

A baseline survey of potentially toxic elements in soils of North-West Syria following a decade of conflict

Dr Jon Bridge, Sheffield Hallam University, on behalf of:

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Summary

The situation in NW Syria

Objectives of the study

Methods and logistics

Results

Implications

The situation in NW Syria 2011-2023

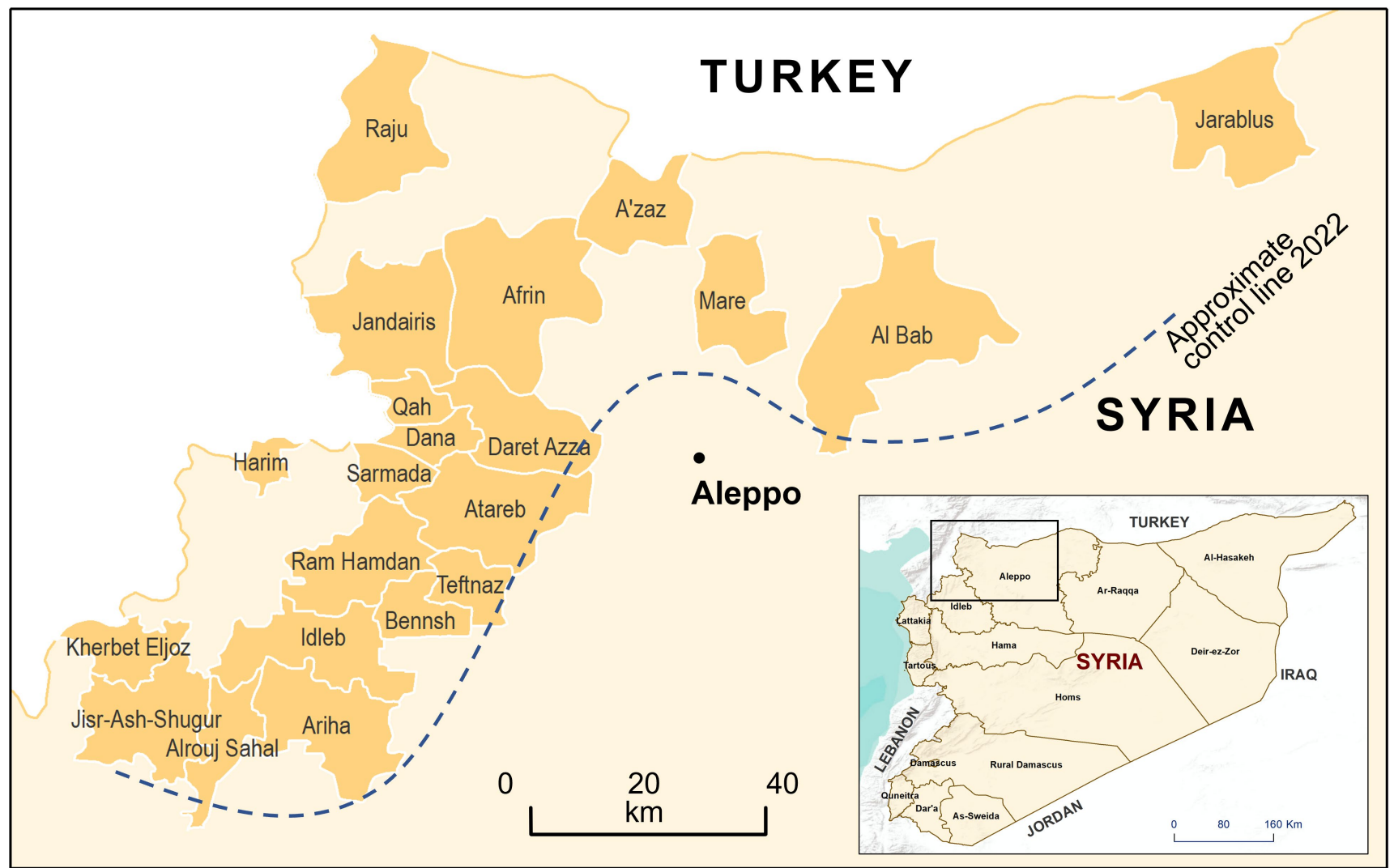


<https://www.theguardian.com/world/2016/dec/23/i-couldnt-take-anything-except-dignity-people-aleppo-syria-on-fleeing-city>

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YCLF meeting, 3rd March 2023**

The situation in NW Syria 2011-2023



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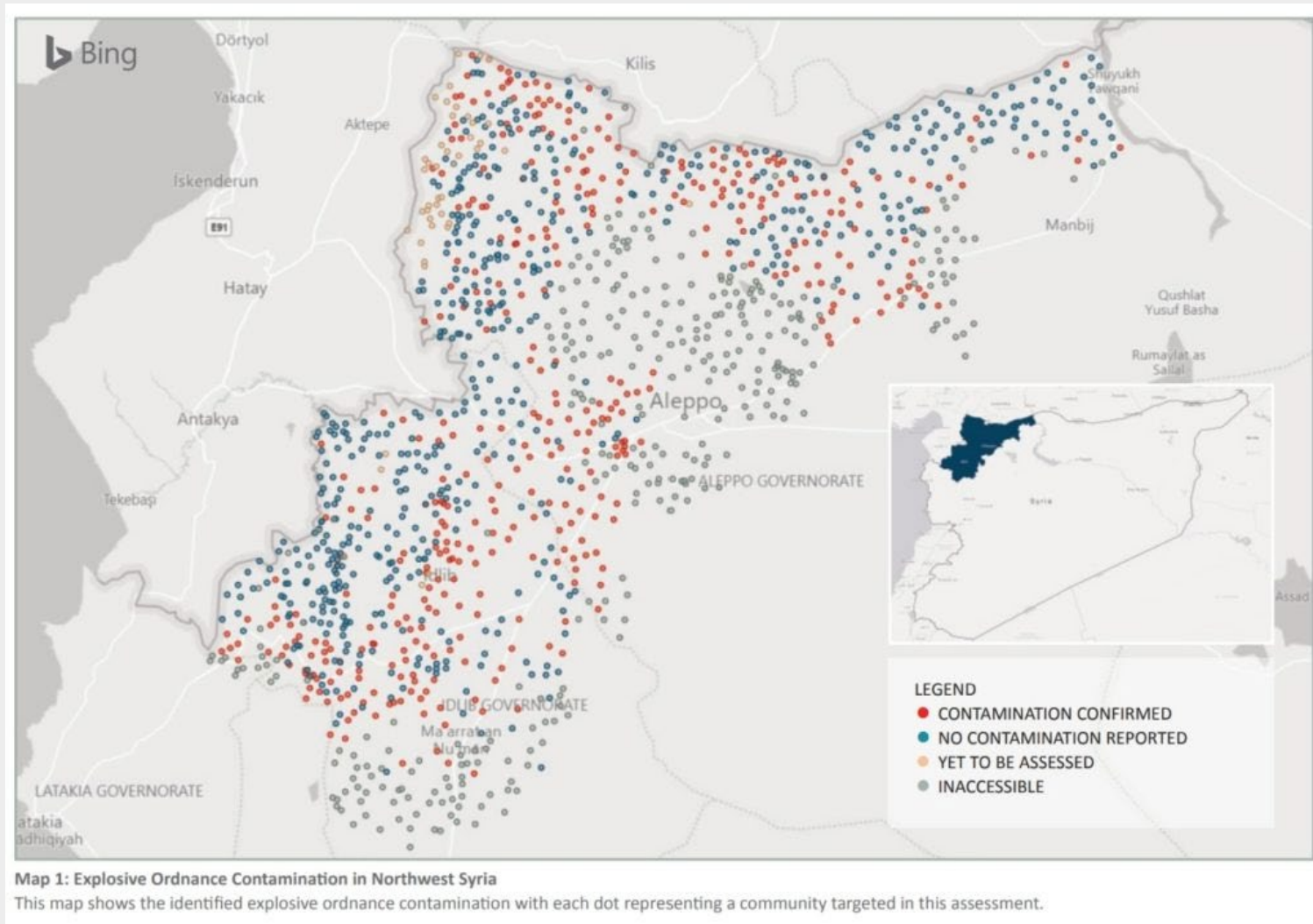
<https://www.binaadev.org/statement-regarding-military-escalation-north-west-syria>

<https://syria.liveuamap.com/>

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The situation in NW Syria 2011-2023



<https://unbiasthenews.org/syria-war-poisoned-soil/>

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The situation in NW Syria 2011-2023

Syrians walk along a refugee camp for displaced people run by the Turkish Red Crescent in Sarmada district, north of Idlib city, Syria, Friday, Nov. 26, 2021. (AP Photo/Francisco Seco)



<https://apimages.com/img/hbg/2021/11/29/town-in-syria-idlib-province-transformed-by-war>

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The situation in NW Syria 2011-2023



<https://www.msf.org/covid-19-complicates-catastrophic-situation-northwest-syria>

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The situation in NW Syria 2011-2023



<https://news.un.org/en/story/2021/01/1083072>

More than 2M people live in 1,750 informal camps in the region. Flooding, January 2021

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The situation in NW Syria 2011-2023

- Large displaced population in need
- Proliferation of camps, few with adequate WASH – current growing cholera outbreak
- High demands on agricultural production
- Decimation of infrastructure, economy, resource base, orchard stocks, seedstock...
- Long-term drought, winter flooding
- Fire, military incursion, direct war impact

Motivation for this study

- We know there will be specific locations of very severe contamination
- We are aware of spatially-extensive risk factors – diffuse pollution at regional scale
- We can conceptualise significant exposure pathways via food, water, direct contact

How can we assess specific impacts without a baseline of regional soil quality?

Existing data is patchy and dated

Location	Reported total soil concentration (mg/kg)								
	As	Ba	Cd	Co	Cr	Cu	Ni	Pb	Zn
<i>Regional, contemporary 2020</i>									
Harran Plain, Turkey	6.36	-	-	16	85	27	89	10.6	68
<i>Pre-conflict Syria 2005-2010</i>									
Gouta (intensive agriculture)	-	-	-	-	57	34	39	17	103
Pre-conflict Syria (industrial)	-	-	9.8	-	-	127	-	95	760
Aleppo - GW irrigated	-	-	1.78	-	96	41	92	50	63
Aleppo - WW irrigated	-	-	1.86	-	112	46	94	72	74
Alsweida Governorate	-	-	0.12	-	2	-	-	0.12	4.37
<i>Global (non conflict)</i>									
EU (Finland soil threshold values)	5	-	1	20	100	100	50	60	200

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Objectives of the study

- To conduct, to the best standard possible, a regional survey of soils across NW Syria
- Base methods on EU LUCAS Topsoil Survey as a transferable template (Tóth et al., 2016)
- Focus on potentially toxic elements ('heavy metals' – As, Cd, Co, Cr, Cu, Ni, Pb, Zn)
- Where possible, assess spatial associations

Tóth, G., T. Hermann, M.R. da Silva, and L. Montanarella. Heavy metals in agricultural soils of the European Union with implications for food safety, *Environment International*, 2016, **88**, 299-309. <http://doi.org/10.1016/j.envint.2015.12.017>

Methods and logistics

Sampling strategy and limitations

- EU LUCAS Topsoil standard is one data point / 200 km²
- We sampled 22 administrative sub-districts with an average area of approximately 200 km²
- Three sample sites per sub-district (LUCAS = 5 samples), typically a few km apart and then mixed in the field
- Samples from 10-20 cm depth, double-bagged in polyethylene. Tools washed in mineral water between sites.
- Number and location of samples constrained by access, safety considerations, and limited budget for analysis

Methods and logistics

Examples of typical sample sites



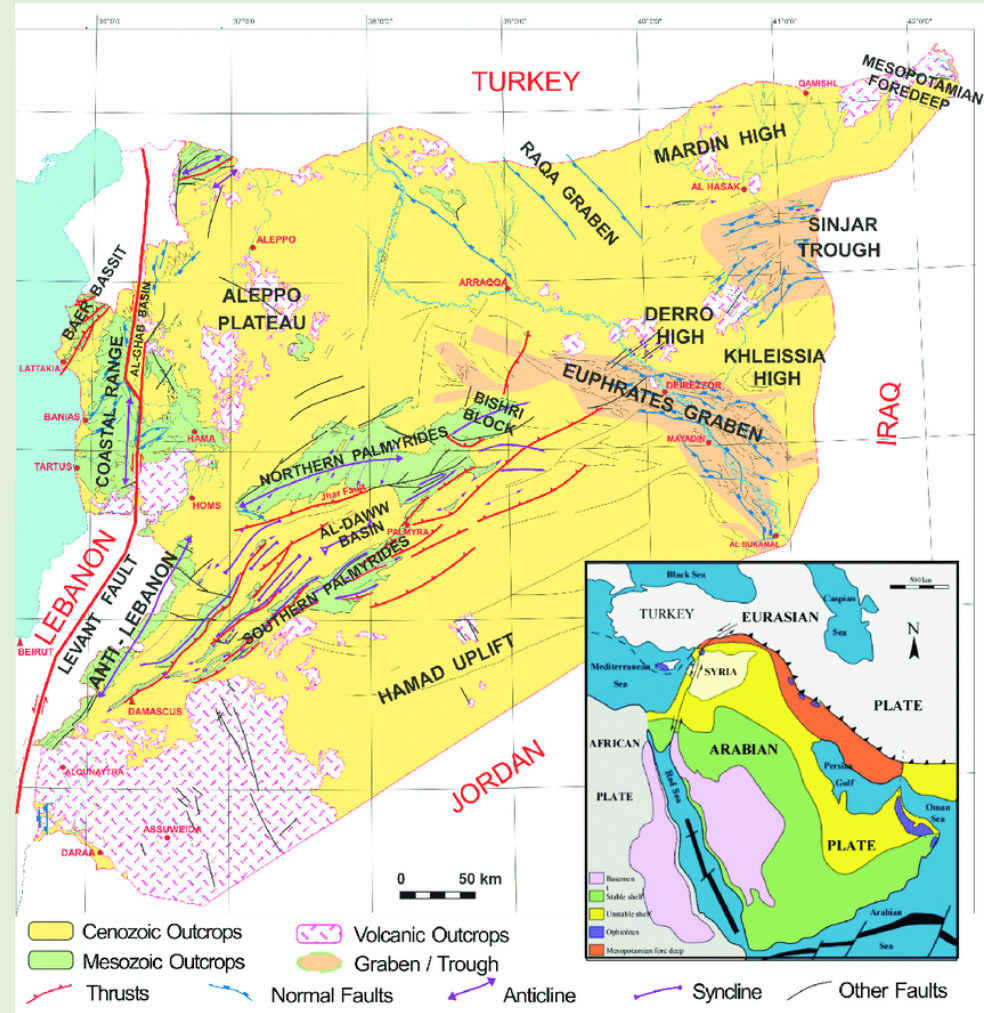
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Methods and logistics

Regional geology

- Tertiary Arabian plateau
- Clays, marls, limestones, evaporites, sandstones
- Localised volcanics (basalt)
- To the W, NW and N is tectonic zone, including Kizildag Ophiolite
- Cambisols, luvisols, fluvisols, some vertisols



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Methods and logistics

Sample return and analysis

- Samples returned to Harran University, Turkey for characterization (pH, OM, EC)
- Sub-samples packed and shipped to UK – James Hutton Institute and University of South Wales
- Aqua regia digest for ICP-MS and ICP-OES (ISO17025:2017) elemental concentrations mg/kg
- Enhancement ratios determined relative to Finnish threshold values after Tóth et al., 2016
- Combined enhancement ratio as mean of As, Cd, Co, Cr, Cu, Ni, Pb, Zn

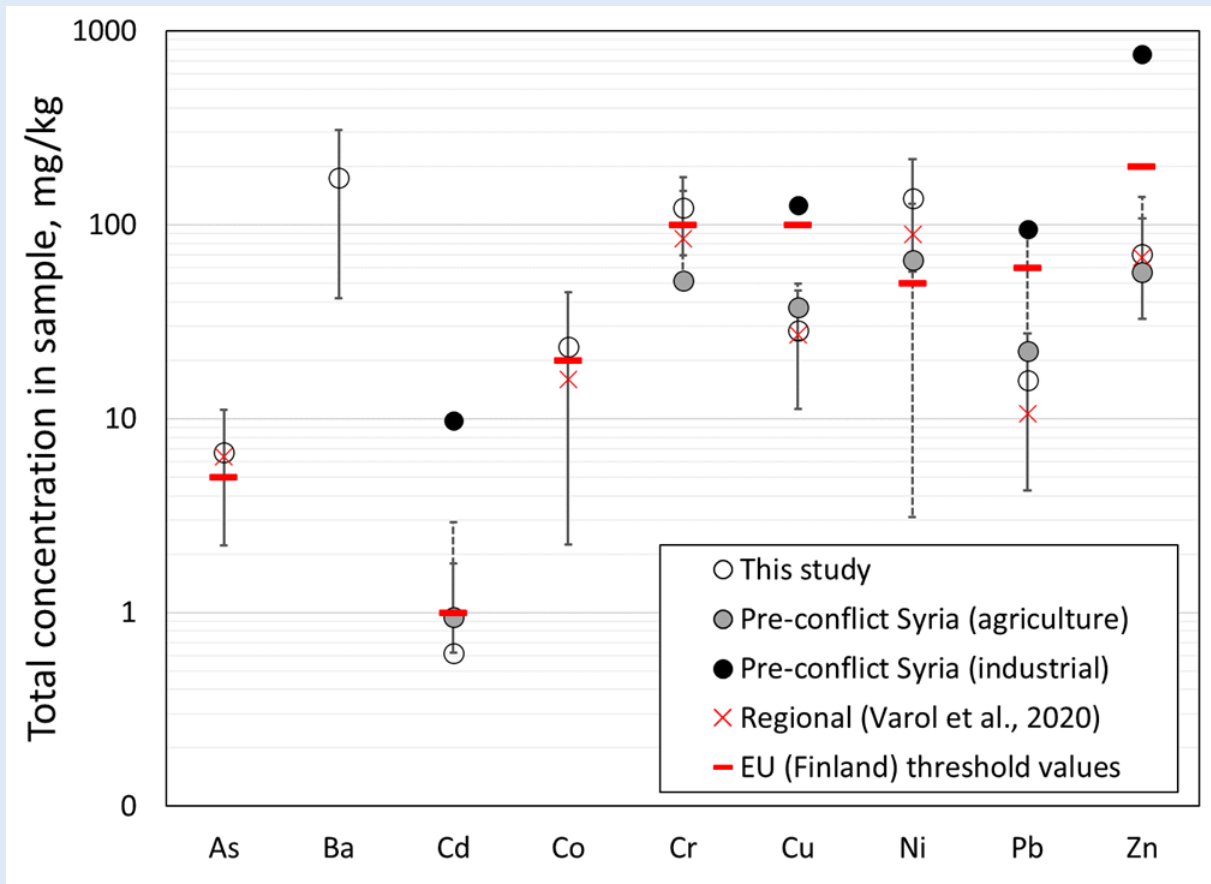
Results

Soil conductivity (<400 mS/m) and pH (mean 8.15)

Sub-district	Sampling site character(s)	Conductivity, mS/m	pH
Afrin	Residential	139.80	8.10
Al Bab	Industry / Residential	147.53	8.22
Alruj Plain	Agricultural	208.90	7.78
Ariha	Conflict activity area / Vehicle transit area / Residential	103.67	8.39
Atareb	Conflict activity area / Residential	238.07	8.16
A'zaz	Vehicle transit area / Residential	204.40	8.14
Bennish	Conflict activity area / Agricultural	154.67	8.44
Dana	Vehicle transit area / Residential / Industry	223.93	7.97
Daret Azza	Residential	148.13	7.90
Harim	Residential	458.00	8.00
Idlib	Vehicle transit area / Residential	213.00	8.33
Jandairis	Residential	233.07	8.36
Jarablus	Industry	123.90	8.34
Jisr-Ash Shugur	Vehicle transit area / Residential	853.33	7.96
Kherbet Eljoz	Conflict activity area	1165.00	8.09
Mare	Agricultural	152.73	8.36
Qah	Camp	129.97	7.97
Raju	Agricultural	156.00	8.30
Ram Hamdan	Conflict activity area / Agricultural	129.90	7.93
Sarmada	Vehicle transit area / Residential	182.03	8.26
Teftnaz	Conflict activity area / Agricultural	225.93	8.15

Results

Summary



*aqua regia extractable concentrations

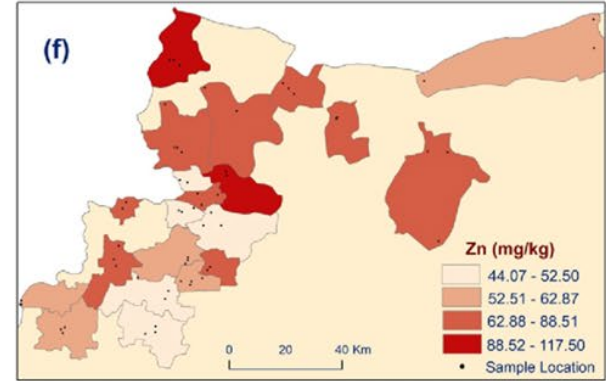
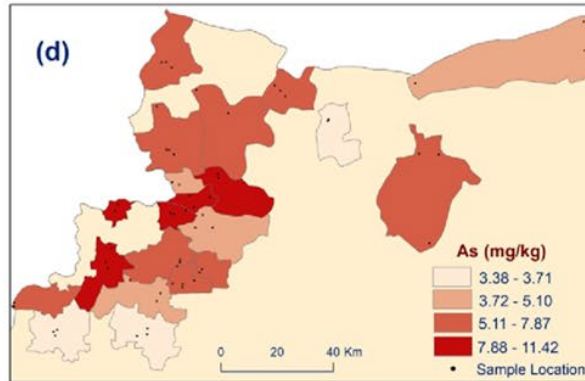
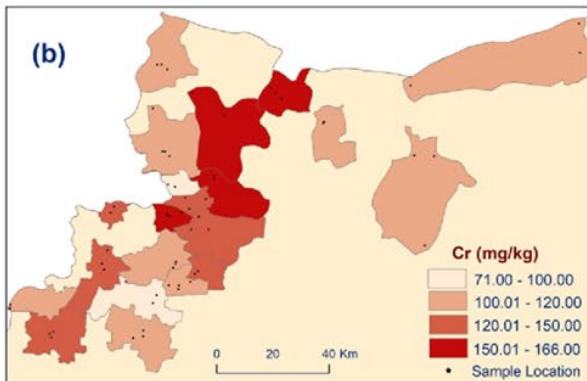
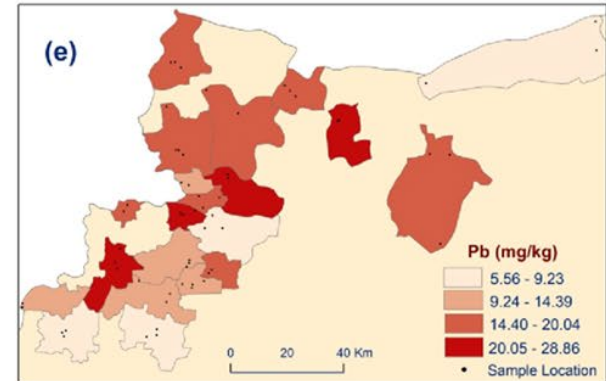
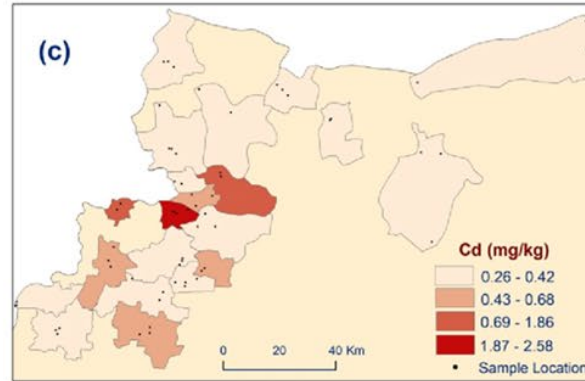
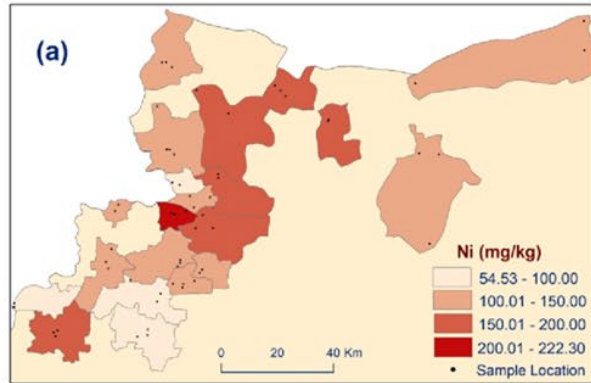
Location	Reported mean soil concentration (mg/kg)								
	As	Ba	Cd	Co	Cr	Cu	Ni	Pb	Zn
This study	6.69	175	0.62	23	122	28	138	16	71
Harran Plain, Turkey	6.36	-	-	16	85	27	89	10.6	68
EU (Finland) threshold	5	-	1	20	100	100	50	60	200

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Results

Spatial distributions



- Ni and Cr elevated regionally
- Ni ++ above threshold values
- No clear evidence for geologic influence

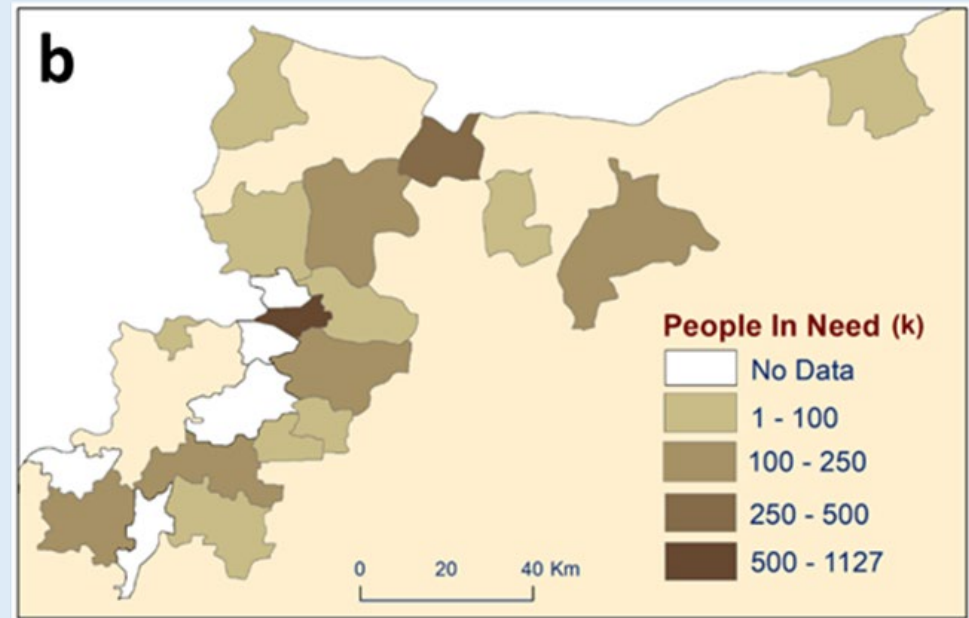
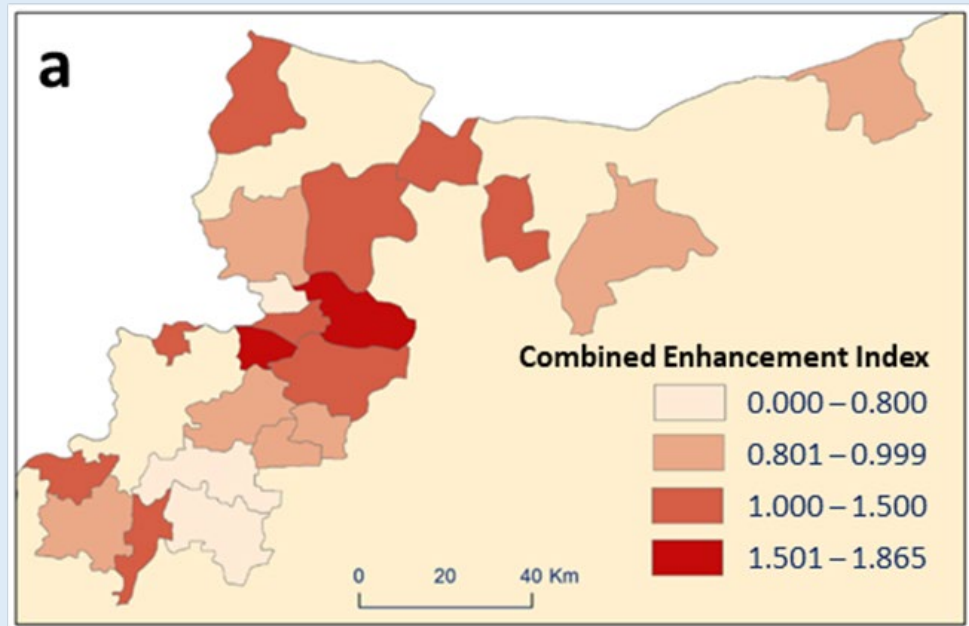
- As, Cd, Co spatially correlated
- As near or above threshold
- Cd max conc highly localized

- Cu, Pb, Zn below thresholds
- No strong spatial patterning

Results

Combined Enhancement Index

- CEI distribution reflects the strong localisation of Cd, As, Co
- Correlation with PIN is not strong but sub-district data are not well-defined
- CEI maxima occur in a 'corridor' between Aleppo and Bab Al-Hawa border
- Most intense combination of PIN, transport, 'informal' industry, conflict in this corridor



Implications

Regional impact of excessive fertilizer use and/or wastewater-contaminated irrigation ...?

Spatial associations between areas of highest PIN, transportation and unregulated industry, and As, Cd, Co ++

Urgent need for further regional studies supported by international geoscience community (analytical resource)

Urgent need for focused S-P-R site assessments

Our dataset, although limited, provides an up-to-date baseline to contextualise site remediation & restoration planning

Credits and acknowledgements

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With thanks to

the research assistants and students in the Agricultural Engineering department at International Sham University, Azaz, Syria

Kate Robertson and the staff of the Cara Syria Programme

technical staff at Harran University, Turkey and JHI / USW



2023 earthquake: plea for donations



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2023 earthquake: plea for donations

cara

a lifeline to academics at risk

Most of our Syria Programme colleagues were based in south-eastern Turkey. 145 of them were living in the worst-affected areas around Kahramanmaras and Gaziantep. Many have lost family members. They are now homeless, in freezing temperatures, camping in cars or mosques. Even if their homes still exist, they don't dare go back into them. They desperately need financial support.

“... the building where my family was living was badly damaged. Now my family lives in a tent outside the housing area until a safe apartment can be found. It is not possible for them to return home because it is unsafe and uninhabitable. I am currently in Syria, so unable to reach my family because of the earthquake and lack of transport, living in a tent in the Azaz area. We are waiting until a safe place can be found for my family in Turkey and for me in Syria.”

<https://bit.ly/CaraQuake>