Soil, plant and goat faeces can be used to map trace elements contaminations in the town of Lubumbashi (RDCongo)

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The town of Lubumbashi has been an important center of Cu-ore treatment for tens of years. Evidence of environmental contaminations from fumes was largely reported in the past and the former Gecamines chimney pointed out as a major source. However, no or few data exist about the spatial extent of the contaminations.

Our research aims at mapping the contaminations of the environment resulting from the ore-treatment activities in order to build appropriate land management strategies. The population of Lubumbashi is growing fast, which generates serious pressure on land in and around the town. There is a real need to identify areas which should be remediated and also areas where food (crop and meat) production should be avoided.

Soil, Plant (*Setaria pallidifusca* (Schumach.) Stapf & C.E. Hubb.) and goat faeces were sampled and analyzed, as diverse steps of a contamination chain. Sixty-five soil-plant pairs were taken in and around Lubumbashi. *S. pallidifusca* was chosen because it could be found in a broad range of situations, from the bottom of the Gecamines chimney to the bush kilometers away from the town. Goat faeces were collected independently from soil and plants at two periods (dry and rainy seasons). Sampling schemes can be considered as stratified-random, as locations were chosen randomly inside cells of a square grid. Soil laboratory characterizations included pH (in water and in 1N KCl), Total Organic Carbon (TOC, after Springer-Klee method), and NH_4-acetate+EDTA extractable trace elements (Cd, Co, Cu, Pb, and Zn). The same elements were measured in plants and faeces after HNO_3-$HCLO_4$ digestion.

Soil pH_{water} was found variable between 4.6 and 7.6 resulting from differences between the main town and the periurban areas (more acidic). Soil TOC content varies in space from 0.5 to 5g.100g^{-1}. Differences in trace element content appeared very important: more than two order of magnitude between minimum and maximum and one order between first and third quartiles, for all elements. By comparison to the estimation of local natural background, more than half of the samples should be qualified as contaminated. Trace elements in plants and faeces appeared far less variable. Differences were also found in the max:min ratios of faeces between dry and rainy seasons.

Significant correlations were found (i) between soil, plant and faeces content, and (ii) between all trace elements. Multivariate PCA-analysis clearly indicate that the trace element contents are driven by the same factor. The high levels measured in plants do not reflect higher uptake and accumulation but close contamination by soil dust. This was confirmed through observation with binocular glass. Goat faeces contained soil particles too. Therefore, the soil, plant and faeces contents are three expressions of the same phenomenon.

All the data were gathered in a database together with results from additional topsoil samples and maps of the contamination of Lubumbashi were realized by co-kriging interpolation. These maps clearly show sources and extent of contamination and should be useful in the evaluation of risks related to land use.