Quantifying Personal Pollution Impacts to Inform Transport Scheme Innovation through New Generation Mobility Data

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http://habitsdata.org/

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Introduction – *habits*

HABITS will take 'track and trace' (T&T) data collected in a transport policy context and explore the challenges, opportunities, methodologies and policy implications related to its use in reducing individual health burdens

Working with Newcastle City Council, HABITS utilises T&T data collected in a new travel app.

Ongoing schemes within Newcastle will be studied to provide insight into policy benefits

Opportunity to show benefits of initiatives to public

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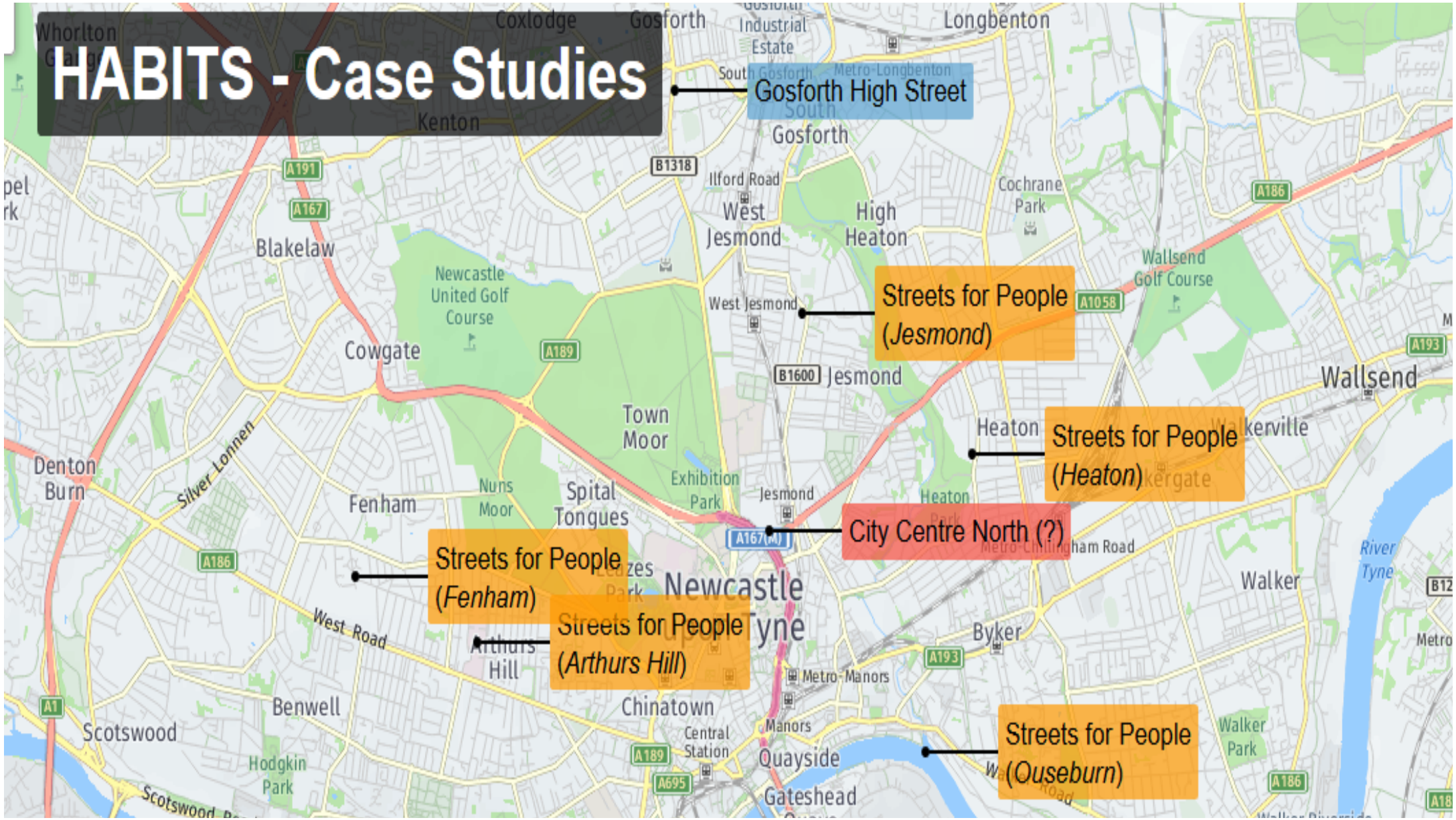
HABITS - Case Studies
Gosforth High Street
Streets for People (Jesmond)
Streets for People (Heaton)
City Centre North (?)
Streets for People (Fenham)
Streets for People (Arthurs Hill)
Streets for People (Ouseburn)
Whorlton
Coxlodge
Gosforth
Industrial Estate
Longbenton
Kenton
South Gosforth
Metro-Longbenton
Gosforth
B1318
Ilford Road
West Jesmond
High Heaton
Cochrane Park
A186
A191
A167
Blakelaw
Newcastle United Golf Course
Wallsend Golf Course
A1058
A189
Cowgate
B1600
Jesmond
Wallsend
Town Moor
Heaton
Walkerville
Denton Burn
Silver Lonnen
Exhibition Park
Nuns Moor
Spital Tongues
Fenham
A167(M)
A186
Leazes Park
Newcastle upon Tyne
Metro-Chillingham Road
River Tyne
Walker
West Road
Arthurs Hill
Byker
A193
Metro-Manors
Benwell
Chinatown
Scotswood
A1
Central Station
Manors
Quayside
Walker Park
Hodgkin Park
A189
A695
Gateshead
A186

Research Objectives

Demonstrate how the linking of high-resolution location data and other databases / models can support better policy making:

Linking of location, activity and air quality data can be used to more accurately quantify individual exposure to air pollution

Linking of location-activity data and existing health databases / models can support better targeted policies

Develop insights on the role of new data in decision-support and policy making in the public sector.

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Background: Pollution

In the UK: outdoor air pollution exposure contributes to 40,000 deaths each year [1].

Exposure calculated using *residential* location substantially underestimates the effect [2-4]

Health Effects Institute: personal exposure and time-activity data are “best” [5]

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Background: Pollution

Can **high-resolution location and activity data**, coupled with **reliable models of air quality**, be used to more accurately **quantify** the true **exposure** of individuals to air pollution and derive robust spatio-temporally explicit **policies to reduce this disease burden**.

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How to Quantify Exposure?

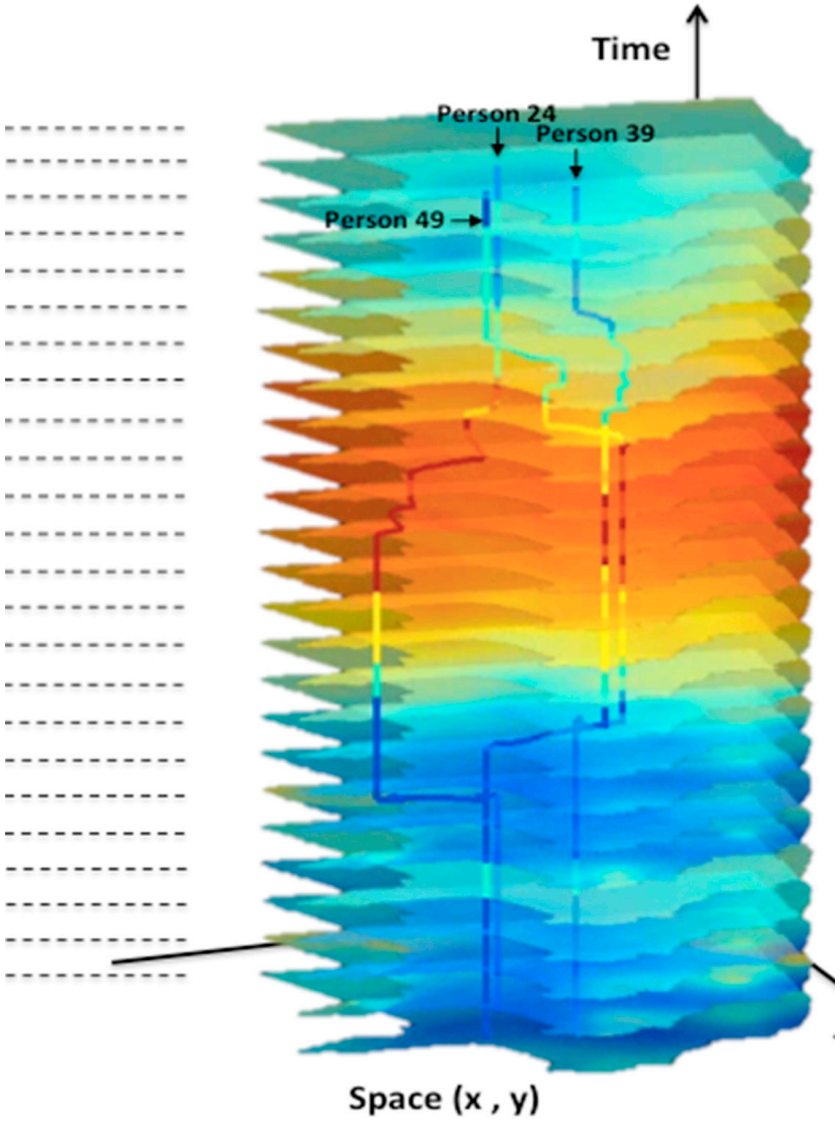
Following: Park, Yoo Min, and Mei-Po Kwan (2017). Individual Exposure Estimates May Be Erroneous When Spatiotemporal Variability of Air Pollution and Human Mobility Are Ignored. *Health & Place* 43: 85–94

But with a larger, real (not simulated), more representative sample

Data requirements:

- Time-activity (aka 'Track and Trace') data
- Spatio-temporal pollution estimates

Source: Park and Kwan (2017)



Data Requirement 1: Time-Activity Patterns

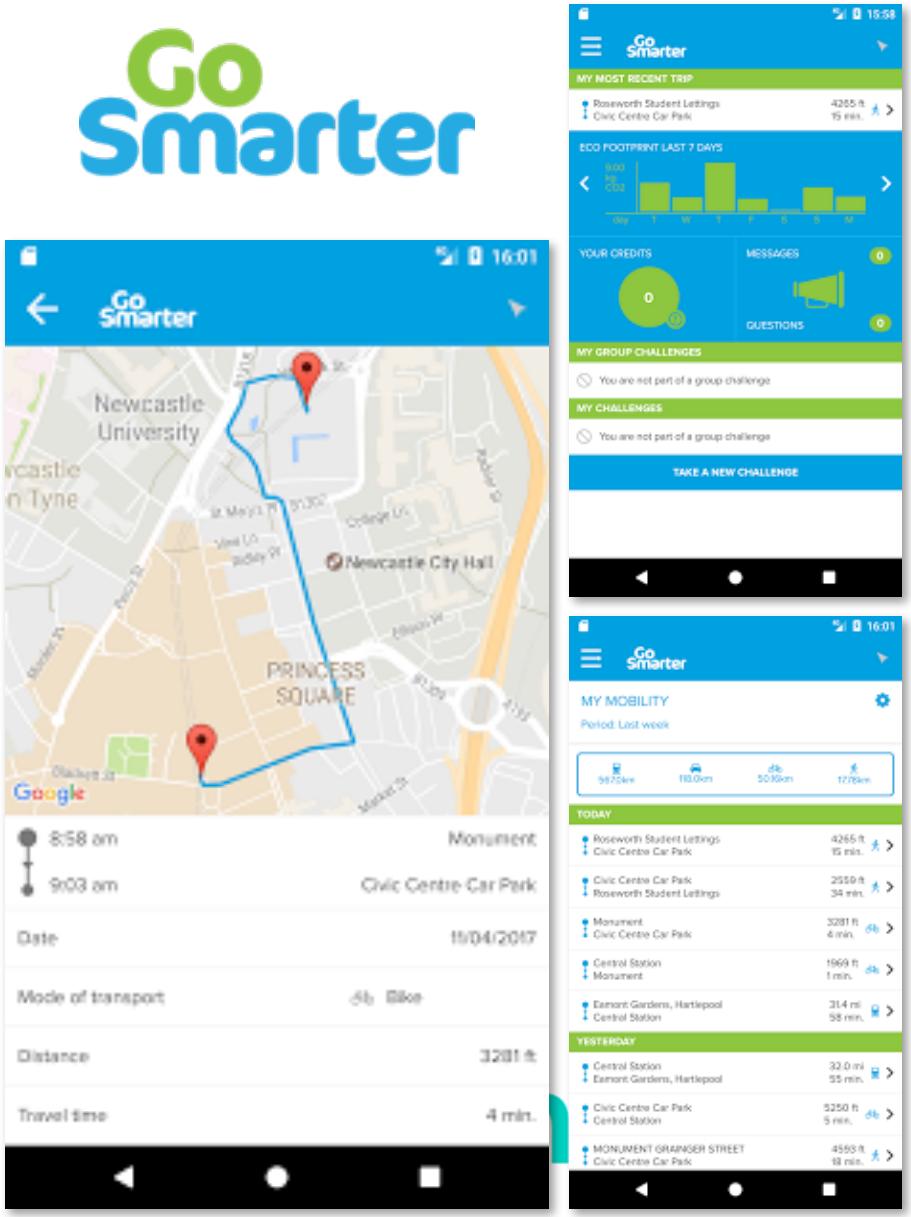
Smart-phone app built in collaboration with Newcastle City Council

Detects when the user is moving and tracks journeys

Estimates mode of travel

Rewards for using active / sustainable modes of travel

https://play.google.com/store/apps/details?id=nl.mobidot.gosmarter



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Data Requirement 2: Pollution Estimates
DEFRA

Department for Environment, Food and Rural Affairs produce pollution estimates (measured and modelled)

EU requirement for air quality compliance

http://cdr.eionet.europa.eu/gb/eu/aqd

High quality, but sparse spatio-temporal resolution

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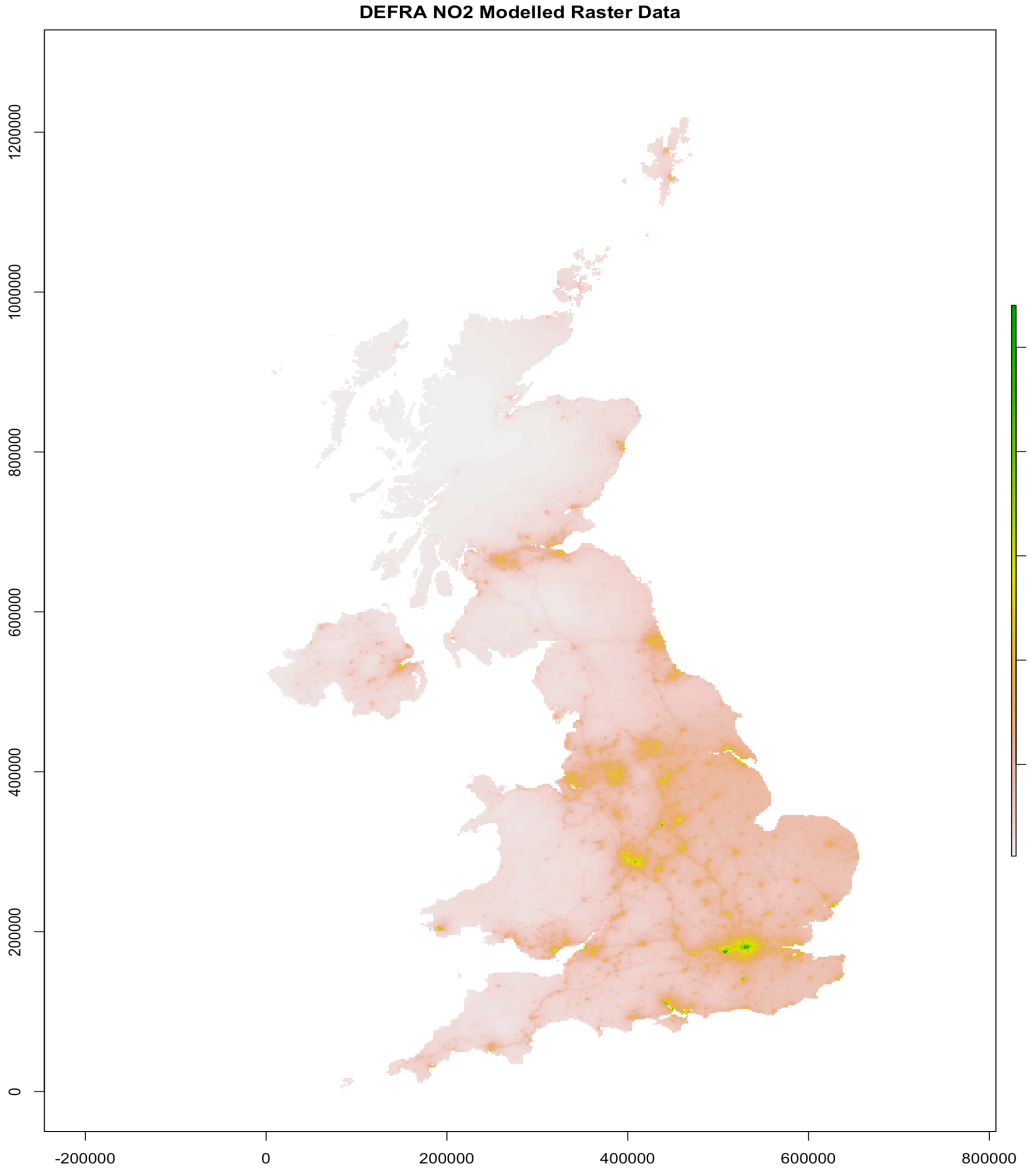
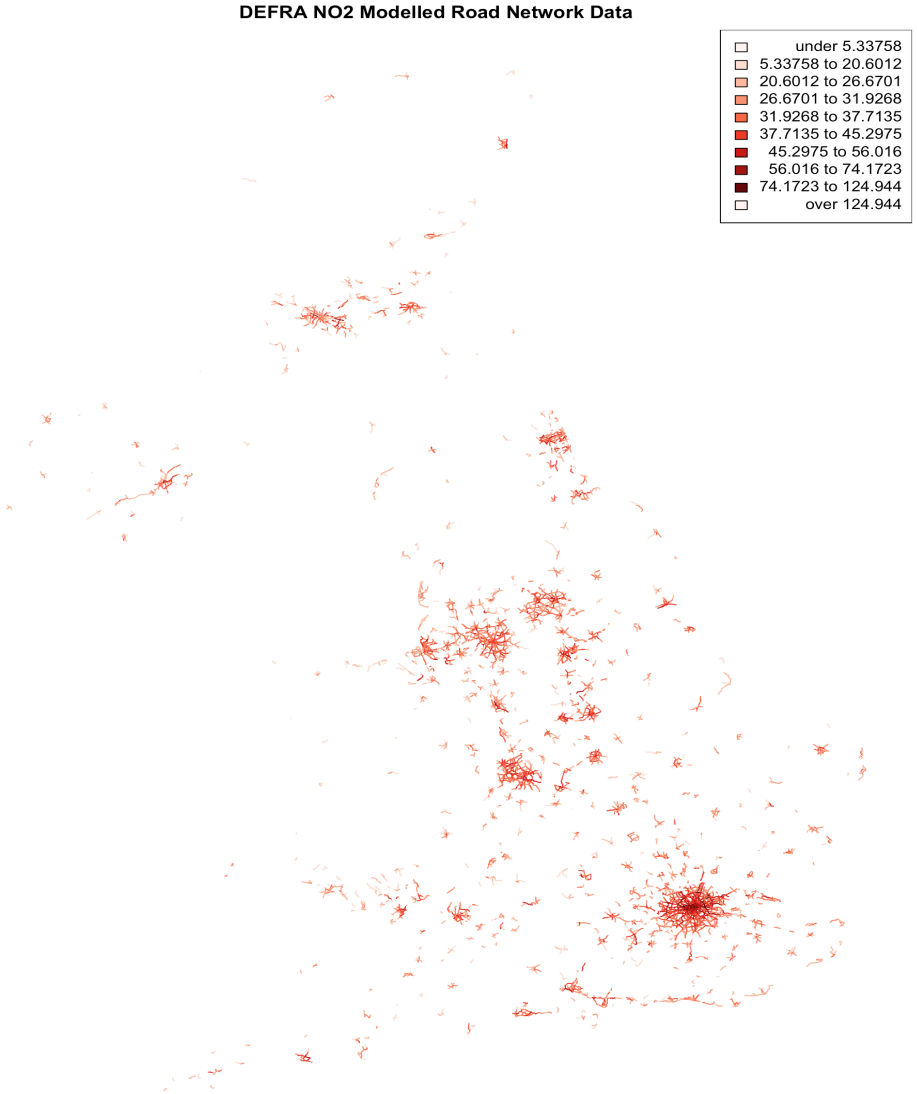
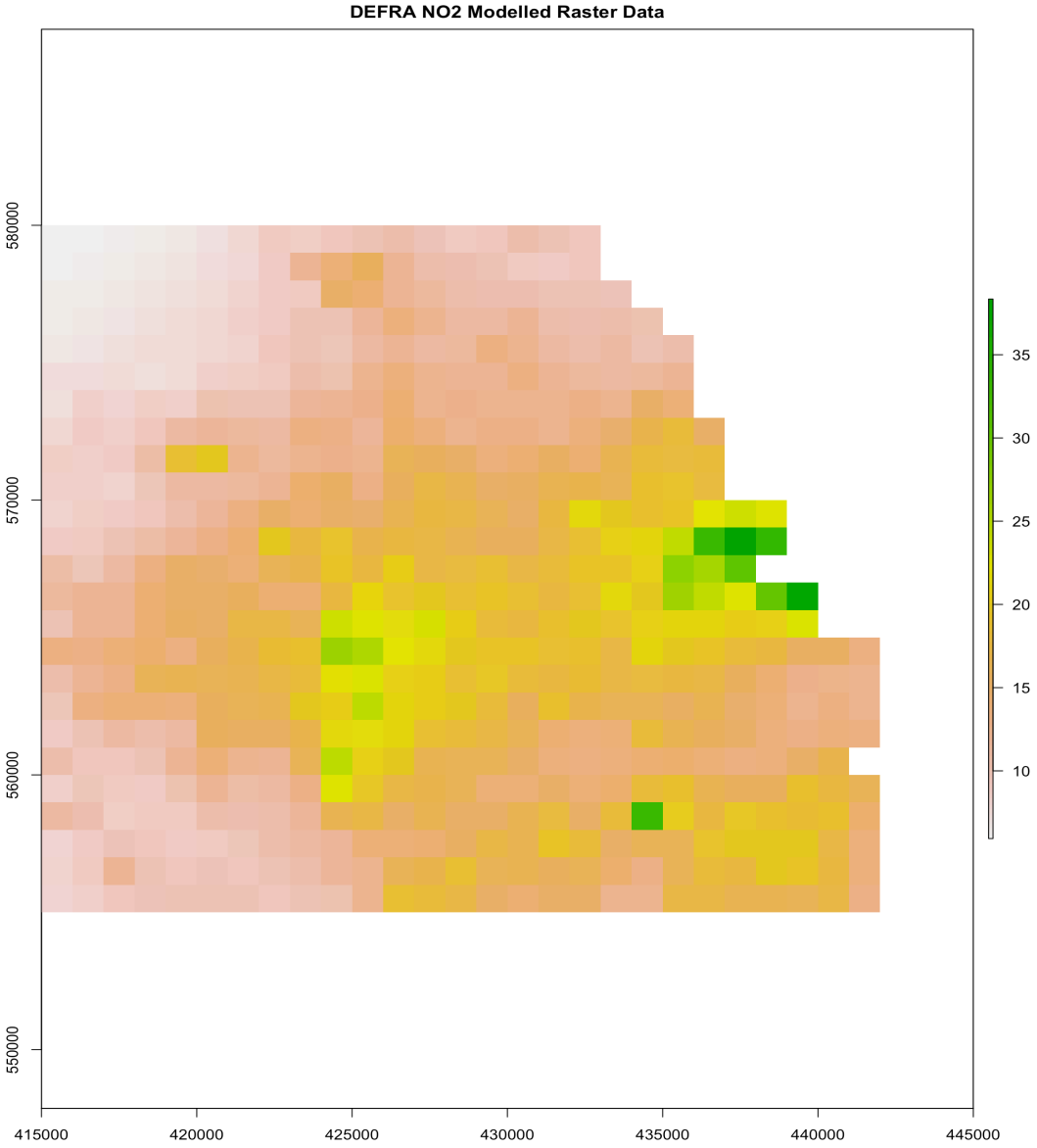
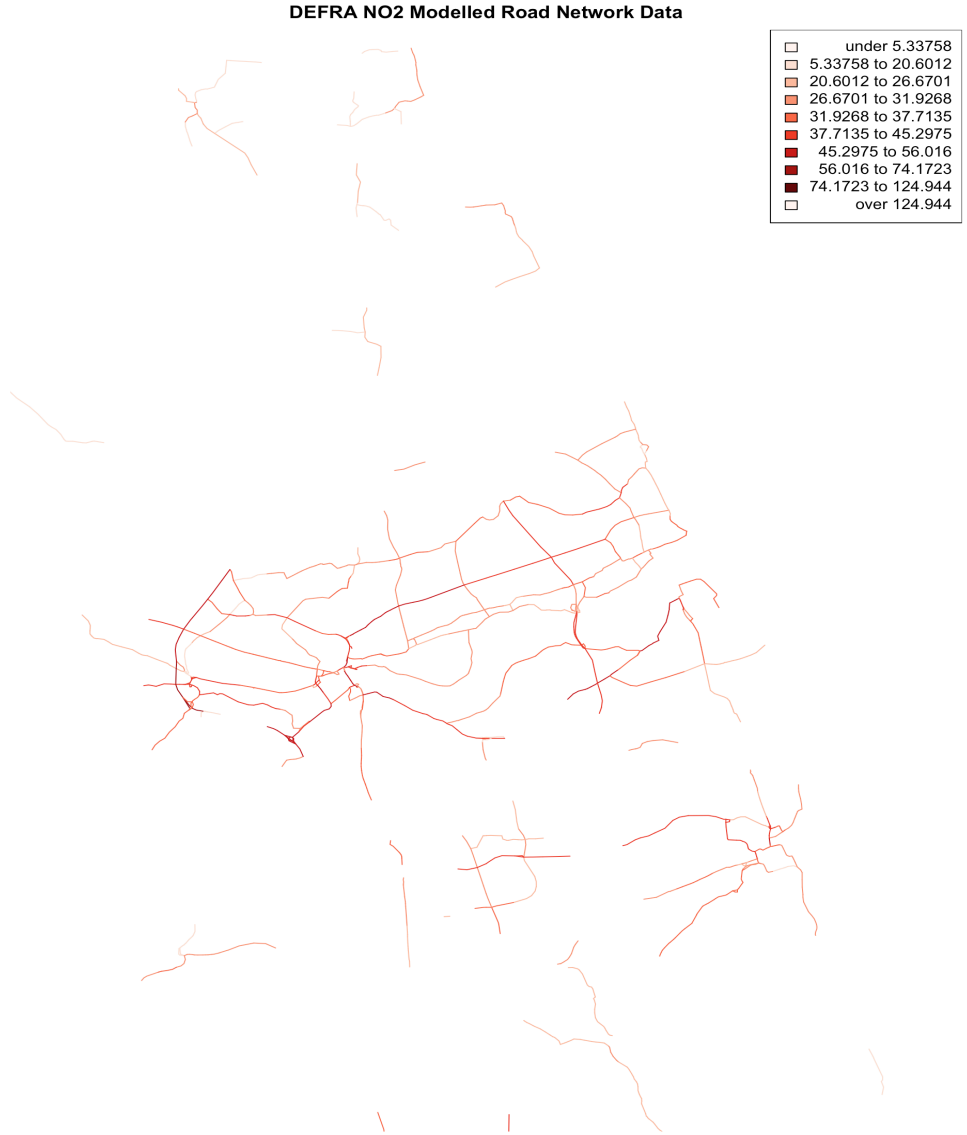

DEFRA NO2 Modelled Raster Data
1200000
1000000
800000
600000
400000
200000
0
-200000
0
200000
400000
600000
800000
50
40
30
20
10


DEFRA NO2 Modelled Road Network Data
under 5.33758
5.33758 to 20.6012
20.6012 to 26.6701
26.6701 to 31.9268
31.9268 to 37.7135
37.7135 to 45.2975
45.2975 to 56.016
56.016 to 74.1723
74.1723 to 124.944
over 124.944

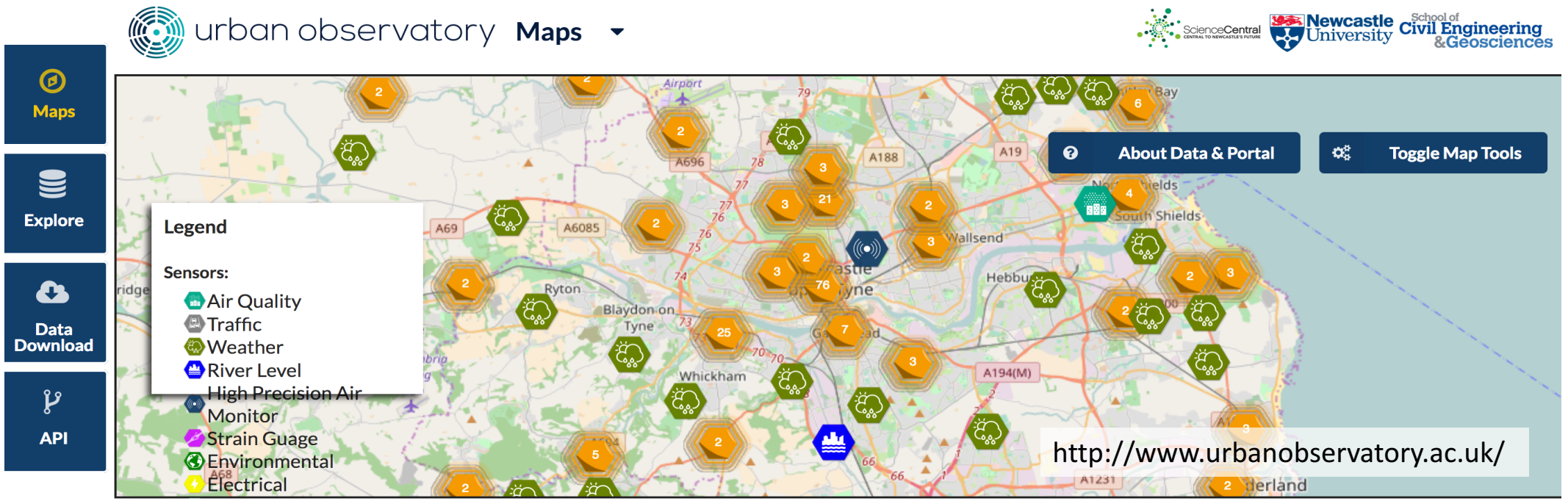

DEFRA NO2 Modelled Raster Data
580000
570000
560000
550000
415000
420000
425000
430000
435000
440000
445000
35
30
25
20
15
10


DEFRA NO2 Modelled Road Network Data
under 5.33758
5.33758 to 20.6012
20.6012 to 26.6701
26.6701 to 31.9268
31.9268 to 37.7135
37.7135 to 45.2975
45.2975 to 56.016
56.016 to 74.1723
74.1723 to 124.944
over 124.944

Data Requirement 2: Pollution Estimates

Urban Observatory Sensors

Maintain a large number of environmental sensors in and around Newcastle, including air quality, traffic, parking, sound, etc.



Pollution Data (Urban Observatory)

Bespoke data extract

- 168 NO_2 and CO sensors
- 1 year data: September 2016 – September 2017
- 74M observations (40M NO_2)

Variety of sensor models; variable quality

- From industry standard to “random noise generators”

Immediate future work: calibration and cleaning

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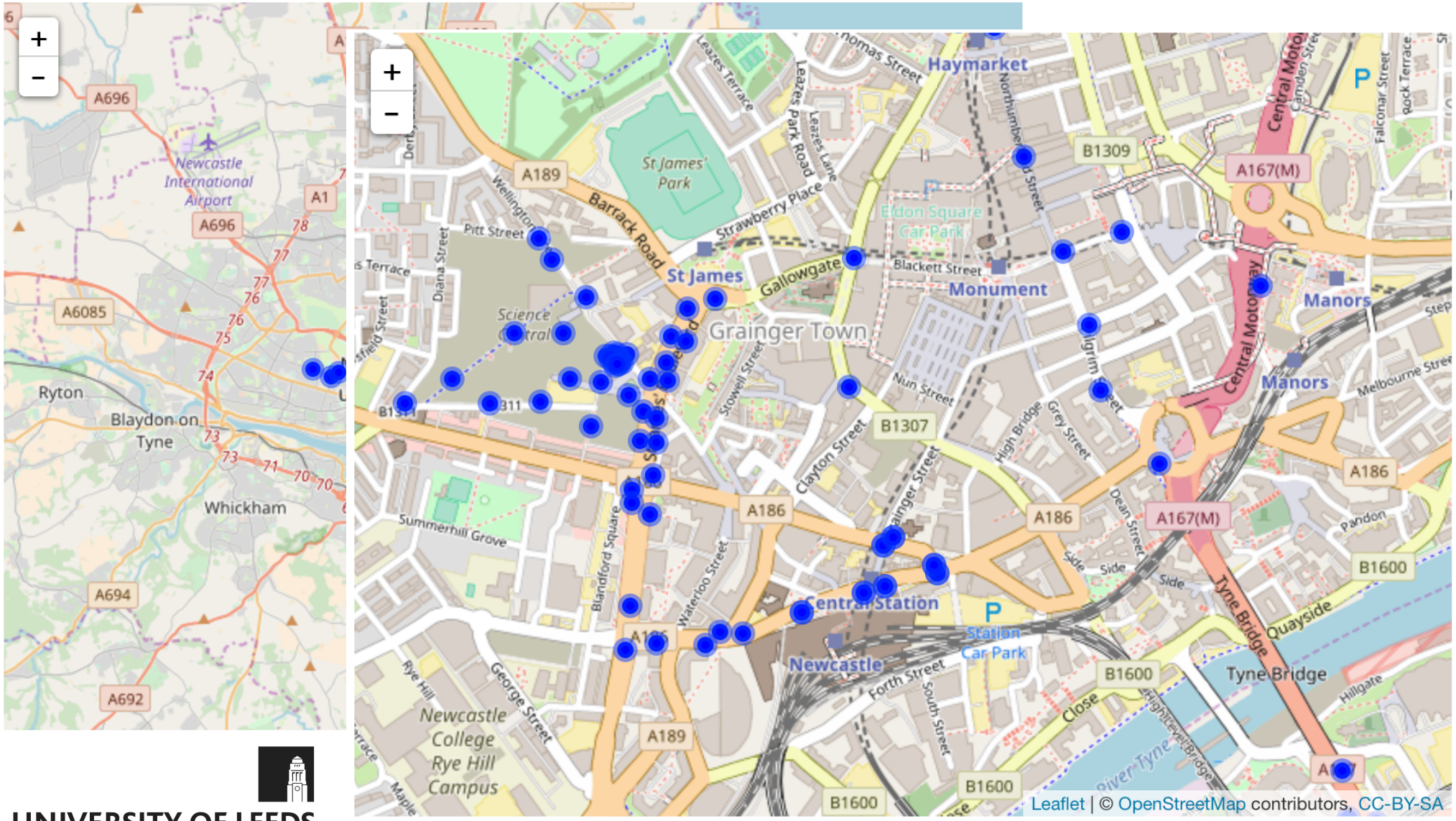

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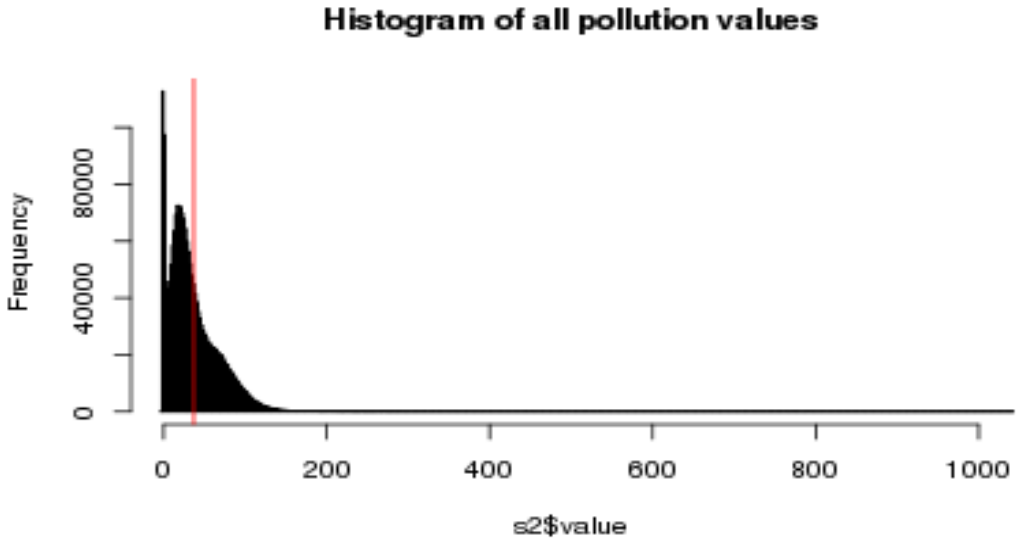
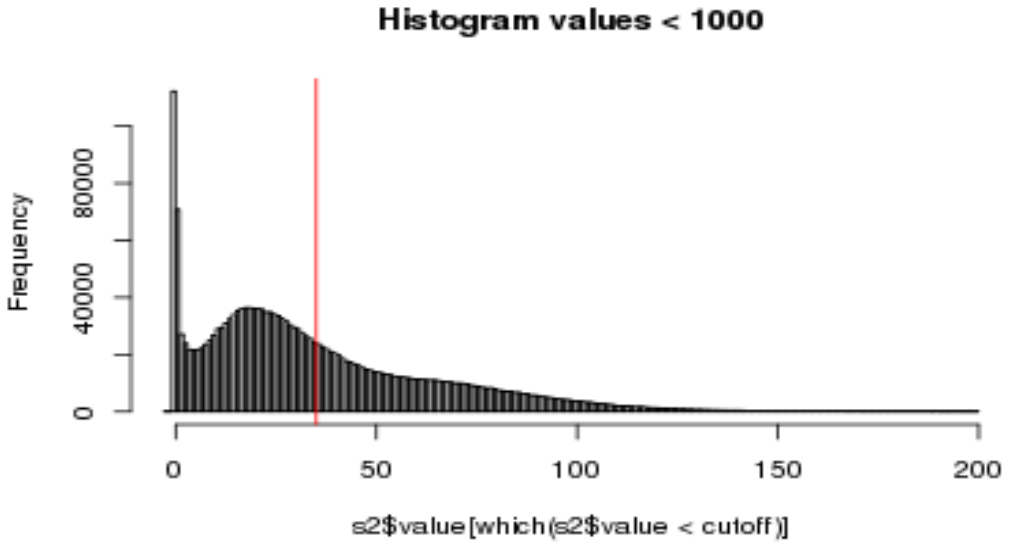
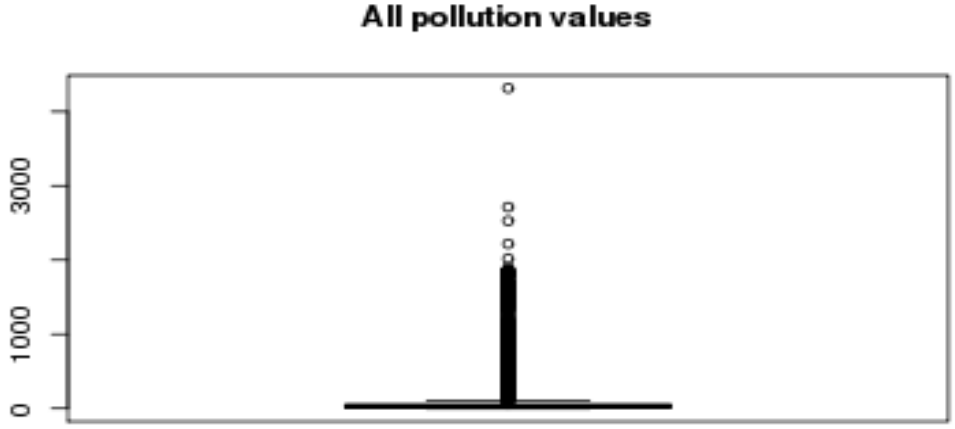
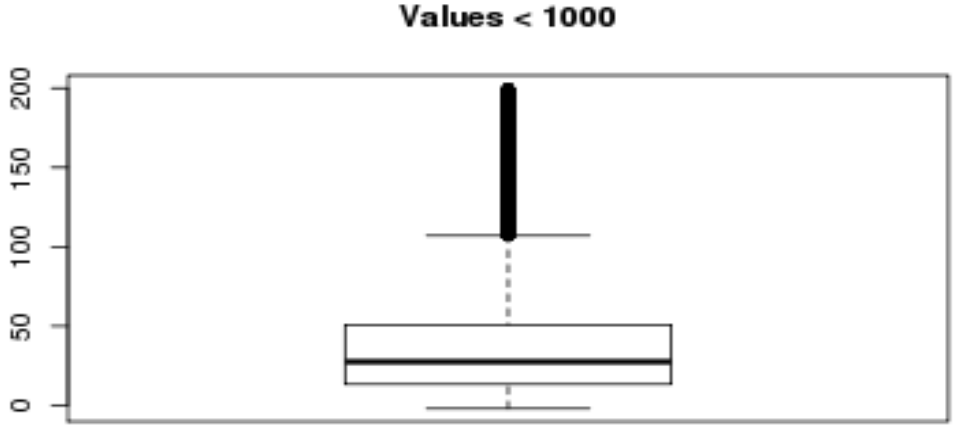
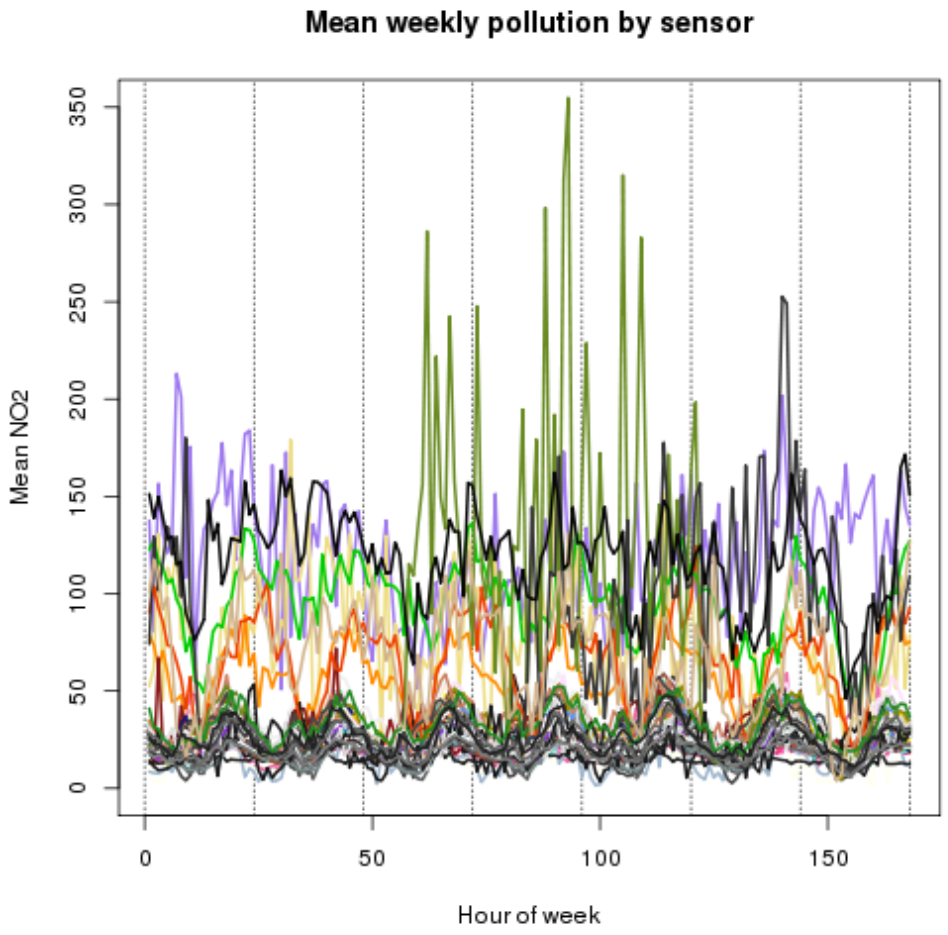

Histogram of all pollution values
Frequency
0
40000
80000
0
200
400
600
800
1000
s2$value


Histogram values < 1000
Frequency
0
40000
80000
0
50
100
150
200
s2$value[which(s2$value < cutoff)]


All pollution values
0
1000
3000


Values < 1000
0
50
100
150
200


Mean weekly pollution by sensor
Mean NO2
0
50
100
150
200
250
300
350
0
50
100
150
Hour of week

Pollution Modelling Method: Cokriging

Interpolate DEFRA and sensor data

Create a higher-resolution spatiotemporal model of pollution

Use secondary variates (Urban Observatory data, temperature, etc) that have been sampled more intensely than primary variate (DEFRA)

Repeat for 7 days * 24 hours

Finally – model exposure by overlaying trace data with pollution estimates

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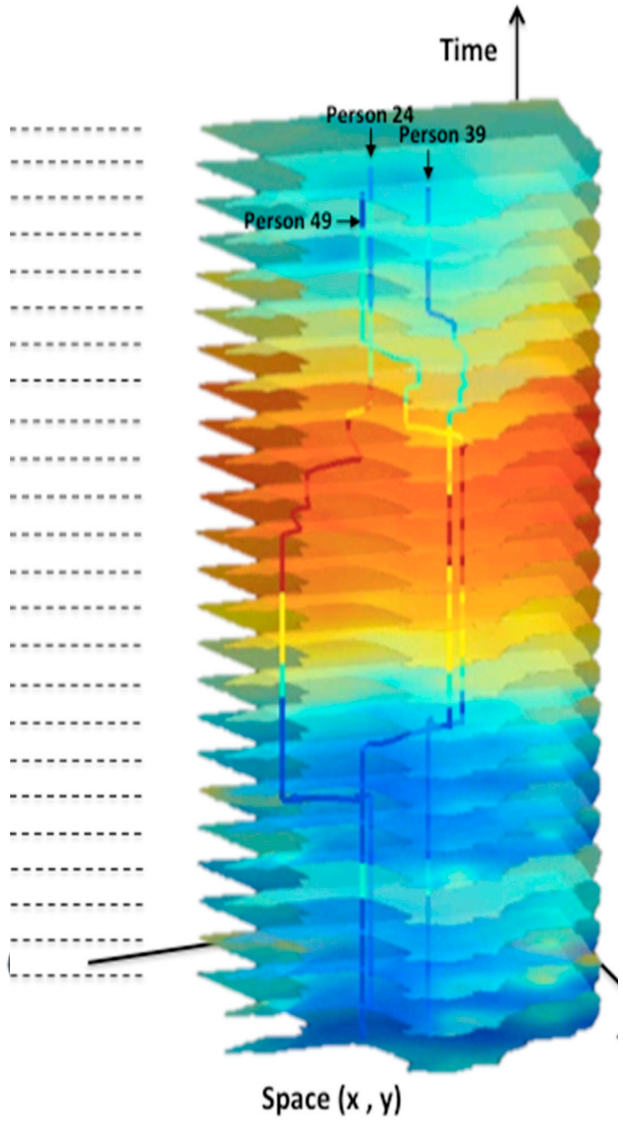
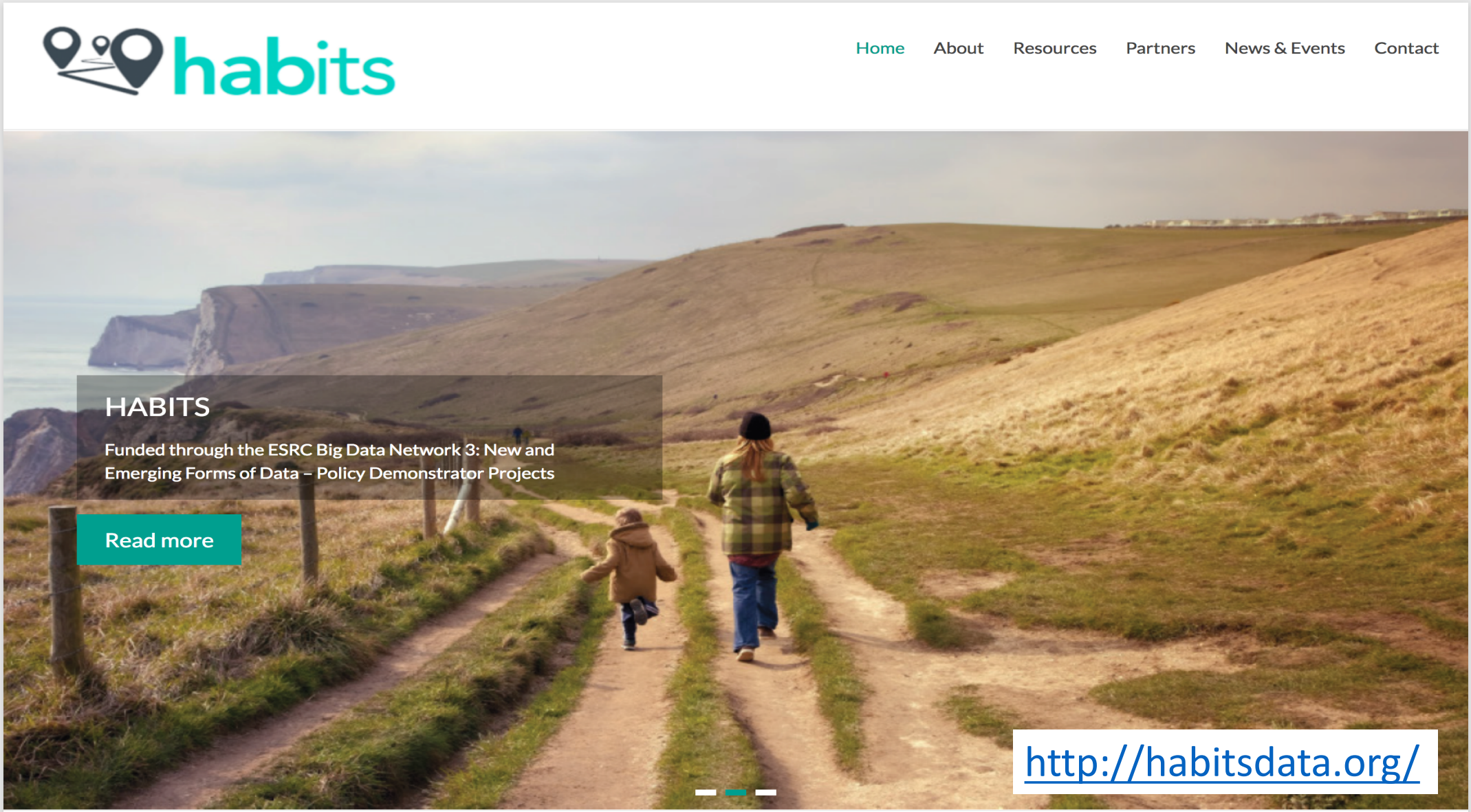
Source: Park and Kwan (2017)

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[5] Health Effects Institute, 2010. *Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects*. Special Reports. Health Effects Institute, Boston, MA.

Park, Yoo Min, and Mei-Po Kwan (2017). Individual Exposure Estimates May Be Erroneous When Spatiotemporal Variability of Air Pollution and Human Mobility Are Ignored. *Health & Place* 43: 85–94

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