



Elevated Baseline Concentrations of Heavy Metals in UK Soils, Bioaccessibility and Risk Assessment: UK Experience to Date

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Synopsis

- **Studies by the BGS and Others have identified elevated concentrations of naturally occurring heavy metals in UK soils over large areas of the country**
- **According to current UK government guidance they may pose a significant threat to the health of people who reside in these areas**
- **Costs to UK of dealing with this problem could easily exceed £200 million and are unsustainable**

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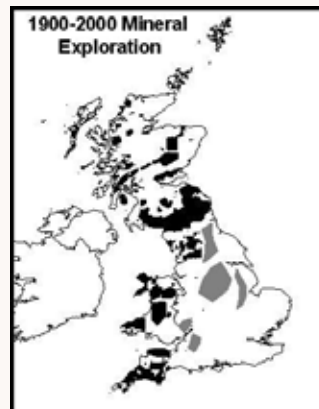


My Presentation

- The National Picture – Heavy Metals (As)
- Midlands - regional study
- Arsenic bioaccessibility: is the present information sufficient to eliminate elevated arsenic as a problem in the study area?



The UK Small But Mineralised Island



Sources:

Atmospheric Deposition

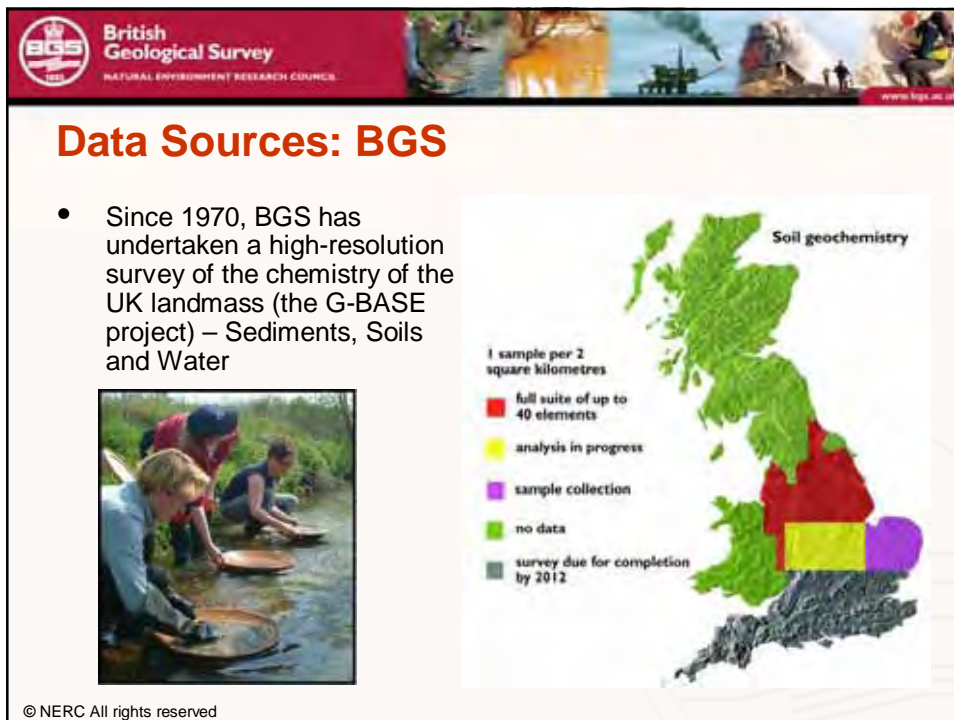
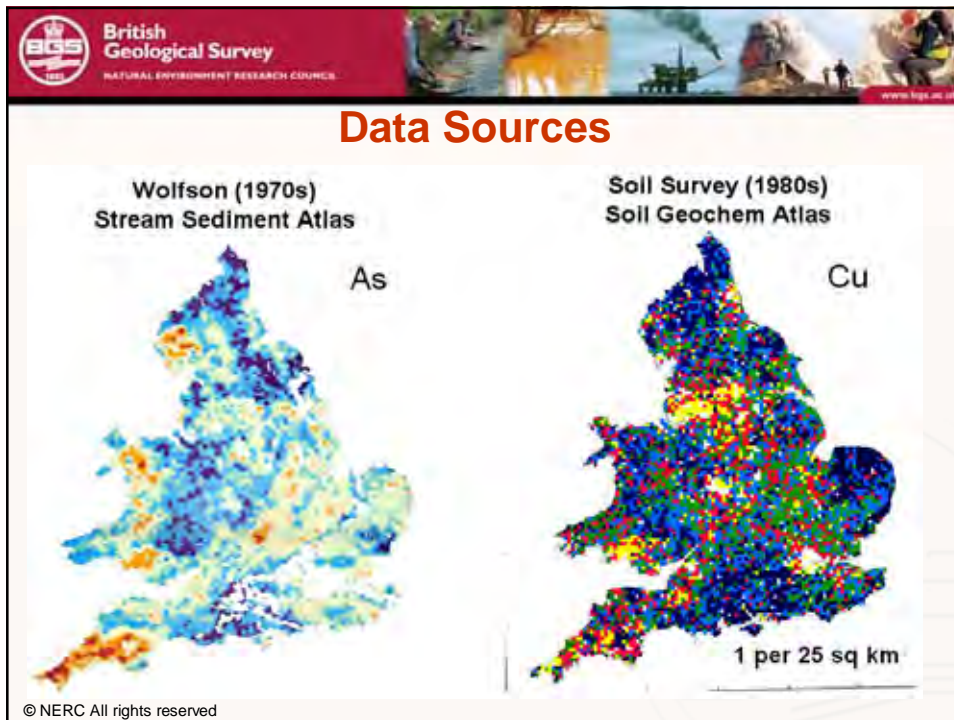
Industry

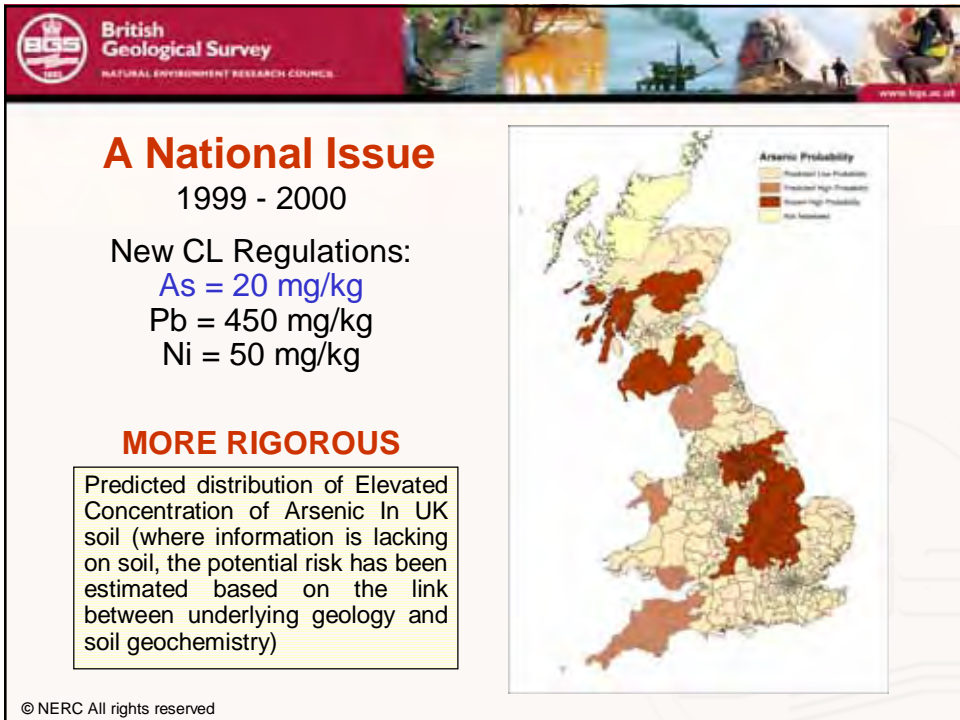
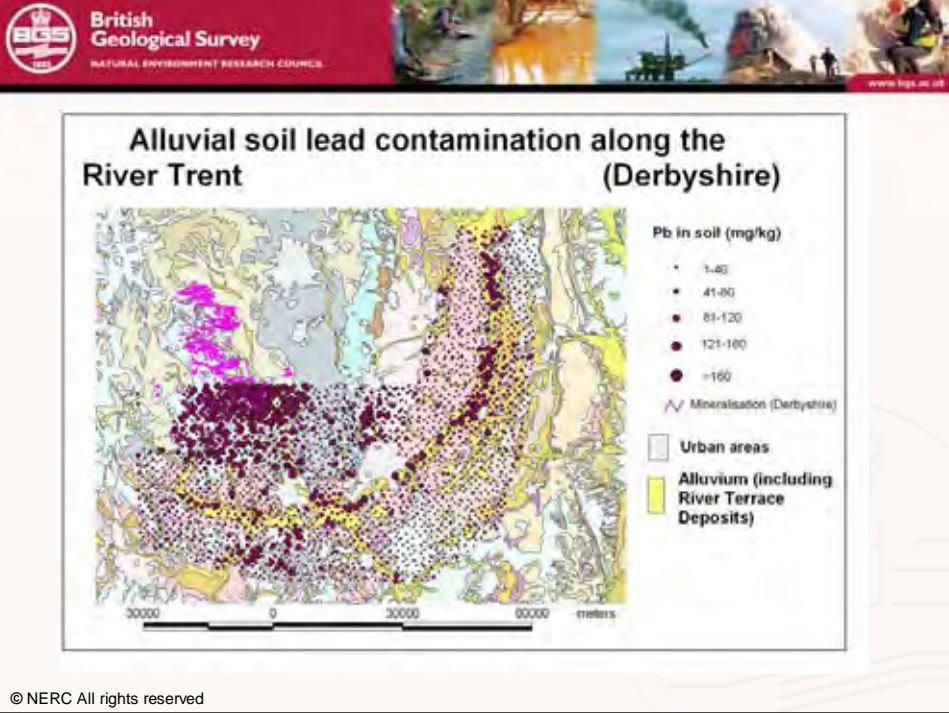
Fertilizers & Sludge
(Agriculture)

Mining

Flooding

Parent Material

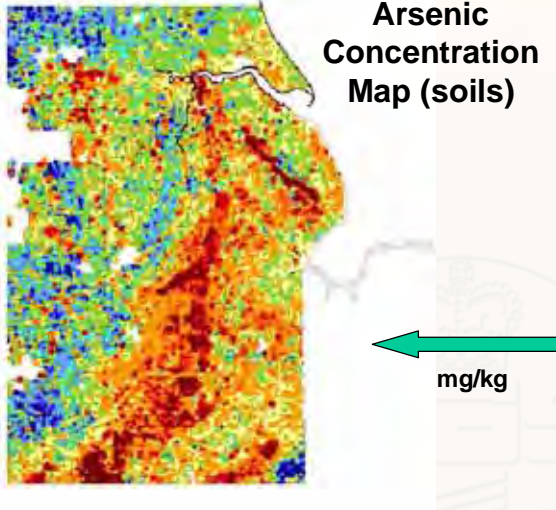




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Midlands regional study

BGS G-BASE survey has identified large areas of the Midlands with arsenic concentrations above the SGV of 20 mg/kg



Arsenic Concentration Map (soils)

mg/kg

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- **What is the source of arsenic in these soils?**
- **How are the elements distributed in the soil components?**
- **What is the actual human exposure?**

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What is the source of arsenic in the soil ?

Not Related to Atmospheric Deposition or Land Use

Strong Relationship with Parent Material

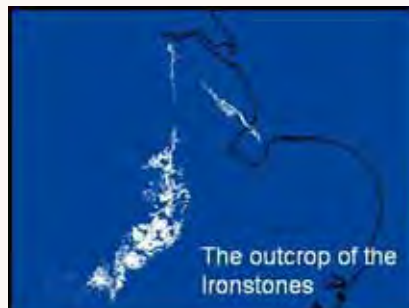


Soils have parent materials which influence the kinds and amount of minerals in the soil and contribute to soil fertility, color and texture of the soil (Important Properties Related to Soil Function)

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The Link to the Ironstones

Correspondence of spatial distribution



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As 37-400 mg/kg



A greenish and reduced ironstone weathers at the surface to a brown rock rich in goethite other minerals present may include "chamosite" and siderite

Soil forming factors (weather, organisms, topography, time) act on the parent material to form these soil types



Brown Rendzina



Brown Earth

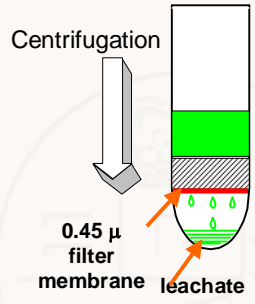
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How arsenic is distributed in the soil components?

CISMeD Test
Chemometric Identification of Substrates and Metal Distributions

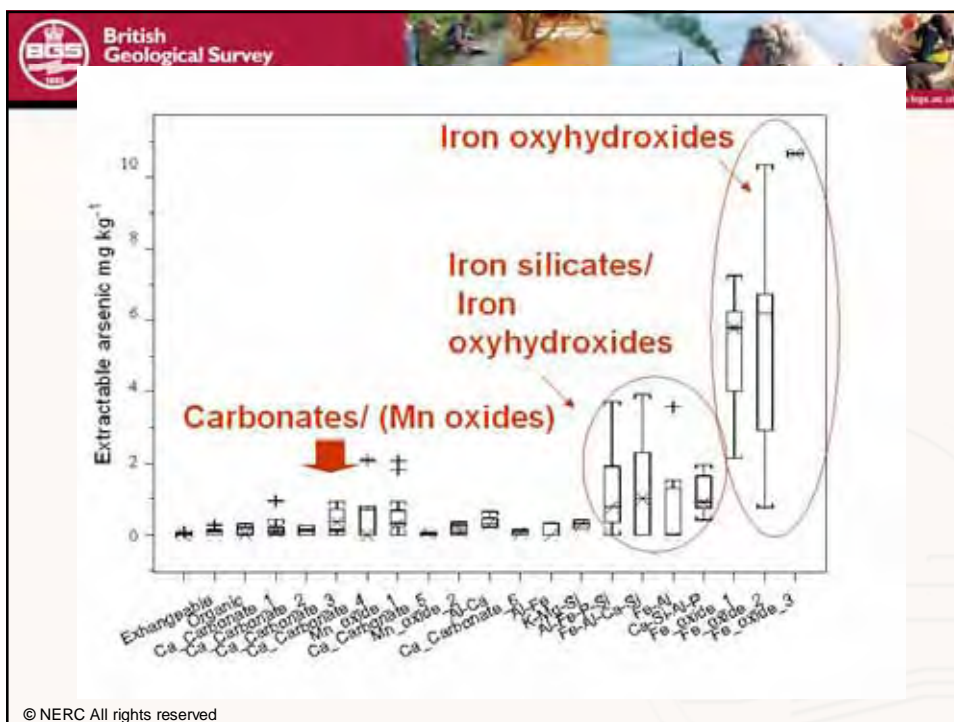
- Separate aliquots of nitric acid of increasing concentration.
- Passed through the sample under centrifugal force.
- Determination by ICP-AES.
- Chemometric data processing .
- Identification of physico-chemical hosts and the metal distributions within the sample under test.



Centrifugation

0.45 μ filter membrane leachate


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What is the actual human exposure?

In assessing the health risk posed by arsenic in soils the exposure pathway of most concern (>90%) is inadvertent or deliberate soil ingestion (100mg per day)



Potassium arsenite or arsenic trioxide

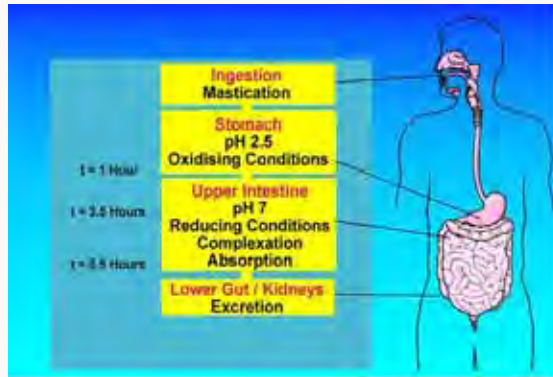


Arsenic-Iron Silicates and Oxyhydroxides

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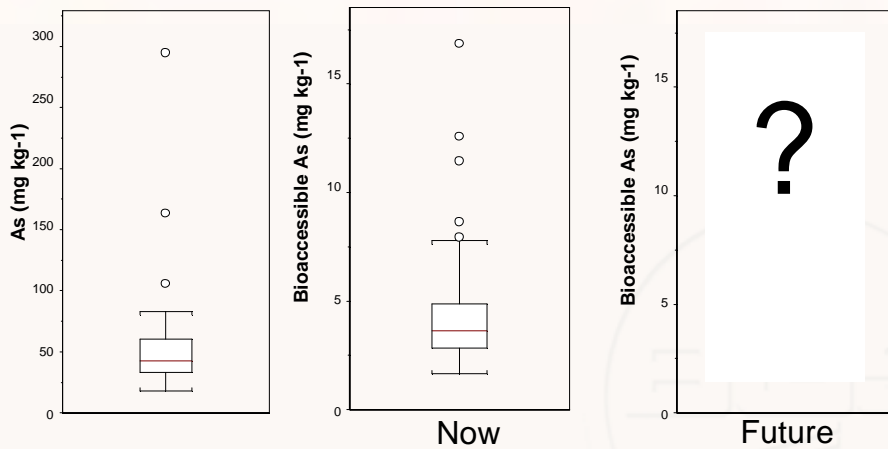
What is the actual health risk?

Physiologically Based Extraction Test (PBET) developed to estimate biological availability of major and trace elements in mine-wastes and soils from domestic gardens - Mimics kinetic and chemical changes in the human digestive system

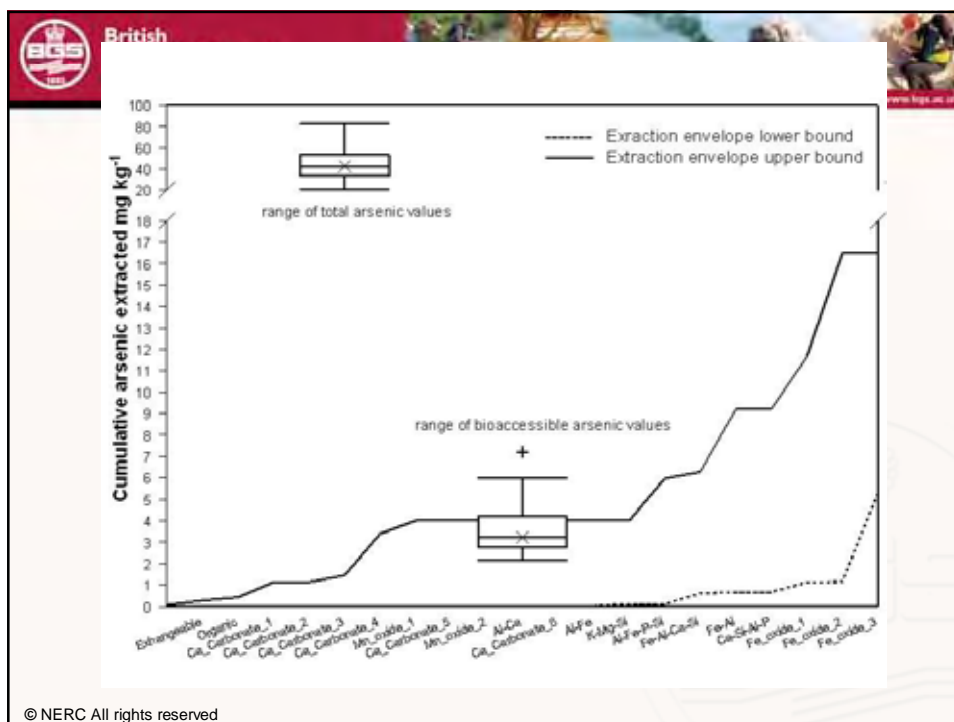


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Distribution of arsenic and bioaccessible arsenic in soils from Midlands study area (N=80)



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Conclusions

- Arsenic derived from mineralised parent material represents a potential issue in the many UK soils due to economic factors rather **than health concerns**
- In vitro bioaccessibility testing has demonstrated that in all of the samples tested the arsenic is below the soil guideline value with the mean bioaccessible fraction of the order of 10% of the total arsenic therefore it is unlikely to pose a health risk through soil ingestion.
- The use a generic pdf for soils developed from Ironstones in the Midlands represents a robust approach.
- Bioaccessible arsenic is derived from mainly carbonate (sideritic) and partially iron aluminosilicate (berthierine rich)/ iron oxyhydroxide phases

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Soil UK: The Main Players

Data & Survey

Environment Agency Regulator (E&W)	National Soil Research Institute (England and Wales)
SEPA (Scotland 7 NI)	Macaulay Land Use Research Institute (Scotland)
Department of Agriculture and Rural Development (Northern Ireland)	Rothamstead Research (E&W)
Natural Environment Research Council	
British Geological Survey (UK Wide)	ADAS (E&W)
	DEFRA Policy (E&W)
Local Authorities (UK Wide)	Centre for Ecology and Hydrology (UK Wide)



Not yet another different set of soil friendly regulations that makes ten and their all different!!

