Heavy Metal Research in Vietnam: an overview

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INTRODUCTION

Vietnam is undergoing rapid development with extensive changes to its social and economic structure. Previously, Vietnam had agriculture as the main base of its economy but in recent years the industrial sector has achieved prominence. This has resulted in an increase in urban populations and urban centres resulting in an increase in industrial and municipal waste. The increase in population has also necessitated an increase in agricultural food production, for local consumption and export of high value produce. This has resulted in an increase in agricultural waste, which can be very high in biological oxygen demand (BOD) and some heavy metals, e.g. copper (Cu) and arsenic (As) in pig and chicken manure, which are routinely returned to the soil as a fertilizer. Biosolids and industrial effluents are also increasingly being used as a soil ameliorants, as fertilizers or are disposed of onto agricultural land and streams and rivers. Contaminants in the food chain are receiving increasing attention by regulatory authorities in many countries. Residues in traded food commodities are monitored in many countries and there are increasing incidences of trade in agricultural commodities being prohibited on the basis of contaminant concentrations.

ISSUES

Research conducted by CSIRO Land and Water with collaborators in Vietnam and funded by ACIAR Project LWR1/1998/119 "Impact of heavy metals on sustainability of fertilization and waste recycling in peri-urban and intensive agriculture in south-east Asia" have highlighted the following issues:

Farmers: Many farmers and agricultural industries are unaware of the contaminants present in agricultural inputs (fertilizers, manures, composts and pesticides), so that where use of these is intensive, significant soil and crop contamination may result. For example, the maximum As, Cd, Co, Cr, Cu, Hg, Ni, Pb and Zn concentrations measured in Vietnam soils exceeded the background concentrations indicating localized heavy metal contamination (Table 1).

Table 1. Mean, median, minimum, and maximum elemental concentrations of all Vietnam soil samples (0-15cm), 95th percentile values and background mean concentrations.

	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Zn
	mg kg^{-1}								
Mean	10.2	0.137	7.72	38.1	20.9	0.069	19	23.0	52.7
Median	3.57	0.081	3.33	25.7	15.9	0.049	7.5	19.5	40.9
Min	1.57	0.004	0.800	1.14	0.585	0.001	0.667	1.97	3.53
Max	410	7.97	92.9	4400	98.6	0.854	234	310	411
N=400									
95th	43.9	0.293	26.7	145	56.8	0.170	68.5	43.1	111
Bgd MeanTam Dao (highland)	4.3	0.057	1.94	7.78	7.91	0.09	2.75	52.2	36.7
Cuc Phuong (lowland)	13.7	0.233	25.5	78.4	61	0.294	45.8	15.9	101
Southern Vietnam	7.5	0.209	25.9	130	31.5	0.055	79.6	25.6	81.4

Zarcinas *et al.*, (2004) have indicated that contamination requires assessment against "background" or benchmark values while "Investigation Levels" provide threshold values to

trigger further evaluation of contamination while not necessarily signifying a potential hazard, but rather indicating that further investigation is needed to determine if the contamination is anthropogenic and/or could develop into a risk to the environment or human health. Tab. 1 reports the95th percentile values which we assign as the "Investigation Levels" for heavy metals in Vietnam.**Organic agricultural inputs:** Agricultural inputs generated in urban areas from municipal waste (e.g. composts, biosolids), industrial wastes (paper wastes, food-processing wastes) and urban replacement materials (e.g. dredged canal muds) and animal manures can be highly contaminated with heavy metals (Figure 1) and are increasingly being used in peri-urban agricultural areas (Ho and Egashira, 2000; Huy et al., 2003). Farmers are continually searching for cheap sources of nutrients and organic matter, as many soils in the region are both infertile and have low levels of organic matter leading to poor water-holding capacity and poor structural stability. No statistics on waste re-use on market basket food quality surveys are available in the countries to assess the likely extent of the problem.

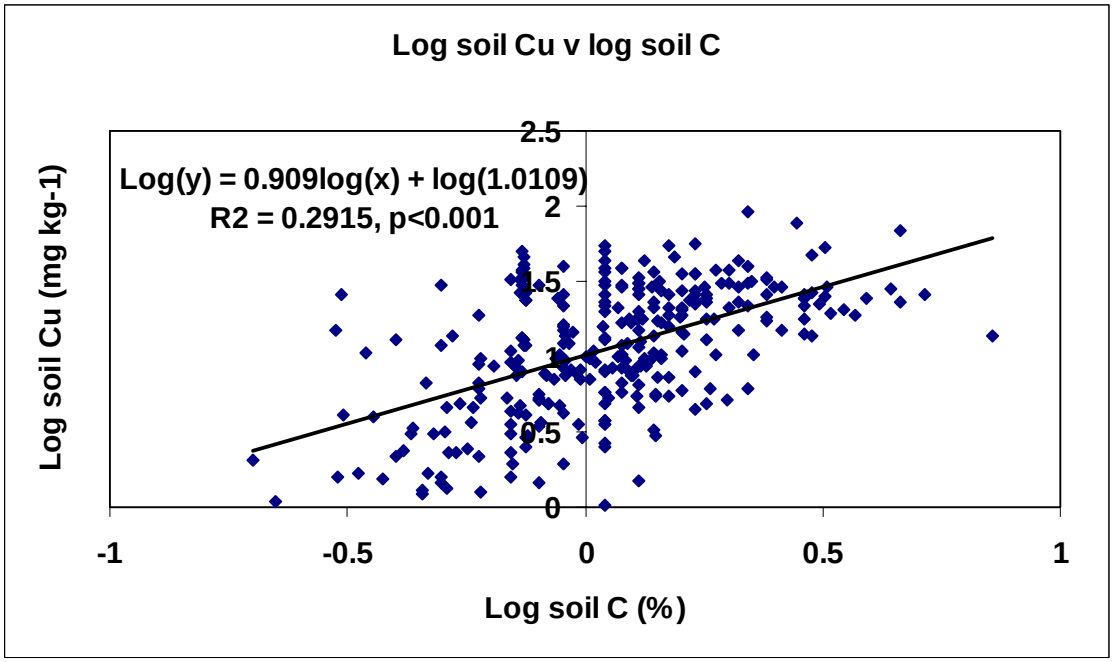

Figure 1. Log soil Cu versus log soil C for all Vietnam soils surveyed.

Chemical agricultural inputs: Intensive use of chemical fertilizers (3.2 tonne ha^{-1} paddy yield using 75 kg nutrient cultivated ha^{-1}) and wastes in agricultural soils which are infertile, deficient in phosphorous (P) and have very low organic matter content, leads to accumulation of Cd to potentially high levels in certain crops e.g. peanuts, oilseeds and grain legumes. In Southeast Asia the main P fertilizers used are phosphate rock and superphosphate, which are of variable quality in terms of Cd, and behaviour of this toxic metal and others in tropical soils is little understood.

REFERENCES

Ho, T.L.T. and Egashira, K. (2000) Heavy metal characterization of river sediment in Hanoi, Vietnam. *Commun. Soil Sci. Plant Anal.* 31(17&18):2901-2916.

Huy, N.Q., Luyen, T.M., Phe, T.M. and Mai, N.V. (2003) Toxic elements and heavy metals in sediments in Tham Luong canal, Ho Chi Minh City, Vietnam. *Environ. Geol.* 43:836-841.

Zarcinas, B.A., Ishak, C.F., McLaughlin, M.J., and Cozens, G. (2004) Heavy metals in soils and crops in southeast Asia. 1. Peninsular Malaysia. *Envirom. Geochem. Health.* 26:343-357