Leaching Profile of Contaminated Soil from Nigeria and It's Potential for Ex Situ Remediation Using Different Chelating Agent By Soil Washing

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Background for the Study

Plate: **Sectional view of auto-mechanic village and associated activities in Owerri Imo state, Nigeria.**

Aim & Objectives

Aims

- To attempt a decontamination exercise targeted at reducing the impacted site to a sustainable threshold level
- Assess the efficiency of the applied decontamination technique

Objectives

- To characterize the polluted soil for its physicochemical properties
- To compare the extraction potentials of EDTA, EDDS, CA & Hacac for metal complexes
- To determine the extraction kinetics of study

Justification

Justification

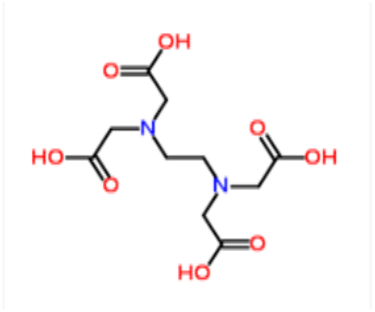
Automobile repairs and its associated activities impact significantly on soil quality; flora and fauna (Shi et al., 2009)

Investigation on road traffic emission reveals that metal depositions are principally induced by the following

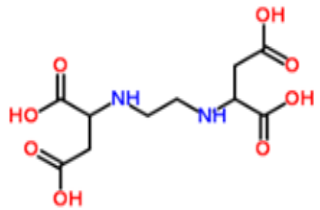
- brake wears/spent batteries
- exhaust fumes/spent batteries
- Organic solvents used as lubricants (Johansson et al., 2009)

Approach

Soil washing of contaminants from bulk soil is achieved by dissolving/suspending the contaminants in an aqueous-based system that is sustained by chemical extractant to improve the washing characteristics(e.g. pH)



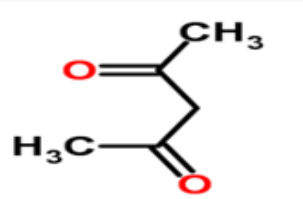
EDTA



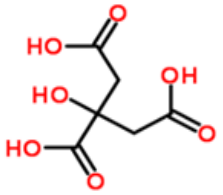
EDDS

Contaminated soil

Treated soil

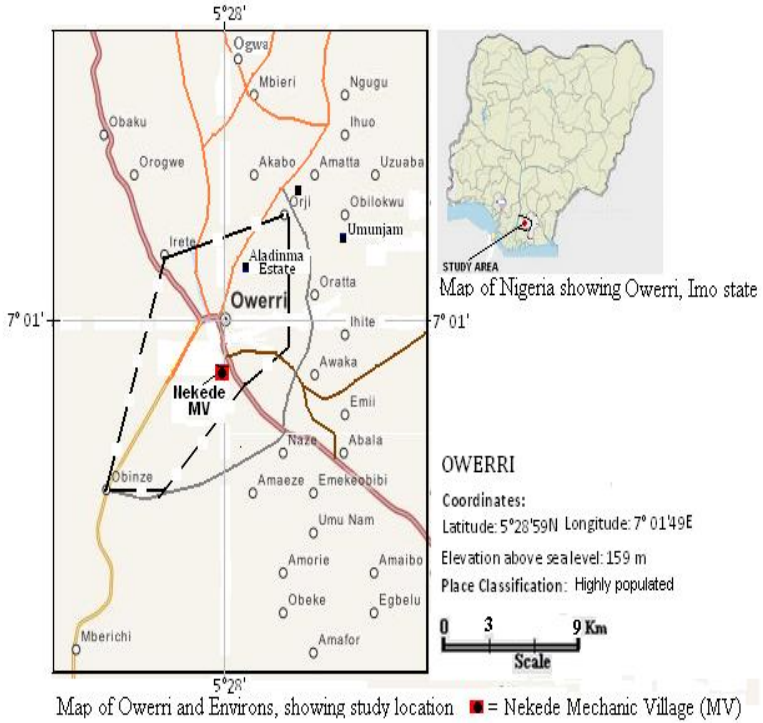


Hacac



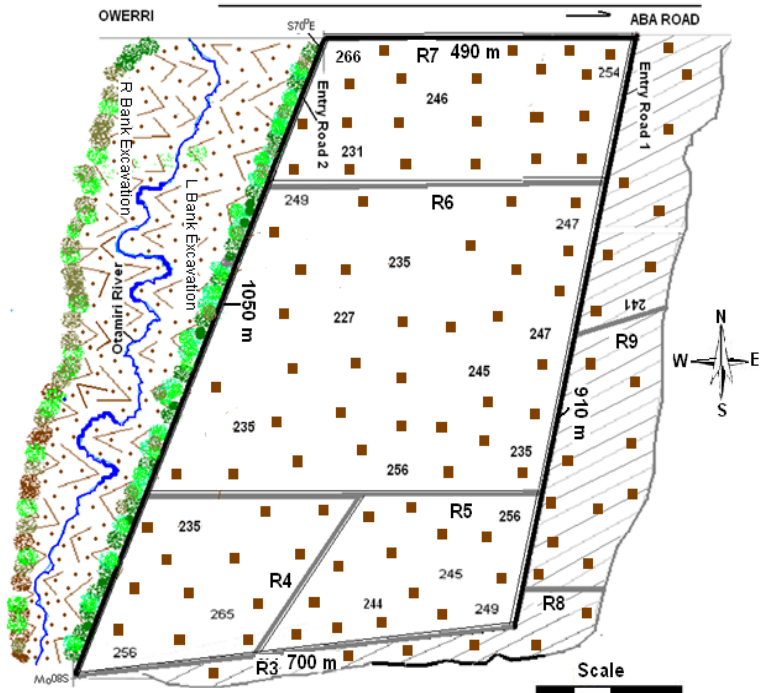
CA

Study map and site description

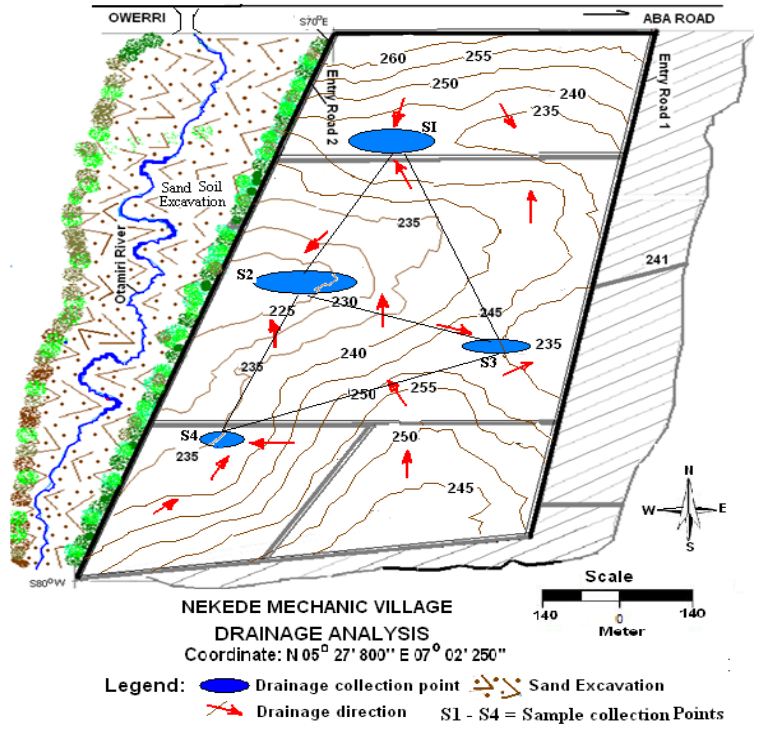


Map of Nigeria showing Owerri, Imo state

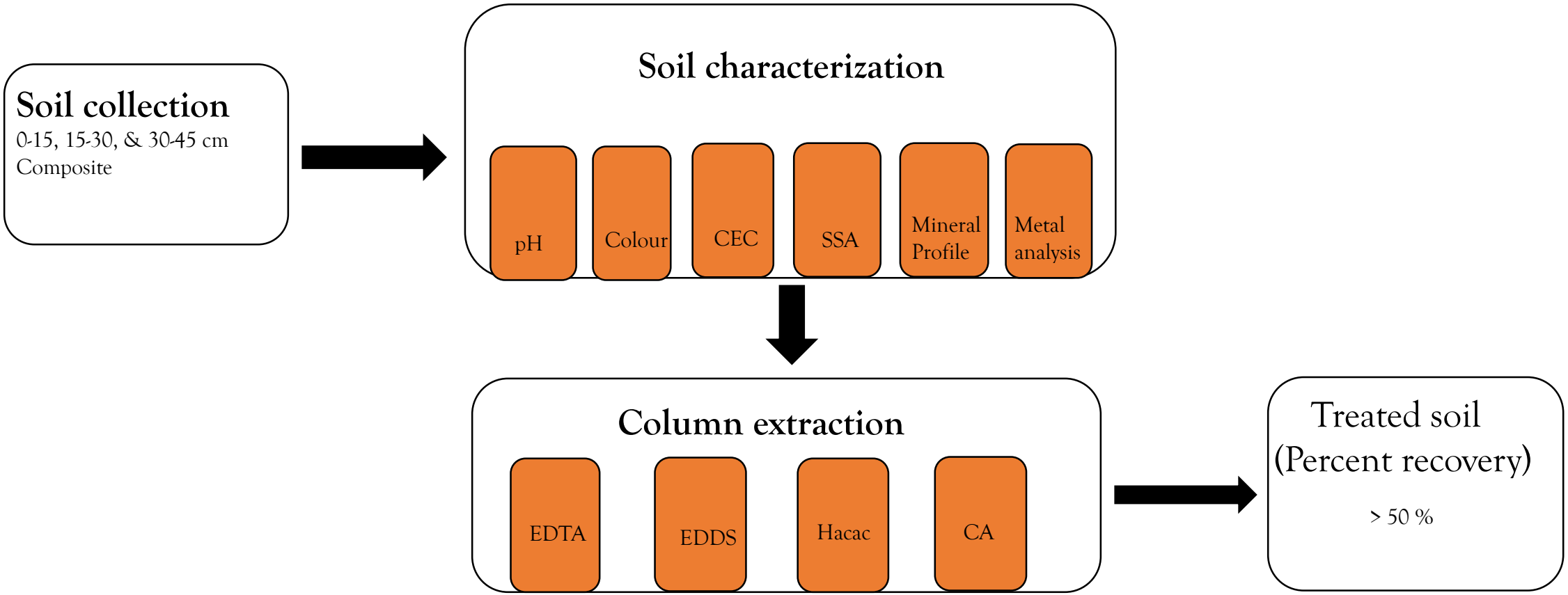
Map of Owerri and Environs, showing study location ■ = Nekede Mechanic Village (MV)



NEKEDE MECHANIC VILLAGE SPOT ELEVATIONS
N 05° 27' 800" E 07° 02' 250"



Materials & Method

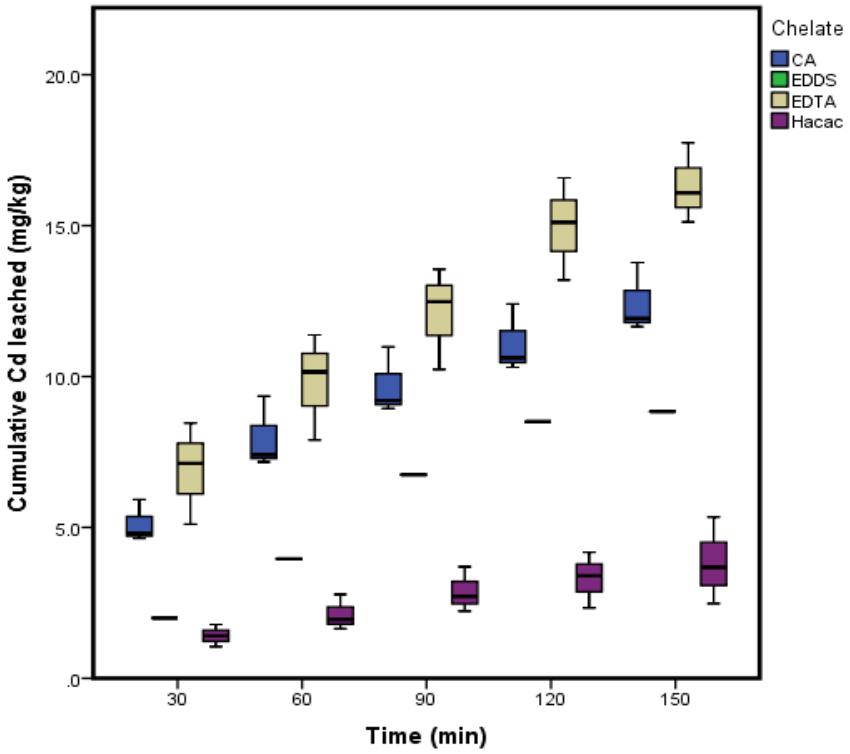


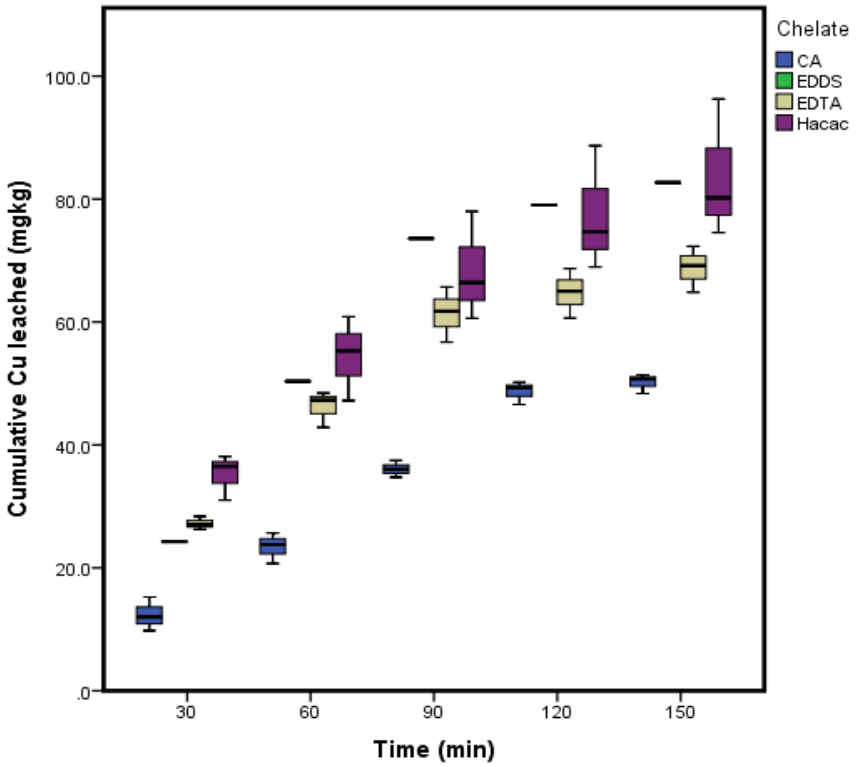
Results

Soil characteristics

Soil	Mineral Type	Characterization				Elemental concentration ($mgkg^{-1}$)				
		Texture	pH	SOM (%)	CEC (meq/ 100g)	Cd	Cu	Ni	Pb	Zn
Nig-S	Kaolinite, Anatase and Quartz	Sandy loam	3.7	0.3	7.3	26.3	155	75	210	350
The European Union Standard (MEF, 2007)						1.0	100	50	60	200
Nigerian Intervention value (DPR, 2002)						17	190	210	530	720

Results Cont'd





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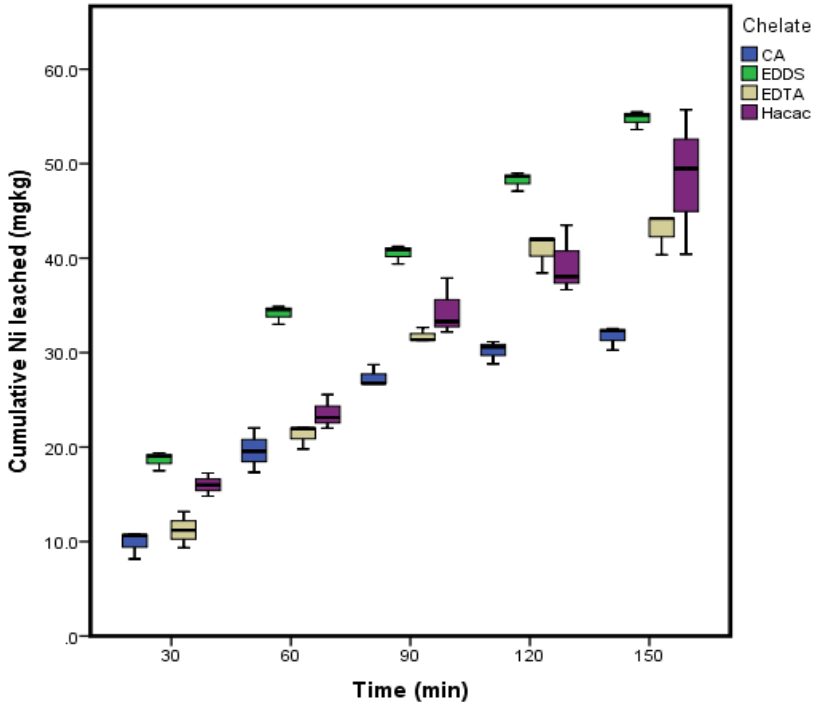

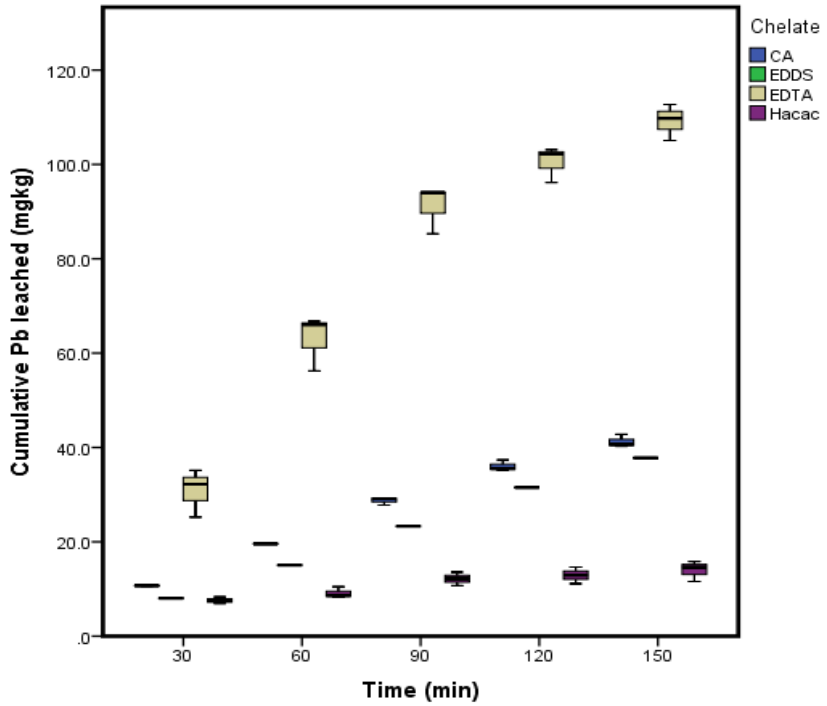

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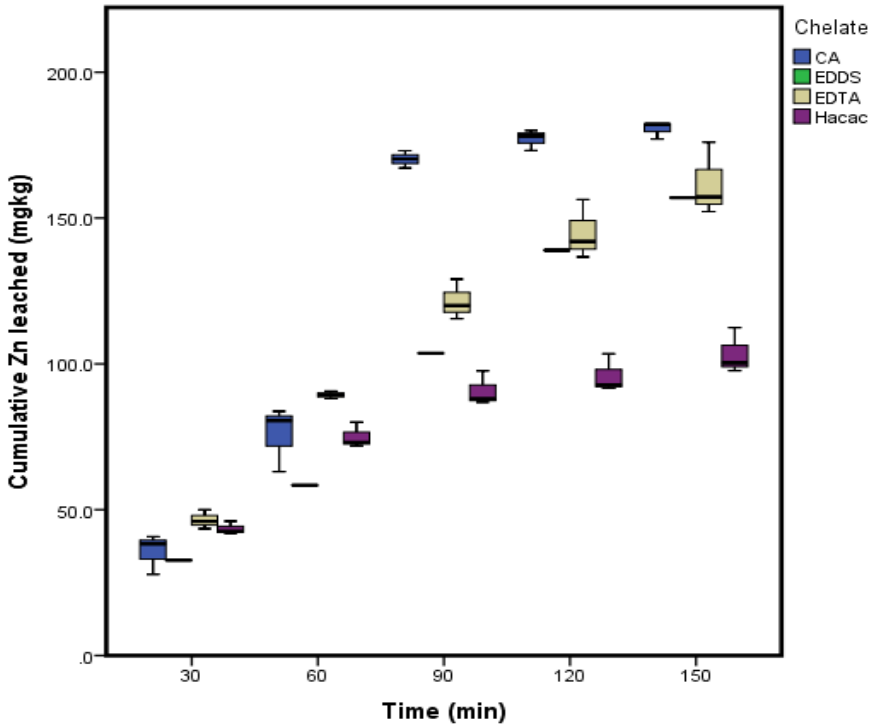

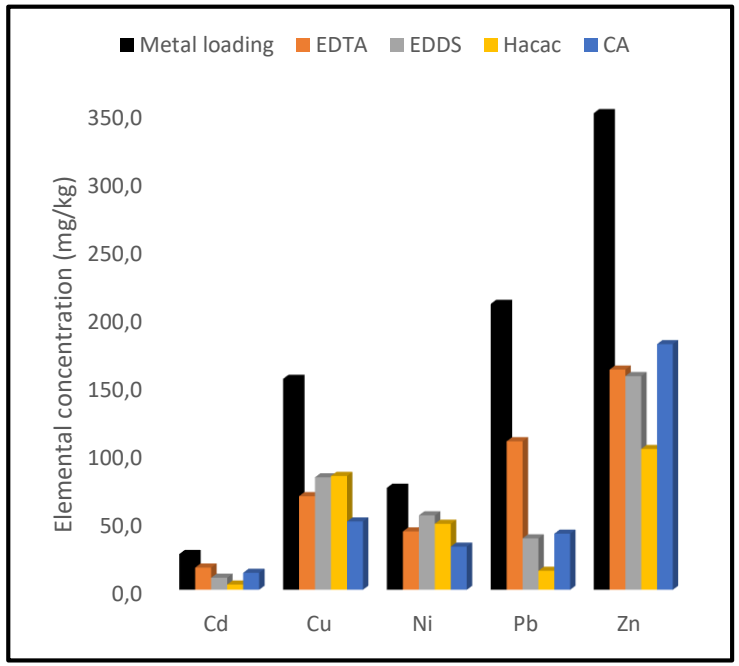

Results Cont'd

Manchester Metropolitan University

Leaching profiles of metals extracted

Soil	Metals	Extractant	Elovich $q_t = \left(\frac{1}{\beta}\right) ln(\propto \beta) + \left(\frac{1}{\beta}\right) ln(t)$			Power function $\ln q_t = \ln a + b \ln t$			First order $\ln(q_e - q_t) = a - k_1 t$		
			α	β^{-1}	r^2	a	b	r^2	a	k_1	r^2
EDTA	Cd	EDTA	1.390	1.450	0.963	2.410	1.330	0.949	2.324	0.0005	0.598
		EDDS	1.900	0.370	0.993	1.760	0.630	0.972	1.808	0.0006	0.485
		Hacac	1.110	7.780	0.979	0.351	0.500	0.955	0.715	0.0005	0.532
		CA	0.940	4.610	0.893	0.392	0.460	0.856	2.146	0.0005	0.329
	Cu	EDTA	1.640	6.380	0.930	2.399	1.090	0.843	3.704	0.0005	0.835
		EDDS	0.730	27.900	0.993	1.001	0.760	0.973	4.018	0.0005	0.407
		Hacac	0.690	22.990	0.986	0.713	0.520	0.962	4.018	0.0005	0.407
		CA	0.470	62.250	0.826	1.660	0.570	0.866	3.615	0.0005	0.238
	Ni	EDTA	2.740	1.590	0.981	2.331	1.090	0.881	3.377	0.0005	0.824
		EDDS	2.740	1.590	0.981	0.588	0.450	0.857	3.586	0.0005	0.688
		Hacac	2.740	1.590	0.981	2.514	1.340	0.974	3.534	0.0005	0.299
		CA	0.220	110.590	0.894	2.078	1.000	0.969	2.985	0.0050	0.882
	Pb	EDTA	1.940	3.960	0.969	2.311	1.040	0.890	4.267	0.0005	0.786
		EDDS	0.990	18.330	0.987	1.635	0.960	0.973	3.383	0.0006	0.286
		Hacac	0.080	292.060	0.982	0.867	0.480	0.957	2.030	0.0005	0.493
		CA	0.370	82.850	0.858	1.109	0.640	0.789	3.393	0.0050	0.948
	Zn	EDTA	1.300	39.150	0.836	2.694	1.410	0.985	4.703	0.0005	0.945
		EDDS	0.160	61.530	0.992	0.599	0.740	0.980	4.776	0.0006	0.158
		Hacac	0.190	416.310	0.987	1.273	0.780	0.968	8.030	0.0050	0.927
		CA	0.170	160.820	0.896	0.593	0.490	0.858	7.470	0.0500	0.690

Conclusion

- Considerable differences in the extraction efficiencies were observed across the four extractants examine
- For Cd, Pb, and Zn, EDTA showed the best extraction efficiency when compared to the other extractants (> 2 folds more than the rest extractants). The efficiency is basically attributed to its stability constants with the metals (Tandy et al., 2004; Pettit and Powell, 2001)
- Hacac and EDDS performed significantly for Cu and Ni when compared to the other extractants. EDDS displayed the highest efficiency for Ni. The efficiency accounted for maybe attributed to metal specificity and kinetic hindrance often experience by reacting species during coordination interactions (Nowack, 2002)
- Elovich model reasonably described the leaching trend of the metals following R^2 and low standard error values obtained

- Values of α and β^{-1} suggests that metal extraction occurred mostly within the exchangeable and carbonate fractions
- Decontamination technique applied in this study has promising potentials as half (> 50%) of the initial metal loading contaminants could be removed. However, further optimization using combination of extractants could achieve higher metal extractions compared to an individual application. Derived model from the kinetic study could be utilized for the design of reactors used for metal extraction processes.

Future work

A useful follow up study would be to investigate the cultivation of a phytoremediation crop to reduce contamination levels even further.

Reference

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Thank You!

Any Question