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Heavy Metal Contain in Drinking Water Collected from Nampala Gold Mine Wells

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ABSTRACT

Heavy metal pollution is global health threat. The aim of this study was to assess some phyco-chemical parameters in Nampala well waters. High concentrations of Nickel and Iron linked to the mineral ore contain of the area were detected instead of a pollution issue.

INTRODUCTION

Water Pollution in heavy metals is a worldwide heath concern [4]. Mercury (*Hg*), Arsenic (*As*), Cadmium (*Cd*), Lead (*Pb*) are increasing in abundance and persistence in the environment; their toxicity for human is known since a while [4]. They are found dissolved in water, suspended as particles and surface sediments [7]. Their emission in the air and a high consumption of fossil fuels, pesticides and fertilizers are leading in an increasing environmental issue [1]. According to a study undertaken by Zhu et al in 2018: «*The contributions of individual heavy metals to the potential ecological risk were in the following order: Cd; Cu; Ni; Cr; Zn; As; Pb*» [2]. The study showed that *Cd* presented serious ecological risk and contributed the most to the sediments of the Heer River. The ecological risk (*RI*) was at a considerable high risk level, and therefore, the environmental dredging depth of the Heer River is 94 cm for the purpose of reducing heavy metal contamination of the Heer River is needed [2]. Supporting results were obtained by Bailon et al in 2018 [4]**.** A study conducted in Benin *i*nvestigated *Eu, Sb, Cs, Nd, Pr, Gd, La, Ce, Tb, Sm, Dy, Ho, Eu, Yb, Lu, Ag, Au, Pd, Pt,* and *Ru* by inductive plasma-mass spectrometry found broad range concentrations of the elements. In addition; *Ce*, *La*, and *Nd* were found in both sediments and sewage sludge at concentrations ranging 5.80–41.30 mg/kg dry matter (DM), 3.23–15.60 mg/kg DM, and 2.74–19.26 mg/kg DM, respectively. *Pr, Sm, Gd, Tb, Dy, Eu, Er, Yb, Cs, Ho,* and *Tm* concentrations were lower (0.02–5.94 mg/kg DM). Among precious elements, *Ag* was detected at the highest concentration in all sites (0.43–4.72 mg/kg DM), followed by *Pd* (0.20–0.57 mg/kg DM) and Au (0.01–0.57 mg/kg DM). *Ru* and Pt concentrations were < 0.20 mg/kg DM in all samples. The evaluation of pollution loading index (PLI) indicated a moderate to strong contamination ($0.12 \le PLI \le 0.58$; $37 \le PLI \le 114$, respectively, for rare earth elements and precious elements), while the degree of contamination indicated a moderate polymetalic contamination for rare earth elements and significant contamination for precious elements [6]. *Hg* has attracted attentions recently. The risk of mercury pollution is extremely threatening because of its ability to be transported over long-range distances [5]. Minamata Convention on mercury was established on October 2013 and was joined by many countries because various mercury pollution sites that were currently observed in India are Kodai Lake, Kodaikanal, Tamil Nadu, and Thane Creek, Mumbai [5]. Besides: "*Since 1992, chlor-alkali plants have been regulated to eliminate mercury cell process of manufacturing*" [5]. Medical and health care facilities are also getting rid of mercury-containing equipment and processes. Various sources of mercury to the atmosphere come from combustion of fossil fuels, processing and mining of primary metal ores, cement manufacturing units, chlor-alkali plants, and the use of mercury in various products like paints, electric switches, and relays [5]. A study of mercury pollution in an urban water body of Mithi River located in Mumbai Metropolitan Region (19.0760° N, 72.8777° E) investigated total mercury in water and derived its relationship with other pollution parameters [5]. Farmers in the Rasht region consume non-significantly higher input and achieved slightly higher output [5]. For researchers, heavy metals are in equilibrium between water and sediment [7]. The amount of heavy metals is determined in water and different sizes of sediment to obtain the relationship between heavy metals in water and size-fractionated sediments, a canonical correlation analysis (CCA) of 9 southwestern Caspian Sea Rivers on 18 sampling stations. First, concentrations of heavy metals (*Cu, Zn, Cr, Fe, Mn, Pb, Ni, and Cd*) are determined in water and size-fractionated sediment samples. Water sampling sites were classified by hierarchical cluster analysis (HCA) by squared Euclidean distance with Ward's method. To interpret obtained results and the relationships between the concentration of heavy metals in the tested river water and sample sediments, canonical correlation analysis (CCA) was used. Rivers were grouped into two classes (those having no pollution and those having low pollution) based on the HCA results obtained for river water samples. CCA results showed numerous relationships between rivers in Iran's Guilan province and their size-fractionated sediments samples. Heavy metals of sediments with 0.038 to 0.125 mm size in diameter are slightly correlated with those of water samples [7]. Heavy metal (HM) pollution of water affects both aquatic lives as well as terrestrial beings, including humans [8]. They accumulate in the environment and are able to contaminate the food chain [8]. Human activities resulted in soil contamination by heavy metals and polluted field need remediation processes among which, immobilization with organic amendments is getting more popular, as it decreases heavy metal bioavailability [10]. A systematic review of lead (*Pb*) contain in foods consumed or produced in Brazil surveyed Seventy-seven publications corresponding to 8466 food samples grouped into 12 food categories with similar characteristics. A random model established that *Pb* in food categories using the R® software to perform the meta-analysis and found a mean occurrence of 0.0541 mg/kg, ranged from 0.0004 mg/kg to 0.4842 mg/kg in foods [11]. Water pollution, precisely underground water pollution is a consequence of human activities [21]. Water pollution in heavy metal is not studied effectively and available data about underground water are very all [22]. In addition, there is need to undertake additional investigation to heavy metal monitoring [15]. The aim of this study was to determine heavy metal contain in drinking water at Nampala, a gold manning area in Mali.

MATERIEL AND METHODS [1, 2, 3]

Study Site

Water samples were collected in Nampala, and Heavy metal analysis was performed at National lab of health of Mali in Bamako.

Sample Collection

Sixteen (16) samples of water were collected from Nampala wells in a mining area in September 2020.

Sample Preservation

Study samples consisted of fresh well waters collected in 1 litter of white clean plastic containers and transported to the national lab of health for analytical purpose. These samples were stabilized by nitric acid at 4% and kept at 4° C then sent to the laboratory.

Apparatus

Heavy metals were quantified by a Perkin Elmer® PinAACle900T atomic absorption spectrometer. Concentration of Lead, Manganese, Arsenic, Nickel, Iron, Magnesium and Cupper were assessed by this method to determine the impact mining activities on underground water pollution.

Study Parameters
The concentrations of Lead, Manganese, Arsenic, Nickel, Iron, Calcium, Magnesium and Copper were determined in sample collected.

RESULTS AND DISCUSSION

The study shows high concentration of Nickel (*Ni*) compared to the normal in seven (7) sample and an abnormally increased concentration of Iron (*Fe*) in 4 samples. These increased concentrations may not be a result of contamination. The other heavy metals were present in normal concentration or absent in water sample. These results are not same as those observed in some are. A study performed in Ivory Coast in 2020 observed high contamination of rivers and surface water by heavy metals [19]. Same study showed supporting results in Tunisia in 2011 [14].

The repetitive application of low concentration of sewage sludge (SS) as an organic fertilizer is a beneficial strategy in getting rid of heavy metals in crops and in water [23]. Cement production plants are part of industries that release heavy metals in the environment [24]. The phenomenon leads researcher to experiment using heavy metal-tolerant as cadmium tolerant microbial agent in agriculture and observe their effects in releasing these elements in the environment [25]. Alternative solutions of releasing heavy metals in soil and underground waters are also welcome to combat toxic heavy metal accumulation in drinking water [18]. Collecting samples adequately is a key element in monitoring soil or water pollution [17].

Table 1: Heavy metal concentrations in Nampala drinking waters

Sample Number	Pb (mg/L)	Mn (mg/L)	As (mg/L)	Ni (mg/L)	Fe (mg/L)	Ca (mg/L)	Mg (mg/L)	Cu (mg/L)
S1	0	0,026	0	**9,891**	0,059	0,228	0,511	0
S2	0	0,056	**0**	**24,331**	0	1,561	7,517	0
S3	0	0,028	0	**26,101**	0,004	0,102	0,449	0
S4	0	0,075	0	**14,521**	0	4,071	10,01	0
S5	0	0,052	0	**11,881**	0,21	5,613	3,28	0
S6	0	0,133	0	**0**	0,198	1,716	7,598	0
S7	0	0,047	0	**8,891**	0,066	0,469	4,236	0
S8	0	0,037	0	0	0,051	0,09	0,499	0
S9	0	0,067	0	0	2,285	1,942	6,275	0
S10	0	0,027	0	0	0,421	2,673	7,132	0
S11	0	0,152	0	0	**1,333**	1,462	5,747	0
S12	0	0,153	0	0	0,037	0,362	6, 137	0,003
S13	0	0,131	0	0	0,042	0,226	5,942	0
S14	0	0,027	0	11,201	**0,634**	0,142	0,47	0,065
S15	0	0,201	0	0	**0,436**	4,708	7,227	0
S16	0	0,032	0	0	**0,395**	2,498	3,569	0,017
Standard value	**≤ 0,01**	**≤ 0,5**	**≤ 0,01**	**≤ 0,07**	**≤ 0,3**	**-**	**-**	**≤ 2**

CONCLUSION AND PERSPECTIVES

The study observed normal level of heavy metals in this mining area. Conventional physical and chemical methods to get rid of HMs from water are expensive, slow, non-environment friendly and inefficient but phytoremediation and microbe-assisted remediation technologies have attracted attention in recent years and offer a better solution. They adopt different mechanisms for HM bioremediation in aquatic ecosystems. Recent advancement of molecular tools improved understands metal adsorption mechanisms, translocation, sequestration, and tolerance in plants and microbes [8]. Albeit immense possibilities of bioremediation as a successful environmental clean-up technology, the method has not been implemented successfully in the field conditions [8]. The limitation of arsenic (As) and cadmium (Cd) bioaccumulation in rice grain attracted global attention. Despite increasing As accumulation in AWD water management, simultaneous use of AWD water management and Fe increased grain yield, enhanced accumulation of less toxic methylated As in rice grains and accumulated low Cd concentrations comparable to that attainable with CF water management indicating that simultaneous use AWD and Fe can be effective in controlling Cd accumulation in paddies highly contaminated with Cd [9]. Jakubus et al investigated the compost applicability as stabilization material to reduce metal bioavailability and determined practical applicability of developed factors as a reliable and helpful indicator of metal-soil-plant interactions under greenhouse conditions with two soils (light and medium) with and without biowaste compost amendment and two test plants (winter barley and white mustard) at a simulated contamination with Cu (doses of 25 and 50 mg kg-1) and Zn (doses of 100 and 200 mg kg-1) [10]. The study showed that compost is a valuable organic amendment, which can significantly reduce metal bioavailability. Moreover, bioconcentration factor (BCFT, BCFA) and the contamination level coefficient (CCL) appear to be useful tools to assess soil contamination in relation to environment phytotoxicity as confirmed by two-sided F-Snedecor test and Student's t-test [10].

References

1. Habibi, E., Niknejad, Y., Fallah, H., Dastan, S., & Tari, D. B. (2019). Life cycle assessment of rice production systems in different paddy field size levels in north of Iran. Environmental monitoring and assessment, 191(4), 1-23. DOI: 10.1007/s10661-019-7344-0

2. Zhu, D., Wu, S., Han, J., Wang, L., & Qi, M. (2018). Evaluation of nutrients and heavy metals in the sediments of the Heer River, Shenzhen, China. Environmental monitoring and assessment, 190(7), 1-10. DOI : 10.1007/s10661-018-6740-1

3. Pipi, A. R., Magdalena, A. G., Giafferis, G. P., Da Silva, G. H., & Piacenti-Silva, M. (2018). Evaluation of metal removal efficiency and its influence in the physicochemical parameters at two sewage treatment plants. Environmental monitoring and assessment, 190(5), 1-10. DOI: 10.1007/s10661-018-6633-3

4. Bailon, M. X., David, A. S., Park, Y., Kim, E., & Hong, Y. (2018). Total mercury, methyl mercury, and heavy metal concentrations in Hyeongsan River and its tributaries in Pohang city, South Korea. Environmental monitoring and assessment, 190(5), 1-16. DOI : 10.1007/s10661-018-6624-4

5. Bhave, P., & Shrestha, R. (2018). Total mercury status in an urban water body, Mithi River, Mumbai and analysis of the relation between total mercury and other pollution parameters. Environmental monitoring and assessment, 190(12), 1-5. DOI : 10.1007/s10661-018-7080-x

6. Yessoufou, A., Ifon, B. E., Suanon, F., Dimon, B., Sun, Q., Dedjiho, C. A., ... & Yu, C. P. (2017). Rare earth and precious elements in the urban sewage sludge and lake surface sediments under anthropogenic influence in the Republic of Benin. Environmental monitoring and assessment, 189(12), 1-12. DOI : 10.1007/s10661-017-6331-6

7. Vosoogh, A., Saeedi, M., & Lak, R. (2016). Heavy metals relationship with water and size-fractionated sediments in rivers using canonical correlation analysis (CCA) case study, rivers of south western Caspian Sea. Environmental monitoring and assessment, 188(11), 1-15. DOI : 10.1007/s10661-016-5611-x

8. Haldar, S., & Ghosh, A. (2020). Microbial and plant-assisted heavy metal remediation in aquatic ecosystems: a comprehensive review. 3 Biotech, 10(5), 1-13. DOI : https://doi.org/10.1007/s13205-020-02195-4

9. Mlangeni, A. T., Perez, M., Raab, A., Krupp, E. M., Norton, G. J., & Feldmann, J. (2020). Simultaneous stimulation of arsenic methylation and inhibition of cadmium bioaccumulation in rice grain using zero valent iron and alternate wetting and drying water management. Science of the Total Environment, 711, 134696. DOI : https://doi.org/10.1016/j.scitotenv.2019.134696.

10. Jakubus M., Bakinowska E., Tatuśko N. 2019. Compost utilisation in heavy metal immobilisation process evaluated by bioconcentration factors. J. Elem., 24(4): 1291-1307. DOI: 10.5601/jelem.2018.23.4.1761.

11. De Vasconcelos Neto, M. C., Silva, T. B. C., de Araújo, V. E., & de Souza, S. V. C. (2019). Lead contamination in food consumed and produced in Brazil: Systematic review and meta-analysis. Food Research International, 126, 108671. DOI : https://doi.org/10.1016/j.foodres.2019.108671.

12. Haddi, Z., Sbartai, A., Namour, P., El Bari, N., Bouchikhi, B., & Jaffrezic-Renault, N. (2021). Conception et développement d’une langue électronique pour la détection des métaux lourds. In Instrumentation et Interdisciplinarité (pp. 345-350). EDP Sciences. https://doi.org/10.1051/978-2-7598-1206-6.c043.

13. Guessasma, Z. (2021). evaluation de la pollution des sols par les métaux lourds de quelques biotopes du nord-est algerien par l'utilisation d'un bio-indicateur animal (Doctoral dissertation, university of souk ahras). Studia Universitatis « Vasile Goldis », Seria Stiintele Vietii.2020 :30(2) :55-63. www.studiauniversitatis.ro.

14. Mlayah, A., Da Silva, E. A. F., & Nouri Hatira, S. Jellali, Fethi Lachaal, Abdelkrim Charef, Fernando Noronha et Chedly Ben Hamza. Bassin d'oued Serrat : terrils et rejets domestiques, reconnaissance des métaux lourds et polluants, impact sur les eaux souterraines (nord-ouest de la Tunisie). Revue des Sciences de l’Eau. 2021,24(2) : 159-175. DOI : https://doi.org/10.7202/1006109ar.

15. GNANDI, K., AHOUDI, H., BADASSAN, T. E. E., AGBERE, S., Tanouayi, G., SOLITOKE, H. D., Sadikou, A., Esso-Essiman, B. T., Housseni, A., & Adje, K. (2021). State of trace element contamination of sediments from the Nangbéto hydroelectric dam lake (Togo). Environnement, Ingénierie & Développement. 2021, 85,12-25.https://doi.org/10.46298/eid.2021.7304.

16. Bertrand, C., Mougin, C., Bérard, A., Morin, S., Crouzet, O., & Karmasyn-Veyrines, P. (2022). Bulletin de veille du réseau d'écotoxicologie terrestre et aquatique. ECOTOX. 2021, 54. https://doi.org/10.15454/x8by-ae98.

17. van Oort, F., Baize, D., & Thiry, M. (2022). Les sols pollués à l’épreuve de l’expertise pédologique. Etude et Gestion des Sols, 29, 5-29. https://www.afes.fr/publications/revue-etude-et-gestion-des-sols/volume-29/.

18. Li, L., & Yan, X. (2021). Insights into the roles of melatonin in alleviating heavy metal toxicity in crop plants. Phyton, 90(6), 1559.

19. AHOUSSI, K. E., & YAPO, A. P. (2021). Étude de la minéralisation des eaux de surface en éléments traces métalliques (ETM) des zones d’orpaillage de la sous-préfecture de Kokumbo, Centre-Ouest de la Côte d’Ivoire. Afrique SCIENCE, 19(4), 36-50. ISSN 1813-548X.

20. van Oort, F., Baize, D., & Thiry, M. (2022). Les sols pollués à l’épreuve de l’expertise pédologique. Etude et Gestion des Sols, 29, 5-29. https://www.afes.fr/publications/revue-etude-et-gestions-des-sols/volume-29/.

21. ZAHEM, A., & SADALLAH, M. (2021). Systèmes de filtration d'eau domestique Fabrication de filtre de purification GAC (Doctoral dissertation, university of M'sila).

22. Milcent, A (1987). Etude et suivi des nappes d'eau souterraines du Mali dans la zone du delta intérieur du Niger. Rapport Final de Synthèse. BRGM. 87 MLI 096 EAU.

23. Marotrao, A. L., Singh, S. K., Patra, A., Kumar, O., Jatav, S. S., & Yadav, S. N. (2021). Assessing heavy metal accumulation in plants and soil with sewage sludge application under rice-wheat system in an Indo-Gangetic Inceptisol. Arabian Journal of Geosciences, 14(22). DOI: 10.1007/s12517-021-08659-y.

24. da Costa Silvia, T. A., de Paula, M., Silvia, W. S., Lacorte, G. A (2022). Can moderate heavy metal soil contaminations due to cement production influence the surrounding soil bacterial communities? Ecotoxicology. 2022. DOI: 10.1007/s10646-021-02494-3.

25. Bravo, D., Braissant, O. Cadmium-tolerant bacteria: current trends and applications in agriculture. Letters in Applied Microbiology 2021. DOI:10.1111/lam.13594.