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Impact of mining on water of the rivers Shinkolobwe, Lwisha and Kansonga in the province of Katanga (DRC)

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Abstract

Background: These last decades were marked by the refuse tips, which caused many problems to the environment. Heavy metals resulting from these discharges are for the very dangerous majority when those manage to contaminate water. The contamination of water by heavy metals became an alarming matter, because not only it limits the use of water by the domestic uses but also for the damage, which it causes at the watery organizations. **Objective:** This study aims at determining the impact of mining around the Shinkolobwe rivers, Lwisha and Kansonga of the province of Katanga. **Methods:** Samples of water of the rivers Shinkolobwe, Lwisha and Kansonga taken during the period from October to December 2010; were used as equipment for the proportioning of heavy metals (52Cr-H2, 54 Fe, 59 Co, 60 Ni-H2, 65 Cu-H2, 75As, 114 Cd, 208Pb and 238U). The spectrophotometric method of atomic emission was used for the determination of various contents of heavy metals. **Results:** The results reveal concentrations out of lead and cadmium higher than the acceptable limits; and compared to other heavy metals, the concentrations either are within the normal limit, or lower than the normal. **Conclusion:** The province of Katanga presents a high potential of pollution and disturbances of esthetics (mining residues left randomly without treatment), requiring a landscape rehabilitation as exploitations. This could be correlated with the consequences of mining near these various rivers.

Keywords: Impact, Mines, Water, Katanga.

INTRODUCTION

Early The study of contamination of the environment by discharges containing heavy metals has been widely discussed by several authors. Baize (1977) and Akujobi (2012) showed that the increase in concentrations of heavy metals of contamination is generated primarily by anthropogenic activity [1,2].

It is true that mining, by the processes of mining ore, its grinding generally in the open air (dust), and the discharge of liquid and solid residues, necessarily involves contamination of the surrounding environment by its residues, Dust and untreated water that drains into the environment [3].

Heavy metals are ubiquitous in surface waters, but their concentrations are generally very low, which explains their name for trace metals.

The main anthropogenic source of heavy metals for inland waters is the mining industry, while one of the derived activities, metallurgy and iron and steel, is the main anthropogenic source of introduction of heavy metals into the atmosphere [4,5]. This is a consequence of the need to use metals for a long time in the technological advance of mankind [6].

Currently, several mining operations are open pit mines, which generate a large amount of waste rock, dust and contaminated water [7].

The problems posed by the dispersion of pollutants in the environment have attracted the interest of the scientific community for many years now [8]. Among the major environmental contaminants, heavy metals present serious ecological problems, both in their ubiquitous nature and in their toxicity and potential bioaccumulation in several aquatic species, which have devastating effects on the ecological

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balance of the aquatic environment.

This work would determine the degree of pollution of heavy metals on some rivers around the mining sites in Katanga province, in the following cases: Shinkolobwe, Lwisha and Kansonga.

METHODS

Water samples from three rivers (Shinkolobwe, Luisha and Kansonga) near the mining sites (Shinkolobwe, Hewa-bora and Kansonga) were collected at three different locations for analysis, from October to December 2010.

Analyzes of trace elements in water were carried out at the Center for Expertise, Evaluation and Certification of Precious and Semi Precious Minerals (CEEC) by inductively coupled plasma atomic emission spectrometry. It is a technique that is particularly sensitive because the sample, dissolved in solution, is nebulized in an Argon plasma of up to 8000 oc, which then allows a very effective excitation of the atoms. The waters were analyzed directly by SEA-ICP without chemical preparation [9].

Several elements were measured. These are 52Cr-H2, 54 Fe, 59 Co, 60 Ni-H2, 65 Cu-H2, 75As, 114 Cd, 208Pb and 238U.

The contents of heavy metals obtained were compared with the reference values.

RESULTS AND DISCUSSION

Table 1 below shows the concentrations found in the Shinkolobwe, Lwisha and Kansonga rivers, respectively.

Table 1: Results of ICP-MS determination of metals in water samples

Places	52Cr-H2	54 Fe	59Co	60Ni-H2	65Cu-H2	75As	114 Cd	208Pb	238U
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Shinkolobwe	2,85	51,57	16,83	2,89	337,2	8,03	0,89	20,69	25,83
Luisha	3,78	16,78	59,81	4,56	70,32	4,16	1,96	28,08	0,00
Kansonga	5,54	47,98	31,83	5,89	102	7,22	2,13	29,08	22,58

In view of the above results, the following observations are made:

For uranium, the highest grade is for the Shinkolobwe site, while the lowest is zero in Luisha. The levels are below the acceptable limit, which is set at 15 µg / L in the three samples; 25.83 for Shinkolobwe, 22.58 µg / L for Kansonga. Whereas the Hewa - bora (Luisha) sample gave no value, ie 0.00 µg / L.

Uranium is found in both surface water and deep water [10]. However, in rivers, uranium concentrations range from a few ng / L to 2 ng / L depending on the concentrations of the element in surrounding soils [11,12].

Moreover, the proximity of a mining area can affect these natural concentrations and result in a locally significant rise in uranium levels of up to 10 to 20 mg / L [13].

For lead, the highest content was 29.08 µg / L (Kansonga site), while the lowest content was 20.22 µg / l (Shinkolobwe site). All samples gave values above the acceptable limit of 10 µg / L. It should also be noted that all values found were more than double the acceptable limit.

Lead is very sparingly soluble, its accumulation in sediments will be relatively higher due to its low solubility in water [14]. Indeed, it is a trace element interesting for the human organism. It would be a growth factor up to 1 ppm. However, it still has a very weak mutagenicity. It should be noted that violent colic, anemia, intellectual disabilities, etc. Are the consequences of lead poisoning.

For Cadmium, the highest content was 2.134 µg / L (Kansonga site), while the lowest content was 0.856 µg / L (shinkolobwe site). Two samples gave values greater than 1 µg / L, namely Kansonga water and Luisha water. It is very soluble in water and is very weakly bound to the organic matter of the sediments and to the soil. This dissolution of Cadmium has been shown to increase its concentration in runoff and surrounding streams, posing a risk to the population using the waters [14].

For arsenic, the highest content was 8.025 µg / l (Shinkolobwe site), while the lowest content was 4.16 µg / l (Luisha site). It should be noted here that in the case of acute poisoning with Arsenic, the symptoms are immediate [15]. Chronic exposure to arsenic is a risk factor for lung cancer [16], prolonged exposure to arsenic also causes skin cancer, bladder cancer and kidney cancer. After prolonged exposure to arsenic, the first changes usually affect the skin through a change in pigmentation. Cancer occurs later and may take more than 10 years to appear [17]. Because of its toxicity, the World Health Organization has proposed very stringent limits for As in human drinking water [18].

For copper, the highest content was 337.2 µg / l (Shinkolobwe site), while the lowest was 70.32 µg / l (Luisha site). Copper, at a very low dose, is an indispensable trace element for life [19,20]. It intervenes in immune function and against oxidative stress, its lack causing menke syndrome [21]. Copper is also, at higher doses and in oxidized form, a powerful poison to man, causing Wilson's disease. Copper also contaminates the surrounding waters at minute doses and concentrations for many organisms [22].

As for iron (Fe), the content was found to be normal in all samples, ie between 5-50mg / L acceptable limit value. Note that iron is one of the nutrients found in food. It is an essential element for man especially in the composition of blood hemoglobin. However, the World Health Organization recommends not to exceed 0.3 g / L because it is not good for the functioning of digestive systems [18].

For nickel, the highest content was 5.89 µg / l (Kansonga site), while the lowest content was 2.89 µg / l (Shinkolobwe site). The limit value is less than 20 µg / L or 0.02 mg / L; Our results revealed values included in the standard. However, ingestion of 0.1 g of nickel causes nausea, vomiting, diarrhea and abdominal pain. On the other hand, chronic toxicity is observed by allergic dermatitis, an increased risk of cancer of the upper airways and stomach. Experimentally, nickel salts are teratogenic [20].

Cobalt had the highest concentration of 59.81 µg / l (Luisha site), while the lowest content was 16.83 µg / l (Shinkolobwe site). In water, cobalt is caused by natural erosion, leaching of soils, industrial discharges and the treatment of industrial effluents and mines. However, it is an essential nutrient; It enters the composition of vitamin B12 (cyanocobalamin). It exerts a stimulating action on the haematopoietic system.

However, exposure to cobalt may induce pulmonary disease (respiratory difficulties, possibly resulting in asthma, or pneumonia in workers who have inhaled cobalt-laden air [23,24].

As regards chromium (Cr); The highest grade 5.54 µg / L for the Kansonga site, and the lowest level 2.85 µg / L for the Shinkolobwe site. It can be exposed to chrome by breathing, eating, drinking or by contact with chromium or chrome compounds. Note that the level of chromium in air and in water is generally low. However, it should also be said that the level of chromium in portable water is also generally low, but in addition contaminated water wells or waters around mines may contain hazardous chromium [4,5,25,26].

Limitations of the study

Some limitations can be found in this study, notably that we did the sampling for each river, whereas it would be better to do it several times at different heights, then compare statistically differences. This means that the conclusion can not be considered absolute.

CONCLUSION

Altogether, the lead and cadmium levels were found beyond the limit values. Lead concentrations were higher than baseline values in all samples from different rivers: Kansonga (29.08 µg / L), Luisha (28.08 µg / L) and Shinkolobwe (20.69 µg / L).

Cadmium elevation was found only in two samples: Kansonga (2.13 µg / L) and Luisha (1.96 µg / L).

In general, heavy metal levels in the waters of the Shinkolobwe, Lwisha and Kansonga rivers remain low and fully meet the water requirements.

The evaluation of heavy metals in these rivers in Katanga province revealed direct impacts and undesirable impacts of mining on the surrounding environment. As in most developing countries, and in the absence of legislation on the management of mining waste; Many of the mines continue to discharge their wastes into river waters. Hence the importance in this environment of rehabilitating mining operations by restoring the natural heritage.

Contribution of authors

All the authors have contributed to this work. They read and approved the final version.

Conflict of interest

The Authors declare that there are no conflicts of interest.

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