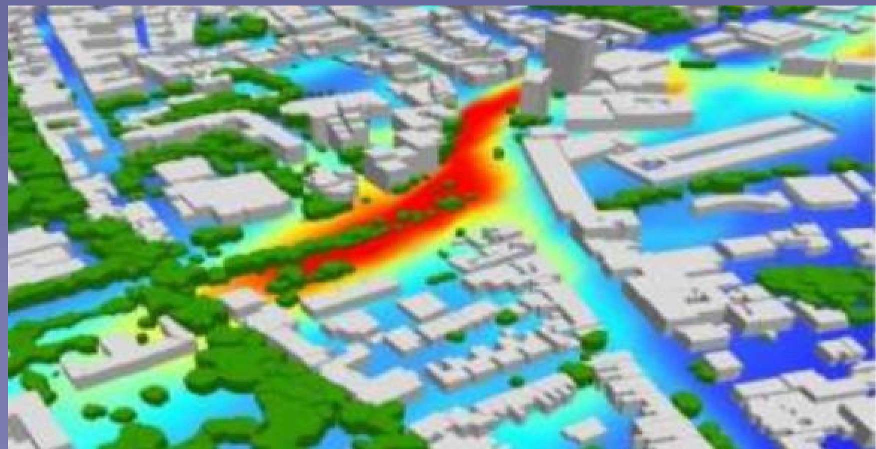
Q Cumber

- Fuses multiple data sets to allow policy decision making.
- Developed with stakeholder input.
- Tools need to be focused on decision making.



Similarly UTRAQ

- Monitor traffic and weather to predict air quality in real time.
- Assess best mitigation strategy and implement.



Air Quality and Health
The Health Board perspective

Dr Stan Murray
Consultant in Public Health Medicine
Greater Glasgow and Clyde Health Board

Plan

- Health Board context
- Data sources
- Epidemiology of Air Pollution
- Risk assessment
- An example
- Conclusions

Three domains of Public Health (Faculty of Public Health)

Health Protection	Health Service Delivery	Health Improvement
•Clean air, water and food •Infectious diseases •Emergency response •Radiation •Chemicals and poisons •Environmental health •Prevention of war and social disorder	•Service planning •Clinical effectiveness •Clinical Governance •Efficiency •Research, audit and evaluation	•Improving health •Reducing inequalities •Employment •Housing •Family/ community •Education •Lifestyles

Role of PHPU in Environmental Incidents

Type of Issue	**Agency with primary responsibility**	**Role of PHPU**
Air	Local authority	•Environmental epidemiology •Risk assessment •Health protection advice
Land	Local authority	•Environmental epidemiology •Risk assessment •Health protection advice
Water	Scottish Water	•Environmental epidemiology •Risk assessment •Health protection advice

Scenarios in Environmental Health Protection

- Known / suspected exposure: risk assessment
  Health Board as Context
- Known / alleged cluster of cases: is an environmental risk factor relevant?

Environmental Health Paradigm

Components of Air Pollution

- **Particulate Matter (PM)**
- Sulphur Dioxide (SO_2)
- Nitrogen Oxides (NOx)
- Carbon Monoxide (CO)
- Ozone (O_3)

Health Effects: Types of morbidity associate with air pollution

- Respiratory disease (CPD, asthma)
- Lung cancer
- Cardiovascular disease
- Adverse outcomes of pregnancy e.g. low birth-weight
- Childhood respiratory disease
- Neurodevelopmental changes?
- Diabetes?

Sources of data

- **Populations**
- **Births**
- **Mortality**
- **Disease registration e.g. diabetes, ID, congenital malformation, cancer, renal, MND.**
- **Morbidity (hospital):** A and E data, SMR, ISD(S)1
- **Other hospital systems:** renal, ITU, radiology etc
- **Pharmacy**
- **Morbidity (primary care): Practice Team Information etc**
- **Dental Health**
- **SIRS**
- **Non-Health Service: Local Authority, Voluntary sector etc**
- **Risk factors: Other sources, local or national**

Attributes

- Collection, routine or otherwise?
- Patient-based?
- Reflect health event or proxy eg contact with service?
- Identifiable fields?
- Disease-specific?
- Proxy for incidence or prevalence?
- Use as measure of process or outcome?
- Coverage?
- Quality?
- Completeness?

Health Outcomes and Sources of Data

Health Outcome	**Indicator**	**Source**
All cause mortality	Numbers of mortality	Mortality
Ischaemic heart disease	Mortality Admissions	Mortality data SMR 01
Lung cancer	Incidence (number of new cases)	Cancer registration data
Respiratory disease	Mortality Admissions	Mortality data SMR 01
Low birth-weight	Prevalence	SMR 02

Sources of data

Source	**Comments**
Disease registration	Direct measure of disease Not available for most types of disease
Mortality data	Proxy measure of disease Routinely-collected Satisfactory measure for many types of pathology
SMR 01	Proxy measure of disease Routinely-collected One case of disease may lead to multiple admissions Affected by other factors Requires understanding of position locally
SMR 02	Proxy measure of disease Routinely-collected Affected by other factors Requires understanding of position locally

Epidemiology of Air Pollution

- Environmental epidemiology
- Risks of exposure
- Concentration-response function
- Risk assessment
- Health protection advice

Sources of Environmental Epidemiology

Issue	Paradigm	Source
Air pollution	Epidemiological	Direct epidemiological observation
Asbestos	Epidemiological	Extrapolation from Occupational Epidemiology
Contaminated land Contaminated water	Toxicological	Threshold values: •Health Criterion Values •Reference doses •Acceptable Daily Intake (ADI)
Mould spores	Toxicological	None

Particulate Matter (PM)

- Microparticles suspended in air
- Vast range of sizes (aerodynamic diameter)
- Epidemiology most developed for PM
- No threshold for effect
- Measured in μg/m(3)

Types of Particulate Matter (PM)

Fraction	**PM designation**	**Aerodynamic diameter**
Thoracic fraction	PM_{10}	$<10\ \mu m$
Fine fraction	$PM_{2.5}$	$<2.5\ \mu m$
Ultrafine fraction	$PM_{0.1}$	$<0.1\ \mu m$

Evidence for air pollution and health

Four types of study:

- Major episode studies (e.g. London smog 1951)
- Time-series studies
- Cohort studies

London Smog Episode 1952

Levels of PM_{10}

- About 30 $\mu g\ m^{-3}$ Contemporary
- About 300 $\mu g\ m^{-3}$ 1950s
- About 3000 $\mu g\ m^{-3}$ December 1952

Development of studies of Air Pollution and Health

- Major UK episode in London, December 1952
- Importance of episode studies as initial studies of air pollution and health
- Initial evidence for effects on health at high concentrations of PM and other pollutants
- Would short-term effects on health be evident at lower concentrations of PM?
- Some investigators assumed that no health effects would be evident at lower concentrations
- Time-series studies designed to address this question
- Day-to-day fluctuations at lower levels of air pollution

Short-term Effect of Particulate matter on health

Usually expressed as effect on health indicator of a specific increase in concentration of:

PM_{10} by 10 $\mu g/m^3$ or

$PM_{2.5}$ by 10 $\mu g/m^3$

PM_{10} as Risk Factor for health in Time-series studies

Increase in all-causes mortality associated with increase in concentration of PM_{10} by 10 $\mu g/m^3$:

- 0.75% increase in total daily mortality
- 1.4% increase in cardiovascular daily mortality
- 3.5% increase in respiratory daily mortality
- no other specific causes of death
- effect is seen after several days

PM_{10} as Risk Factor for health in Time-series studies

Increase in mortality associated with increase in concentration of PM_{10} by 10 $\mu g/m^3$:

- 0.75% increase in total daily mortality
- or Relative Risk= 1.0075
- i.e. increased individual risk very small
- but large proportion of population exposed to risk factor

Effect of PM_{10} on health

- Increase in concentration of PM_{10} by 10 $\mu g/m^3$ associated with 0.75% increase in daily mortality.

- This represents dose-response function for pollutant

Groups at greatest risk of exposure to air pollution

- Children and infants
- Elderly people
- Patients with chronic cardiac disease
- Patients with chronic pulmonary disease

Concentration-Response Function

- Allows an exposure to be translated into a predicted health effect
- No evidence for “safe” threshold level
- Any further improvements in air quality would have incremental benefits for health
- Importance for regulation
- Issue for policy-makers

Pollutant	Standard	Standard
PM_{10}	annual	$18\mu g/m^3$
PM_{10}	daily	$>50\mu g/m^3$ on not more than seven measurements per year
NO_2	annual	$40\mu g/m^3$
NO_2	hourly	$>200\mu g/m^3$ on eighteen measurements per year

Common scenario

- Known / suspected / perceived breach in air quality
- Public / political / professional source
- Approach made to Public Health Protection Unit (PHPU)
- Risk assessment required
- Predicted effects on health

Examples of queries received by PHPU re Air Quality

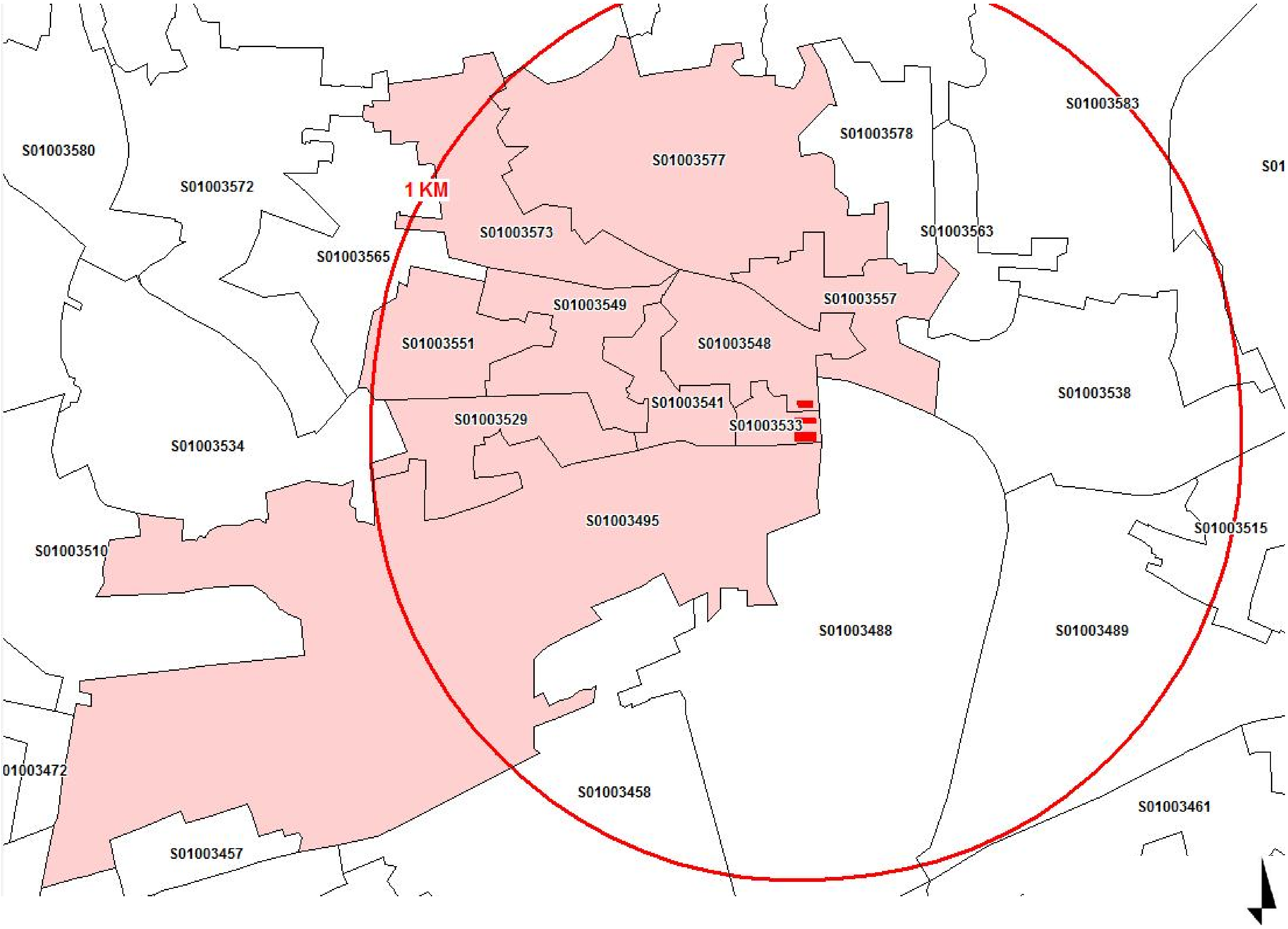
Type of Issue	Source	PHPU advice
Air quality in vicinity of school in Bearsden	Parents Association	Confirmed. AQMA established by Local Authority
Breaches of Air Quality in Byres Road area of Glasgow	Freelance Journalist	Investigated by Local Authority Malfunction of monitoring equipment
Release of particulates at time of demolition of high-rise flats	Housing Association	Health protection assessment and reassurance

Demolition of block of high-rise flats In Glasgow

- Concern re local emissions of PM at time of demolition
- PHPU approached by Housing Association re risk assessment
- Renewal of older housing (Demolition / Construction)
- Deprived areas often affected (Existing high prevalence of respiratory and circulatory disease)
- High population densities
- High emission rate / levels of PM
- Spectacle / media promotion
- Settlement and resuspension of PM
- Proximity to hospitals, care homes etc

Model of Health Effects of Implosive Demolition

- Magnitude of emission
- Composition of dust-cloud
- Wind direction
- Population at risk (about 8,000)
- Measure of health effect
- Size of effect
- Other assumptions

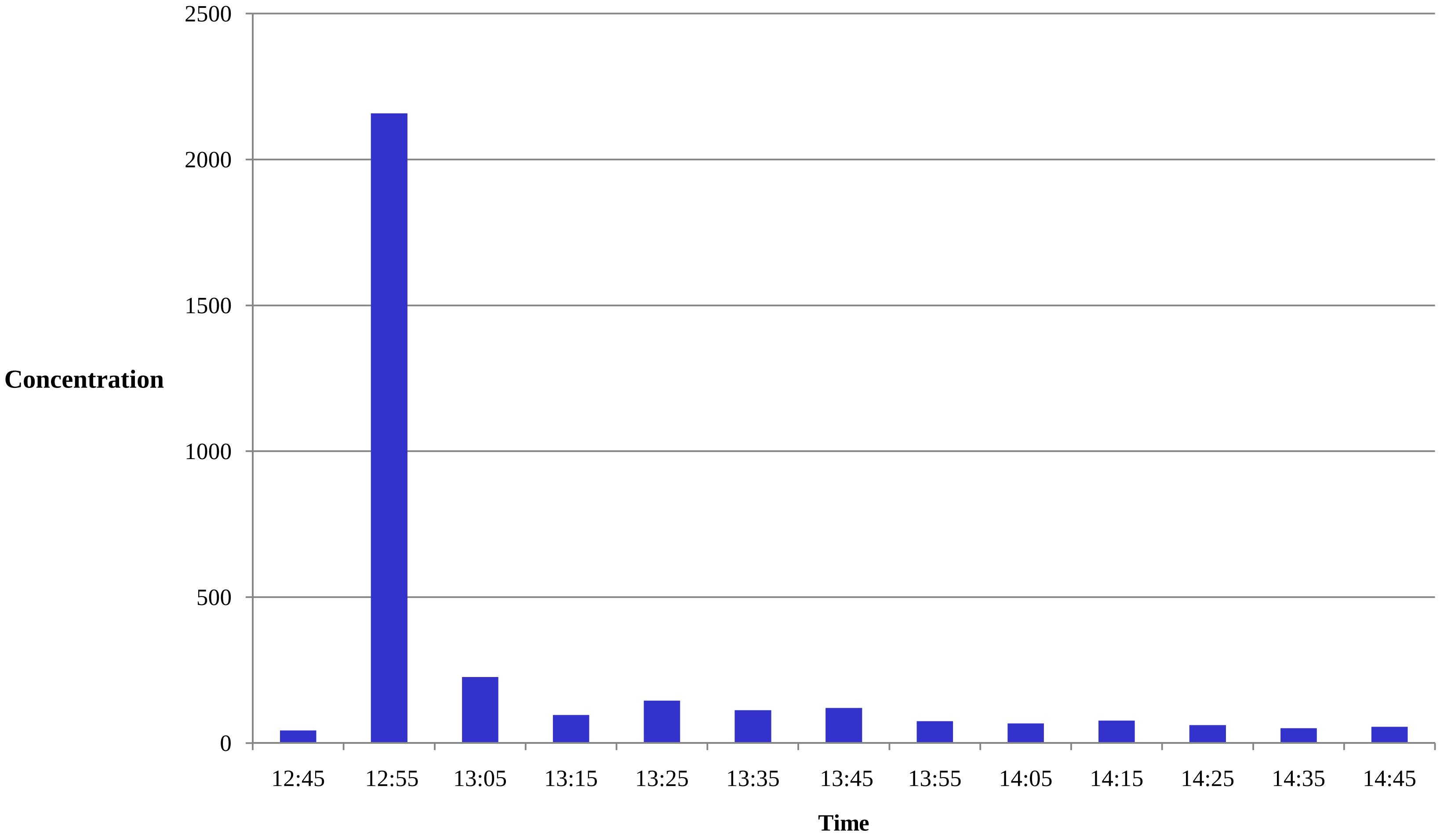


Information Services - NHS Greater Glasgow & Clyde

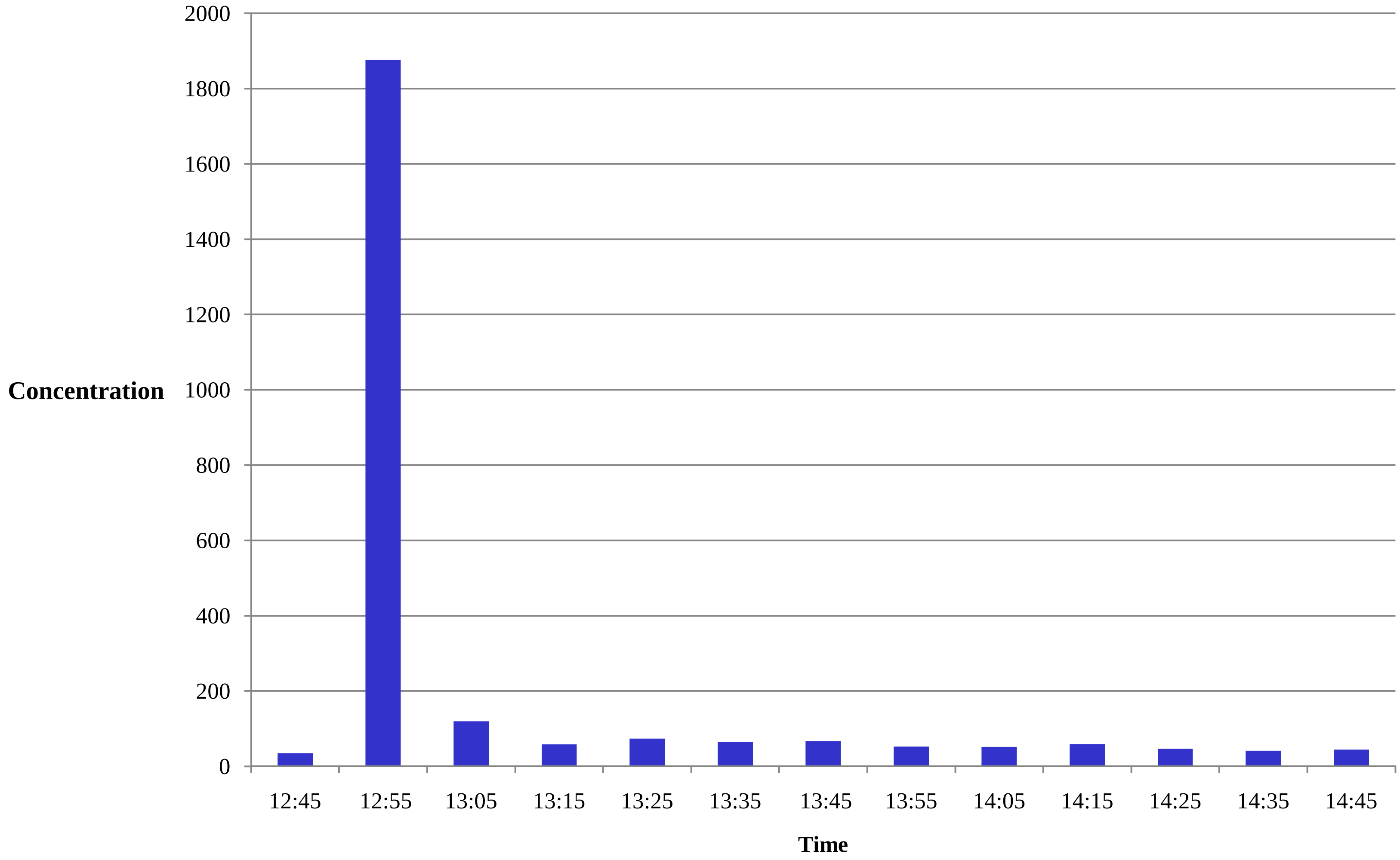
Concentrations (µg/m3) of PM after demolition of block in June 2012

Time	total part	PM10	PM2.5	PM1
10/06/2012 12:45	43.7	34.8	11.24	2.85
10/06/2012 12:55	2157.8	1876.3	140.45	90.86
10/06/2012 13:05	226.5	119.4	11.15	2.87
10/06/2012 13:15	95.8	58.5	12.29	3.06
10/06/2012 13:25	145	73.9	12.21	2.89
10/06/2012 13:35	112.7	63.8	11.81	2.73
10/06/2012 13:45	120.2	67.1	12.55	2.97
10/06/2012 13:55	74.6	52.7	12.2	2.94
10/06/2012 14:05	67.4	52	12.71	3.09
10/06/2012 14:15	77	58.8	13.3	3.3
10/06/2012 14:25	61.2	46.7	12.43	3.02
10/06/2012 14:35	50.7	41.4	13.16	3.49
10/06/2012 14:45	55.4	44.4	16.78	4.86

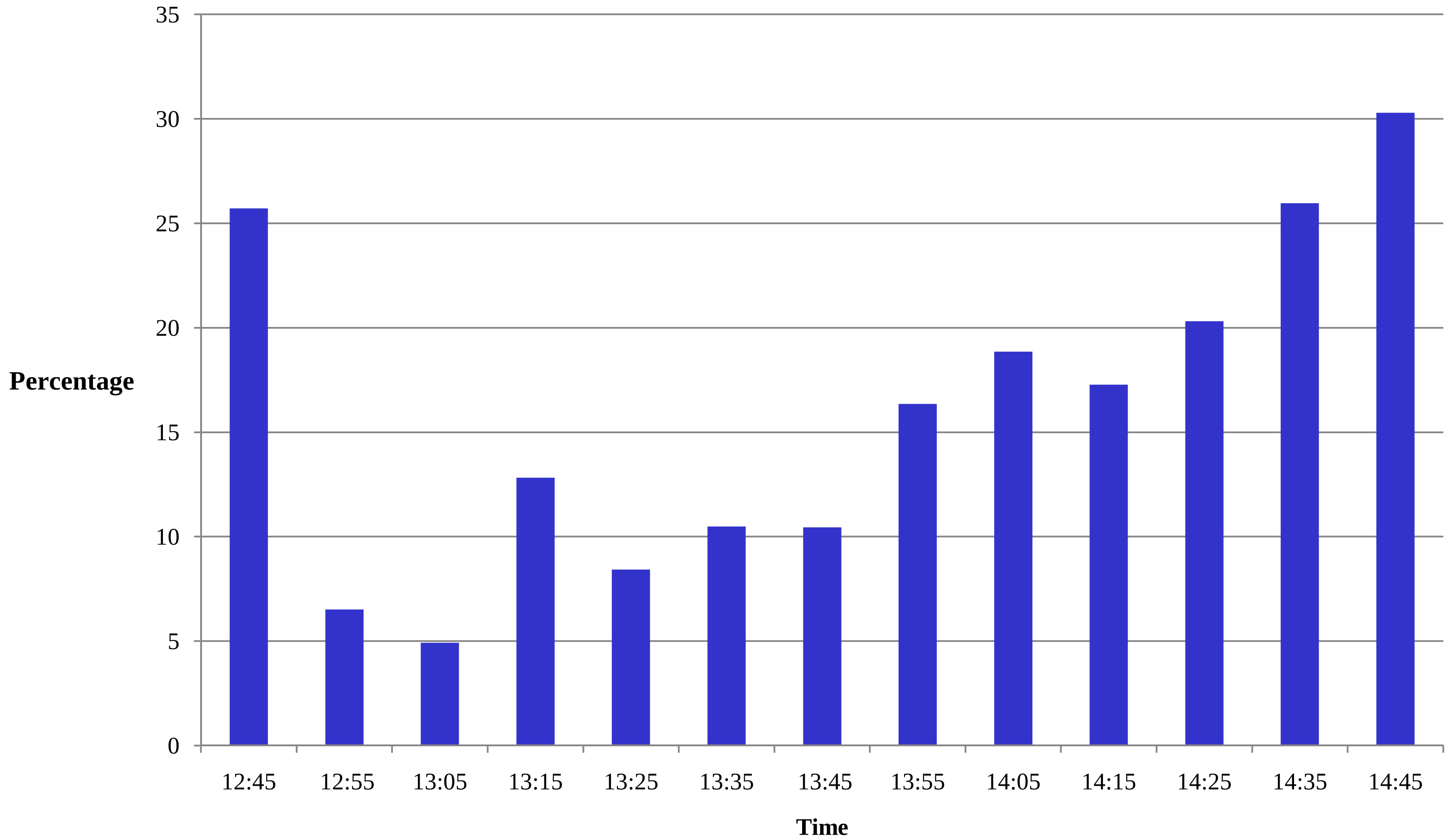
Concentration (µg/m3) of Total Particulate Matter after demolition



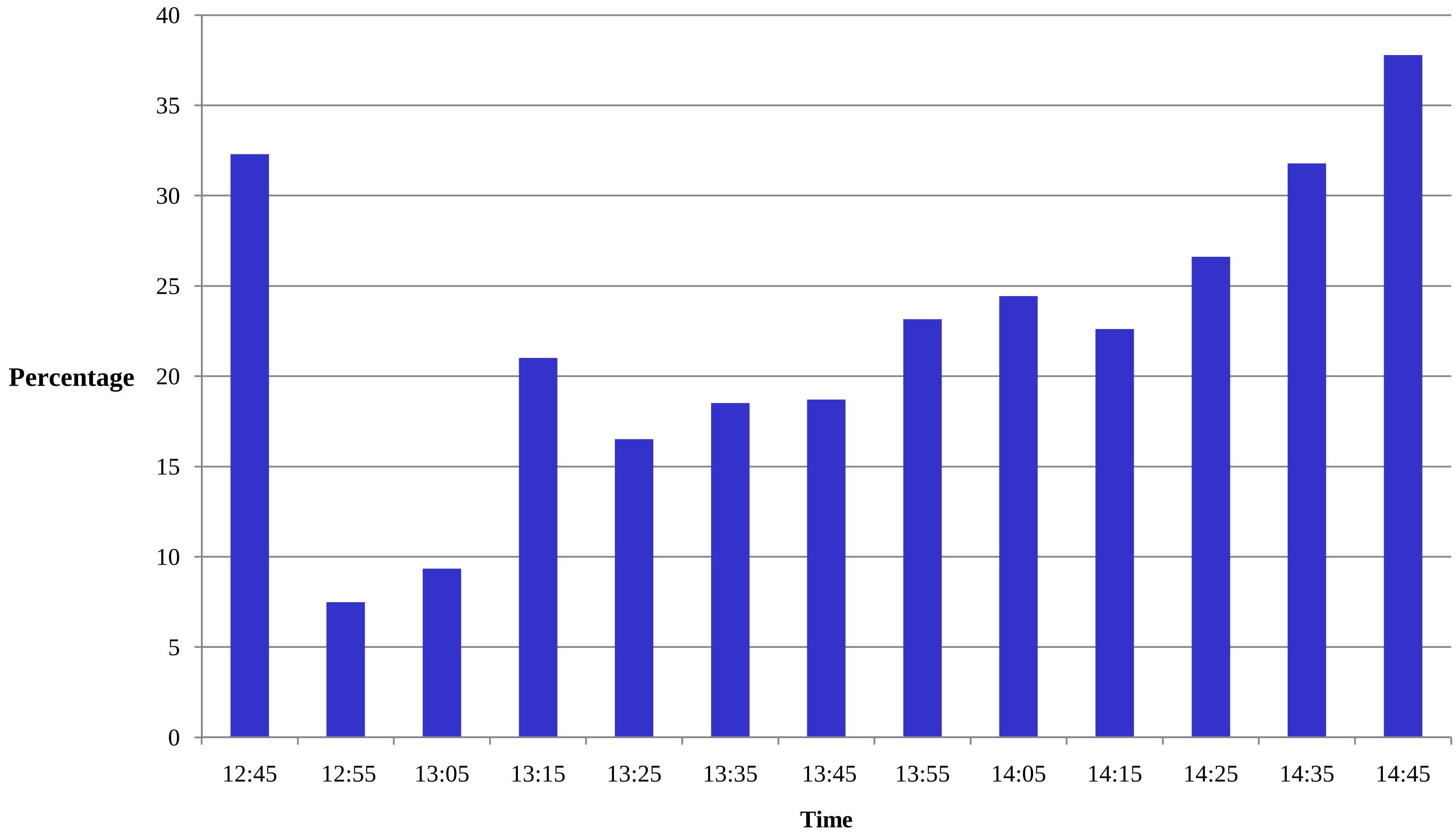
Concentration (µg/m3) of PM (10) after demolition



Proportion of all PM Comprised by PM 2.5



Proportion of all PM 10 Comprised by PM 2.5



Time	Fraction	
	PM10/ TSP	*PM 2.5/ PM 10*
12.45.	0.80	0.32
12.55.	0.87	0.07
13.05.	0.53	0.09
13.15.	0.61	0.21
13.25.	0.51	0.17
13.35.	0.57	0.19
13.45.	0.56	0.19
13.55.	0.71	0.23
14.05.	0.77	0.24
14.15.	0.76	0.23
14.25.	0.76	0.27
14.35.	0.82	0.32
14.45.	0.80	0.38

Exposed population

- Assume population resident within one km at risk
- Ten datazones to west of demolition site lie within one km of site
- Total population= 7,941
- Annual mortality = 63.8
- Average daily mortality = 0.175

Model of exposure on health

- Mean value PM 10 during day of demolition = 62.4 µg/ m^3
- Assume baseline PM 10 = 34.8 µg/ m^3
- Assume mean elevation in PM 10 during day of demolition = 27.6 µg/ m^3
- This represents 2.76 increases of 10 µg/ m^3
- So predicted mortality = $0.175 * (1.0075)^{2.76}$
- So predicted mortality = 0.177
- So predicted increase in mortality = 0.002

Advice to residents

- Stay away from site
- Stay indoors
- Close doors and windows
- Use damp cloth to clear settled dust from surfaces
- Rinse drives, pavements etc with hose
- Remove shoes before entering homes

Conclusions

- Air pollution is recognised as an important environmental risk factor for health
- Risk factor for vascular disease, cancers and developmental effects
- Additional effects on health may become established in due course
- Routinely-derived data can be used to measure health effects
- Epidemiology well-established for particulate matter component
- Corpus of epidemiology available for carrying out risk assessment

SEPA
Scottish Environment Protection Agency

Modelling Glasgow within the CAFS National Modelling Framework

Alan McDonald, Andrew Malby and Alan Hills
OceanMet Unit, SEPA

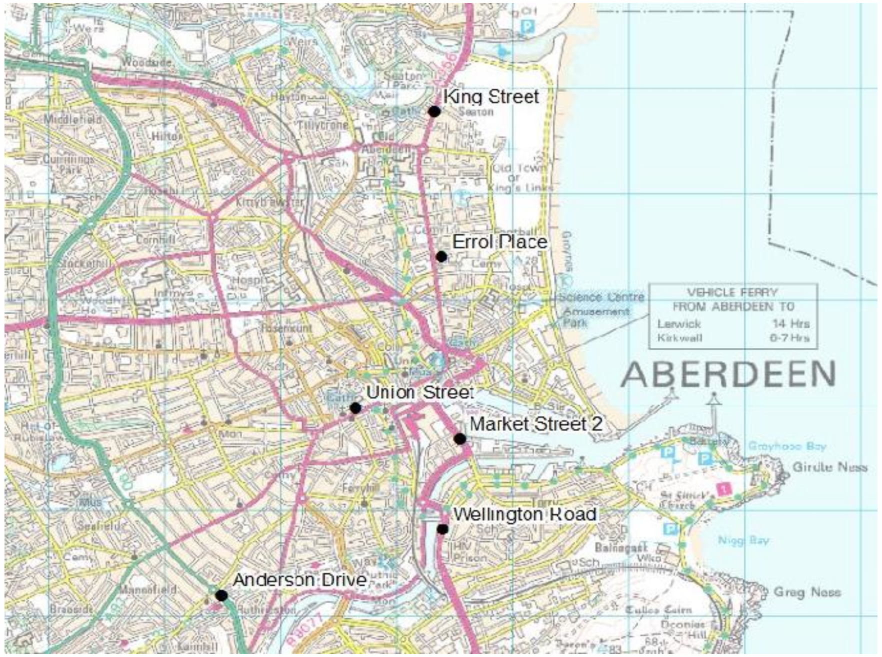
SEPA
Scottish Environment Protection Agency

Introduction

- Aberdeen Pilot Project: Lessons Learnt
  - Data
  - Results
  - Data Analysis
- Glasgow
  - Monitoring
  - Traffic Data

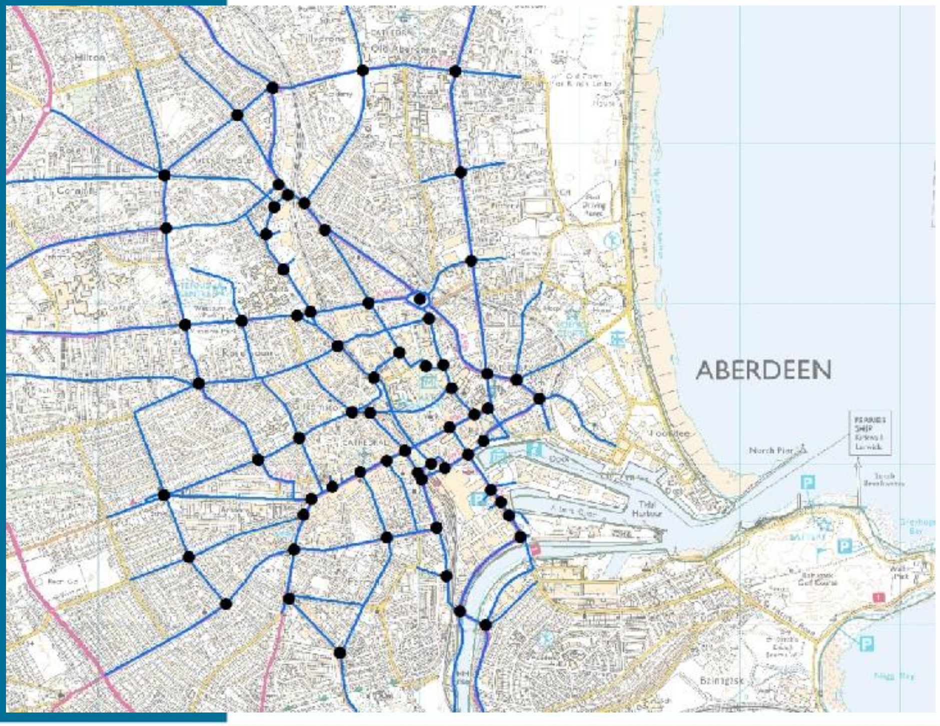
Aberdeen NO_2 Observations

Annual Mean (µg m^{-3})	2009	2010	2011	2012	2013	2014	2015
Anderson Drive	24	27	23	30	22	25	-
Errol Place (Urban Background)	26	22	23	21	20	21	23
King Street	32	29	32	29	28	27	28
Market Street 2	39	**44**	**40**	**44**	**43**	**40**	36
Union Street	**51**	**58**	**44**	**53**	**48**	**46**	**46**
Wellington Road	**43**	**52**	**51**	**59**	**52**	**47**	**40**



Aberdeen:Traffic Data

- Detailed traffic data **key** to Aberdeen model
- Junction turns converted into traffic flow along road sections (12 hour counts)
- For other roads, DfT data used



Aberdeen: Traffic Data Sources

- Detailed traffic data reports greater traffic volumes than DfT data

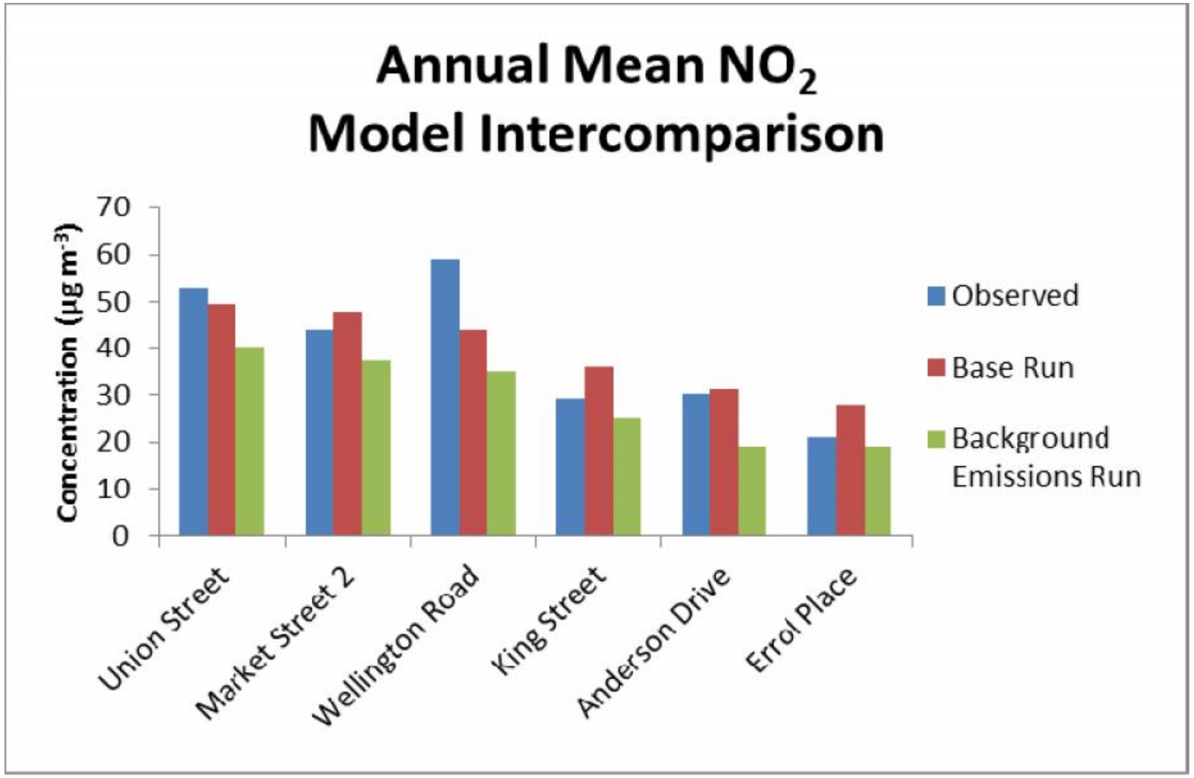
Vehicle Class	Motor Cycle	Car	LGV	Buses	OGV1	OGV2	All Vehicles
Aberdeen Council	150	12745	1291	2069	571	44	17501
DfT	113	9311	1404	1107	235	27	12197
% Diff	33	37	-8	87	142	63	43

Aberdeen: AADF conversion rate

- Defra AADF conversion factor: 1.15
- ATC data used to calculate local AADF conversion factor (Union Street: 1.48, Market Street: 1.28)
- Factor of 1.21 used elsewhere (based on Glasgow City council traffic tables)

Aberdeen: Background Concentration

- Urban Background (Errol Place)
- Rural Background and NAEI (non-traffic) 1km background emissions



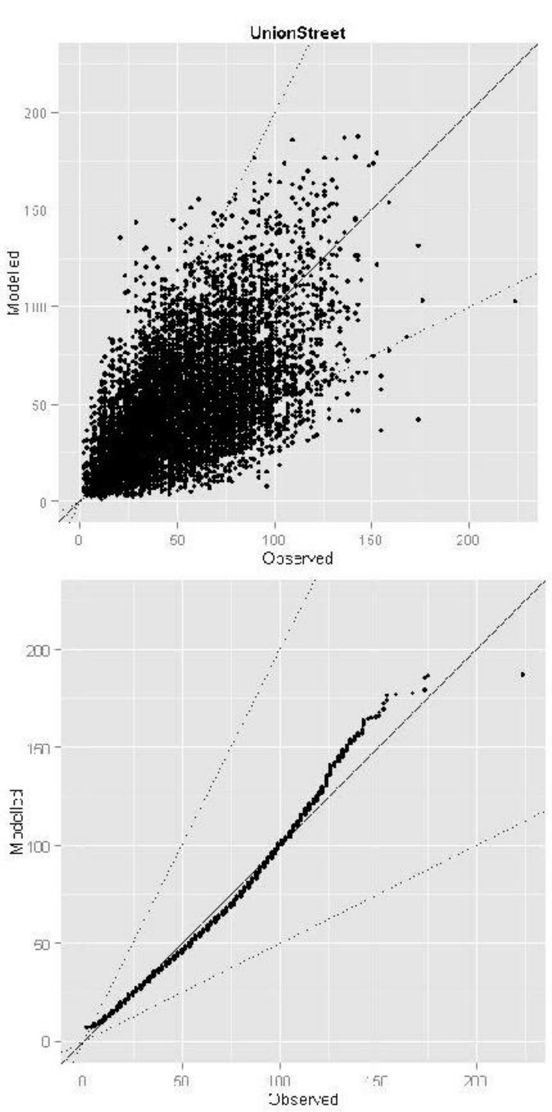
Aberdeen: Model Results

- Good at Union Street, and Anderson Drive
- Issues identified at Wellington Road, King Street, Market Street 2

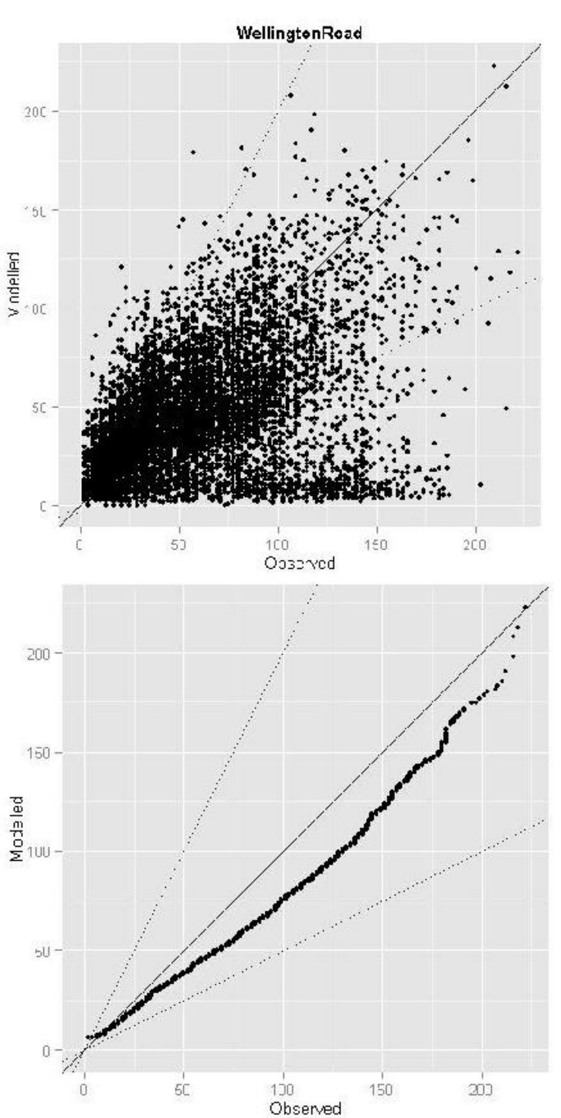
Monitoring Point	Annual Mean			99.79th Percentile of 1hr Means		
	Observed	Model	Ratio	Observed	Model	Ratio
Union Street	52.8	49.4	0.94	143	163.5	1.14
Market Street 2	44.1	47.6	1.08	161	171.5	1.07
Wellington Road	59.1	44	0.74	187.8	167.6	0.89
King Street	29.2	36	1.23	107	134.3	1.26
Anderson Drive	30.4	31.4	1.03	115	121.4	1.06

Results: Union St, Wellington Road

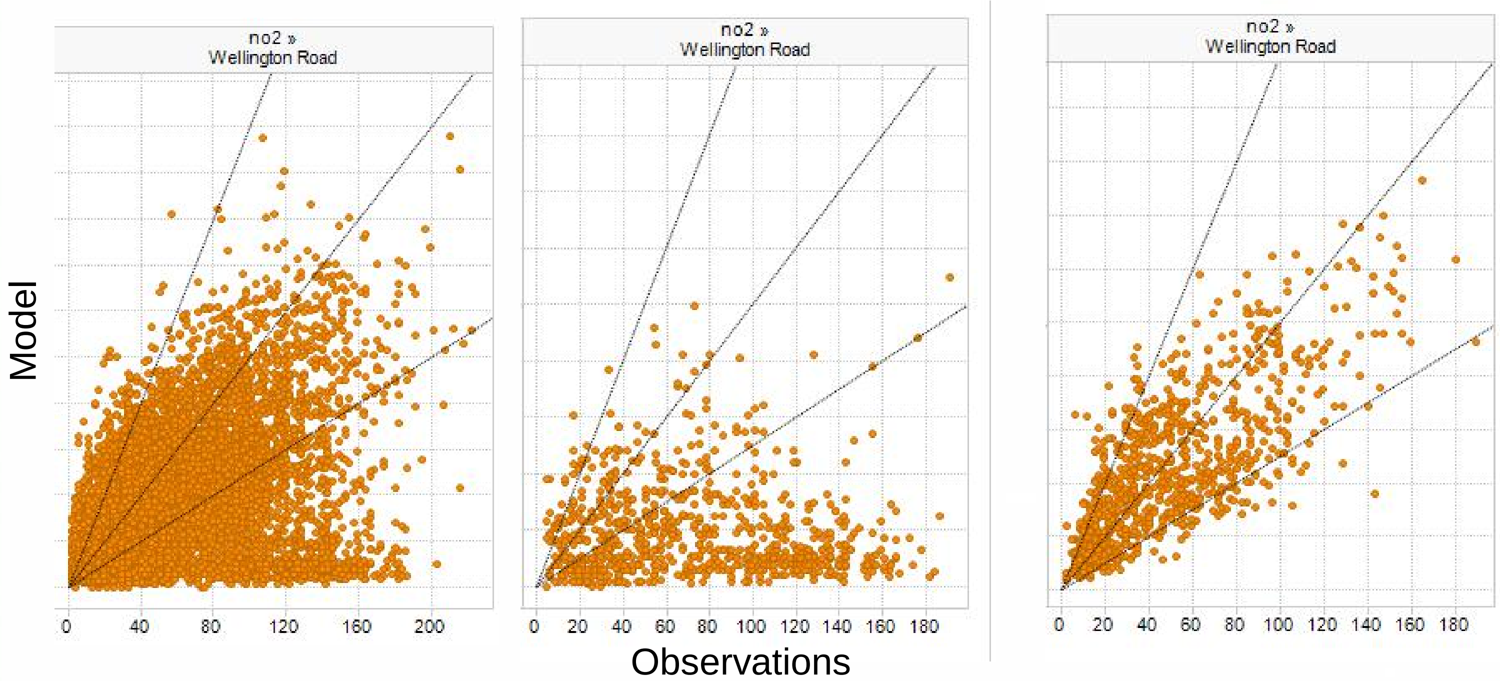
Union Street



Wellington Road



Wellington Road: Directional Dependence



All Directions ESE WSW

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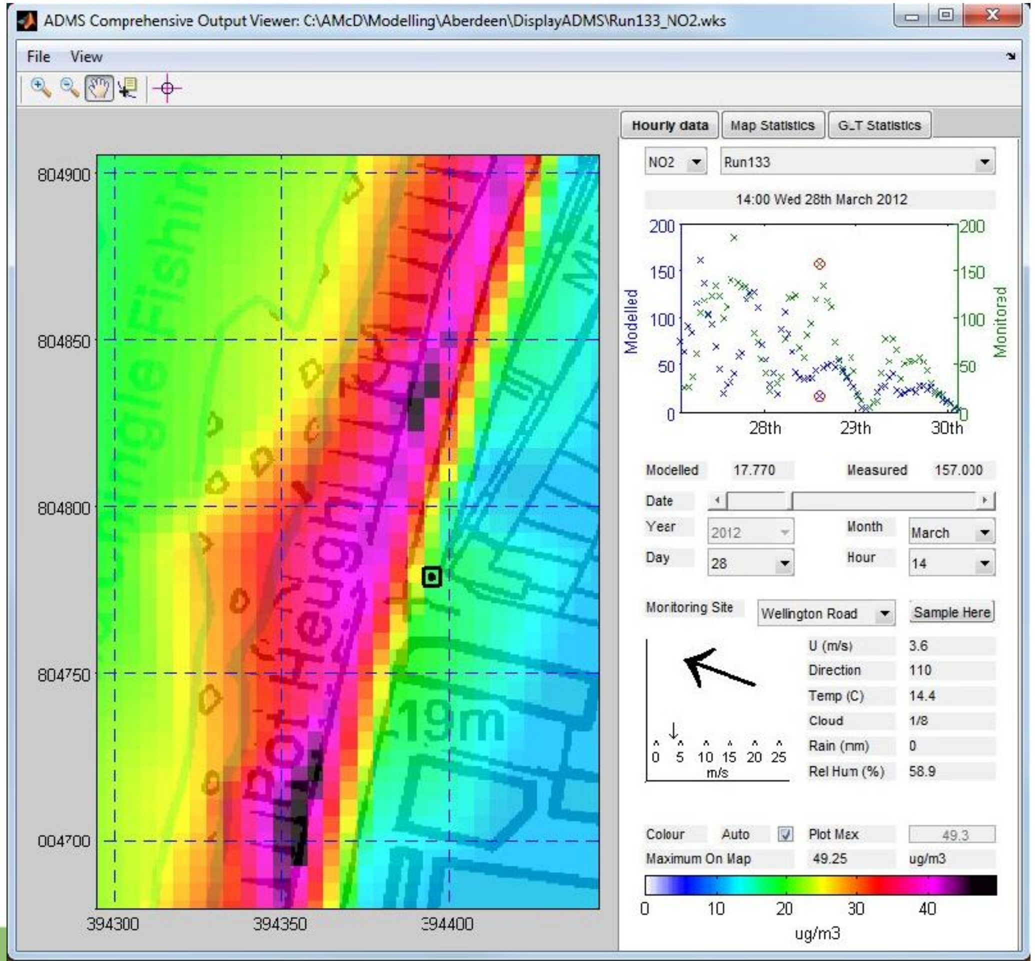
Wellington Road: Easterly Winds

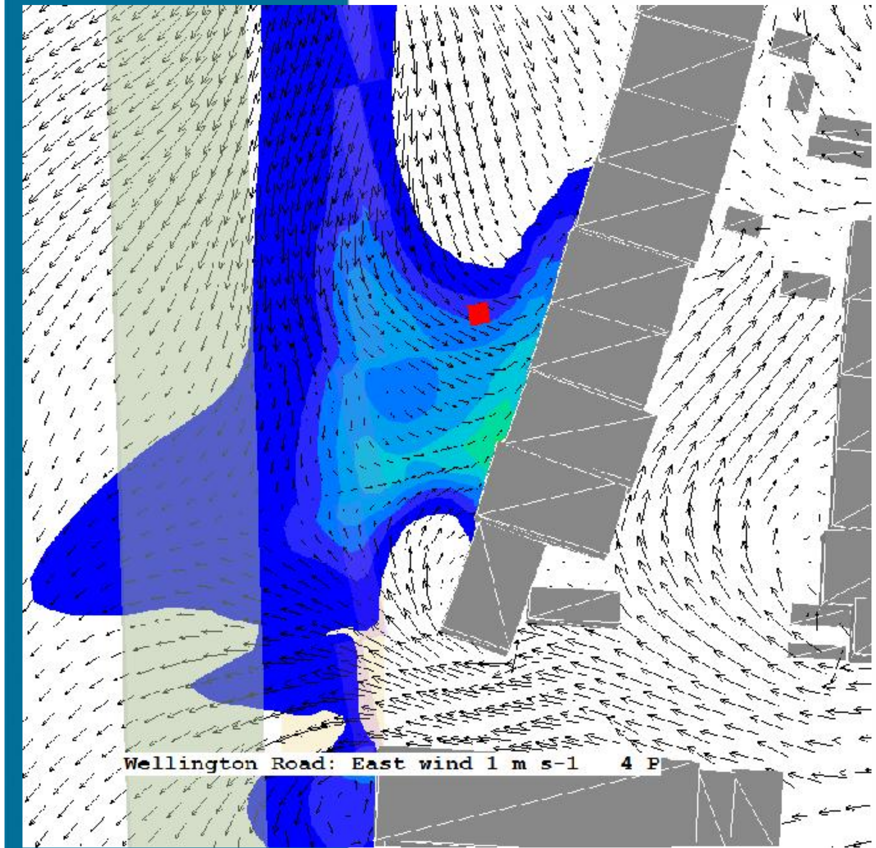
- Building Geometry? Emissions underestimated?
- ADMS predicts pollutants advected to west on Easterly wind when high concentrations observed

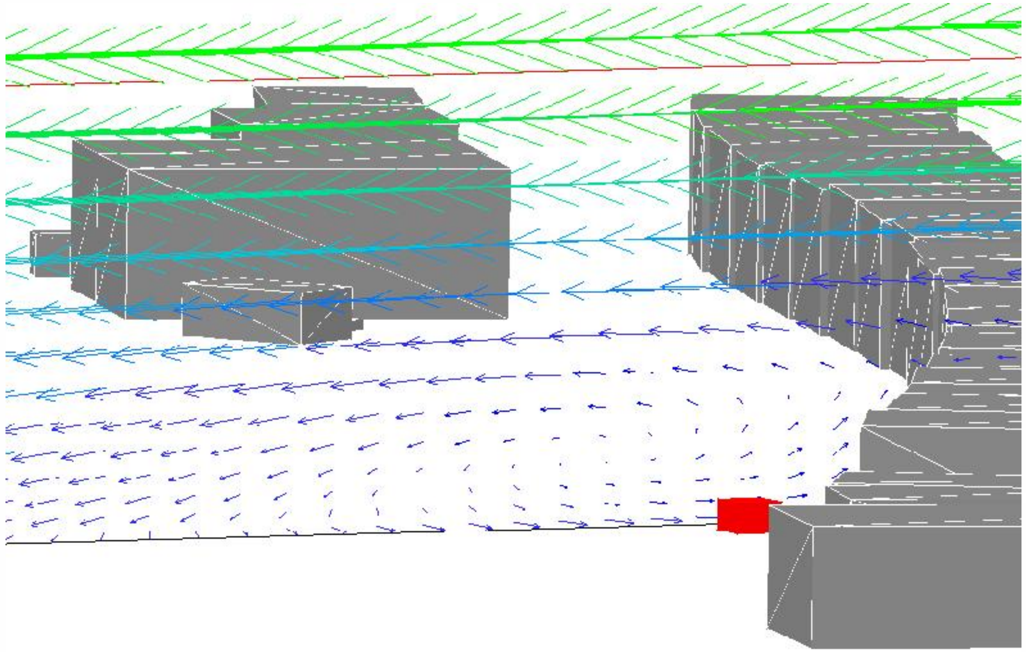
Monitor Location



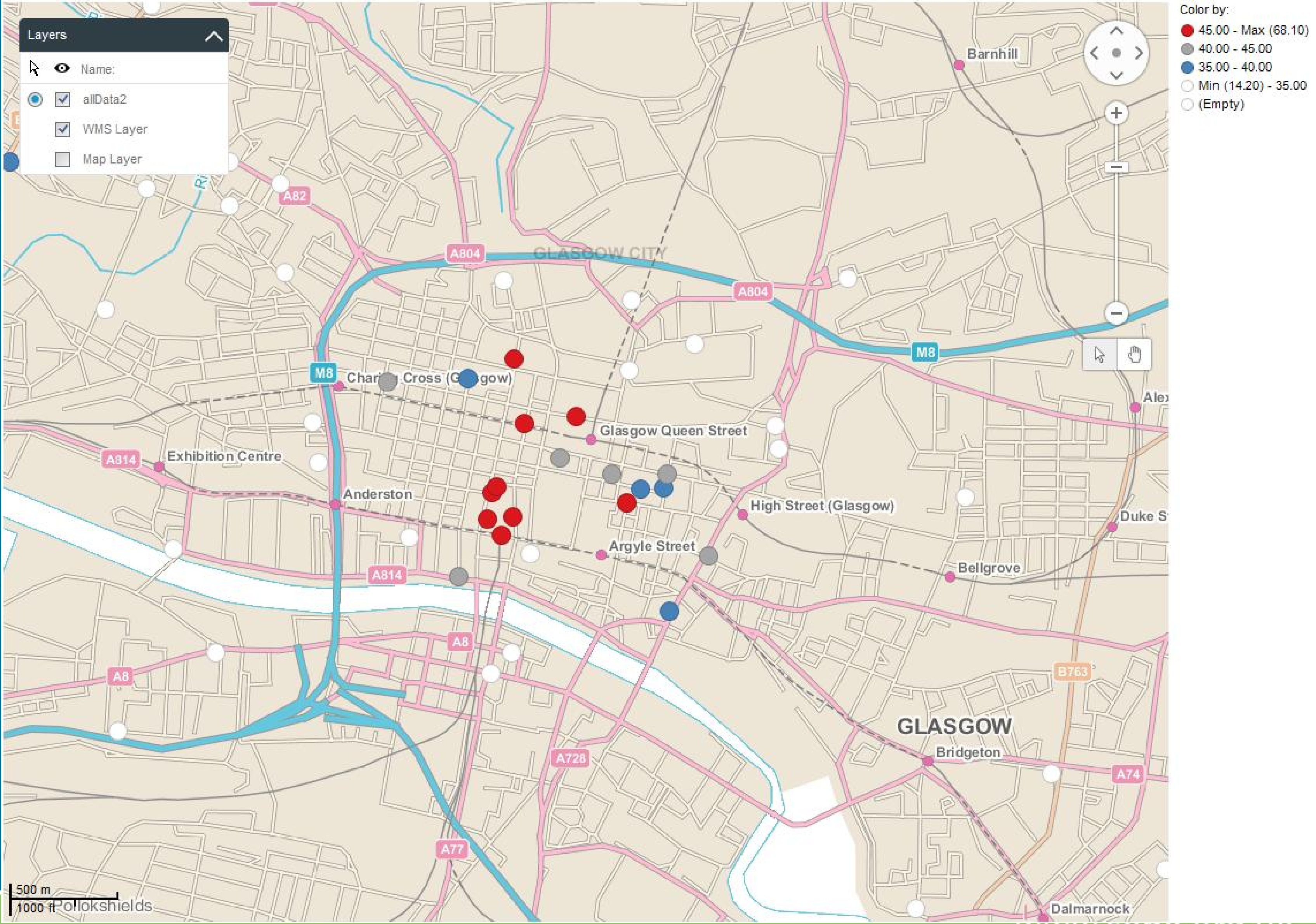
Wellington Road: CFD East Wind

- Local air flow at ground level is North-Easterly
- CFD shows recirculation zone at monitor

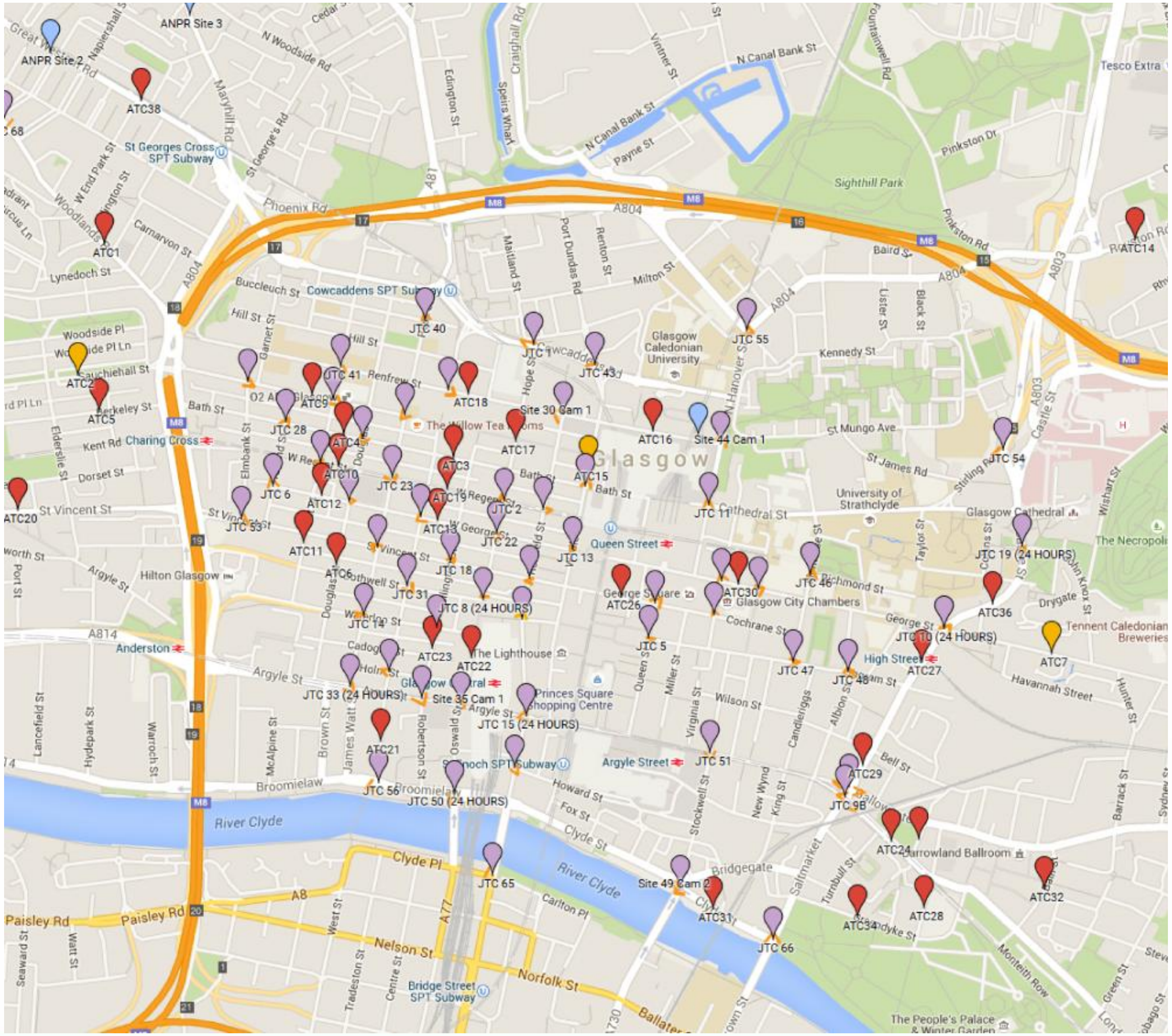




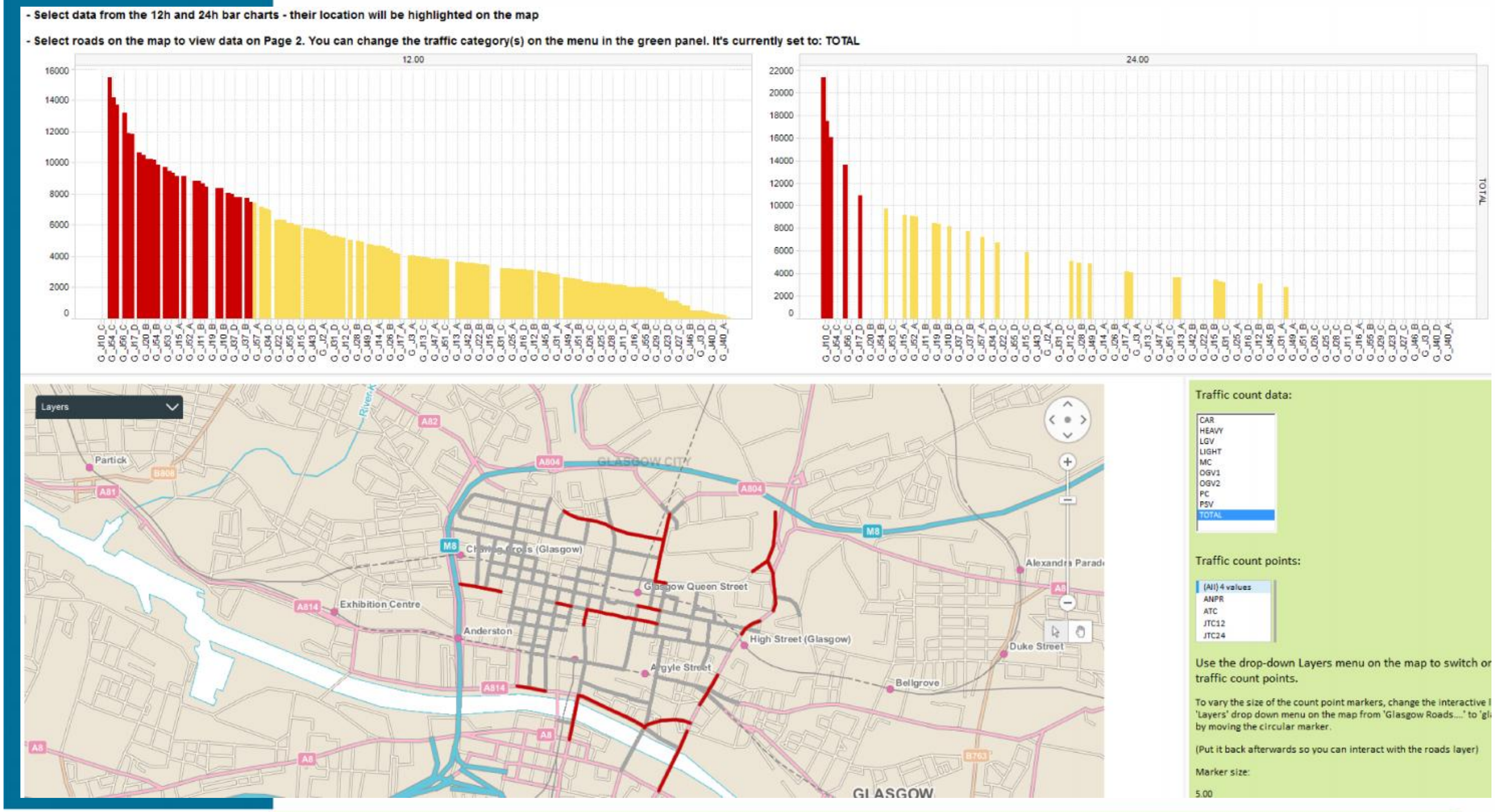
Glasgow: NO_2 Concentrations



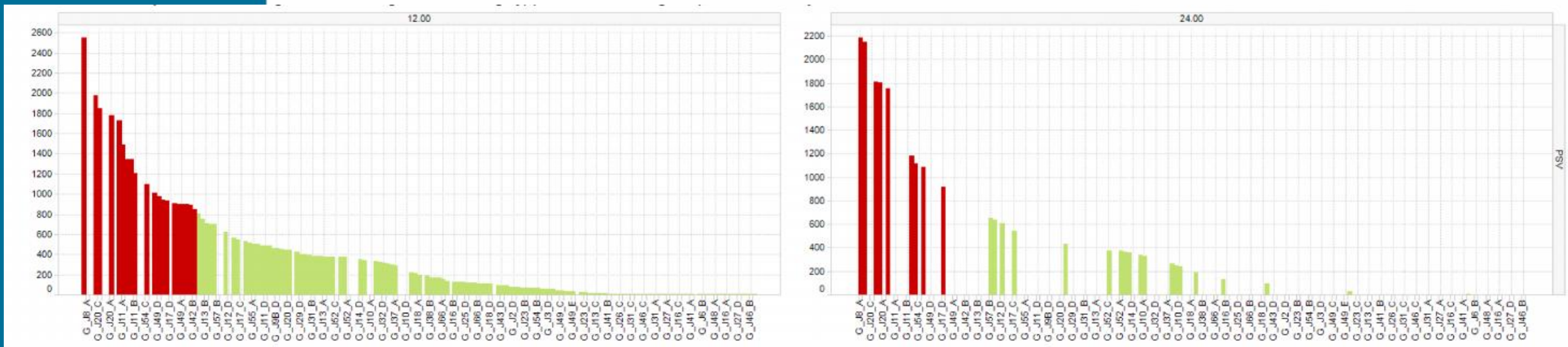
Glasgow: Traffic Data Collection

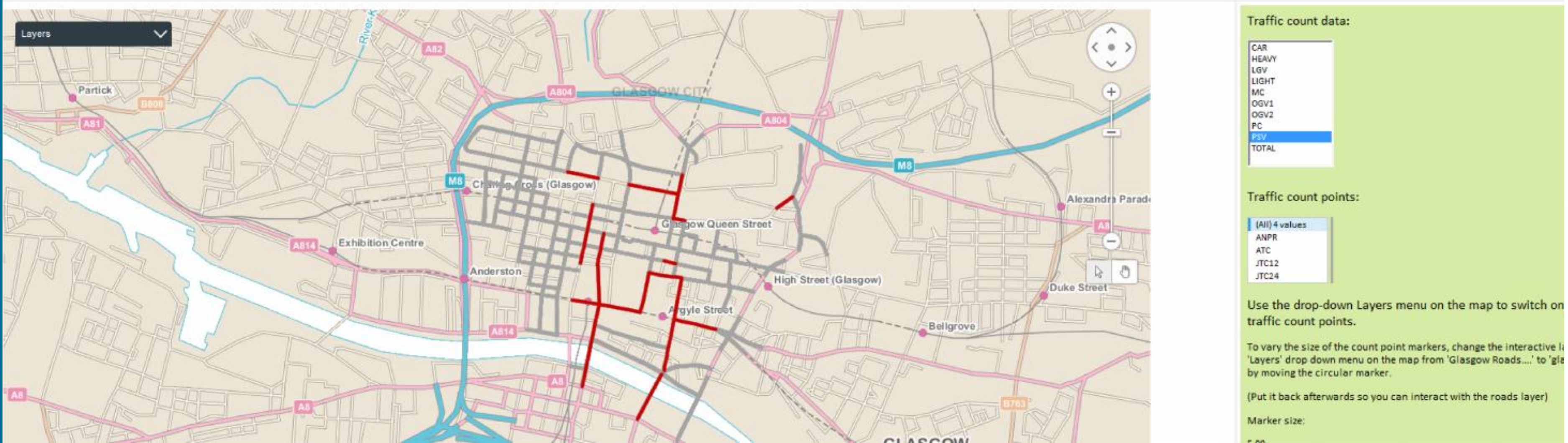


Glasgow: Traffic Data Collection (Total Traffic)



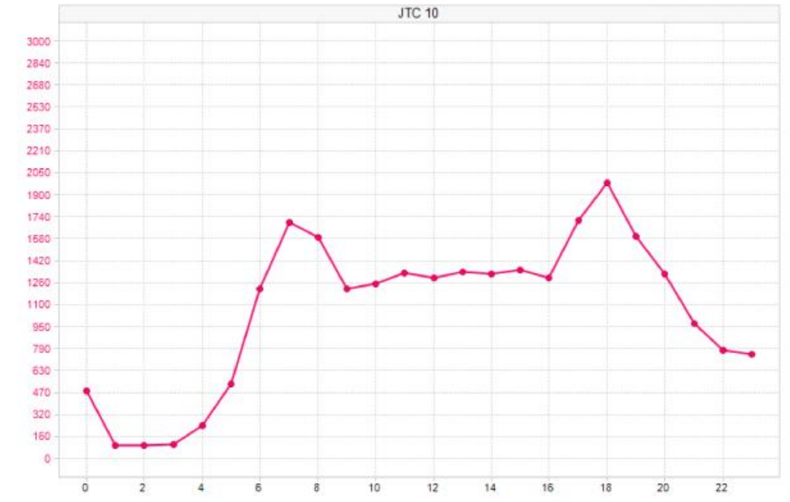
Glasgow: Traffic Data Collection (PSV Traffic)

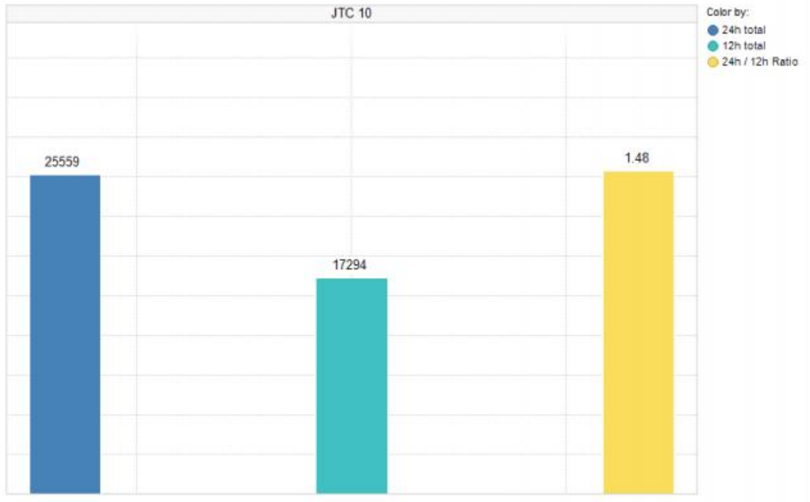


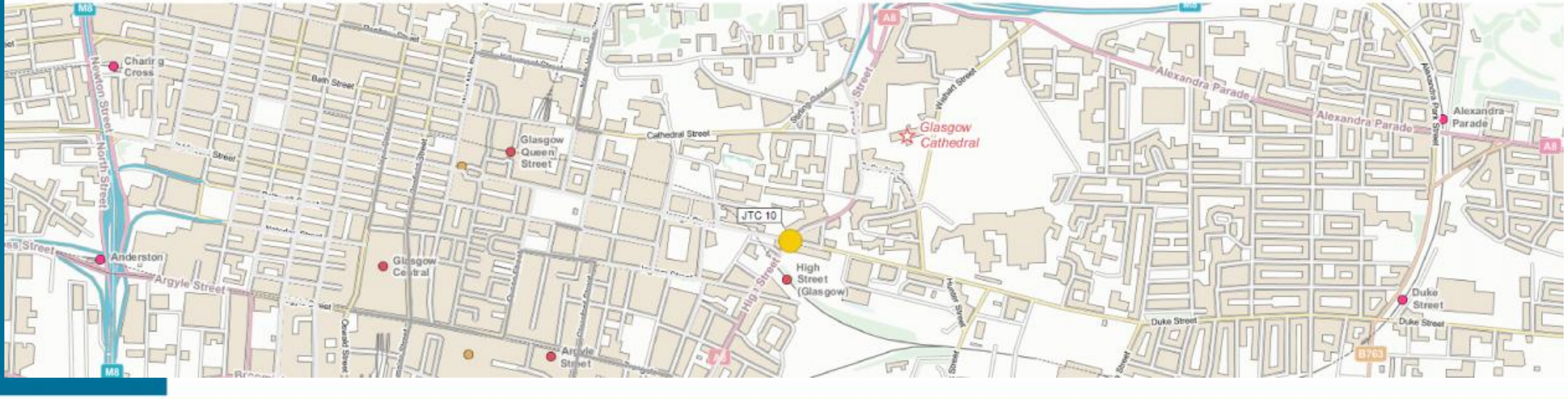


Glasgow: Traffic Data Collection

- Similar 12 to 24 hour AADF conversion rates to Aberdeen (~1.48)

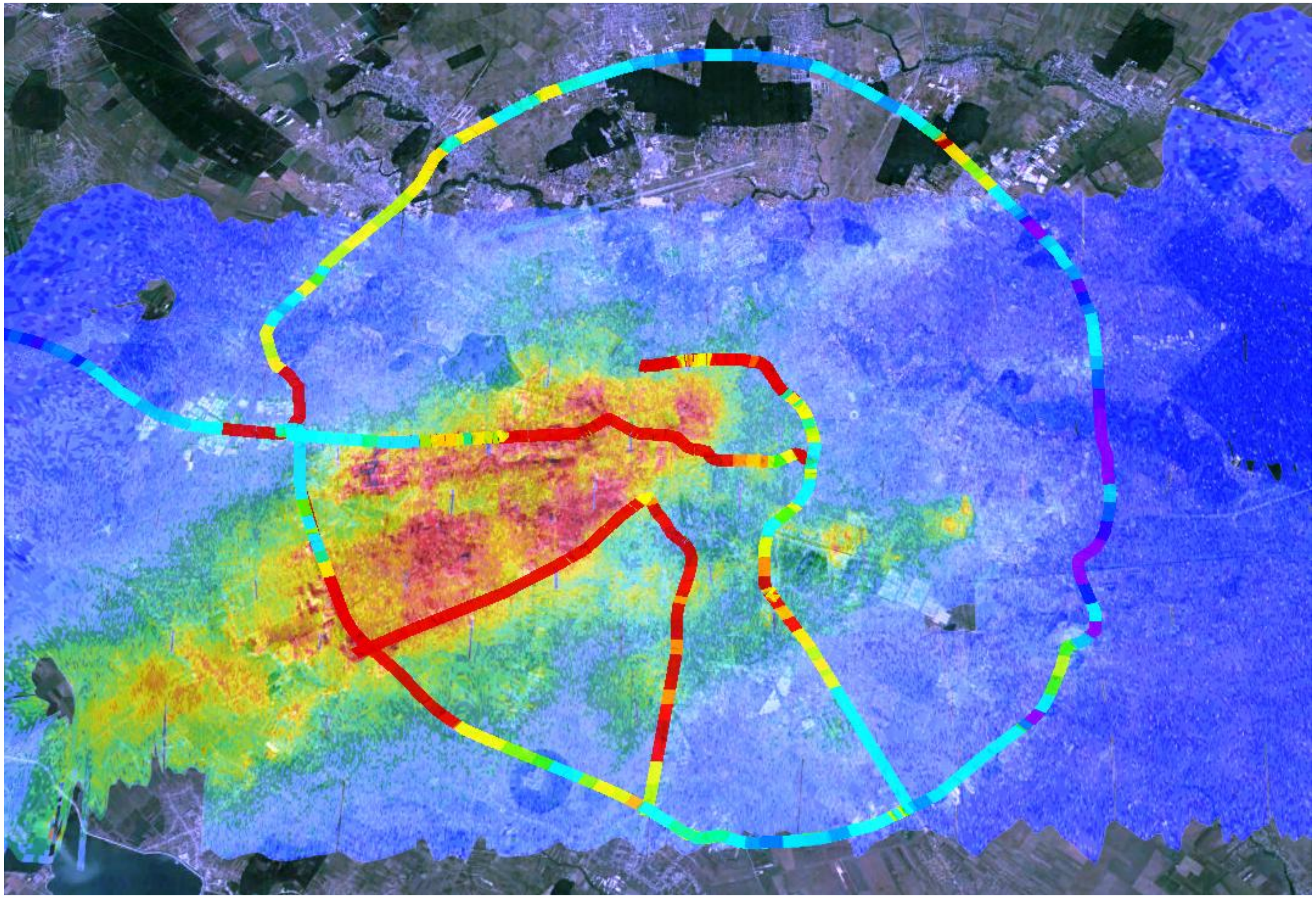






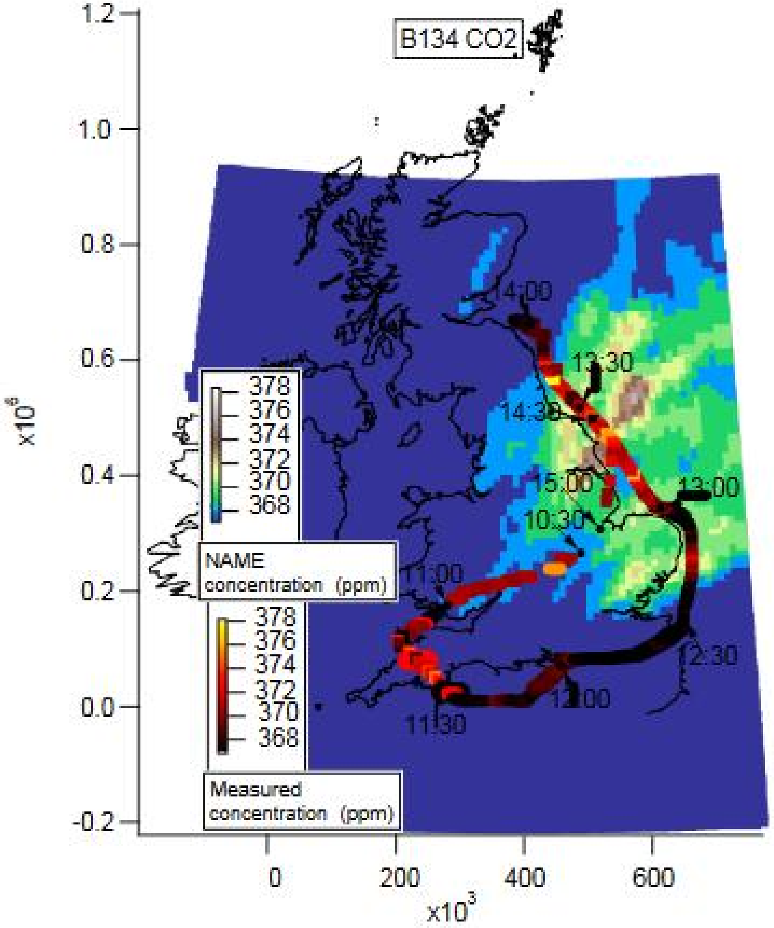
Glasgow: CFD modelling

Bucharest NO_2 Concentration



Source: ESA

National Modelling/Measurements



Source: CEH

Summary

- Aberdeen Pilot Project identified:
  - Key data required (e.g. Traffic)
  - Background data (different background types)
- Glasgow project:
  - Traffic survey complete
  - Model build underway

Acknowledgements

- Aileen Brodie and Nick Glover, Aberdeen City Council
- Andrew Taylor, Scottish Government
- Dom Callaghan and Vincent McInally, Glasgow City Council
- SEPA Colleagues (Alan Hills, Eddy Barratt, Fraser Gemmell, Colin Gillespie, John Lamb, Chris Connor)

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Lighthouse - Glasgow – 13th June 2016

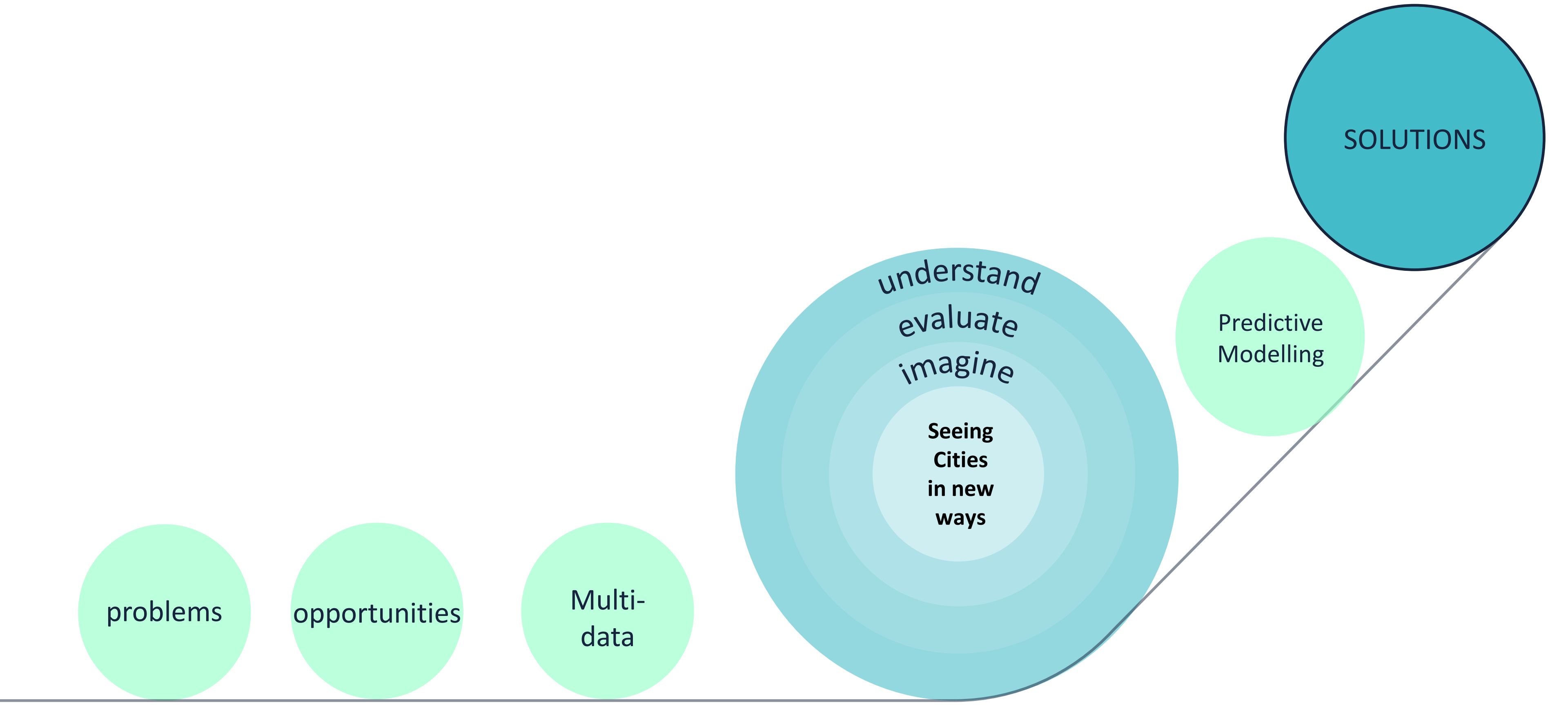
Janette Hughes – Project manager for City Observatory

Innovate UK
Technology Strategy Board

Glasgow CITY COUNCIL

Vision and Mission

What is a City Observatory?



City Observatory

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CENSIS

Challenge – to understand AQ throughout the City -

“Sensing The City” mobile air quality (AQ) system.

- Reduction in emissions with targets from EU, UK and Scotland

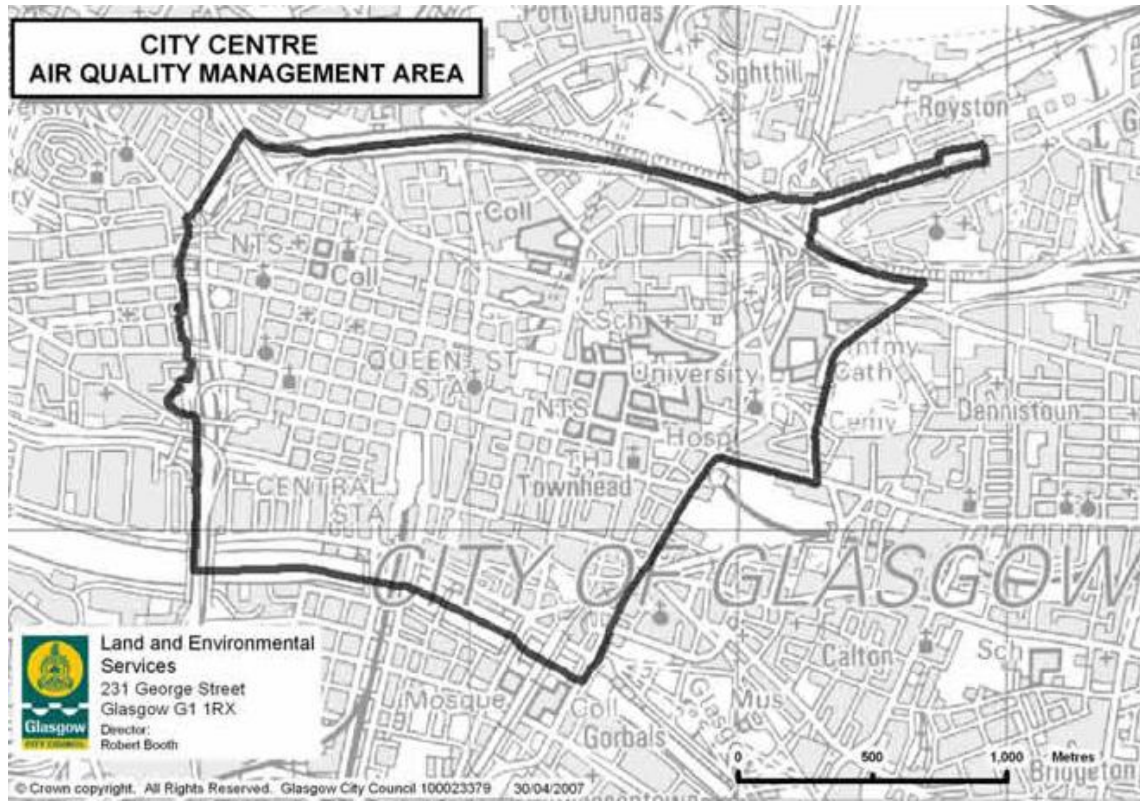
Table 1. EU, UK and Glasgow carbon and greenhouse gas targets

Source	Baseline year	Target 2020	Target 2030	Target 2050
EU policy framework for climate and energy	1990	–	40%	–
EU Europe 2020 strategy, 2010	1990	20% CO_2		
Climate Change Act (UK), 2008	1990	34% CO_2		80% CO_2
Climate Change (Scotland) Act[1], June 2009	1990	42% GHG	50% GHG	80% GHG
Glasgow SEAP, 2010	2006	30% CO_2	none	none

[1]The reduction targets include emissions from international aviation and shipping, six GHG(greenhouse gases), including CO_2

Ref – Energy and Carbon Masterplan – Sustainable Glasgow

Traditional methods deployed make it challenging to monitor all areas



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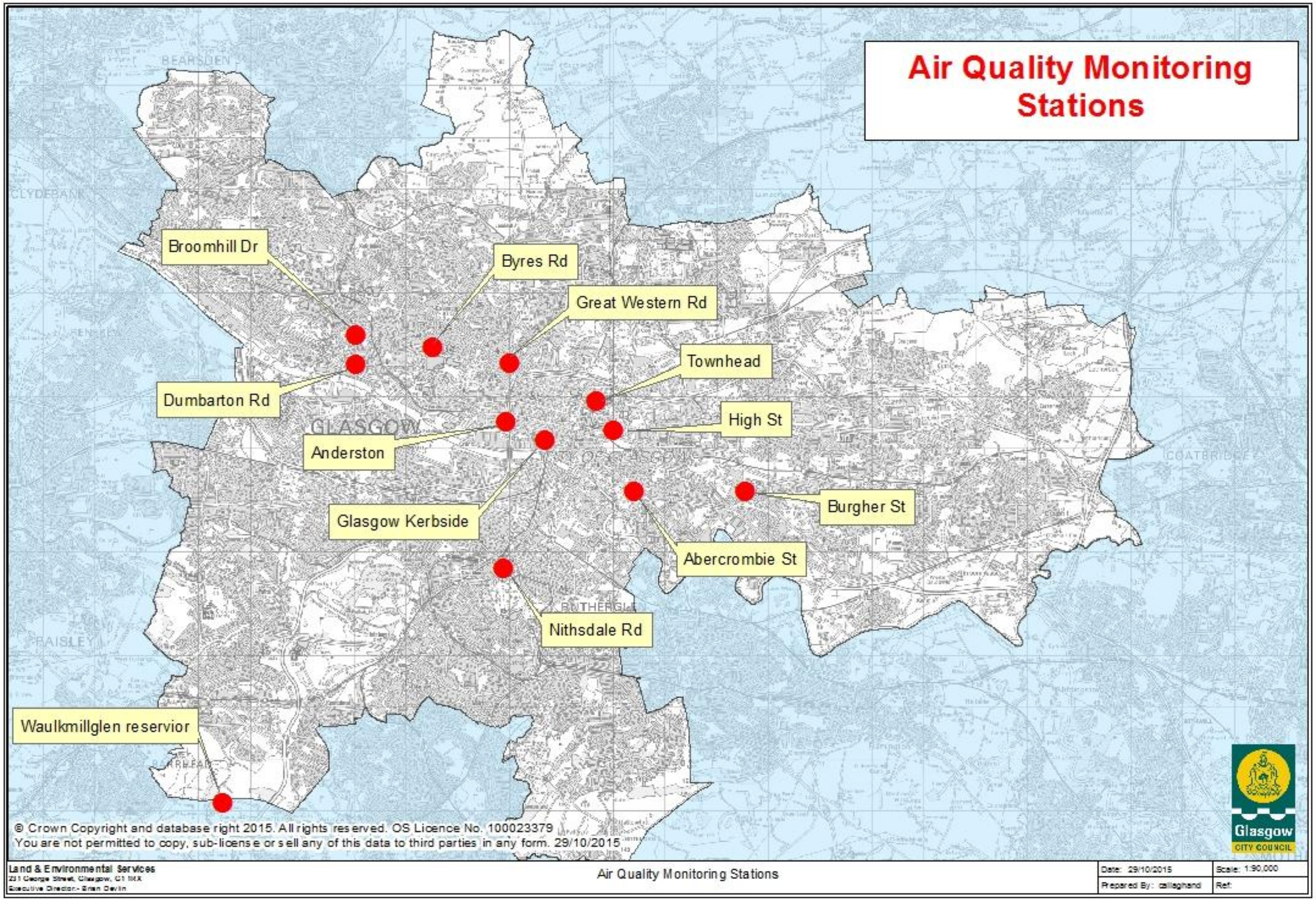
Static AQ Stations in Glasgow



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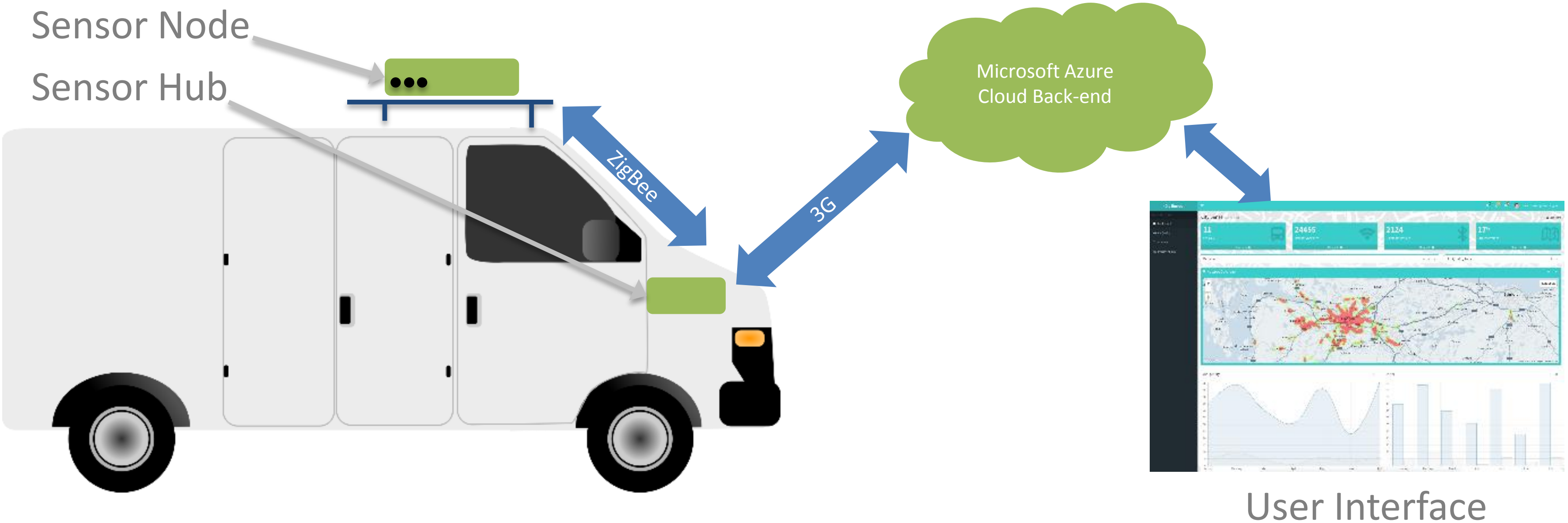
Overview of Mobile AQ System



Mobile AQ system currently consists of two physical units:

(i) **Sensor Node** which collects data and manages the sensors, before wirelessly communicating with the Hub.

(ii) **Sensor Hub** accepts data from the Node, seeks GPS location data and manages data upload to cloud database.

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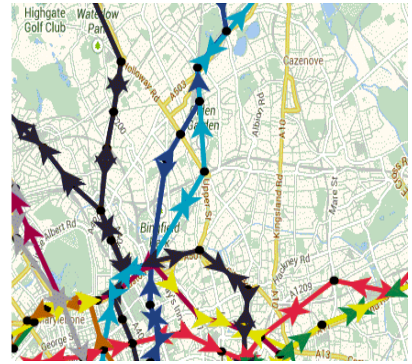
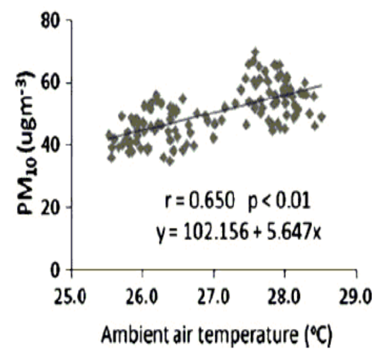
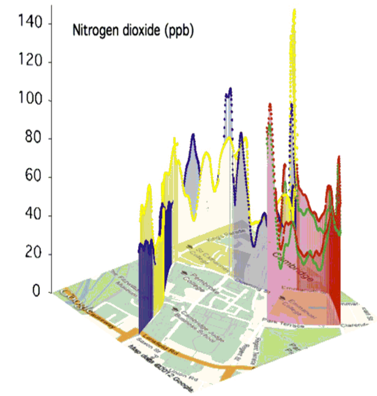
AQ Data Analysis

(1) Data Cleansing



(2) Calibration and Drift Correction with Static Sensors





(3) Models for Prediction Spatial/Temporal

(4) Visualisation and Interpretation

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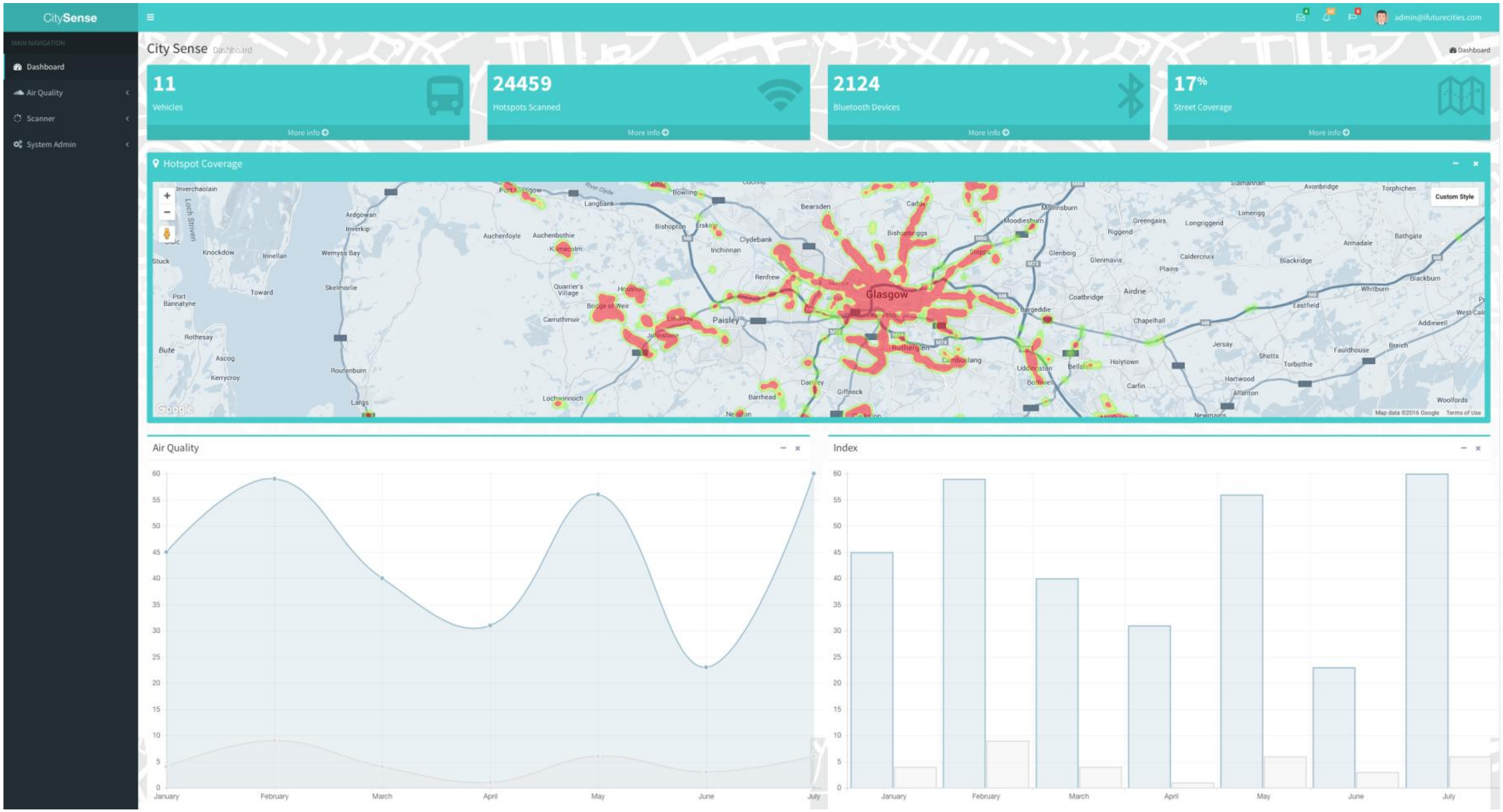
Dashboard



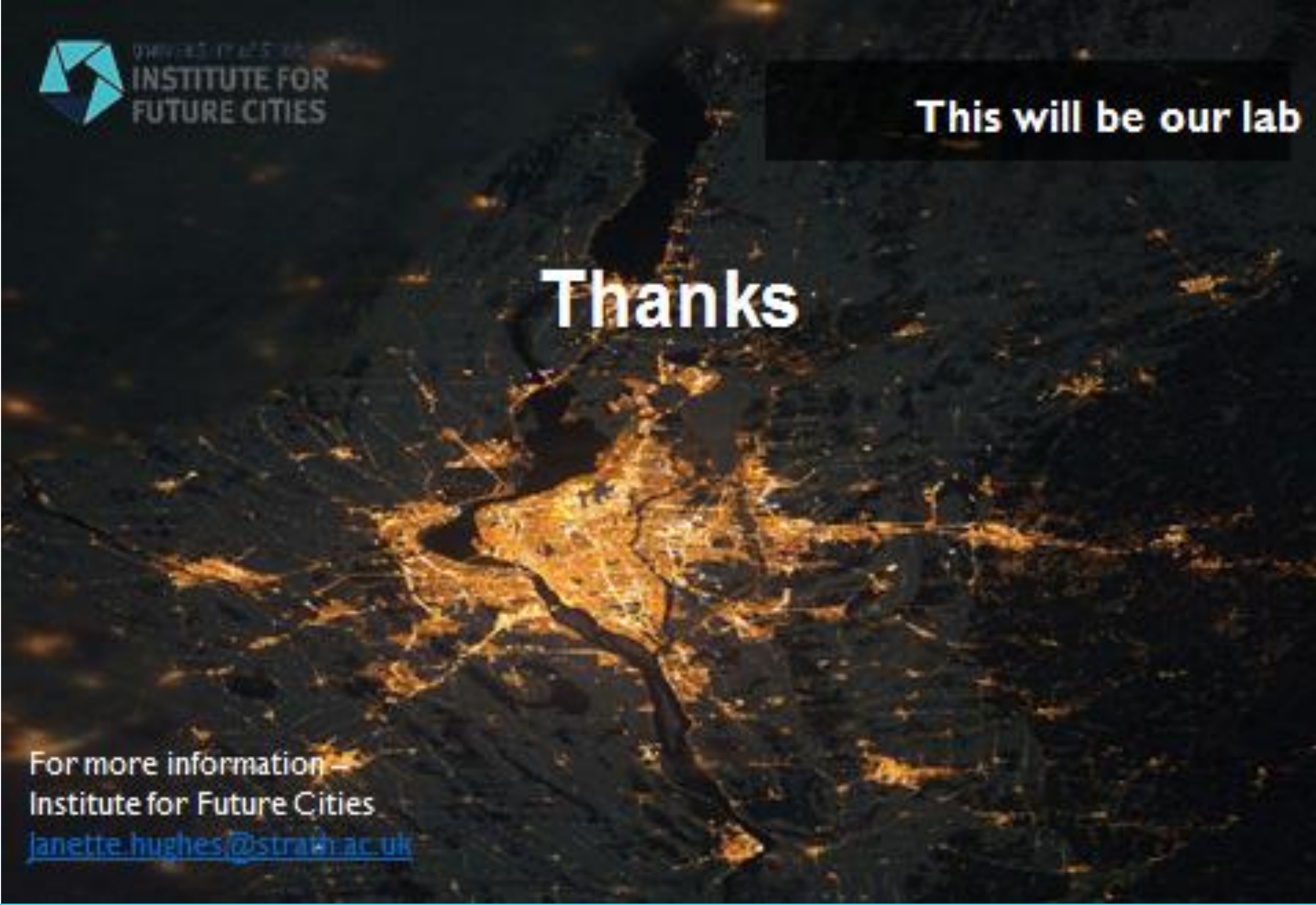
A web-based user interface visualises data, allows interaction with the cloud services & includes capability to embed data processing and analytics outputs.

System Capabilities

- Highlight of current capabilities:
  - **Reliable** capture of sensor readings in near real-time.
  - **Low-cost** and flexible system.
  - **Robust** system operation.
  - **Efficient** cloud-based data gathering platform.
  - **High Density Geo-Spatial** visualisation of AQ data.
  - **Remote** access allowing Over-the-air (OTA) updates.

Not constrained

A living lab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This will be our lab
Thanks
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