Refining the Human Health Risk Assessment Process from Soil Contaminant Exposure

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Project Aim and Objectives

The aim of this research is to investigate human health risks associated with exposure to potentially toxic elements (PTE) in Northern Irish and Irish soils by exploring the geogenic associations of soil contaminants observed to be associated with human disease burden such as renal disease and investigate mechanisms governing their mobility and bioaccessibility. This aim is supported by the following objectives:

1. **Obtain new X-ray fluorescent spectrometry (XRFS) data for selected soil samples (Fig. 1)**
2. **Identify elevated PTE source domains (Fig. 2) and calculate their typical threshold concentration values (TTV)**
3. **Establish relationships between total XRFS concentrations and partial *aqua regia* concentrations (Fig. 3)**
4. **Undertake elemental and mineralogical mapping of Ni and Cr in soils overlying basalt bedrock to support results of bioaccessibility testing (Fig. 4)**
5. **Identify controlling factors over PTE bioaccessibility such as rock or soil type and produce regional maps to illustrate bioaccessibility (Figs. 3, 4 and 5)**
6. **Measure the oral bioaccessibility of PTEs observed to be present at elevated levels using the Unified BARGE Method (UBM) (Fig. 5, Table 1)**
7. **Review published literature investigating environmental factors associated with renal disease, linking findings to oral trace element bioaccessibility**
8. **Evaluate how these findings may be incorporated into a refined approach to quantitative human health risk assessments (Table 1)**

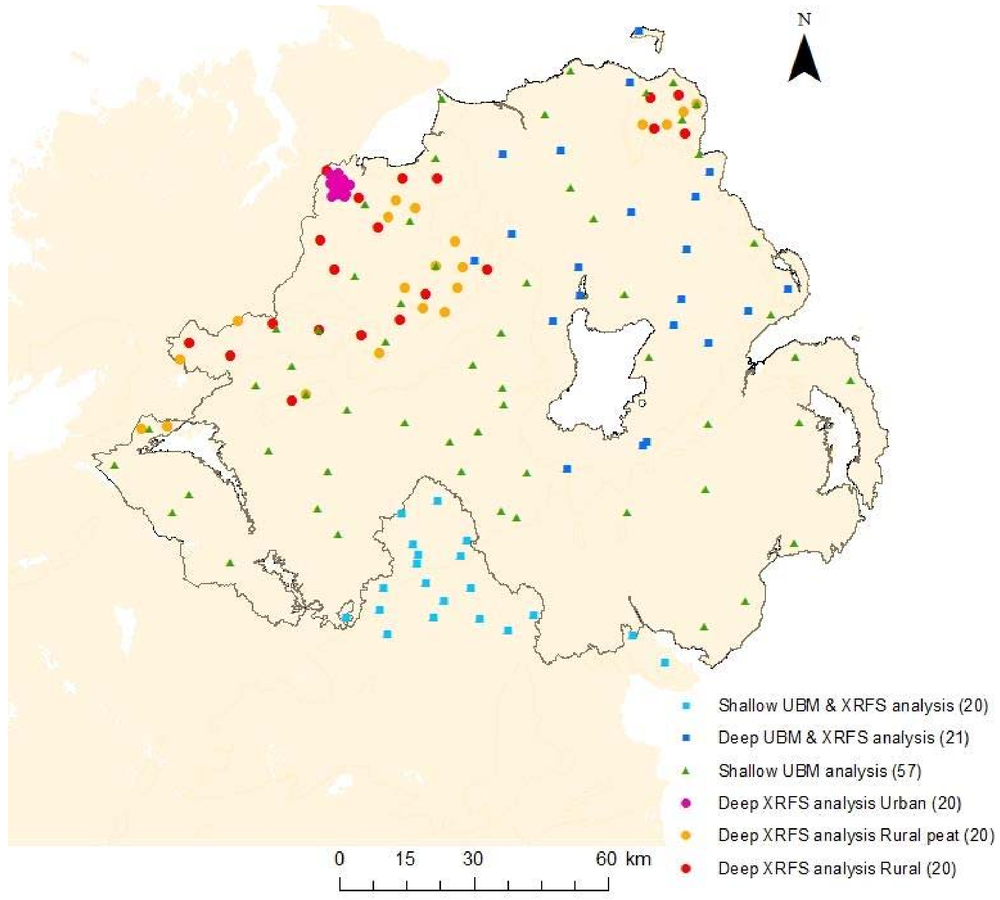
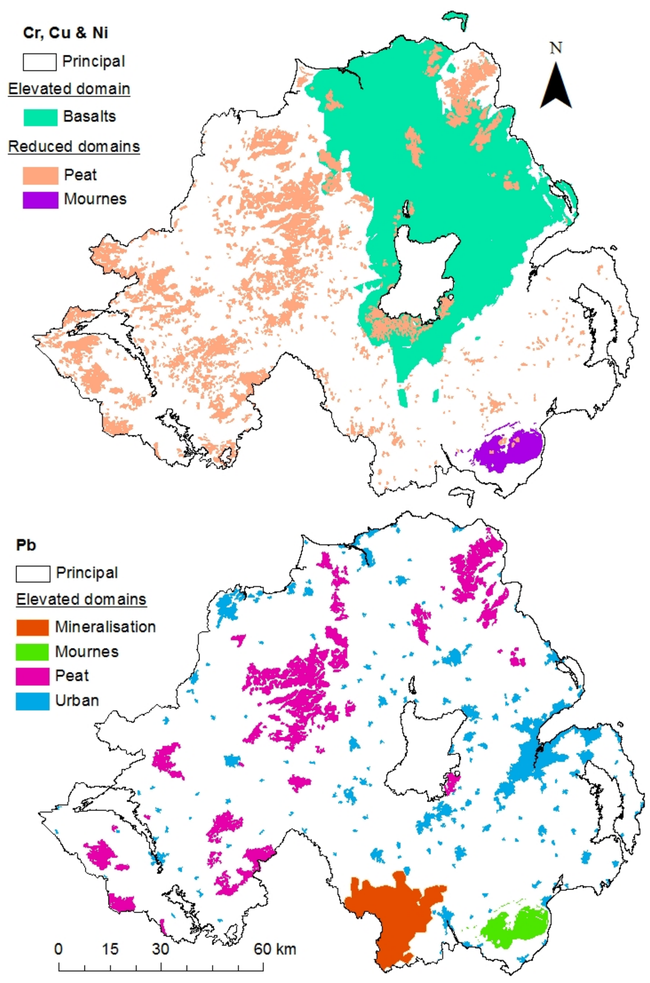


Fig. 1. *Sample locations were selected from the Northern Ireland Tellus and Tellus Border surveys for further investigation including extension of XRFS analyses across the region, conducting detailed investigations of mineral forms of Ni and Cr overlying basalt, and augmenting bioaccessibility analysis coverage for the region*



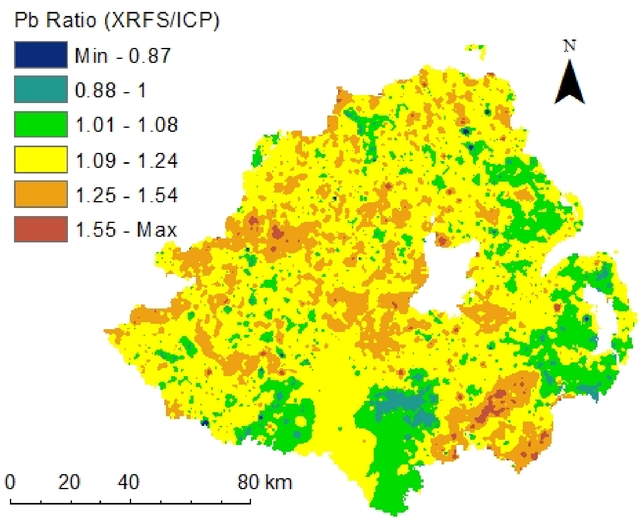


Fig. 2 (left)*. Elevated and reduced domains controlling Cr, Cu, Ni and Pb concentrations in shallow soils identified through comparison with bedrock and superficial geology, land use and mineralised areas.*

Fig. 3 (above)*. Ratio of total XRFS/partial ICP shallow soil Pb concentrations. Where relatively lower ratios occur the elements are more easily extracted from the soil and where relatively higher ratios occur the elements are more tightly bound into the soil.*

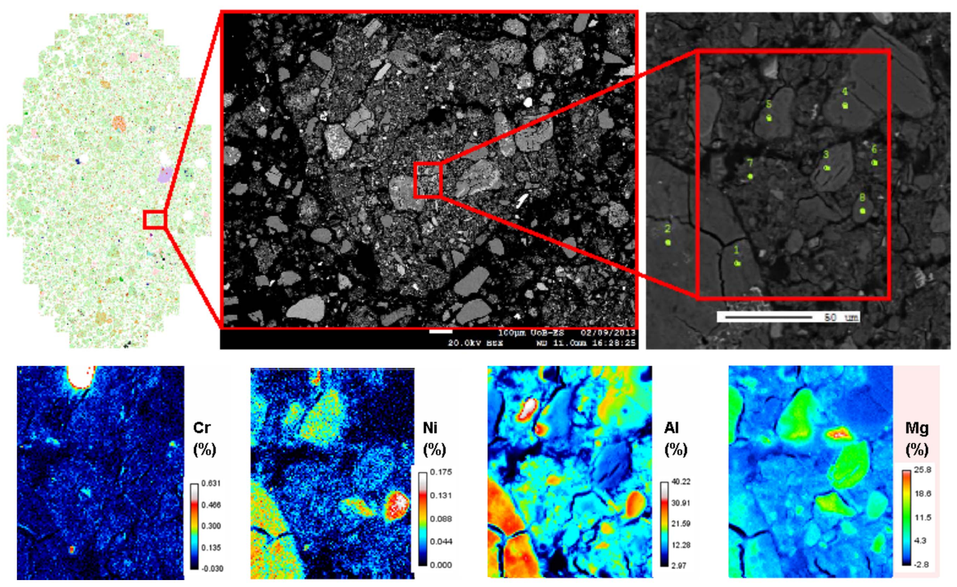


Fig. 4. *Detailed mapping of a sample taken from soils overlying Antrim Basalts. Top left image shows mineralogical mapping of the entire thin section, while top middle and top right images show the area selected for elemental mapping. Bottom images show elemental mapping undertaken for nickel (Ni), chromium (Cr), aluminum (Al) and magnesium (Mg).*

Table 1. *Median oral bioaccessibility values for PTE are below generic screening criteria where available, although maximum measured bioaccessibility does exceed such criteria in a limited number of sample locations. SGV/GAC are calculated using all possible relevant exposure pathways whilst the UBM measures the oral exposure pathway only.*

Element	SGV/GAC		Max Total Concentration	Max Measured Oral Bioaccessibility	Mean Oral Bioaccessibility	Median Oral Bioaccessibility
	Residential	Allotment				
Ni	130	230	235	30.7	3.7	2.5
Cr	4.3	2.1	510	9.9	1.4	0.98
As	32	43	136	37.2	1.4	0.95
Pb	-NA-	-NA-	291	199.8	15.2	8.6
Cd	10	1.8	63.3	45.2	0.54	0.21

Values in mg/kg
UBM results and XRF total concentration data provided for 2013 and 2009 shallow soils, *n = 165*
Mean Ni, Cr, Pb, Cd results provided for gastric data; mean As upper intestinal data presented

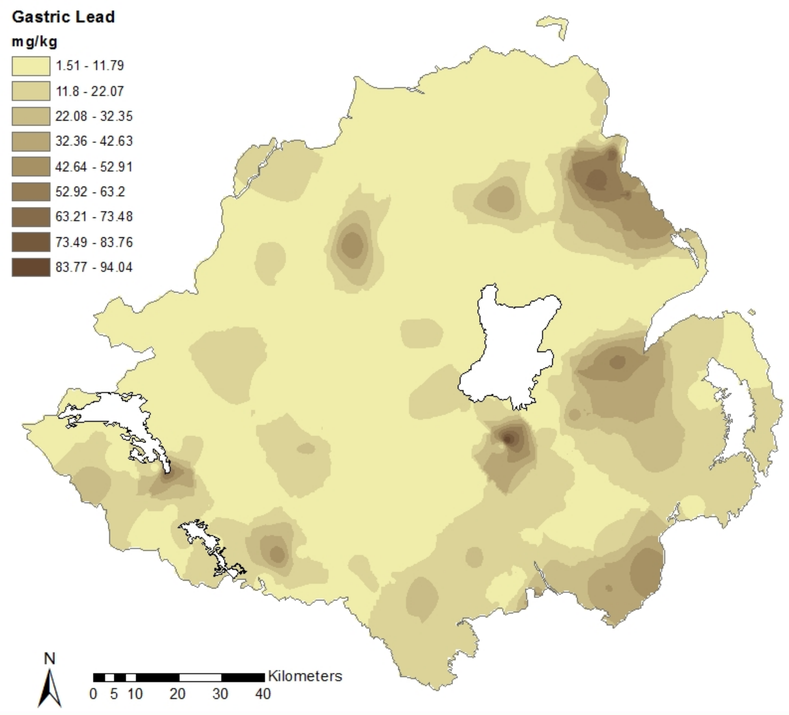


Fig. 5. *Lead (Pb) gastric bioaccessibility interpolated across study area (n = 165). In geographic areas of higher bioaccessibility, higher Pb solubility has also been illustrated as shown in Fig. 3*

References available upon request

The Tellus Border Results and Research Conference
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