ACCUMULATION OF AS, CD, CU, PB, AND ZN IN NATIVE PLANTS GROWING ON CONTAMINATED THAI NGUYEN SITES, VIETNAM

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INTRODUCTION

Phytoremediation is a green remediation technology, a cost-effective and aesthetic solution for remediation of contaminated soil (Ma et al., 2001).

(a) (b)

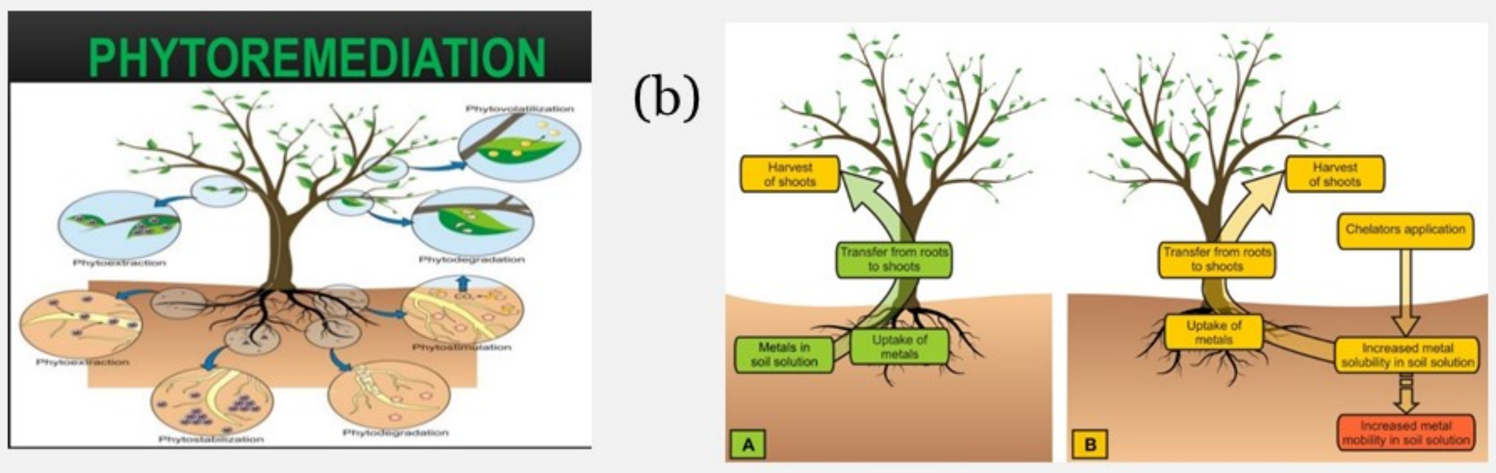


Figure 1. *(a) Phytoremediation (b) Schematic representation of the processes of natural (A) and assisted (B) phytoextraction (Paulo et al., 2004)*

One of the strategies of phytoremediation in metal-contaminated soil is phytoextraction through uptake and accumulation of metals into harvestable biomass of plants (i.e., shoots), which can then be harvested and removed from the site.

Another application of phytoremediation is phytostabilization, where certain plant species are used to immobilize the metals in the soil and could be considered as an integral part of risk management (Bolan et al., 2014).

This study evaluated the potential of most common native plants (2 species) including lau plant LP (*Erianthus arundinaceus (Retz.)* and reed plant RP, *Phragmites australis (Cav.)*, growing on three selected contaminated sites in Thai Nguyen province, northern region of Vietnam.

(a) (b)

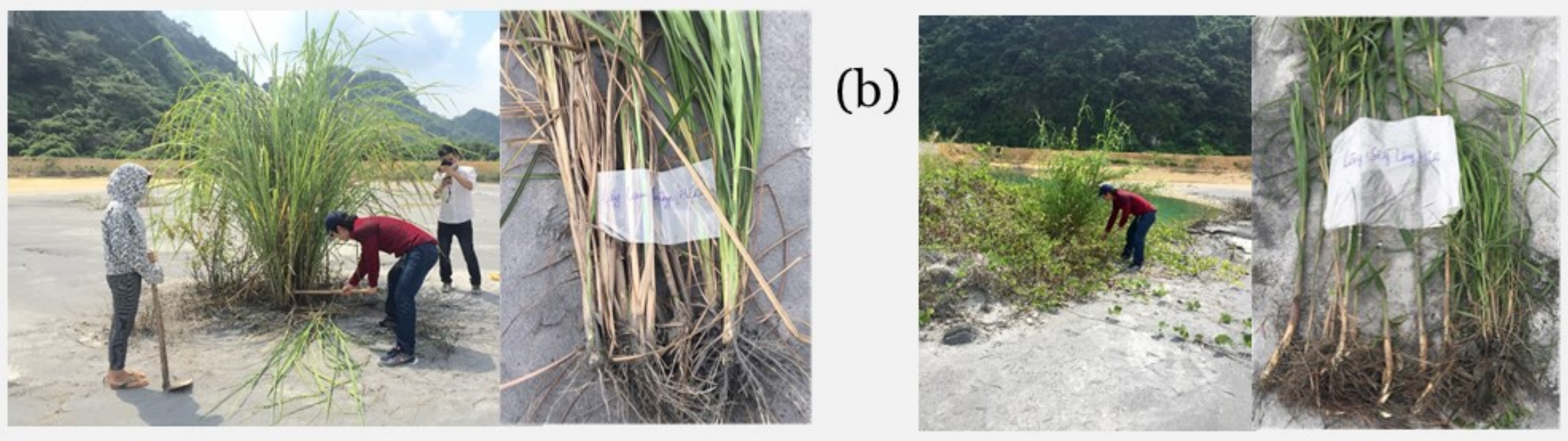


Figure 2. *(a) Lau plant (b) Reed plant in mining sites in Thai Nguyen, Vietnam*

OBJECTIVES

- To characterize contaminated soils, in the three selected mining sites (lead-zine mine, tin mine and iron mine).
- To study bioaccumulation of heavy metals (HMs) in the plants and potential relationship between total metals in soil and plants (root, stem and leaves) of RP and LP growing in the different mining sites.

METHODS

- 36 contaminated soil samples (0-20 cm and 20-40 cm) from the point of sampling, 28 reed and lau plants were taken from 6 different locations in the 3 mining sites.
- Soil and plant sample were analyzed total metal contents by ICP-MS 7900.
- Appropriate QA/QC was maintained: Montana Soil 2711A and spinach leaves (2511A) from National Institute of Standards and Technology.
- Soil samples analysed using SEM and EDS, XRD

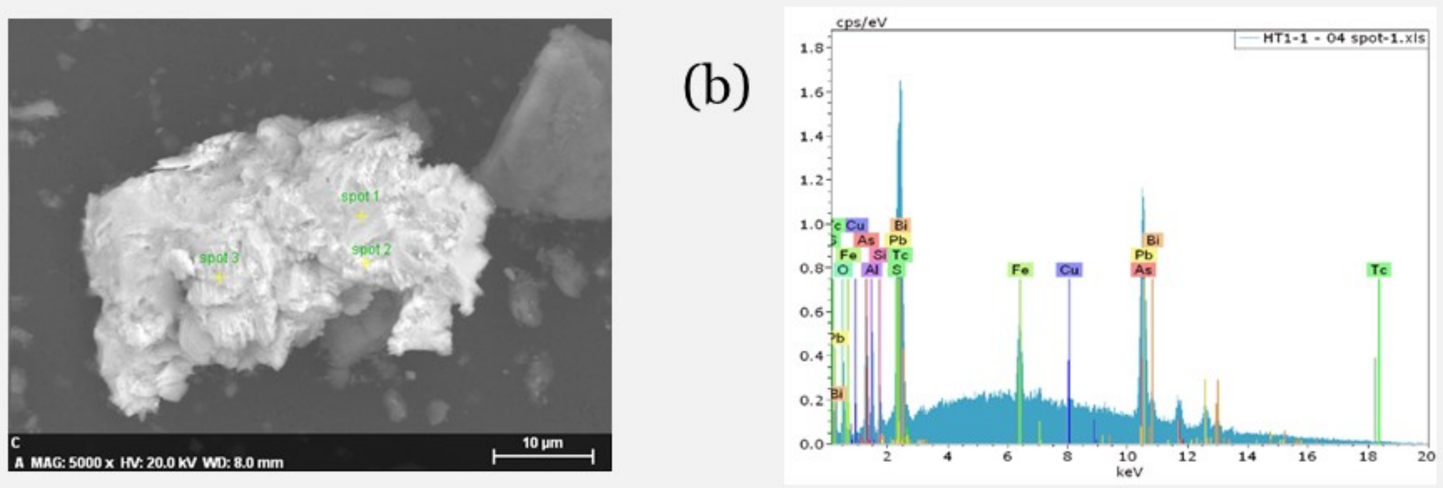
RESULTS

Table 1 – Soil properties

Average	Ha Thuong (HT) Tin mine	Hich Village (LH) Lead-zine mine	Trai Cau (TC) Iron mine
pH	**5.00** (4.12-5.95)	**8.28** (7.43 – 8.72)	**6.96** (6.01 – 7.74)
EC um	102.11 (15.09 – 320.00)	227.74 (97.85 – 850.50)	166.13 (26.00 – 355.00)
CEC meq/100g	2.44 (1.74 – 3.29)	2.71 (1.20 – 4.67)	**9.51** (2.68 – 17.95)
Sand (%)	53.75 (42.50 – 67.50)	66.88 (47.50 – 87.50)	29.17 (10.00 – 50.00)
Silt (%)	25.29 (18.75 – 30.00)	16.67 (7.50 – 26.25)	34.25 (24.25 – 43.75)
Clay (%)	20.96 (7.50 – 35.00)	16.46 (5.00 - 32.50)	36.58 (22.50 – 52.50)
As (mg kg^{-1})	**1515.91** (**430.49–2604.62**)	44.35 (0.95–184.02)	43.31 (3.89–242.79)
Cd (mg kg^{-1})	2.93 (0.00-10.20)	**36.87** (0.00–123.71)	2.52 (0.00–7.65)
Cu (mg kg^{-1})	292.90 (151.39-602.95)	18.67 (3.18-36.04)	208.67 (146.37-312.33)
Pb (mg kg^{-1})	1224.35 (270.13–4140.86)	1801.40 (53.60–**5007.99**)	720.91(238.28–2092.32)
Zn(mg kg^{-1})	1853.36 (46.69–7863.29)	7099.33 (63.93–**31788.38**)	1463.74 (566.69–2962.55)

Table 1. *The soil properties of contaminated soils collected in selected mining sites in Thai Nguyen province, Vietnam*

(a) (b)



(c)

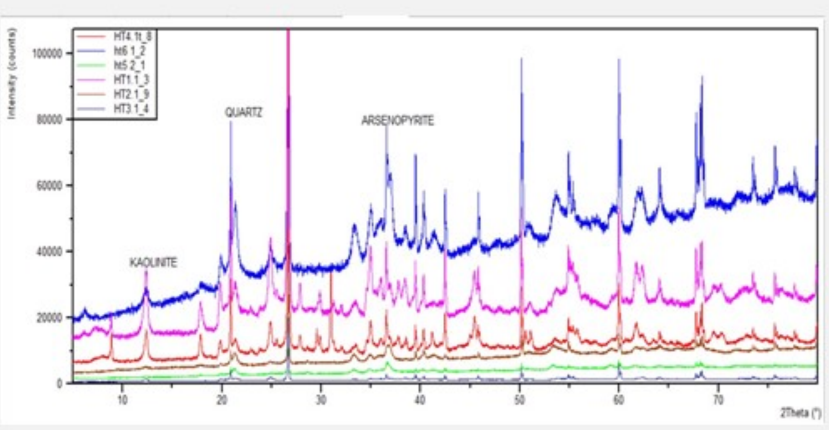


Figure 3. *Result analysis of soil samples in Ha Thuong (HT) Tin mine (a) SEM (b) EDS (c) XRD*

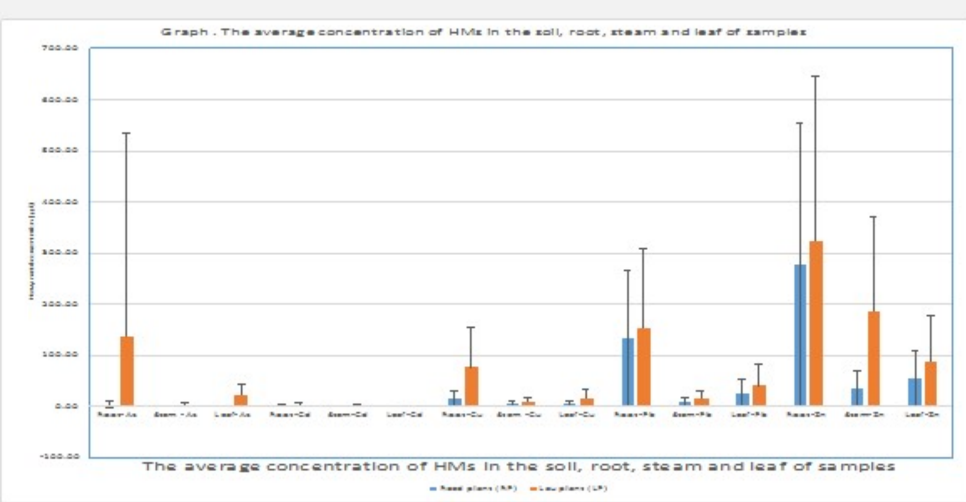


Figure 4. *The average concentration of HMs in soil, root, steam and leaves of plant samples in Ha Thuong Tin (HT) mine*

Table 2. The Bioconcentration factor (BCF), Translocation factor (TF), and Enrichment factor (EF) of RP and LP

Metals	Reed plant RP (*Phragmites australis (Cav.)*)			Lau plant LP (*Erianthus arundinaceus (Retz.)*)		
	Bioconcentration Factor (BCF)	Translocation Factor (TF)	Enrichment Factor (EF)	Bioconcentration Factor (BCF)	Translocation Factor (TF)	Enrichment Factor (EF)
As	0.15 ± 0.11 (0.04 – 0.35)	0.24 ± 0.18 (0.04 - 0.66)	0.03 ± 0.02 (0.00-0.07)	0.20 ± 0.27 (0.00 - 0.85)	1.39 ± 3.54 (0.02 - 13.63)	0.06 ± 0.14 (0.00 - 0.60)
Cd	0.20 ± 0.27 (0.00 – 0.81)	0.29 ± 0.29 (0.05 – 1.04)	0.03 ± 0.04 (0.00 – 0.13)	**6.45** ± 23.38 (0.00 - 99.50)	**0.74** ± 0.58 (0.01 - 1.86)	4.76 ± 17.00 (0.00 - 72)
Cu	0.37 ± 0.45 (0.04 – 1.19)	0.52 ± 0.18 (0.34 - 0.82)	0.22 ± 0.30 (0.02 – 0.95)	0.64 ± 0.91 (0.04 - 2.97)	0.48 ± 0.32 (0.02 - 1.59)	0.27 ± 0.49 (0.01 - 2.09)
Pb	0.28 ± 0.41 (0.02 – 1.13)	0.30 ± 0.30 (0.05 – 1.05)	0.05 ± 0.05 (0.00 – 0.14)	0.21 ± 0.48 (0.00 - 2.04)	0.56 ± 1.25 (0.01 - 5.45)	0.04 ± 0.06 (0.00 - 0.22)
Zn	0.22 ± 0.28 (0.03 – 0.81)	0.34 ± 0.18 (0.06 - 0.56)	0.08 ± 0.13 (0.01 – 0.44)	0.44 ± 0.99 (0.01 - 4.33)	0.64 ± 0.44 (0.03 – 1.56)	0.19 ± 0.41 (0.01 - 1.79)

- Native LP species have high BCF (6.45) and low TF (0.74) in terms of Cd indicating the LP has the potential for phytostabilization of Cd contaminated sites.

FINDINGS

- High concentration of HMs (As. Cd, Cu, Pb and Zn) in most soil samples.
- LP has much higher tolerance for multiple HMs concentration in soil environment compared with RP especially for As.
- HMs accumulated by LP much higher than RP, especially As.
- LP has the potential for phytostabilization of Cd contaminated sites.
- The phytoextraction capacity of RP and LP is relatively low; however their larger biomass results in much greater total accumulation of HMs.

FUTURE RESEARCH

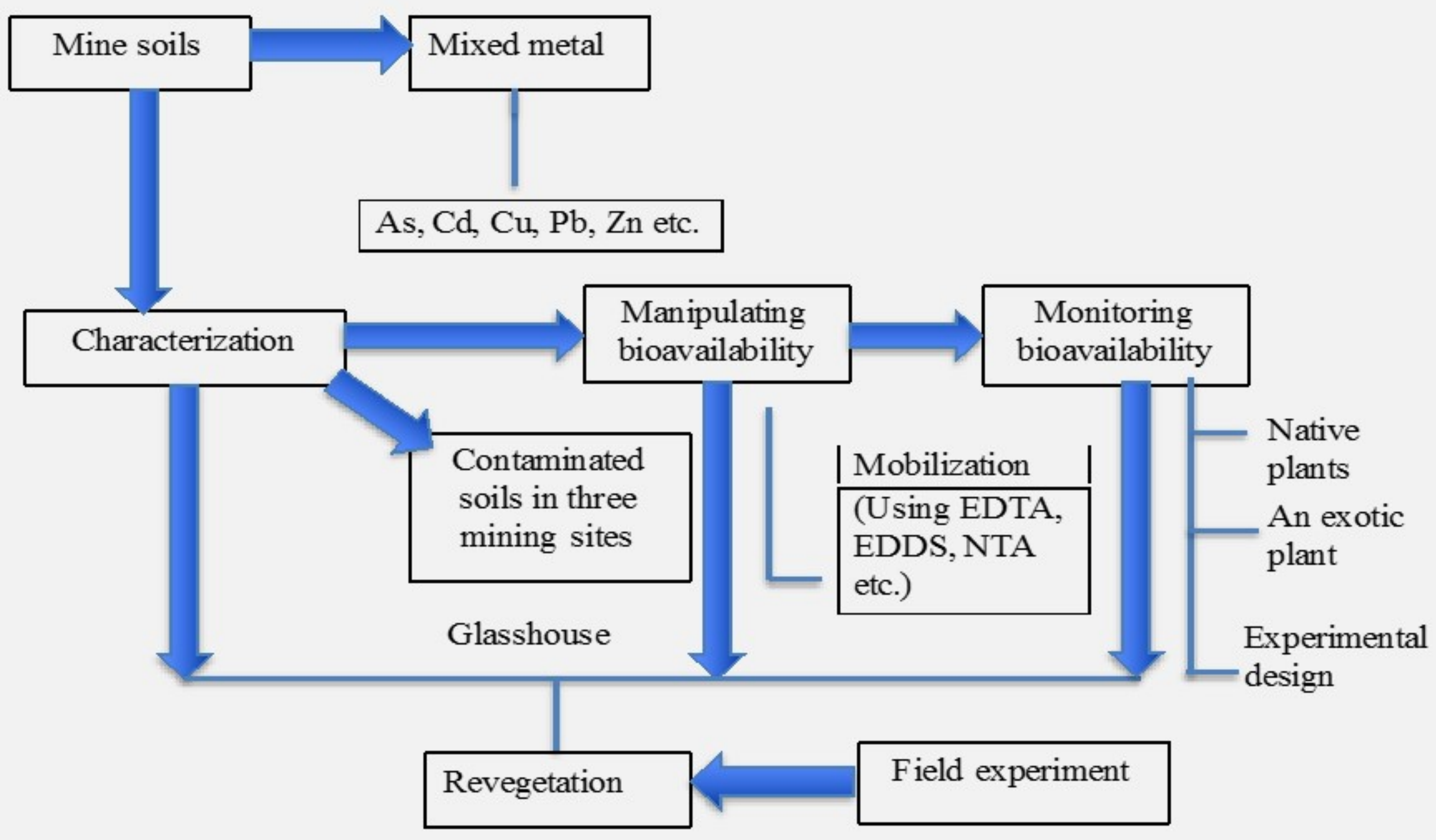


Figure 5. *Overview of research methodologies*

CONCLUSIONS

- LP and reed RP species growing on contaminated sites have the potential for phytoremediation to remediate metal-contaminated sites.
- RP and LP might not be appropriate for extracting HMs in the contaminated soils, however they could be used to stabilize soil especially in extremely high concentrations of multiple HMs (As, Cd, Cu, Pb, Zn), thereby reducing offsite pollution in the mining areas.

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