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Assessment of heavy metal composition of Ogbujilekwe Stream Watershed in Nimo, Njikoka L.G.A. of Anambra State

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Abstract

The study on heavy metals was conducted at the Ogbujilekwe stream watershed. The study aimed to ascertain the heavy metal content of the watershed and the water from the nearby stream and to find out if there is any relationship between the heavy metals in the watershed and that in the waters sample. The experiment was laid out using Randomized Complete Block Design. The heavy metals that were investigated in this research work are Copper (Cu), Mercury (Hg), Lead (Pb) and Zinc (Zn). The result of mean values of the heavy metals shows that the heavy metals were significant and Cu followed by Hg was the most significant at $p< 0.005$. Also, Hg in soil was above the permissible limit for soil samples. Results from the mean values of the water samples also showed that all the heavy metals were significant in water, and mercury was the most significant heavy metal. From correlation analysis of the heavy metals in soil and water, only mercury in the soil had a positive correlation with mercury in water, and an increase in other heavy metals in the water had no relationship with the watershed. The mercury pollution in the water can therefore be attributed to the discharge from the watershed.

Keywords: Heavy metal, Pollution, Mercury, Correlation Analysis

1. Introduction

Heavy metals are natural components of the environment. Heavy metal pollution is of interest to ecologists because they are being deposited, alongside other wastes directly on the watersheds in increasing amounts. Heavy metals from automobiles cause serious environmental hazards. Heavy metals are released from mechanic workshops and during different road transport operations such as combustion, fluid leakage, corrosion of metals, corrosion of batteries and wear out of tyres. Some heavy metals, for example, Copper, Manganese, and Zinc are micronutrients that are essential in a small amount for plants and animal life [1]. Heavy metals represent the greatest hazard to plants and animals. Seepage from waste disposal sites, application of sewage sludge, pig manure and certain fertilizers, factory waste and metal ores are the major sources of heavy metals. Heavy metals are also contained in Phosphate fertilizer and other agrochemicals used for the growing of crops and this has been reported to cause contamination of groundwater in cultivated areas [2]. Researchers however believe that the threat of heavy metal ingestion as a result of eating food cultivated with fertilizer is very low. Metal toxicants on watersheds have more detrimental effects on both plants and animal species in the ecosystem. Lead compounds can be leached from lead pipes and result in high lead concentration in drinking water. Lead is a cumulative health poison and is associated with several health hazards like anaemia. Heavy

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metal pollution in soil and water has a lot of adverse effects and is therefore of great concern to public health. Metal pollutants generally do not decompose. Metals such as Zn, Cu, Pb and organic compounds, hydrocarbons, pesticides and industrial chemicals are not biodegradable and consequently continuously accumulate in water and soil [3]. Eventually, such accumulations may increase in magnitude, thereby getting to concentrations that can cause both chronic and acute toxicity. The world health organization and Dutch ecologists gave the maximum permissible additions of heavy metals which has no observed concentration effect on soil (NOEC) as follows: Copper 36, Cadmium 0.8, Zinc 30, Chromium 100, Lead 55, Nickel 35, Mercury 1.9 (WHO, 2010). While the permissible level of heavy metals for drinking water is as follows: Iron 0.1, Copper 1.0, Mercury 0.001, Cadmium 0.005, Lead 0.05, Zinc 5.0 etcetera [4]. Excessive release of heavy metals into the environment has created a great problem worldwide for various life forms and does not degrade into harmless products [5].

2. Material and methods

2.1. Study area

The study was carried out in Ogbujilekwe stream watershed in Njikoka L.G.A. of Anambra state. The watershed is used for the commercial farming of vegetables.

2.2. Experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD).

2.3. Sampling technique

A random sampling method was used for sample collection.

2.4. Data collection

The concentration of the following heavy metals (Cu, Pb, Hg, and Zn) were analyzed for both the soil and water samples.

2.5. Statistical analysis

The mean values collected were analyzed using correlation analysis.

2.6. Determination of heavy metal (Pb, Hg, Cu, Zn) content of soil samples

The soil sample was air dried, and sieved, 5g of each of the soil samples were weighed in an electronic balance and then placed in a beaker. The soil samples were digested by the addition of 20ml of Sulphuric acid to the soil sample. The samples were then heated in an electric furnace for 2hrs at 550°C until becomes colourless. After the preparation of the reference solution, 1ml of Nitric acid was then added to the digested sample. The sample is then carried to the spectrophotometer to check for the concentration of the heavy metals.

2.7. Heavy metal analysis of water samples

The heavy metal analysis for the water samples was conducted using Varian atomic Absorption Spectrophotometer according to the method of APHA [6] . For water samples, 1ml of Nitric acid was added to 100ml of water, boiled for 30mins and then allowed to cool. The samples were then placed one after the other on a spectrophotometer to check the rate of absorption against concentration.

3. Results

The mean values of heavy metal analysis of the soil and water samples are presented in Table 1 and Table 2.

Table 1 Mean value heavy metal analysis of the soil samples

Soil Sample	Depth	Pb	Hg	Cu	Zn
Arep	1	0.22667	0.4167*	1.9933*	10.8333*
	2	0.09333	0.3667	1.4733*	7.2333
	3	0.22333	0.2100	2.4933*	9.2333
Brep	1	0.19333	0.4700*	1.7467*	10.7667*
	2	0.29000	0.2933	1.1767*	9.2133*
	3	0.33000*	1.0000	1.44678	9.6667*
Crep	1	0.32333*	0.3233	2.3600*	6.1967
	2	0.34667*	0.3600	1.9100*	5.3433
	3	0.32667*	0.3733	1.7967*	4.0667
Control	1	0.23667	0.4800*	0.8467*	8.5100
	2	0.17000	0.4500	0.5633	6.2667
	3	0.18800	0.4500	0.5033	5.1333

Results in Mean *Significant at 0.05 level of significance

Table 2 Mean and standard deviation heavy metals of the water samples

Sample	Pb	Hg	Cu	Zn
Control	0.387±0.061	.9333±.9203*	0.4733±0.6429	0.2423±0.1155
Aws	0.327±0.055	1.0533±.01528*	0.1300±0.100*	0.1126±0.1528
Bws	0.3267±.05508	0.5400±.21656*	1.3133±0.1628	0.1322±0.2517
Cws	0.4200±.02000*	1.0700±0.500*	0.4200±0.500	0.1900±0.5568

Results in Mean ± standard deviation *Significant at 0.05 level of significance

4. Discussion

The result from the mean values of heavy metals in both the soil and water samples shows that the heavy metals were significant $p< 0.005$. The most significant heavy metal in the soil is Cu, while the most significant heavy metal in water is Hg. From the correlation analysis of the soil and water samples, most of the heavy metals in water were positively correlated with other heavy metals in water. Only Mercury in soil was positively correlated with Mercury in water. A positive correlation means that as the heavy metal in soil increases, there is a subsequent increase in the heavy metal in water.

5. Conclusion

From this correlation analysis, it could also be depicted that the increase in mercury in the water is caused by the activities in the watershed but an increase in other heavy metals in water may be a result of non-point pollution of water bodies. Although the concentrations were within the permissible range for drinking water, further input accumulation may result in a serious health hazard to the neighbouring communities in Anaocha Local Government Area of Anambra state.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there was any conflict as regards the research work as well as this publication.

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