Normal levels of contaminant concentrations in soils are referred to in the contaminated land Statutory Guidance for the Part 2A regime Defra 2012. This Technical Guidance Sheet (TGS) gives an indication as to what copper concentrations can be expected in soils based on results from samples systematically collected across England. Normal Background Concentrations (NBCs) can be used along with other criteria (e.g. site investigation data and risk assessments) to help decide whether land is contaminated land as defined by Part 2A, on a site-by-site basis.

The NBCs are not intended to be a tool to be utilised when undertaking works via the planning regime. *They are contaminant concentrations that are seen as typical and widespread in topsoils (depth 0 – 15 cm) and include contributions from both natural and diffuse anthropogenic sources.*

When using this Guidance Sheet, please refer to the section on 'Using Normal Background Concentrations' at the end, the Supplementary Information, and the revised Part 2A Statutory Guidance.

COPPER (Cu)

Technical Guidance Sheet TGS03, July 2012.

Copper (Cu) is an essential micronutrient for the growth of plants and animals, with a reported Earth's crust abundance of 55 mg/kg and impacts on health are related to deficiency as well as excess. The effects of high Cu concentrations in soil in decreasing the uptake of other essential micronutrients by plants are well known.

Much of the soil chemistry of Cu is related to sulphur and organic matter. Sulphide minerals (*e.g.* chalcopyrite $CuFeS_2$) are the main detrital Cu phases in soil in mineralised areas and may result in high Cu concentrations. Copper released during the weathering of these minerals is readily adsorbed and complexed by organic matter, clay minerals and oxides, and co-precipitated with carbonates. Mobility and displacement of Cu in soils is therefore low. High concentrations of Cu in soil can also be associated with coalfields due to enrichment with organic matter during coal formation (resulting from the strong affinity of Cu for organic ligands) and the presence of sulphides in Coal Measure sediments.

Copper is often found enriched in the top horizons of a soil profile. Its accumulation in topsoils is seen in urban areas resulting from human activity. Anthropogenic sources of Cu include mining and smelting, the electrical and metallurgical industries, agriculture, sewage sludge and steel works.

Domain	Area (km^2)	Area (%)	NBC (mg/kg)	n
Urban	5,400	4	**190**	7,475
Mineralisation	1,600	1	**340**	153
Principal	125,900	95	**62**	34,504

Table 1: NBCs for the copper domains (cited to 2 significant figures, n is number of samples used in the calculation). Copper is determined by laboratory-based X-ray fluorescence spectrometry (XRFS), *i.e.* total Cu in soils sampled from a depth 0 – 15 cm. The NBC is the upper 95% confidence limit of the 95th percentile of the domain data (see supplementary information).

NORMAL BACKGROUND CONCENTRATIONS (NBCs)

Methods

NBCs are calculated using contaminant data, with demonstrably high levels of quality assurance, for English topsoils systematically collected from a variety of land uses and analysed using certified methods. For this purpose the primary data sets used are the British Geological Survey's G-BASE results and samples collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales (now the National Soil Resources Institute (NSRI), Cranfield University, UK) (see Figure 1). The G-BASE samples cover both urban and rural locations and all data used are total concentrations, measured by X-ray fluorescence spectrometry (XRFS). Soils used to calculate NBCs are from a consistent depth (0 – 15 cm) and are based on aggregating sub-samples collected from within a 20 m square.

England's soils have developed on a diverse range of parent materials (including those hosting copper mineralisation) which are inherently variable in their chemical composition. These soils have also been subjected to a long history of diffuse pollution from human activity. A combination of soil parent materials and urbanisation/industrialisation causes a significant

variability in the Cu distribution across the country (Figure 2).

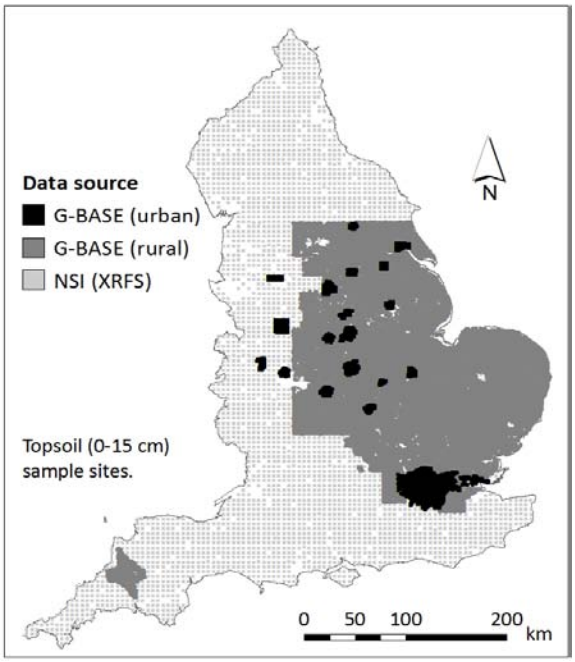

Figure 1: Map showing the distribution of samples used in the Cu NBC determination. NSI (XRFS) covers the whole of England at a sample density of 1:25 km^2. G-BASE sampling densities for rural and urban areas are 1:2 km^2 and 4:1 km^2, respectively.

Results for Cu in topsoils range from <1- 5,300 mg/kg with a mean of 35 mg/kg and a median of 22 mg/kg. In order to establish meaningful NBCs, soils are grouped in domains, defined by the most significant controls on a contaminant's higher concentrations and distribution.

NBCs are determined for each domain using robust statistical analysis that investigates the distribution of results and, by a process of iteration, takes into account the results that may be associated with point source contamination. "Normal" levels of contaminants are referred to in the Statutory Guidance (Sections 3.21-3.26 and 4.21(b)). They are represented here by the 95th percentile upper confidence interval, *i.e.* the NBC value is the upper limit at or below which contaminant levels can be considered to be normal for the defined domain. Levels at or below the NBC may not be naturally occurring.

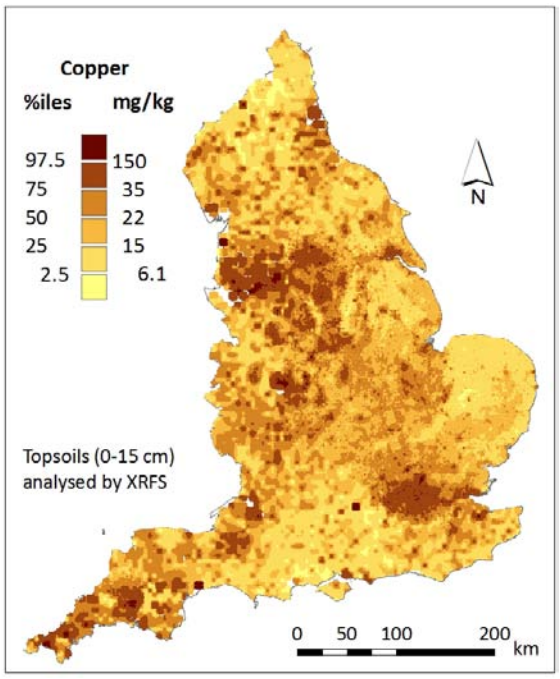

Figure 2: Map showing Cu in topsoil as a percentile classified interpolated image (all data are total concentrations by XRFS).

Results

Exploration of the soil data shows two significant controls on the distribution of higher Cu concentrations in England. These are in areas where: (i) soils have been impacted by copper mineralisation with a legacy of mining and associated activities (SW England); and (ii) soils in urban and industrialised areas affected by anthropogenic diffuse pollution and exemplified by many of the urban area soil data sets. Therefore, two important domains are identified, the Mineralisation Domain and the Urban Domain. The area not covered by these two domains is referred to as the Principal Domain (Figure 3 and Table 1).

Although three domains have been distinguished, further spatial variability will occur within these domains. This can be seen in maps such as Figure 2 (and see supplementary information) and there are

also known areas of Cu mineralisation (*e.g.* Lake District) not captured by the low density NSI sampling and so remain outside the Mineralisation Domain.

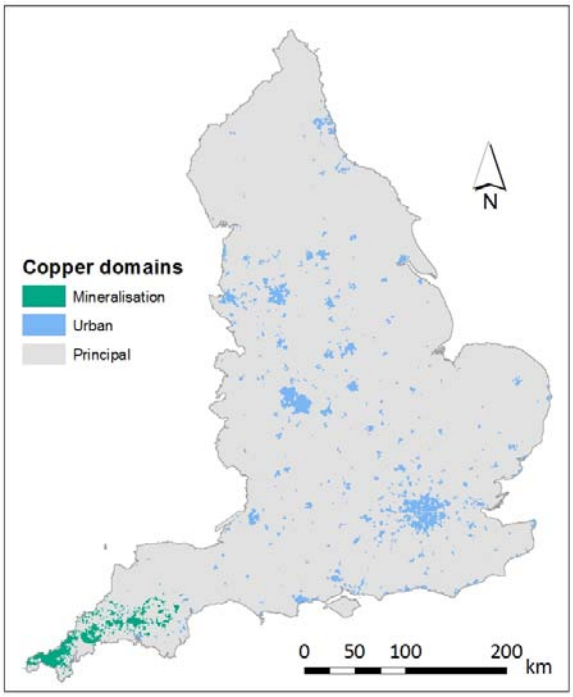

Figure 3: Copper domain map

USING NORMAL BACKGROUND CONCENTRATIONS

The NBCs are produced to support the Part 2A contaminated land Statutory Guidance (SG) and help inform as to what are normal levels of contaminants. Using this TGS, along with the further information and resources provided, a NBC test can be carried out:

1. A soil sample under investigation for Cu concentration should be spatially located in one of the three domains described. This should be part of a preliminary step in which the scenario and conceptual site model are considered.
2. If the Cu concentration is at or below the NBC for the specified domain then "*the result should not be considered to cause the land to qualify as contaminated land, **unless** there is a particular reason to consider otherwise*" (SG, Section 3.22). If the latter applies, then proceed to the use of other screening tools or further site investigation as necessary and appropriate.
3. If there is no reason "*to consider otherwise*" then the decision can be made that there is no evidence that the land is contaminated under Part 2A with respect to Cu (SG, Sections 5.2 – 5.4), that is, the land lies outside Categories 1 or 2.
4. If the Cu concentration is above the domain NBC then using the additional resources, including those provided with this technical guidance, a more detailed investigation at a local scale should be carried out or the use of other screening tools considered as appropriate. This is to determine whether the concentrations reflect "*levels of contaminants in the soil that are commonplace and widespread....and for which....there is no reason to consider that there is an unacceptable risk*" (SG, Section 3.21). If this is so, then step 3 applies. In the case of Cu, for example, this may be an area within the Principal Domain where a particular land use has caused widespread low level diffuse pollution.
5. If the concentration of Cu in the soil is not considered to be commonplace and widespread then further testing is required (apply quantitative risk assessment (QRA)).

FURTHER RESOURCES

Additional resources on NBCs are available from the BGS project website and the more detailed supplementary information provided with this guidance sheet. Additional on-line resources include: project reports; a database of essential information about relevant soil data sets; technical guidance sheets for other contaminants; polygons defining domain boundaries in various GIS formats; and a project bibliography.

THIS TGS SHOULD BE READ IN CONJUNCTION WITH THE FOLLOWING:

Part 2 A documents:

Available from the Defra Contaminated land web site at:
http://www.defra.gov.uk/environment/quality/land/

Part 2A of the Environmental Protection Act 1990, as amended.
The Contaminated Land (England) (Amendment) Regulations 2012 (Statutory Instrument 2012 No 263) (Amends Contaminated Land (England) Regulations 2006 ("the 2006 Regulations") (S.I. 2006/1380).)
Defra. 2012. Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance. Department for Environment, Food and Rural Affairs. April 2012

Project Reports:
Available from the Defra Project SP1008 web page and the British Geological Survey at:
http://www.bgs.ac.uk/gbase/NBCDefraProject.html

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2011. Normal background concentrations of contaminants in the soils of England. Available data and data exploration. *British Geological Survey Commissioned Report*, CR/11/145. 124pp.

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Cave, M.R., Johnson, C.C., Ander, E.L. and Palumbo-Roe, B. 2012. Methodology for the determination of normal background contaminant concentrations in English soils. *British Geological Survey Commissioned Report*, CR/12/003. 56pp.

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ACKNOWLEDGEMENTS

The British Geological Survey has produced this series of Technical Guidance Sheets as part of a project funded by Department for Environment Food and Rural Affairs (Defra) (Soils R&D Project SP1008, October 2011 – March 2012). This sheet was compiled by Chris Johnson, Louise Ander, Mark Cave, Paul Nathanail and Barbara Palumbo-Roe. The project thanks the many people and projects that have assisted in the provision of data. In particular, the BGS G-BASE project and the NSRI NSI soil samples (reanalysed by BGS). These systematic national surveys have created unbiased data sets sampled and analysed to consistent and high standards of quality that have enabled the NBCs for many inorganic contaminants to be calculated with a high level of confidence.

BIBLIOGRAPHIC REFERENCE

When referring to this document the following bibliographic reference should be made:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Copper. Technical Guidance Sheet No. TGS03, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SP1008. Available on-line from Defra project SP1008 web page.

The accompanying supplementary information for the Copper Technical Guidance Sheet:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Copper – supplementary information. Technical Guidance Sheet No. TGS03s, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SP1008. Available on-line from Defra project SP1008 web page.