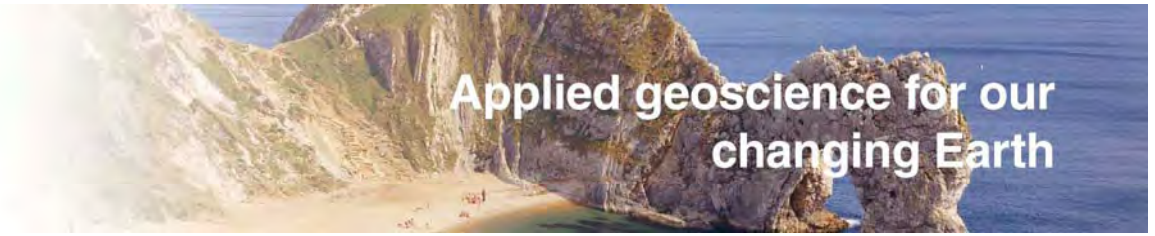
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL



London Earth: the chemistry of the surface environment in the UK's most populous city

London Earth

Scheib, C*., Flight, D., Lister, T.R., Nice, S., Scheib, A., Fordyce, F., Everett, P., Knights, K., Green, K., Johnson, C, Cave, M, Bearcock, J, Ander, L and Lark, M.

All laboratory staff and student volunteers!

Geochemical Baseline Survey of the Environment (G-BASE)

What is *London Earth*?

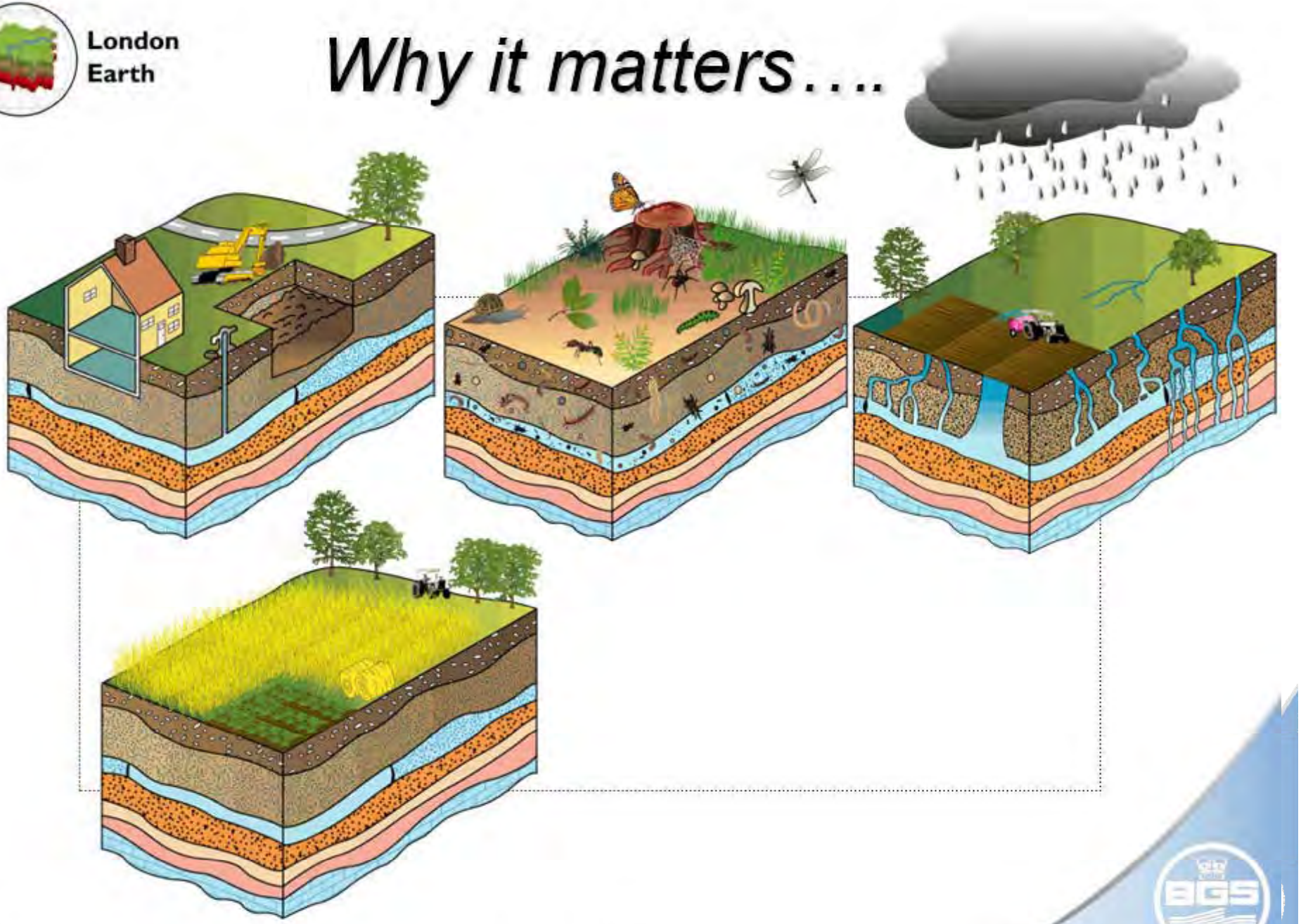
Unique, comprehensive, systematic survey of soil chemistry across entire Greater London Authority area

Vital statistics!!

- 6288 sites visited
- 18,800 samples collected and archived
- Almost 10 tonnes of soil
- 5 person years of sampling effort
- 400,000 individual measurements
- Completed in 3 years.....
- *but this is only the beginning*

London Earth

Why it matters….



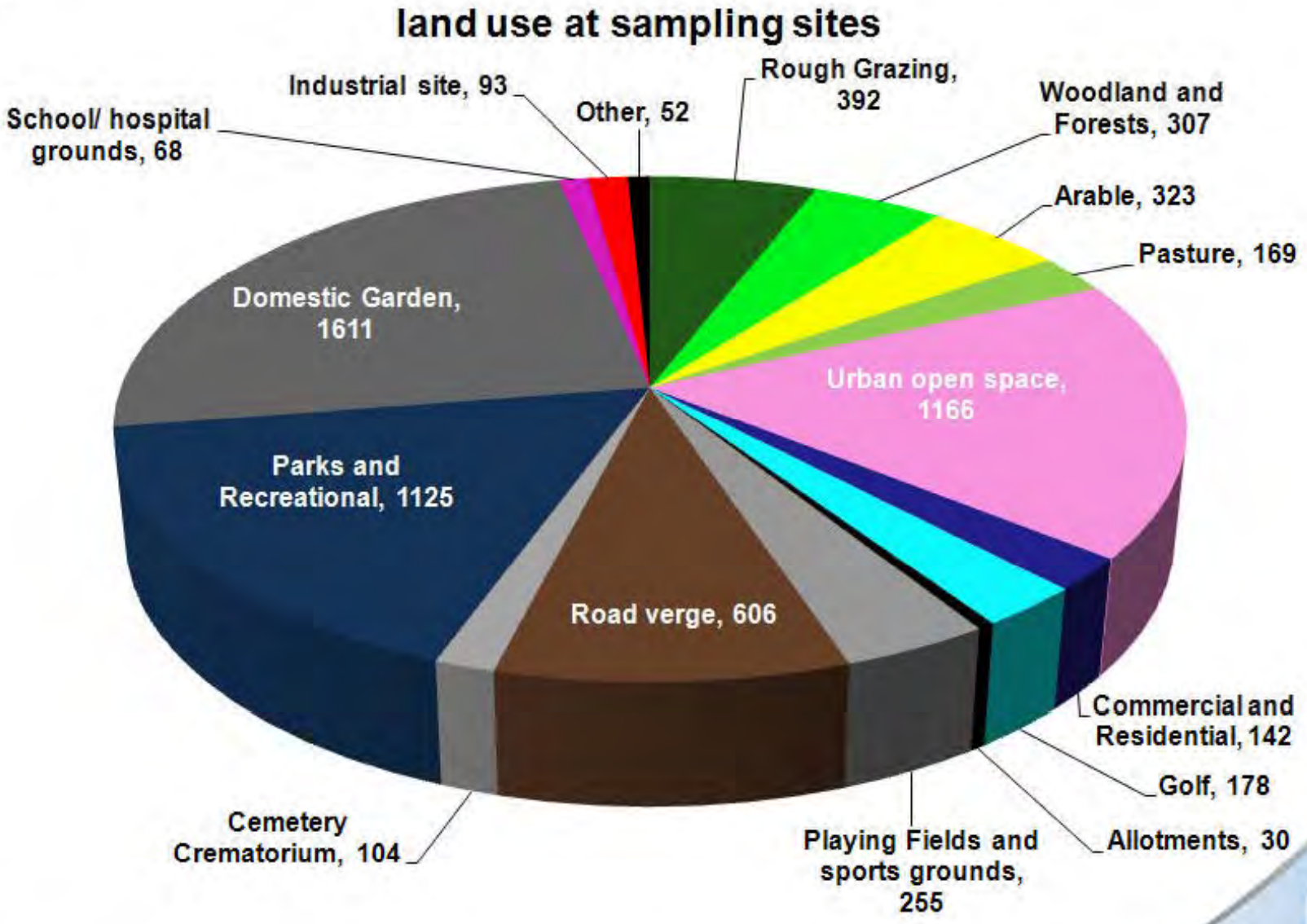
Urban soil pressures…

***London Earth* survey**

- Environmental science resource base
- London-wide benchmark
- Natural baseline; geology
- Man's impact on our Capital city
- Robust, UK-wide survey; inter-city or urban-rural comparisons can be made

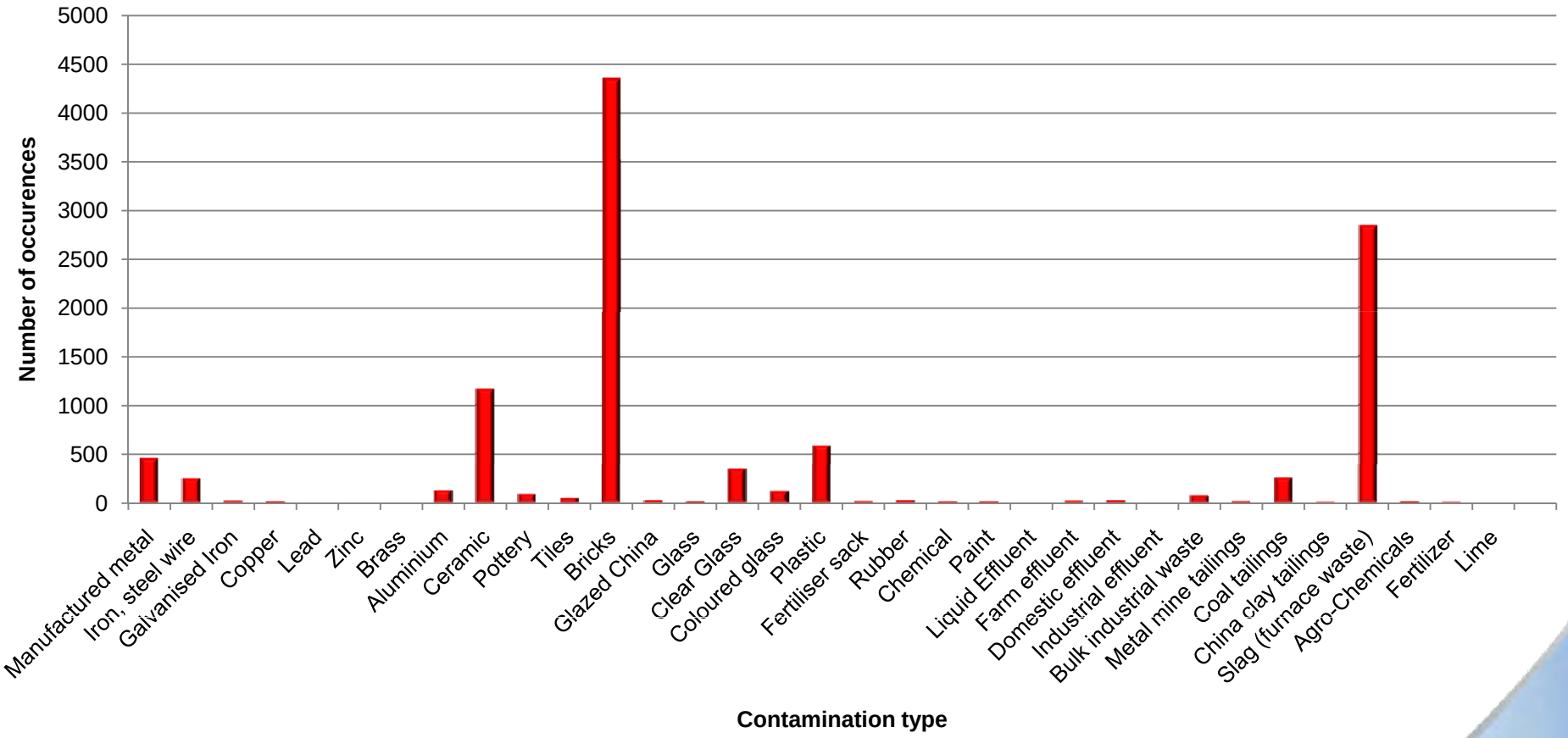
London Earth

Where?

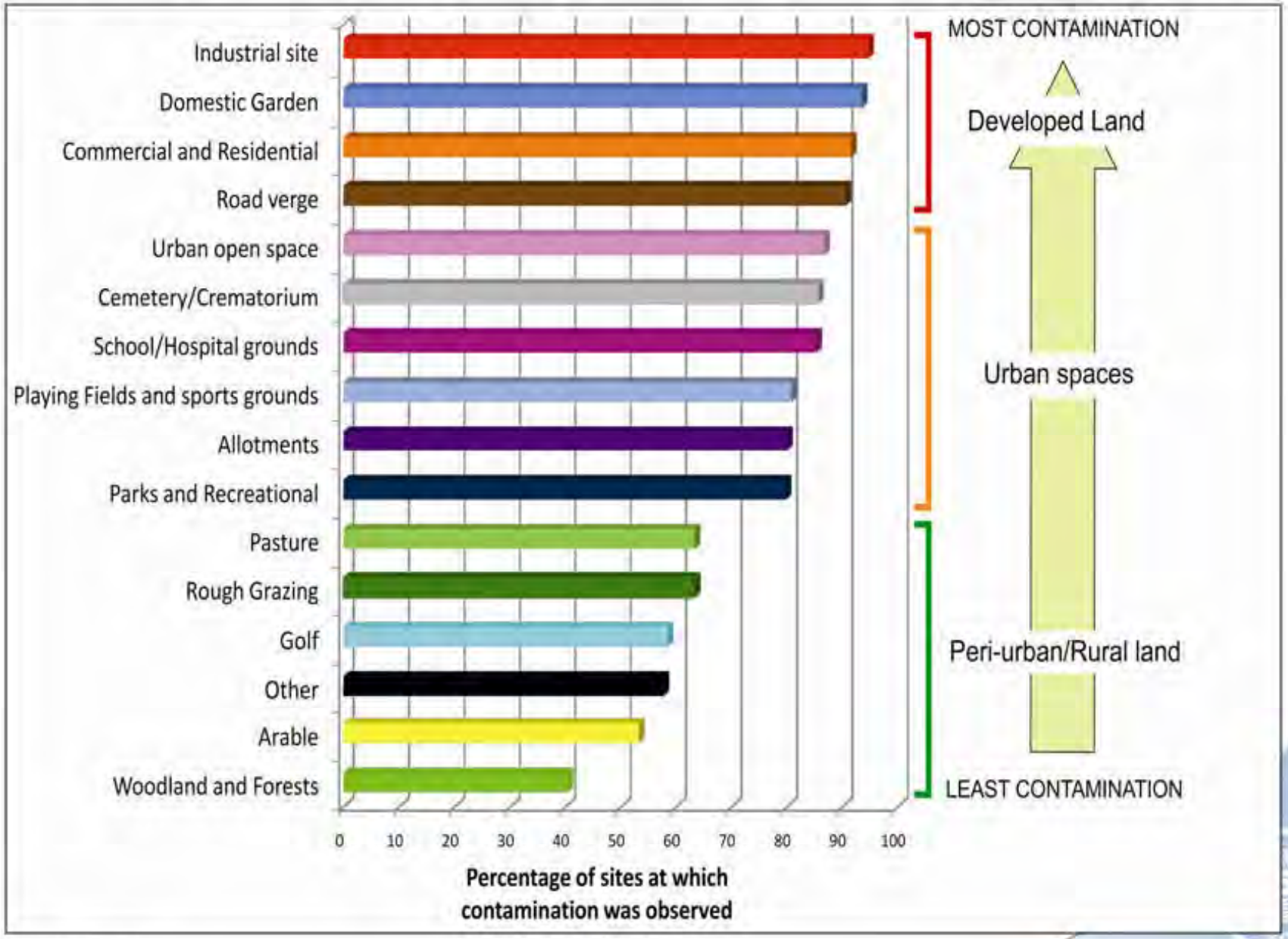


Observed man-made material in soil

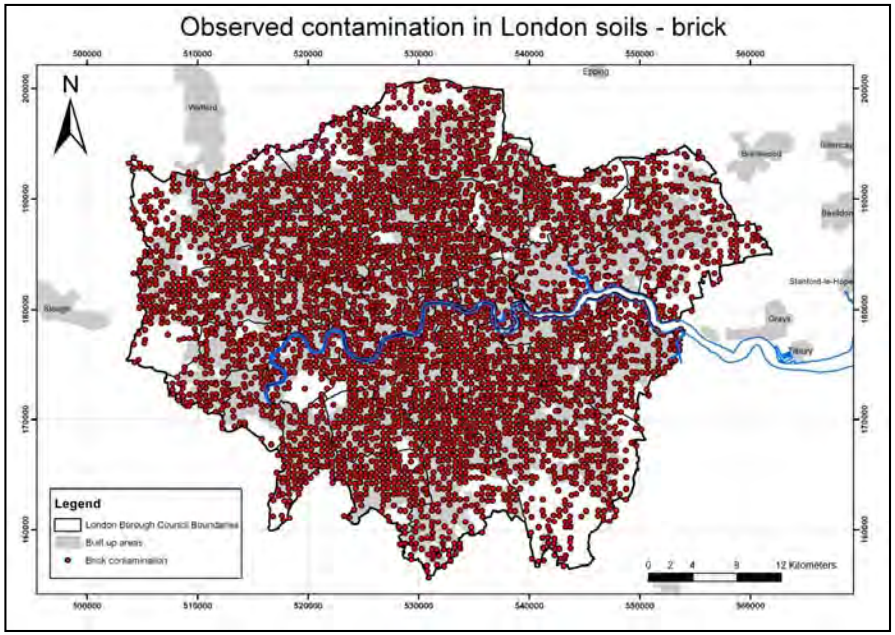
(Sample contamination)

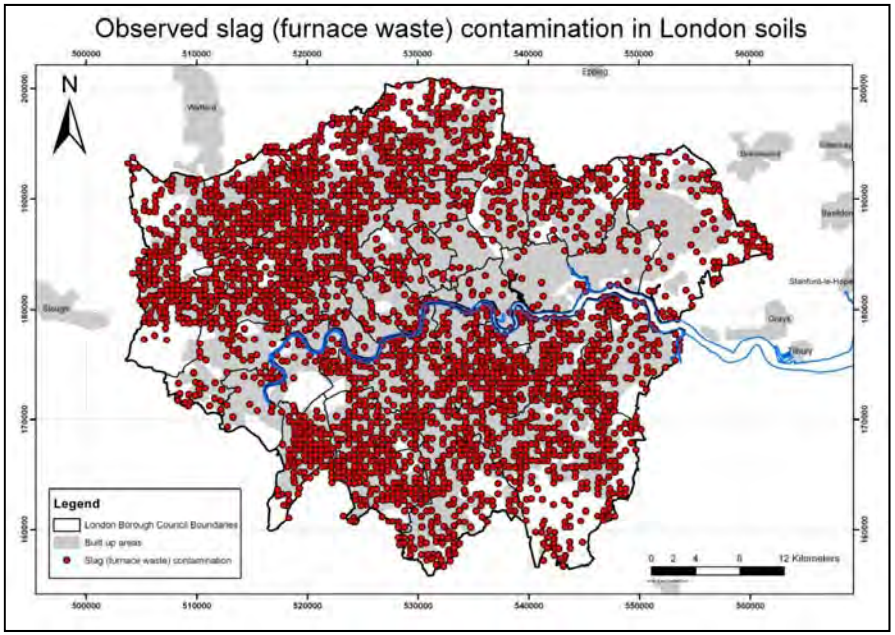


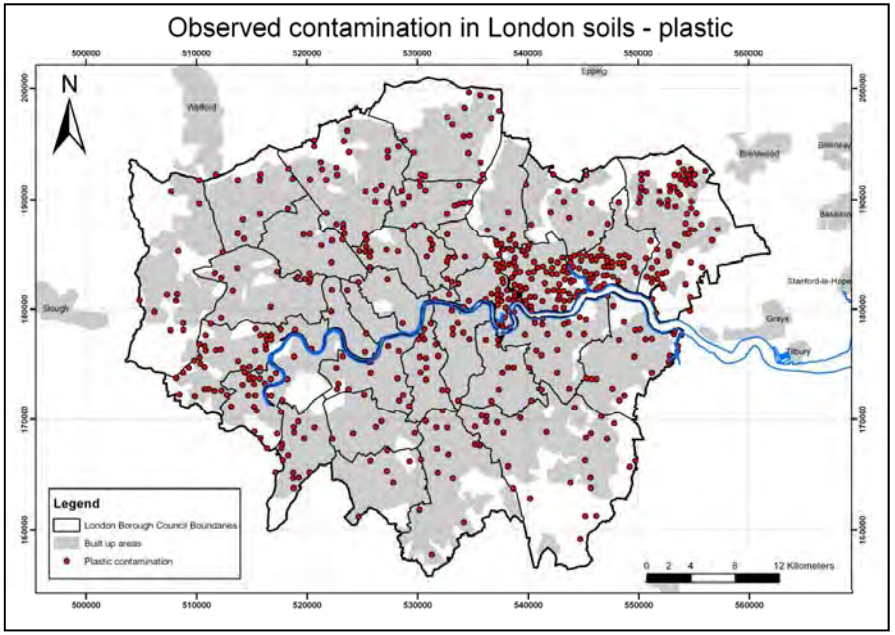
Observed man-made material; by land-use



www.bgs.ac.uk/gbase



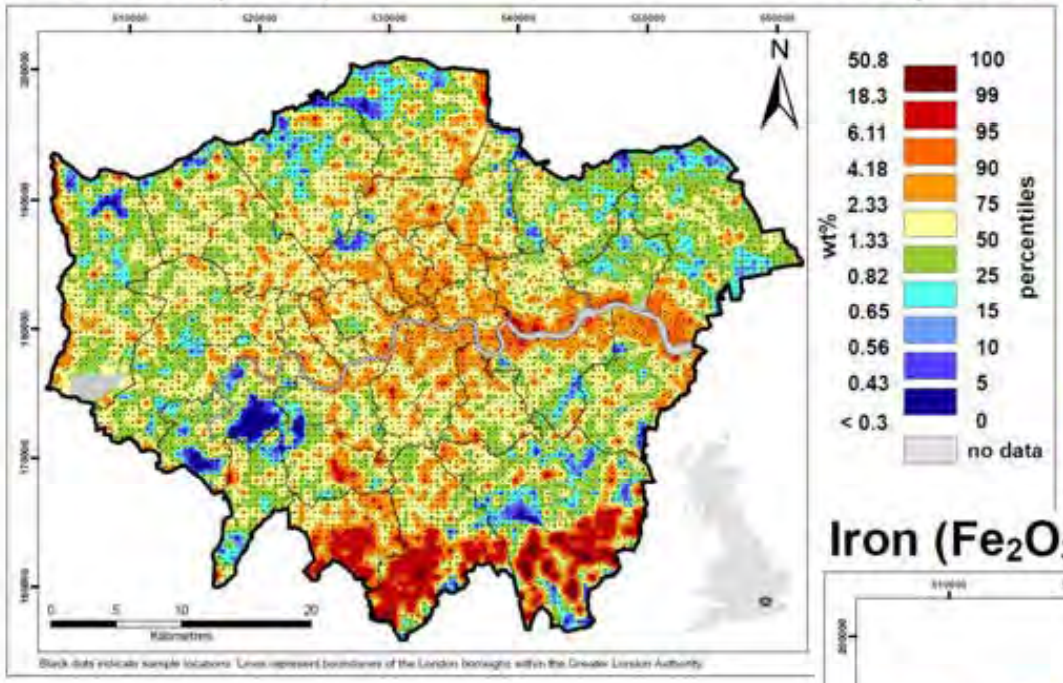


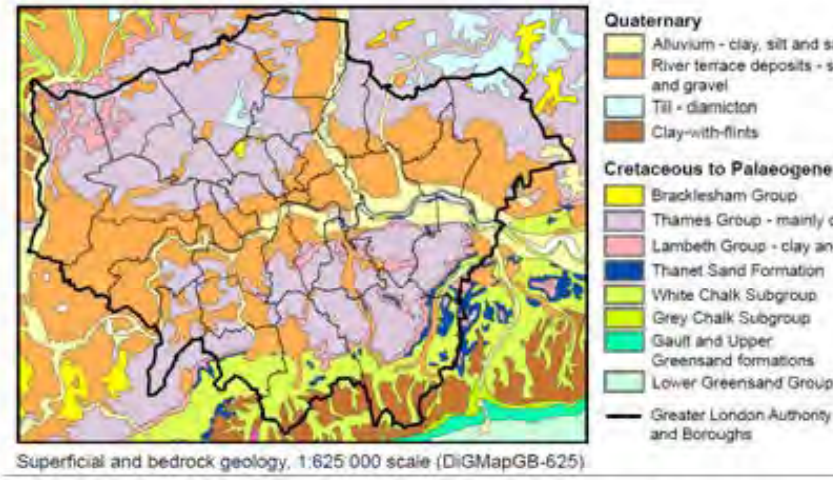


London Earth

Not a blank canvas!

Calcium (CaO) in topsoils

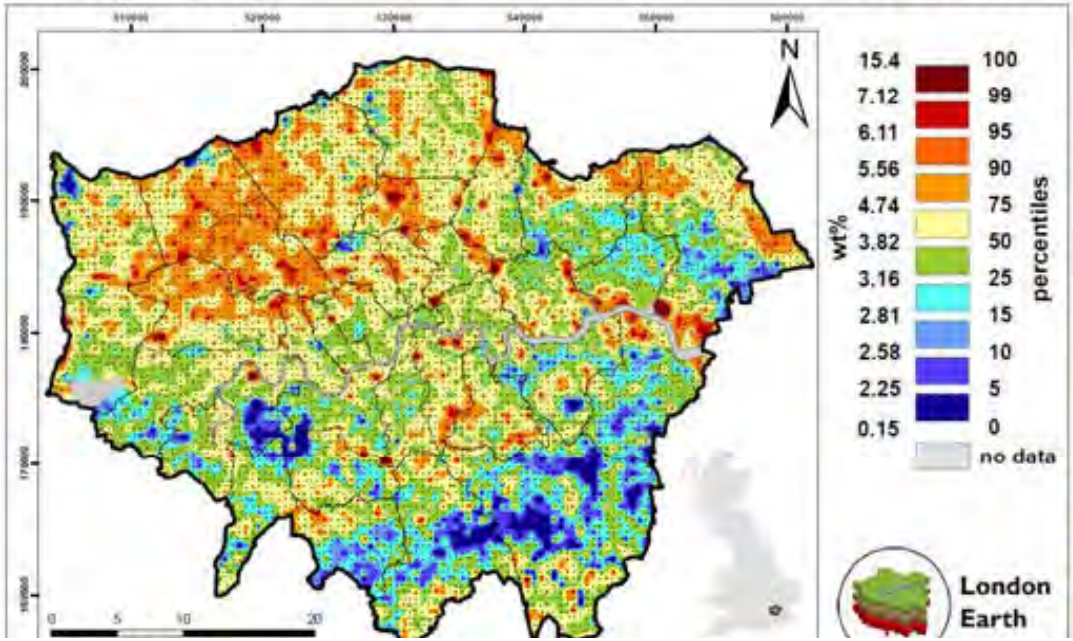




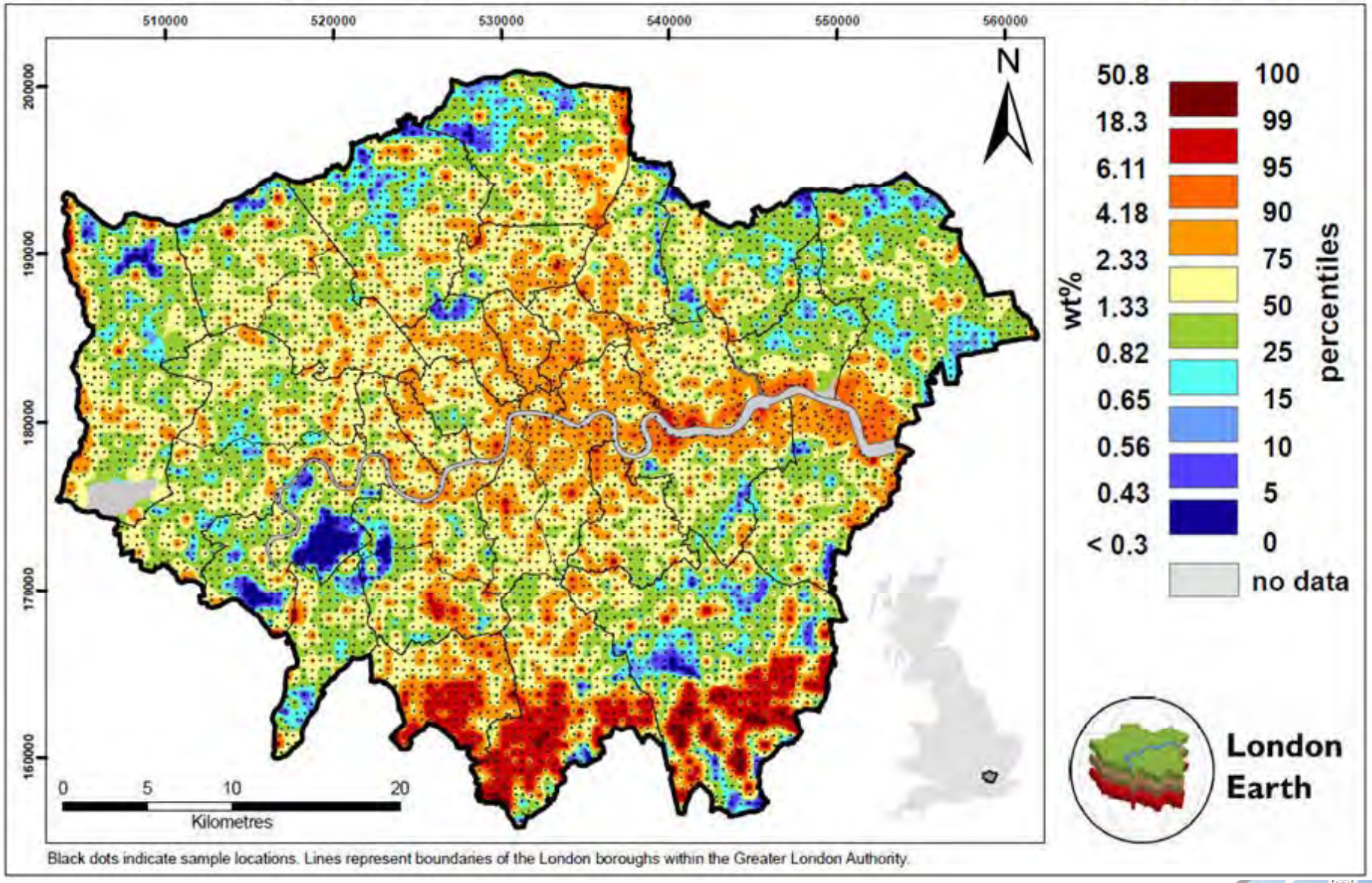
Superficial and bedrock geology, 1:625 000 scale (DiGMapGB-625)

- Geological footprint is evident in many elements
- Natural variability

Iron (Fe_2O_3) in topsoils



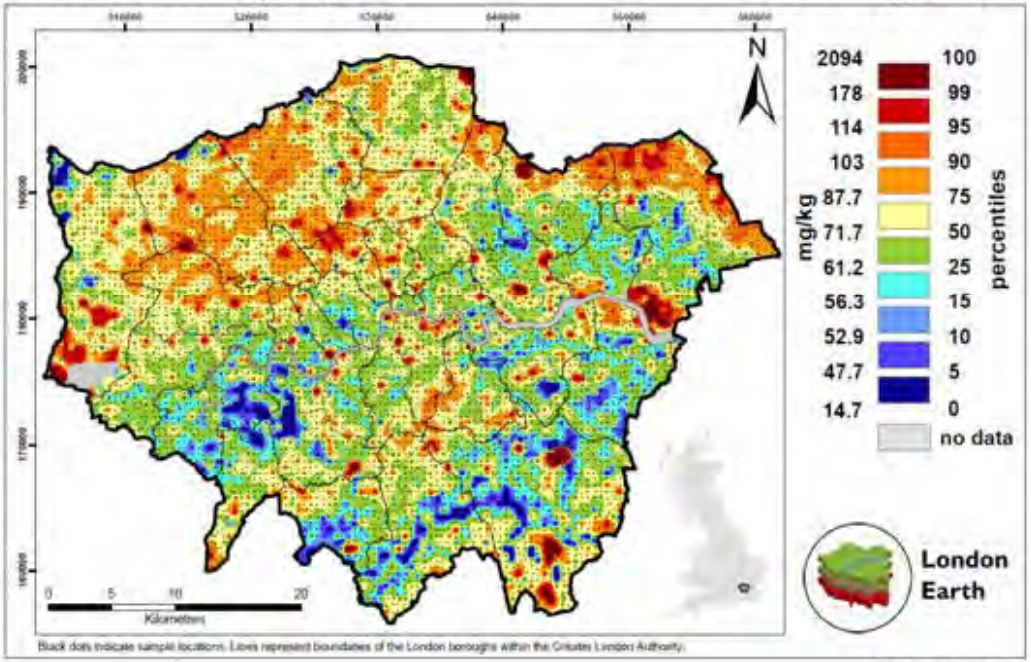
Calcium (CaO) in topsoils



Black dots indicate sample locations. Lines represent boundaries of the London boroughs within the Greater London Authority.

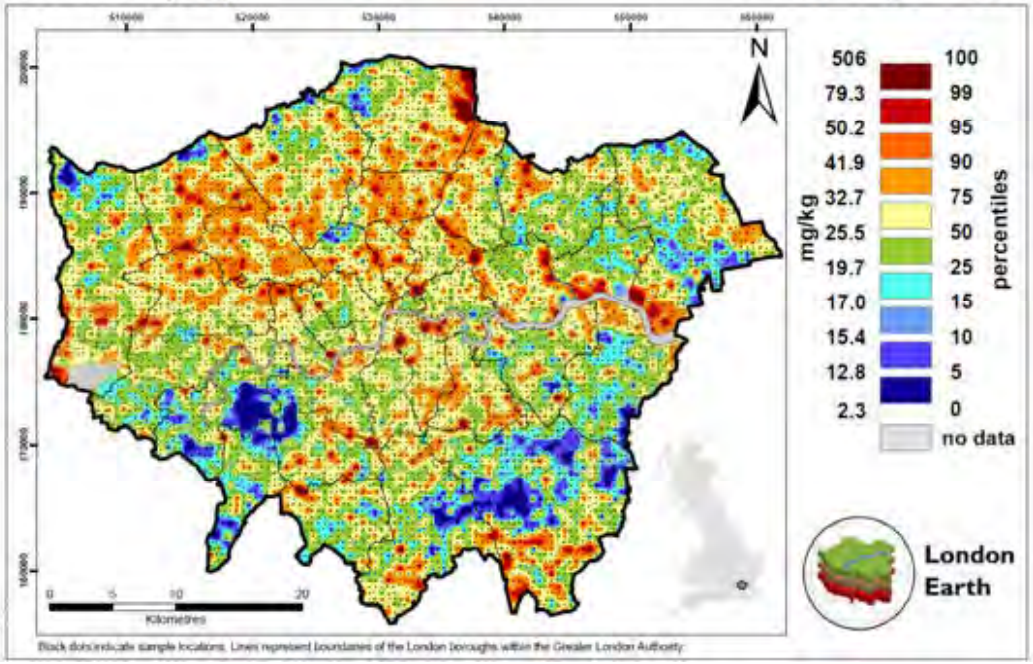
Chromium and Nickel

Chromium (Cr) in topsoils



- Baseline geological control
- Natural variation
- Context for site-specific studies

Nickel (Ni) in topsoils



- Localised man-made impacts
- Industry, urbanisation
- Parks, nature reserves low relative to more urbanised areas

Parklands – indicators of undisturbed soil?

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

London Earth

Examining the Soil Chemistry of London's Parklands

Knights, K.V.* and Scheib, C.

British Geological Survey, Kingsley Dunham Centre, Nicker Hill, Keyworth, Nottingham, NG12 5GG, UK
*kvk@bgs.ac.uk

London Earth

London Earth is a high-resolution, systematic geochemical baseline survey of soil across the Greater London Authority (GLA) area. More than 6000 topsoil samples were recently collected and analysed by XRFS for total concentrations of 53 elements, plus pH and loss-on-ignition. These samples cover a wide range of land uses and soil types. London has a large number of green spaces, including large parks, wetlands, heaths and common-lands, borough parks, country parks and private estates, plus a range of domestic and public gardens. The aim of the *London Earth* survey is to define the 'baseline geochemistry' of topsoils (*c.* 5–20 cm depth)—a snapshot of the chemical make-up of soils. Characteristics of the baseline geochemistry of some of London's parklands are presented here.

Soil geochemical data for London's parklands reveal new information about the effects of urbanisation on the city's soils. Geological sources of some elements and soil processes are key. The *London Earth* information from the parklands can be used to understand and contrast the changes in the soil chemistry in areas around parklands, where the geology is consistent since the parks have remained free from urban pressures.

London Parklands

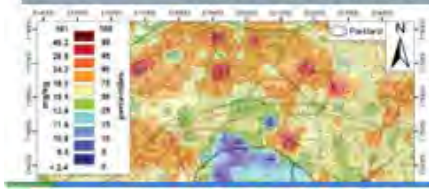
London's 'parklands' are large open spaces (approximately >½ km²) which are subject to less disturbance than other urban soils. In particular, the Royal Parks have been historically protected and maintained as open spaces. However, even the Royal and other parks have been subjected to a degree of anthropogenic influence. Metal, ceramic or glass fragments were observed in 45% of *London Earth* samples from the main Royal Parks. Man-made materials, such as brick, ash or plastic, were observed at 81% of all sites sampled across the GLA, including parklands.

Some environmentally important elements are characteristically elevated in urban centres due to a range of anthropogenic activity. A summary of the typical concentration values for a selection of elements from the *London Earth* survey are shown in the table below.

Element	As	Ca	Cr	Cu	Fe	Ni	Pb	Zn
Median concentration	15.5 mg/kg	1.33 wt% (CaO_{eq})	71.7 mg/kg	46.9 mg/kg	3.82 wt% (Fe_2O_{3eq})	25.5 mg/kg	185 mg/kg	158 mg/kg

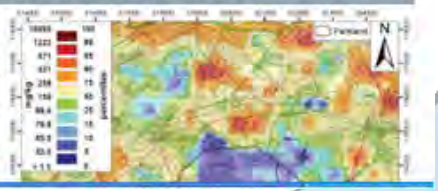
Table 1. Median topsoil concentration values for selected elements from the *London Earth* survey (n=6288).

South-west London: Richmond Park, Bushy Park, Hampton Court Park, Wimbledon Common

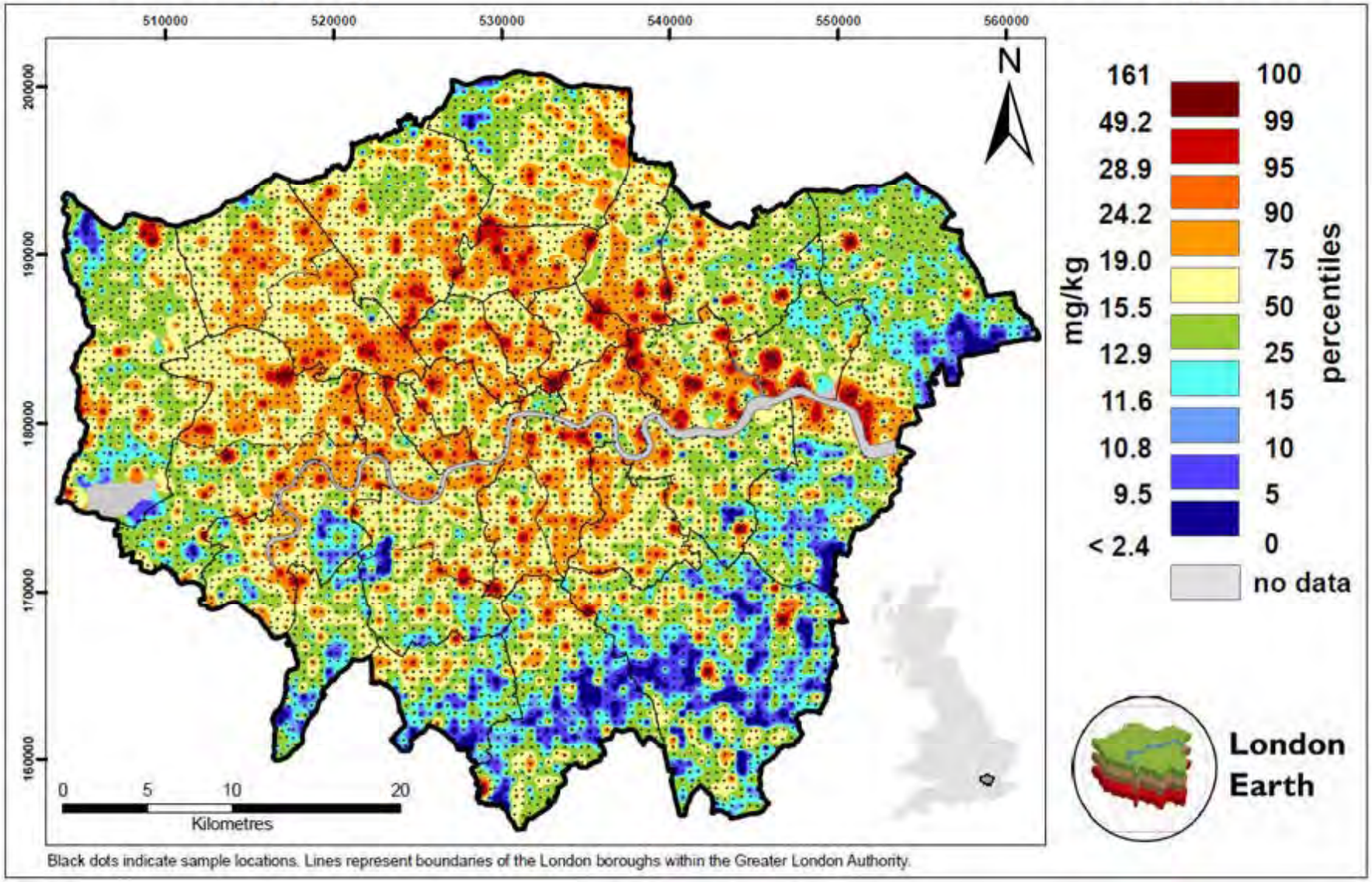


Across Richmond Park, Bushy Park, Hampton Court Park and Wimbledon Common (outlined), concentrations in soil of As (Map 1), Ca, Cr, Cu, Fe, Ni, Pb, and Zn (Map 2) are typically low (<15th percentile of data) compared to the whole GLA dataset.

In these parklands these eight elements, indicative of urbanisation and/or contamination, are substantially less concentrated than in soils from surrounding built-up areas. This is unique considering the geological similarities across the area. They are some of the largest open spaces in

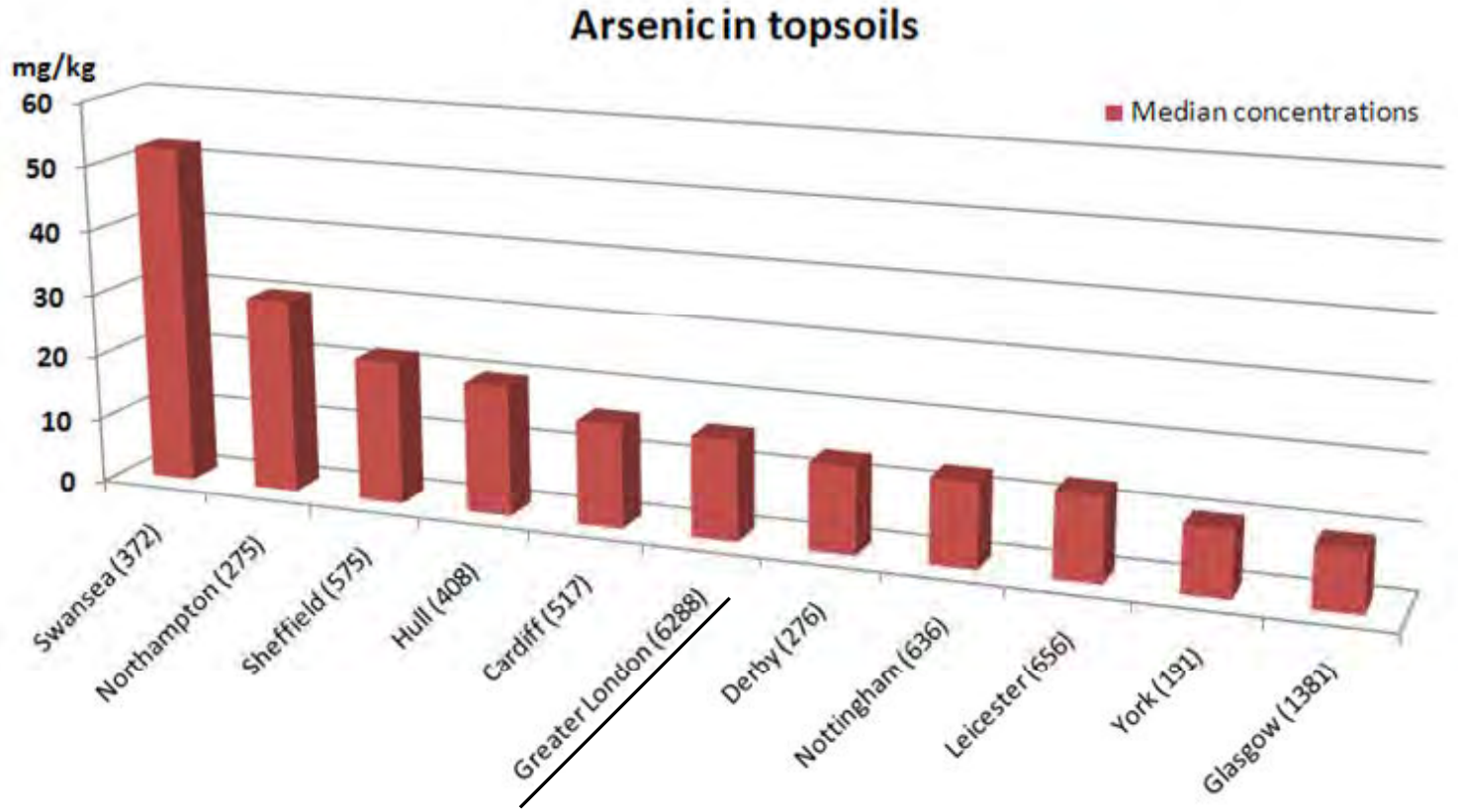


Arsenic (As) in topsoils



Significant differences between land-use; Industrial land has the highest mean

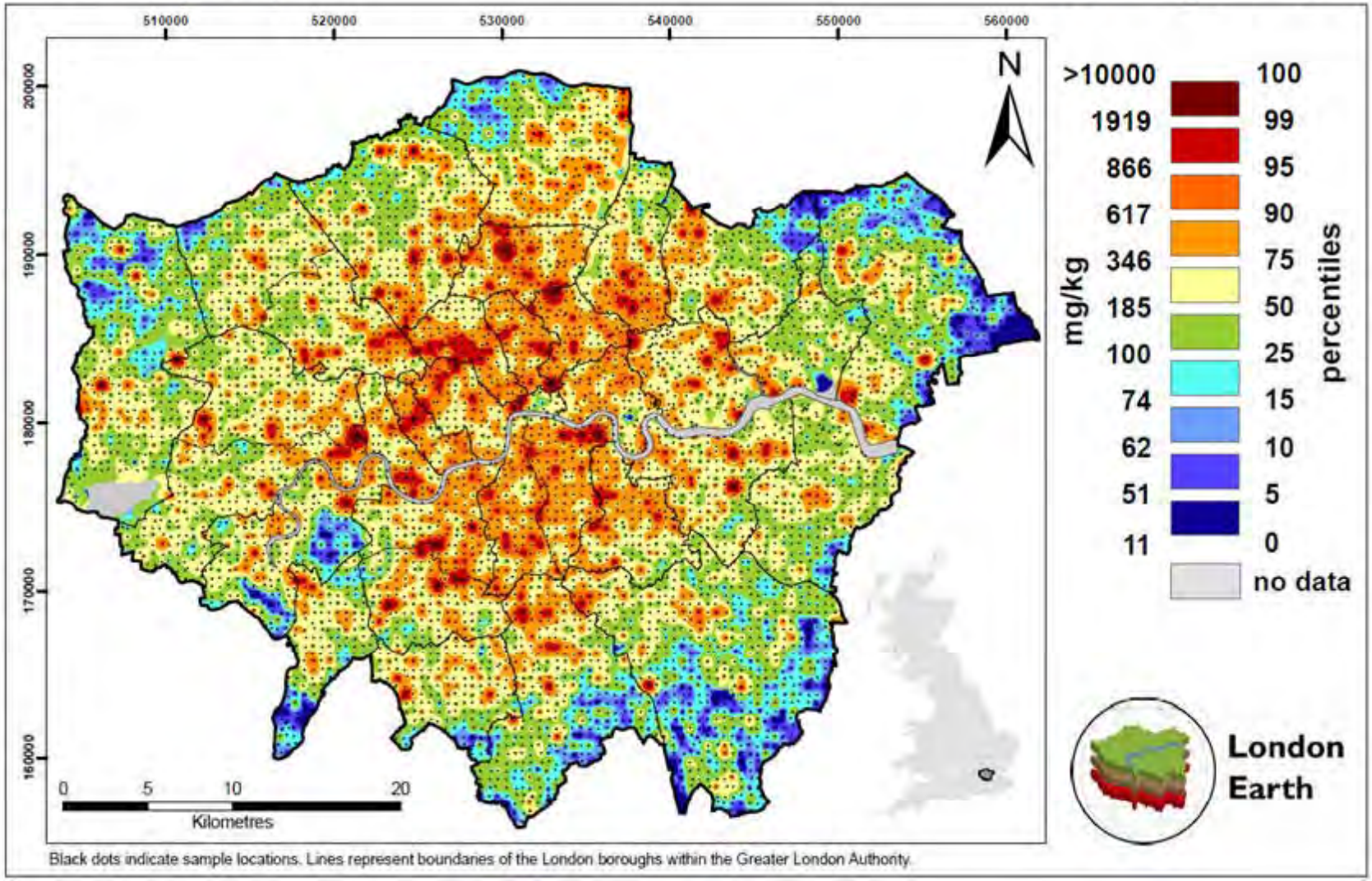
UK city inter-comparison; arsenic



Typical concentrations within range of other UK cities

Some of the higher measurements may exceed guideline values

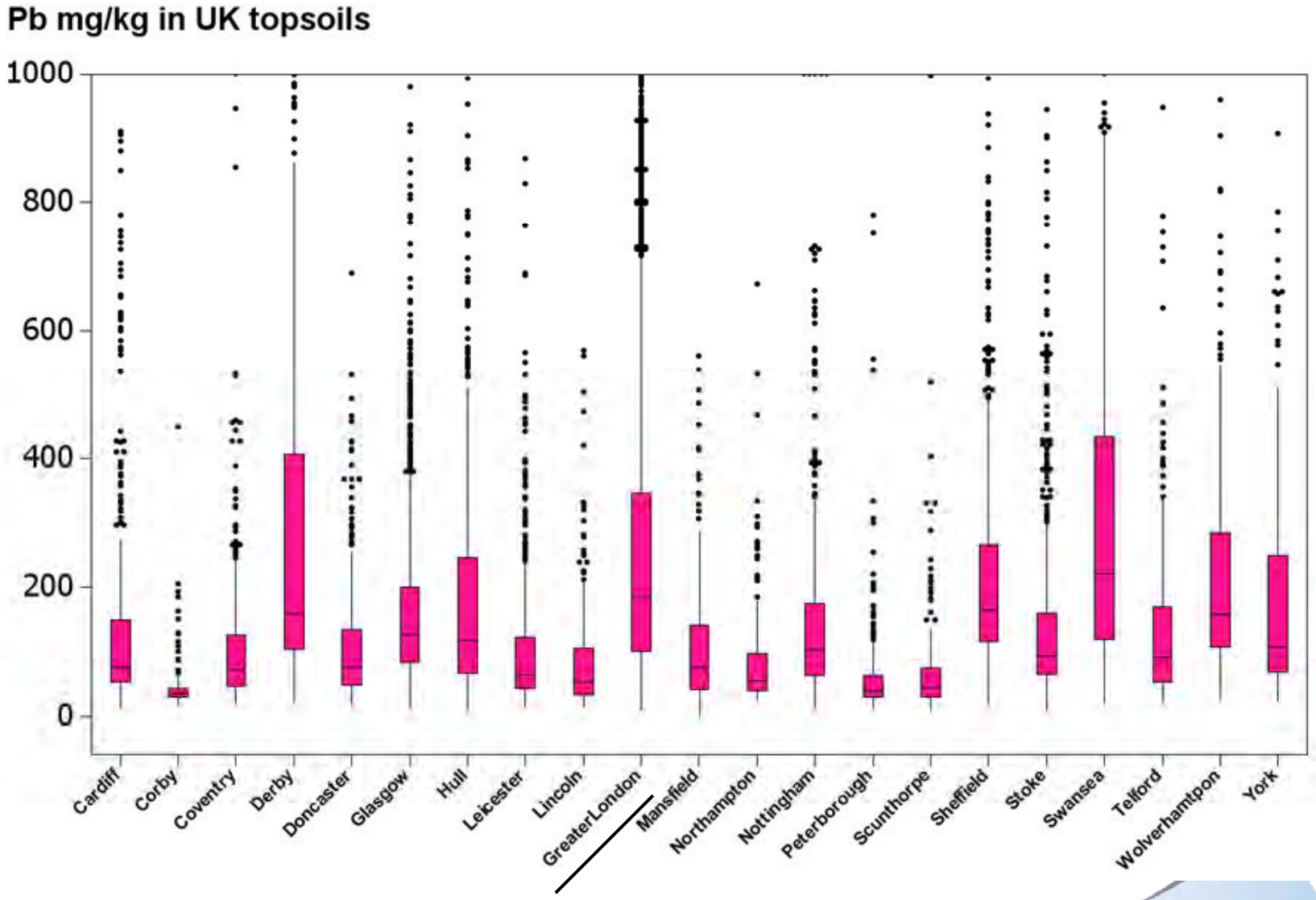
Lead (Pb) in topsoils



- Centrally located highs, likely to relate to legacy of leaded fuel
- Other sources likely to be locally important (e.g. leaded paint)
- ~ 5 times higher typically than local rural samples (n= 1900)

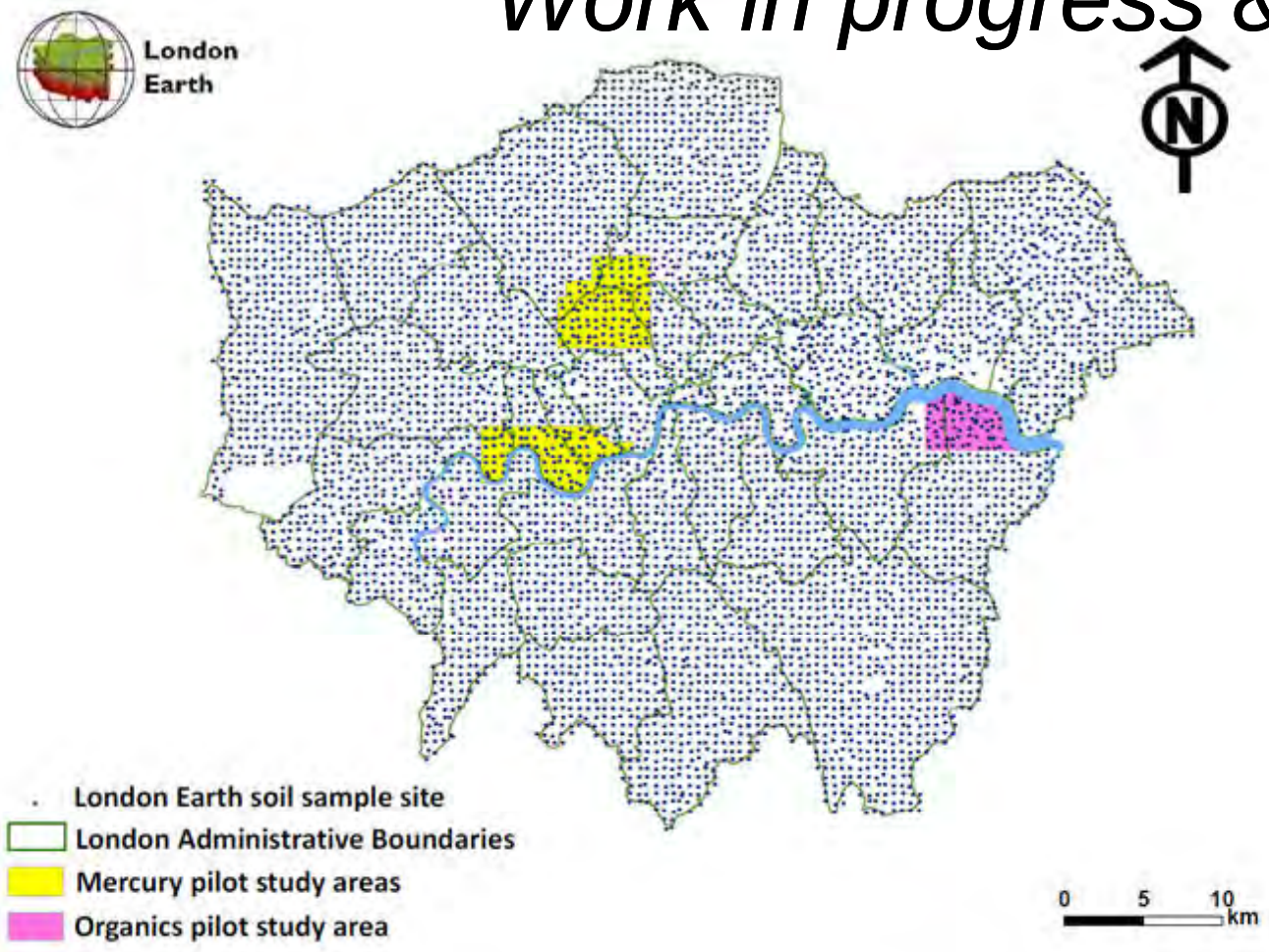
London Earth

UK city inter-comparison
Lead concentrations



www.bgs.ac.uk/gbase

Work in progress & Planned



- *Pilot studies*
- *Choose 100 sites to measure bioaccessibilty (How available the metals and metalloids are to be absorbed by the body)*
  To be done by the BGS Medical Geology Team

Accessibility

- All data available from 13/05/2011 via a licence
- Topsoil (5 -20 cm), >50 elements XRF, pH, LOI
- Maps and descriptions for 10 elements available as free downloads on BGS website
- Web-based easy-access viewer in development (**feedback**)

- http://www.bgs.ac.uk/gbase/londonearth.html

- enquiries@bgs.ac.uk

London Earth

BGS Information Products

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Urban Soil Chemistry Data for Great Britain

Andreas Scheib, James Appleton, and Geraldine Wildman

Introduction

Potentially harmful chemical elements (PHEs), including arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni) and lead (Pb), occur in the environment both naturally and as a result of human activities. Under certain circumstances can be harmful to plants, animals or people. Whether or not a particular PHE constitutes a hazard depends on a variety of factors including, e.g. its chemical form (speciation), concentration, soil or water acidity (pH), the type of vegetation cover, the extent of exposure and the dose received. PHEs exist in a range of inorganic forms which have varying toxicity. Ambient background concentrations of PHEs in surface soil from natural and non-natural sources are required for: i) risk assessments and, ii) establishing whether elevated measurements may be the result of significant anthropogenic contamination.

The BGS urban soil chemistry dataset identifies areas of elevated topsoil concentrations of PHEs and can be used in conjunction with proposed Soil Screening Value (SSV) for assessing ecological risks and/or the former Soil Guideline Value (SGV), which is a threshold used in the preliminary assessments for land contamination.

The BGS urban soil chemistry dataset for GB

The BGS urban soil chemistry dataset comprises of two different products: a) the BGS digital POINT SOURCE URBAN SOIL CHEMISTRY DATA giving the locations and concentrations (mg/kg) of As, Cd, Cr, Ni and Pb in urban topsoil samples and b) the BGS digital ESTIMATED URBAN SOIL CHEMISTRY DATA, which indicates the estimated geometric mean concentrations (mg/kg) of As, Cd, Cr, Ni and Pb in topsoil derived by spatial interpolation of the POINT SOURCE URBAN SOIL CHEMISTRY DATA. Figure 1 displays the GB urban areas for which both the digital point source and estimated urban soil chemistry data are available.

How is it derived and what does it show?

Both urban soil chemistry datasets are derived from high-resolution urban soil geochemical data from BGS's Geochemical Baseline Survey of the Environment (G-BASE) project. To derive the urban chemistry dataset, data were transformed by taking the natural logarithms as urban soil geochemical data generally have large positive skewness coefficients. To overcome the bias associated with traditional measures of location (mean) and scale (standard deviation) for log-normal data, the inverse distance weighted (IDW) mean and standard deviation of

1 Glasgow
2 York
3 Hull
4 Scunthorpe
5 Sheffield
6 Manchester (part)
7 Doncaster
8 Lincoln
9 Mansfield
10 Nottingham
11 Derby
12 Stoke-on-Trent
13 Leicester
14 Corby
15 Peterborough
16 Northampton
17 Coventry
18 Wolverhampton
19 Telford
20 Ipswich
21 Thames Gateway north
22 Greater London
23 Cardiff
24 Swansea

Acknowledgements

- Thank you to all individuals and organisations that helped during the sampling phase of the project
- Without you it would not have been possible!

- Our student volunteers!

Thank you!