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Research Article

CHEMICAL POLLUTION ASSESSMENT IN THE KATANGA COPPER BELT MINING REGION AND EFFLUENTS CHARACTERIZATION (D R CONGO, SUBSAHARAN AFRICA): AN INTRODUCTORY PAPER

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Abstract

The Katanga region in D R Congo, within the copper belt area, is heavily polluted with toxic trace elements from mining activities. The extent to which this pollution threatens supporting ecosystems and human health has been determined in this study. Mining effluents, air dust and sediments were analysed and the concentration of As, Cd, Pb, Co, Zn, Ni, Cr hexavalent determined. Results show that only Pb, Cu, Co concentrations in water were higher than these from the national standard values and from the World Bank as well. Zn was higher in Kafuba water at the bridge sampling site. Other trace elements were in non toxic species forms and showed lower values. However, epidemiological studies regionwide are recommended to determine the extent to which bioaccumulation process occurs in food chains.

Keywords: Katanga, Copper Belt, toxic, trace elements.

INTRODUCTION

The pollution of the environment by mining industry discharges is one of the main sources of toxic chemicals and heavy metals in various environmental compartments such as water, soil atmosphere and the trophic chains. The weakness of the regulation has increased such pollution. In the Katanga Province, hundreds of mining companies are operating there without any concern about the pollution generated. Raw wastewater is daily discharged into the environment, thus contaminating the biodiversity and supporting ecosystems. Acute toxicity incidents caused by such activities are not common despite the high risk of the chemical pollution. This might be due to the lack of the implementation of the environmental management policy and practices despite the release of the mining Code and regulatory guidelines and national standards for mining industry (DRC, 2002). Field experiments to assess the biological effects of industrial effluent discharges are well documented (Pascoe, 1988; McCahon *et al.,* 1991; Musibono and Day, 1999; Eisler, 2000). Pollution of ecosystems by mining industry is one of the most dangerous threats for the environment. Indeed, for mining countries such as DRCongo, the pollution of the mining areas is crucial and negatively impacts human and ecosystem health. Their trophic chains are usually heavily contaminated. Various chemical and ecotoxicological studies illustrate these facts (Hale, 1977 ; Korte, 1983 ; Laurinolli & Bendell-Young, 1996 ; Lubaba *et al.,* 2009). In the D R Congo, mining is the main economic sources since the colonial era vwithout any attention to the environmental safety and sustainability. The Katanga Province is the most exposed area to mining pollution. More than 200 mining companies are daily polluting this region and the National mining Code is not well implemented. This situation is leading to the environmental chaos countrywide.

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LOCALISATION, MATERIAL AND METHODS

Katanga mining province is the main study areas. We sampled water, sediment, air dust and industrial effluents from mining industries from the following sites: Canal Albert/Likasi, Chemaf/Lubumbashi, CMSK/Kipushi and Luilu/Kolwezi. These sites were investigated because of their intensive activities and risk of pollution. The study was carried out between the 7/7/2009 and 26/8/2012 based on several field missions, ERGS being the CEMIC Consultant and partner.
Water and effluent samples were collected in sampling bottles and stabilized with concentrated nitric acid (65%), 1ml/100 ml of water or effluent sample, and kept at 4^0C. These were then brought into the Ecotoxicology Laboratory ERGS at the University of Kinshasa/ D R Congo and to the Forel Institute and Institute of Environmental Sciences, University of Geneva, CP 416, 1290 Versoix (Switzerland). To determine the dissolved heavy metal concentrations, 100 mL of water samples were filtered (0.45micrometer) and stabilized with 1mL diluted nitric acid (10%) and 0.1mL citric acid (0.25mol/L). We then used either HACH methods using dithiver complex and chloroform as solvent, or the ICP-MS method. Air dust samples were collected using a high volume air sampler; and the air dust was collected on a nitrocellulose membrane (8 microns). The sampling time was 30 minutes for a volume of 4.5 m^3 air. The air filters were afterward brought into laboratories for appropriate analyses using ICP-Mass spectrometry half the filter was completely digested by microwave digestion technique at the University of Geneva.

Sediment samples were dried at 40 Celsius degrees, crushed and sieved less than 2mm to remove stones and plant debris, homogenized and an aliquot was milled at less than 100 microns. For the analysis of the metals by ICP-MS, an aliquot of 0.5g was completely digested by microwave digestion technique. All these specific analyses occurred at the Geneva University, Forel Institute/ Institute for the Environmental Sciences. We only considered the following elements for analyses: As, Cd, Pb, Co, Ni, Cu, Co and Zn. The dissolved element concentrations, 100 mL of water sample was filtered (0.45 micrometers and stabilized with 1 ml diluted nitric acid (10%). The ICP-MS analysis based on microwave digestion technique was then used for above heavy metals.

RESULTS

The results are summarized in the Tableau 1 below.

DISCUSSION

Various chemical analyses have revealed that Katanga is exposed to chemical threats and public health risks. The paper by Lubaba *et al.* (2009) revealed high risk for heart illnesses to the people exposed to cobalt pollution in this cobalt-rich province. Our results and concerns are also similar to those by Tembo *et al.,* (2006) and May & Mc Kinney (1981), Gomot (1998), Hale (1977), Gopalan (2003). These authors determined high concentrations of Cu, Pb, Cd and Zn in soils around Kabwe town in Zambia. This region being part of the copper belt, the pollution should be similar. The Blacksmith Institute (2008) reported the Katanga Province and Zambia to be among the World's most polluted places (www.blacksmithinstitute.org, accessed June 2013). Katanga region remains under environmental threats and attention should be paid to determine to which food-chains are contaminated and therefore all consumers. Epidemiological study is urgently recommended province wide.

Table 1. Concentrations of dissolved As, Cd, Cu, Co and Pb in water and air dusts from Katanga province (7/7/8- 15/8/2012)

Sites	**Elements (in mg/L for water and in microgram/m^3 for air dust)**							
Shituru/Likasi (Canal Albert)	Pb	Cd	Cu	Co	As	Zn	Ni	Cr (VI)
Water	0.636	0 .015	305	84	0.055	2.6	0.583	0.115
Solids/ tailing CMSK	0.045	0.015	6.9	2.3	0.026	1.5	0.066	0.104
Kafubu River Bridge	1.168	0.199	11	2.3	0.352	25	0.066	0.120
Air sample/ Kipushi (sampling 30min. = 4.47 m^3)	0.55	0.06	6.2	1.3	0.2	8.4	0.05	0.08
CHEMAF/ Lubumbashi	Pb	Cd	Cu	Co	As	Zn	Ni	Total Cr
Water	0.641	0.015	306	82	0.058	2.7	0.581	0.113
Air	0.65	0.04	5.5	1.2	0.1	9.2	0.06	0.09
Solids/sediments	1.182	0.189	10.	2.2	0.354	24	0.73	0.123
Luilu/ Kolwezi	Pb	Cd	Cu	Co	As	Zn	Ni	Cr
Water	0.645	0.013	307	83	0.057	2.8	0.590	0.112
Sediments	1.192	0.190	308	85	0.068	2.820	0.593	0.116
Air	0.68	0.06	5.8	1.1	0.08	9.4	0.07	0.2
National standards (Mining Code of the D R Congo), especially in Reglèment minier 2003, pp.343): effluents (mg/L)	5 mg/L	0.5 mg/L	1.5mg/L	N.A.	5 mg/L	10 mg/L	1.0mg/L	5 mg/L
World Bank values (mg/L)	0.1	0.1	0.5	NA	0.1	1.0	0.5	0.1
Comment	NS 5X higher the WB's	OK	NS, 3X higher		NS, 4x higher	NS, 10x higher	NS, 2x higher	NS, 10x higher.

Conclusion and suggestions

The mining area of Katanga province in D R Congo (copper belt) is highly polluted by various trace elements, especially Pb, Cd, Cu, Co, As, Zn, Ni and hexavalent Chromium. Results of different analyses show that all environmental compartments are heavily contaminated, even above all legal standards of the DR Congo. Based on national standards (NS) and the World Bank's (WBS), all values are stressful, except for Cd. This situation allows us to conclude that the mining environment of Katanga is dangerous and at risk for both humans and ecosystems.

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