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Heavy Metals inDilimi River and Their Uptake By Irrigated Crops, Jos-Plateau, Nigeria.

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ABSTRACT:*The concentration in mgl^{-1} and mgkg^{-1} of Cr, Cd, and Pb were determined in water, soil and crops (Carrot and Lettuce) using the atomic absorption spectrophotometer. A total of 12 samples with 4 samples in each station were collected for analysis. The stations are Dilimi, Gangare and Uni-Jos sites as station 1, 2, and 3 respectively. The result obtained from water sample revealed that, Pb (0.026 mgl^{-1}) and Cr (0.480 mgl^{-1}) in station 1; Pb (0.097 mgl^{-1}) in station 2; Pb (0.722 mgl^{-1}) in station 3 exceeded the WHO/EU limit. From the soil in Gangare, Cd (3.94 mgkg^{-1}) and Cr (8.6 mgkg^{-1}) exceeded WHO/EU limit, while in carrot, there is an insignificant value in all the 3 stations. From lettuce, Cd (0.0218 mgkg^{-1}), Cr (0.3 mgkg^{-1}) in station 2 and in station 3, Cd (0.0561 mgkg^{-1}) and Cr (2.16 mgkg^{-1}) exceeded the WHO/EU limit, which signifies that consumers of Lettuce are at high risk of metal exposure. Therefore, as the high values of these trace metals in the crops and water put the consumers of these vegetables at high risk, the study recommended that, health practitioners, teachers as well as parents should create awareness about the health implication of heavy metals.*
KEY WORDS:*Concentration, Spectrophotometer, Absorption, Practitioners, Exposure*.

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I. INTRODUCTION

Heavy metals have played a vital role in the society. In most part of the world, heavy metals toxicity can result to significant illness and reduce quality of life (Ferner, 2000). Metal pollution in soil can be brought about by several anthropogenic activities such as sewage, sludge application, mining, smelting operations and application of synthetic fertilizers. Heavy metal has to do with any toxic metal irrespective of their atomic mass.

According to Oguize, (2003) heavy metal is a loosely defined term, it is widely recognized and usually applied to the wide spread contaminants of terrestrial and fresh water ecosystems. Some examples of heavy metal include lead, zinc, cadmium, copper and manganese (Opaluwa*et al*, 2012). Many of these heavy metals are toxic to organisms at low concentration. Small amount of these heavy metals are common in our environments, and are actually necessary for good health. However, large amount of any of them may cause acute toxicity.

Heavy metal toxicity can result to damage of mental and central nervous functions which leads to lower energy levels that damages the blood composition, lungs, kidneys, liver and other vital organs. The long term exposure to this heavy metal may result in slowly progressing physical, muscular, and neurological degenerative process, reported long-term contact with some metals may result to cancer Abdullahi (2007). In recent years, heavy metals accumulation in plants has been a serious environmental concern, primarily because of their uptake by plants from contaminated soils. The occurrence of such metals in excess of natural load, according to Anthony, and Balwart (2004) has become a problem of increasing concern not only to environmentalists but also to health practitioners.

The concern about heavy metals stems from their persistence in the environment as they are not easily degraded either through biological or chemical means unlike most organic pollutants (Sabo *et al*, 2013). Different kinds of effluents are discharged from domestic and industrial activities into River Dilimi as it passes through Jos city. Earlier studies by Singh *et al*, (2010) revealed that the water in River Dilimi is already contaminated with some heavy metals. As a result, this study aimed at assessing heavy metals (Cd, Pb and Cr)

of River Dilimi in Jos with a view to determining its suitability for use in vegetable crop irrigation as practiced in Jos city.

II. MATERIALS AND METHOD

Study Area

The study was conducted at three (3) irrigation sites (Delimi, Gangare, and University village) irrigation sites in Jos-North Local Government Area of Plateau State. Jos – North local government is located at the extreme north of Plateau State on Latitudes 09^0 53^1 and 09^0 59^1 North, and Longitudes 08^0 51^1 and 09^0 02^1 East. It shares boundary to the North with Toro Local Government Area of Bauchi State; to the South with Jos-South Local Government area; to the North-East with Jos-East Local Government Area; and to the West with Bassa Local Government Area (Dung-Gwom*et al*, 2009).

Jos-North Local Government enjoys a temperate climate with average temperatures of between 28^0C (81.7^0F) maximum and 11^0C (51.7^0F) minimum. It covers the total land area of 291 km^2 (112 sq mi) with the 2006 provisional population census figure of 429,300 people. The warmest temperatures usually occur in the dry season months of March and April (Ahonsi, 2011). Similarly, Jos-North Local Government is characterized by mean annual rainfall of between 1317.5mm (131.75cm) and 1460.00mm (146.0cm), mostly in the months of May to August. The Onset and Cessation of rainfall in Jos-North is experienced in the months of April (±15 days in the month of April), and October (±15 days in the month of October). Relative humidity is characterized by a marked seasonal variation (Mailoushi*et al*, 2015). The Jos Plateau makes it the source of many Rivers in northern Nigeria including the Kaduna, Gongola, Hadejia and Yobe River (Sabo *et al*, 2008). As a result, this study was conducted at river Dilimi in Jos North Local Government Area of Plateau State in Central Nigeria. Water from this stream is used for domestic purposes and irrigation.

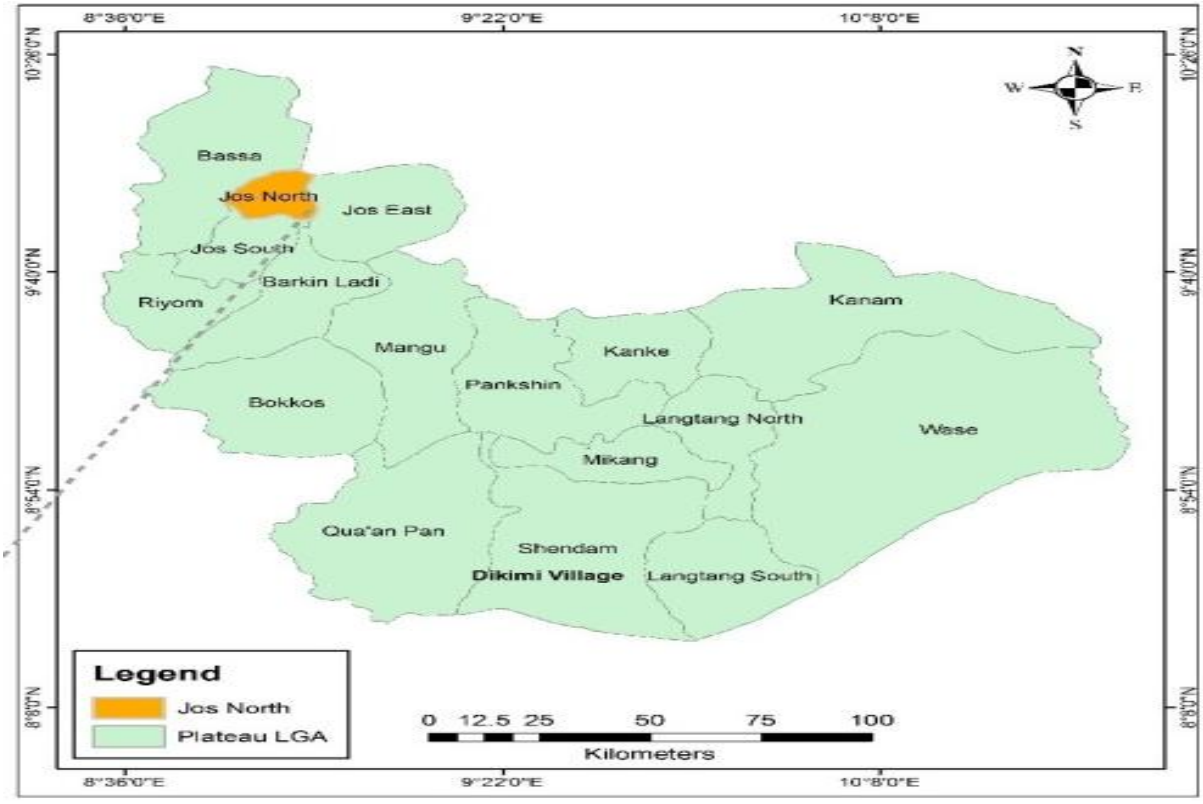

Figure 1: Plateau State Showing Jos-North

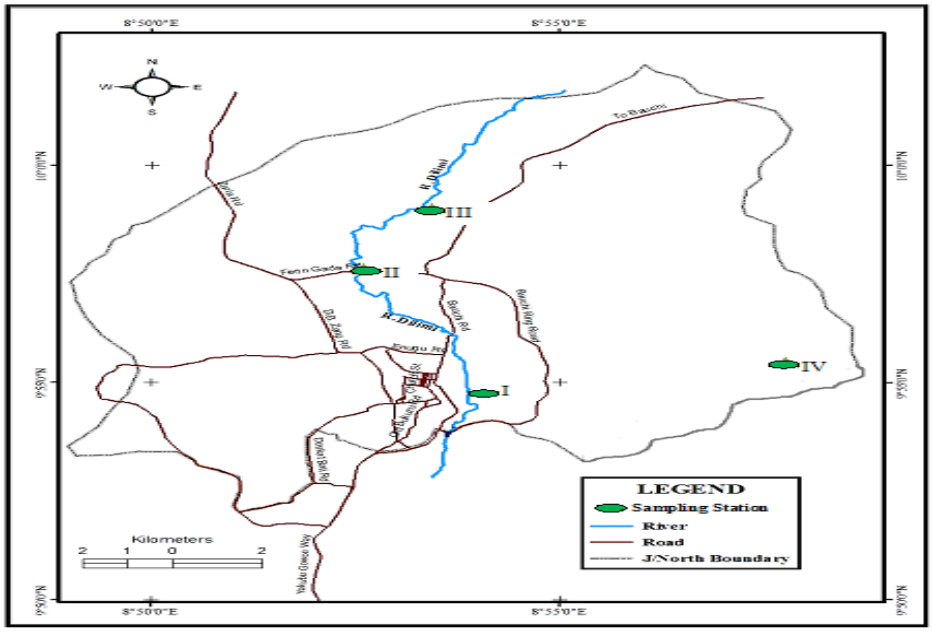

Figure 2: Jos City showing the Sampling Stations.

Data Collection

The vegetables (Carrot, Lettuce), Water and Soil samples were collected for the study. The vegetables sample were collected in Polythene bags from each site which were washed with distilled water as such carefully dried with brown envelopes and weighed immediately after collection before being dried in the oven at 60^0C for twenty four (24) hours. These samples were weighed and pounded in a mortar and pestle after which 0.5g of each was collected for use.

The soil sample was collected in a flat white plastic container. These plastic materials were screened to be metal-free in order to avoid contamination. The samples were then dried at 105^0C for twenty four (24) hours in the laboratory and then sieved with 2mm sieve, and 0.5g of the sample was stored for analysis. The water samples were collected with amber brown bottles which some drops of nitric acid was drop into the water to stop any microbial activity.

The sample were placed on a digester by which 4ml of perchloric, 25ml of concentrated HNO_3 and 2ml of concentrated H_2SO_4 were added and kept under a fume hood. The samples were digested to be colorless and were marked with distilled water. The sample solutions were returned to the refrigerator in the laboratory until they were analyzed using atomic absorption spectrophotometers (AAS model VGP).

III. RESULT

The concentrations of the heavy metals in Delimi Rivers were presented in Table 1. The highest value of Cd (0.006mgl^{-1}) was recorded in station 3 (Unijos), followed by the value (0.005 mgl^{-1}) recorded at station 1 (Dilimi Site). Cd metal was not detected at station 2 (Gangare Site). The highest concentration of Pb (0.722 mgl^{-1}) was recorded in water sample obtained from station 3. Whereas the least value of 0.097mgl^{-1} was recorded at station 2. The value of Cr (0.48 mgl^{-1}) was recorded at station 1, and it was detected at the other stations.

Table 1: Concentration of Metals in River Dilimi at Sampling Station

S/N	Sample Station	Metals (mg^{-1})		
		Cd	Pb	Cr
1	Dilimi	0.005	0.226	0.48
2	Gangare	N.D	0.097	N.D
3	Unijos	0.006	0.722	N.D
FEPA		0.01	0.05	0.05
WHO/EU LIMIT		-	0.05	0.05

Source: Authors' Field Work, 2018

From Table 2, the highest value of Cd (3.94 mgkg^{-1}) was recorded at station 2, whereas the lowest value of 0.08 mgkg^{-1} was recorded at station 3. However, Cd was not detected in soil samples obtained at station 1. The highest value of Pb (0.54 mgkg^{-1}) was recorded at station1. Whereas the least value of 0.06 mgkg^{-1} was

recorded at station 2. The highest concentration of Cr (11.8 $mgkg^{-1}$) was discovered in station 3; and the minimum of 8.6 $mgkg^{-1}$ was recorded at station 2. However, there was no any detected value for Cr, in station1.

Table 2: Concentration of Metals in Soils of Irrigation Sites at Sampling Stations

S/N	Sample Station	Metals ($mgkg^{-1}$)		
		Cd	Pb	Cr
1	Dilimi	N.D	0.54	N.D
2	Gangare	3.94	0.06	8.60
3	Unijos	0.08	0.34	11.80
WHO/EU LIMIT		1	50	30

Source: Authors' Field Work, 2018

Table 3: Concentration of Metals in Carrot and Lettuce Crops Obtained from Irrigated Farmland fed with Water from Dilimi River

SAMPLING STATION	METALS ($MgKg^{-1}$)					
	Carrot			Lettuce		
	Cd	Pb	Cr	Cd	Pb	Cr
Dilimi	0.003	0.008	0.06	ND	ND	ND
Gangare	ND	ND	ND	0.022	0.249	0.30
Uni-Jos	0.007	0.670	0.05	0.056	ND	2.16
WHO/EU LIMIT	0.01	0.10	5.00	0.01	0.1	50

Source: Authors' Field Work, 2018

From Table 3, the highest concentration of Cd (0.007$mgkg^{-1}$), in Carrot samples was recorded at station 3, and the Pb concentration (0.003$mgkg^{-1}$) was recorded at station 1. The highest value of Pb (0.670 $mgkg^{-1}$) was recorded at station 3; whereas, the least value of 0.08 $mgkg^{-1}$ was recorded at station 1. However, no value was detected at station 2. Cr (0.06 $mgkg^{-1}$) was the highest value recorded at station 1, while 0.05 $mgkg^{-1}$ was recorded at station 3. However, there was no any detectable value of Cr at station 2. Similarly, the highest value of Cd (0.056 $mgkg^{-1}$) in Lettuce sample was recorded at station 3, and the least value of 0.22 $mgkg^{-1}$ was recorded at station 2. However, at station 1, no detectable value of Cd was recorded. The concentration of Pb (0.249 $mgkg^{-1}$) was recorded at station 2 which was the highest value, whereas no detected value was recorded at stations 1 and 3. For Cr, the highest value of concentration (2.16$mgkg^{-1}$) was recorded at station 3, and the least value of 0.30 $mgkg^{-1}$ was recorded at station 2, and no value was detected at station 1.

IV. DISCUSSION

The result obtained from the analysis of soil, water and crop samples from the various stations under study was found to be in different phases. Some metals were found to be higher than WHO/EU limit whereas others were found to be lower than WHO/EU limit. From the water sample, Pb (0.226mgl^{-1}) and Cr (0.480 mgl^{-1}) in Dilimi site exceeded the WHO/EU limit. In Gangare site, only Pb (0.097 mgl^{-1}) exceed the WHO/EU limit, and in Uni-Jos site, Pb (0.722 mgl^{-1}) was higher than WHO/EU limit. The high level of these trace metals in the water put the consumers of water i.e. both plants and animals at high risks of its exposure. From the soil sample, only at station 2 that Pb (3.94 $mgkg^{-1}$) and Cr (8.60 $mgkg^{-1}$) exceeded the WHO/EU limit. The high level of the trace metals in soil may lead to its uptake by the irrigated crop which eventually affects the consumers. At the site where carrot samples were collected, there was no significant contaminant as the values obtained were less than the maximum contaminant level of WHO/EU limit. In station 2, Cd (0.0218 $mgkg^{-1}$) and Cr (0.30 $mgkg^{-1}$) exceeded the WHO/EU limit, and in station 3, Cd (0.0561 $mgkg^{-1}$) and Cr (2.16 $mgkg^{-1}$) also exceeded WHO/EU limit. This signifies that consumers of lettuce are at high risk of metal exposure which is likely to pose danger for both short and long term illness. As a result, the study recommended that, health practitioners, teachers, the clergy as well as parents should create more awareness to the society on the health implication of heavy metals in Dilimi River.

V. CONCLUSION

The trend of occurrence of metal concentration in the samples of soil, water and crops are such that, the heavy metal concentration is higher than the limit of exposure while others were lower than the limit and some were not detected. The high concentration of the metal could be attributed to the run-off of fertilizer from farmlands, wastes dumped into the river and their availability in the earth's crust. Pesticides and herbicides are some of the contributing factors with the use of organic waste on farmland which constitute a lot of garbage from different unknown sources as another contributing factor of the high level of metals in the soil which in turn are taken up by the irrigated crops through the process of mineralization.

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A.Aliyu" Heavy Metals in Dilimi River and Their Uptake By Irrigated Crops, Jos-Plateau, Nigeria."American Journal of Engineering Research (AJER), vol.8, no.05, 2019, pp.224-228