

Trace element abundance & human epidemiology: the Tellus case study

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1) Introduction

As the impact of infectious diseases has declined over time with advances in medical care, so cancer has become an increasing factor in mortality. In Northern Ireland, cancer accounted for 27% of all deaths in 2008. There are many factors that come together to cause cancer, and it is likely that some of those are of environmental origin. This project will bring together data from the Tellus Project and the Northern Ireland Cancer Registry for the first time in an attempt to quantify the relationships. Northern Ireland's geology is a microcosm for the rest of the UK and Ireland, any correlations found therefore will have a wider impact.

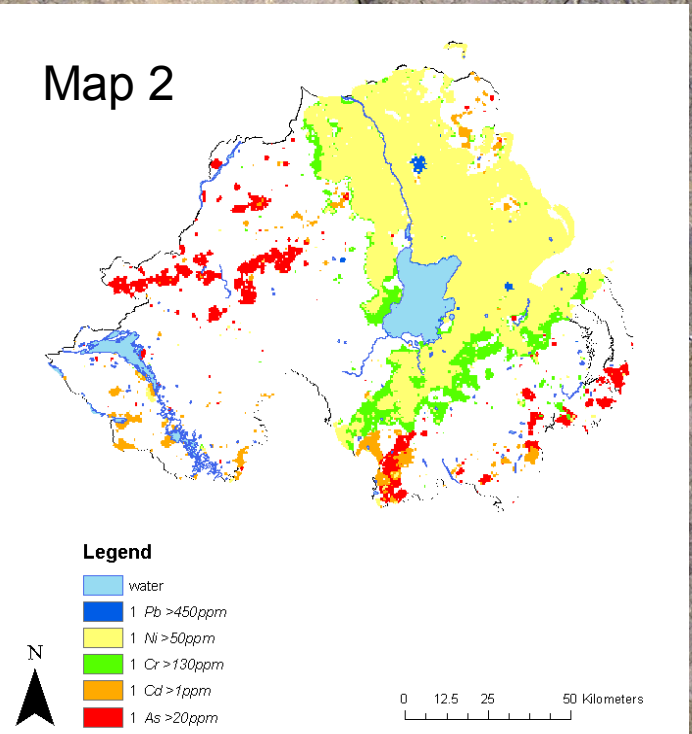
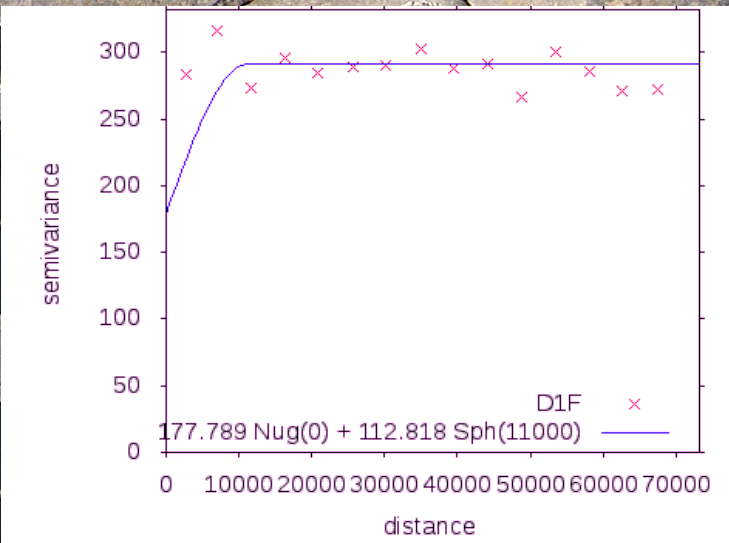
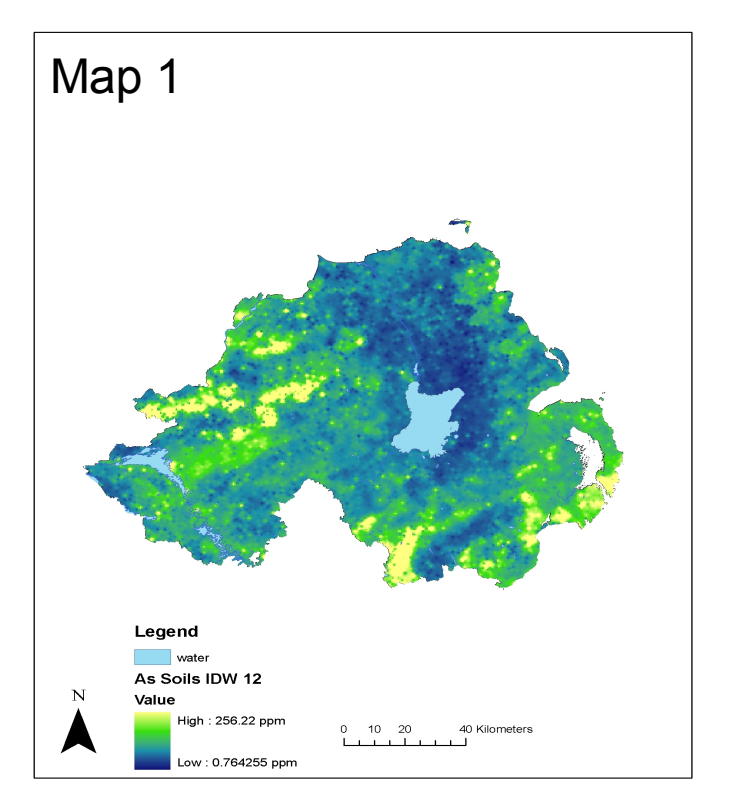
2) Aims

This project explores the spatial correlations between trace elements such as Arsenic, Cadmium, Chromium and Lead found in the soils and human diseases. A subset of the Tellus soils will be analysed for bioaccessibility of the heavy metals.

3) What is Tellus?

The Tellus Project is the most comprehensive mapping project ever undertaken in Northern Ireland.

The project consisted of two parts, an airborne geophysical survey and a ground based geochemical survey which collected 13,860 soil, 5,970 stream sediment and stream water samples. Samples were collected on a grid of one sample site every 2km², with soils being collected at depths of 20 and 50cm. Samples within urban areas were collected on a density of 4 samples per km². ¹ The samples were then analysed for more than 50 elements and inorganic compounds.



4) Methods

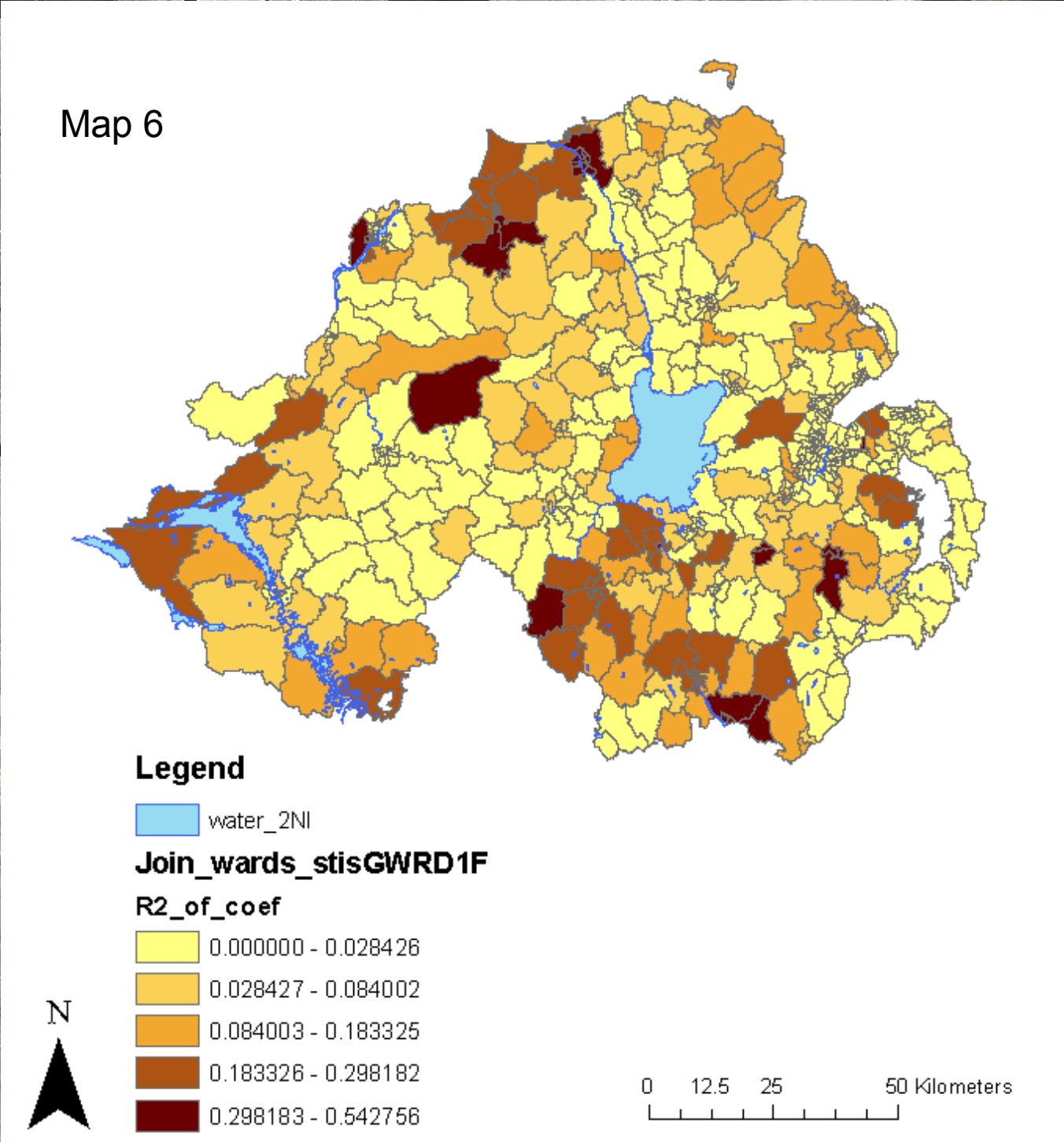
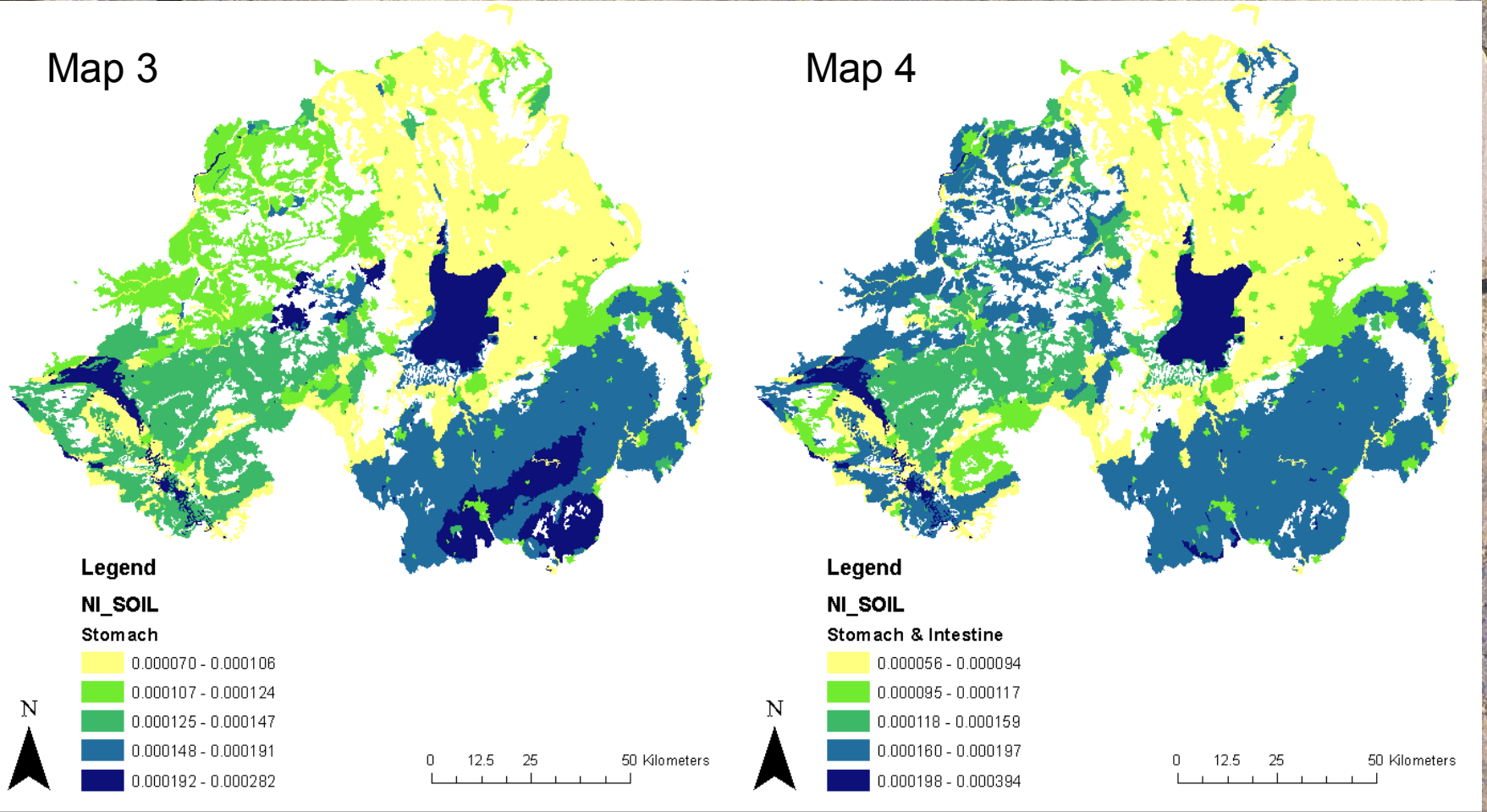
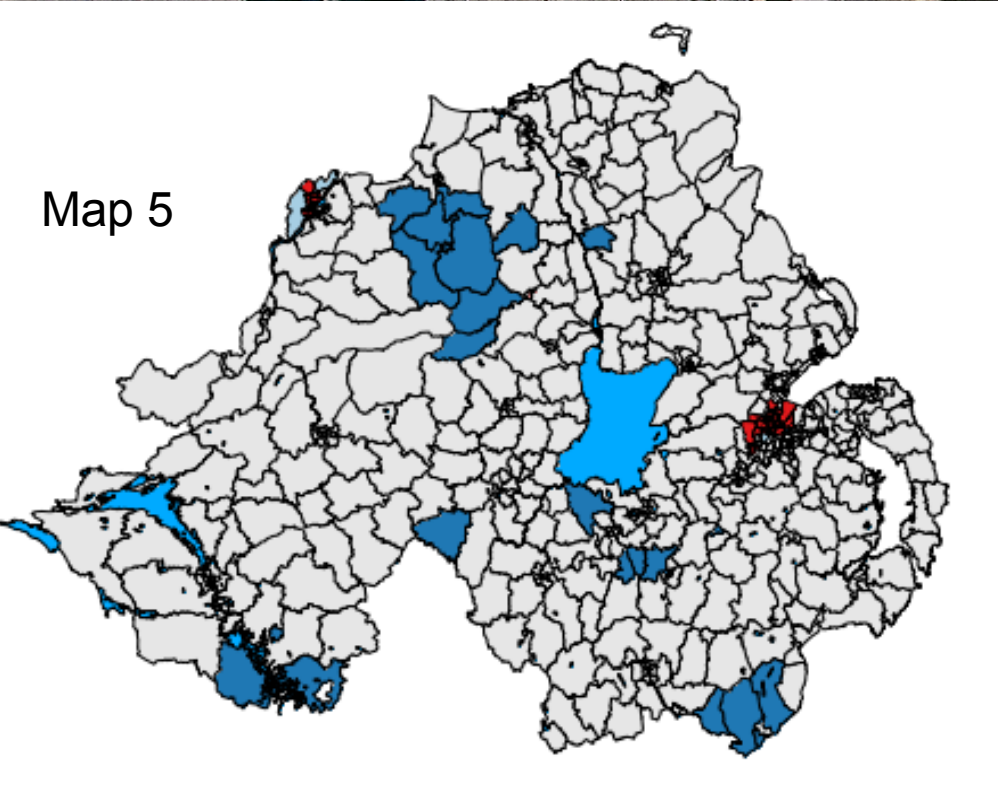
- Literature review.
- Map the trace elements in soils.
- Age-standardise the disease data to account for differences population and map the disease rates.
- Create variograms of the disease rates to see if there is any spatial structure in the data
- Test for clusters in the disease data (eg. "Local Moran's i" using STIS software).
- Using geographically weighted regression test for local correlations between the disease data and the trace elements.
- Carry out bioaccessibility tests on a subset of the soils (simulating the human digestive system)

Local Moran's I Result	Number of Wards
High-High	37
High-Low	1
Low-High	3
Low-Low	23
Not Significant	518

Table 2

Soil Guideline Values in mg/kg	As	Cd	Cr	Ni	Pb
Residential	20	10	130	130	450
Allotment	20	1.8	200	230	450
Commercial	500	230	5000	1800	750

Table 1



5) Results

The maps above show a complete work through for one disease dataset and one trace element (Disease1 in Females & Arsenic). Map 1 shows the inverse distance weighted (using 12 neighbouring points) interpolation of Arsenic in soils. Map 2 shows the areas where the soil guideline values are exceeded for several trace elements, the values are given in table 1. While initially alarming that large areas of land might have to be considered for remediation, however Maps 3 & 4 show the bioaccessible fraction of the Arsenic for each phase (stomach, and stomach & intestine), the numbers are extremely small and should not constitute a major risk. The D1F age standardised incidence rates for each ward shows no clear patterns and this is borne out by the variogram which does not exhibit a particularly strong spatial structure. A pattern does become apparent in Map 5 of the Local Moran's I results. This compares each ward's disease rate with that of its neighbours to identify clusters of wards of both high and low rates. The results for D1F seem to show a clear concentration within the urban areas of Belfast and Londonderry. Map 6 shows the geographically weighted regression R² value for the local correlation between D1F and As.