BASELINE VERIFICATION OF HEAVY METAL DISTRIBUTION IN SURFACE WATER BODIES OF OKPOSI AND ENVIRONS, OHAOZARA LOCAL GOVERNMENT AREA, EBONYI STATE, SOUTHEASTERN NIGERIA

Ezennubia, V.C.[1]; Onunkwo, A.A.[1] and Ozotta, O.[2]
[1]Department of Geology, Federal University of Technology,
P.M.B 1526, Owerri, Nigeria.
[2]Department of Petroleum Engineering, University of North Dakota, Grand Forks, North Dakota, U.S.A.

ABSTRACT

Heavy metal is the generic term for metallic elements having an atomic weight higher than 40.04mg. Atomic absorption spectrophotometer was used in the identification of heavy metals. Geographic Information System (GIS) was also used in plotting the variation map of the locations. The variation and distribution of heavy metals at Ata River, Orugwu River, Ogurazu River, Affor River and Asu River for Chromium were measured in ppm as .00022, .0032, .0025, .019 and .0023 respectively and some were not detected in the general distribution. The heavy metals detected are within the permissive limit of WHO (2006) standard for drinking water. Since heavy metal is harmful to human health and could lead to stunted growth of plants and disruption of balance in the ecosystem, effort should be made to prevent its increase by observing all environmental rules. Therefore, in order to ensure sustainable development of the surface water resource in Okposi area of Ohaozara Local Government of Ebonyi State, conventional water treatment methods should be used to treat the heavy metal levels before the water is used for domestic purposes. Periodic measurement and monitoring of the concentration of the aspects of groundwater is required to forestall pollution impacts.

Keywords: Heavy Metals,GIS, Groundwater and Surface Water Contamination.

INTRODUCTION

According to Khlifi and Hamza-Chaffai (2010), heavy metal is the generic term for metallic elements having an atomic weight higher than 40.04mg. They enter the surface water environment by natural and anthropogenic means. These sources are weathering of the earth's crust, mining, soil erosion, industrial discharge, urban runoff, sewage effluents, disease or pest control agents applied to plants, air pollution fall out (Salem et al., 2000). They are the source of such ailments like cancer problems. Consuming water polluted by heavy metals is a risk (Morais *et al*., 2014).

LOCATION OF THE STUDY AREA

The study area covers Okposi and environs in Ohaozara Local Government of Ebonyi State, South Eastern Nigeria. The area is located between latitudes $6^0$00' N to 6^0 10' N and longitude $7^0$42' E to 7^0 52'E (Fig. 1). According to Obasi and Akudinobi (2015), it extends from Isu in the North of Okposi in the South. Laterally, it extends from Asumabom through Okposi and Uburu. Other major villages surrounding the area include: Umuka, Ndiagu-Onicha, Eneagu and Isuachara. The topography of the area is generally a low lying one, particularly in the eastern and the western axis, while the northern zone is hilly especially at the Ugwulangwu, where there is large expense of layers of iron rocks (Obasi and Akudinobi, 2015). This research exposes the extent of heavy metals distribution in the surface water of Okposi in land lake areas, the extent of heavy metal distribution.

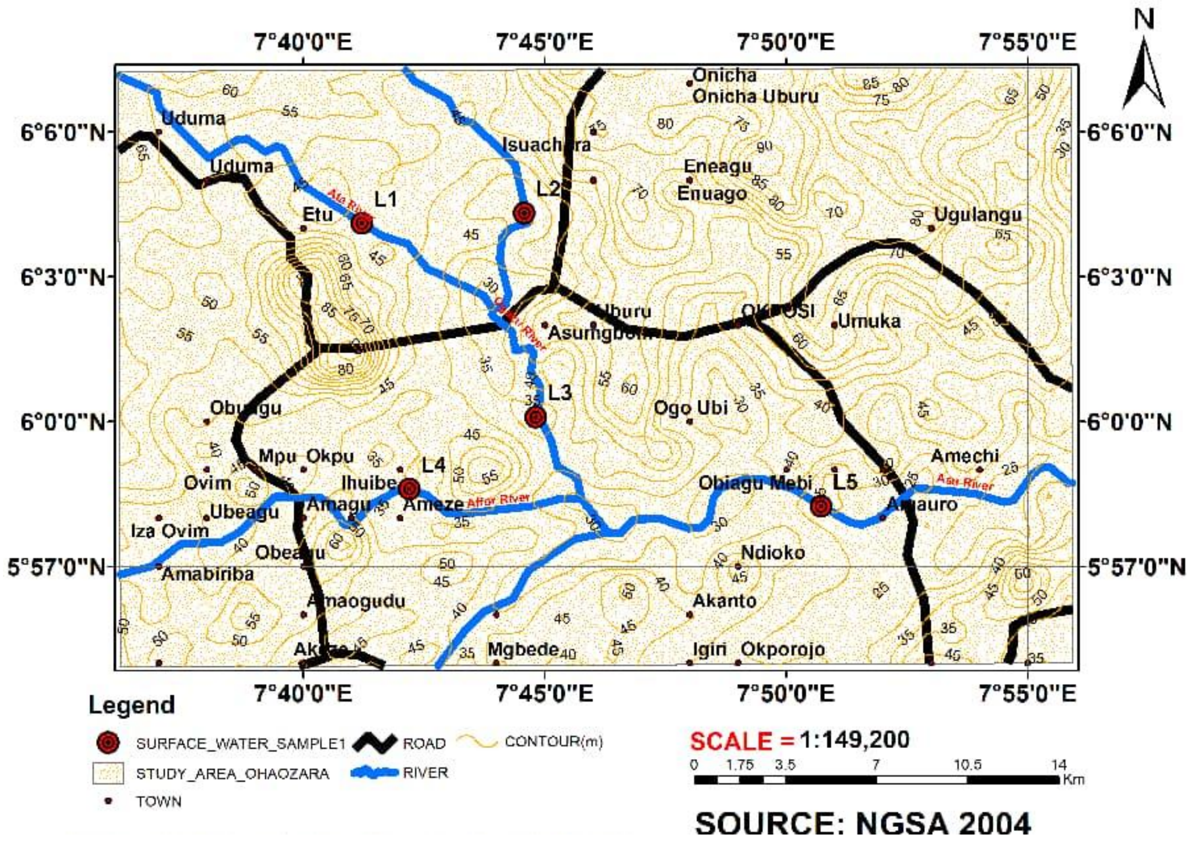

Fig. 1: Location, Accessibility and Topographical Map of Study Area.

Table 1 below gives the list of the locations studied, their coordinates and elevations.

Table 1: List of the locations studied, their Coordinates and Elevations

Name of Location	Coordinates		Elevation (m)
	Longitude	Latitude	
Ata River	7.6828ºE	6.0665ºN	45
Orugwu	7.7403ºE	6.0665ºN	45
Oguazu	7.6995ºE	5.9794ºN	40
Affor	7.7485ºE	6.0069ºN	35
Asu River	7.8437ºE	5.9722ºN	25

Salem *et al*. (2000) indicated in their study of heavy metal in drinking water, that renal failure is related to contaminated drinking water which is polluted by lead and cadmium. They also observed that liver cirrhosis is associated with copper and molybdenum.

Dakar (2005) attributed hair loss to nickel and chromium, chronic anemia to copper and cadmium. Essa (1999) stated that abnormal incidence in human health is related to heavy metals in industrial wastes and agricultural activities that led to the contamination of surface water by heavy metals.

Obi et al. (2001) investigated the geological and hydrochemical composition of Okposi and Ubili South spring areas of Ohaozara and observed that bromide (Br) Fluoride, Aluminum, Molybdenum, Cobalt, Mercury, Chromium, Nickel, Cadmium, and Silver are the main geochemical constituents. According to them, leaded gasoline has negative effects on children's physical and mental development. Lead exposure can cause neurological deficit such as mental retardation in children and kidney disease. According to WHO (2011), exposure to lead may also contribute to hypertension and cardiovascular disease and can pose a threat during pregnancy.

In the case of cadmium accumulated in the human body can affect several organs negatively, e.g. liver, kidney, lung, bones, placenta, brain and the central nervous system (Apostoli and Catalani, 2011). Other effects include reproductive problems, haematological and immunological effects (Appostoli et al., 2008). The summary effects of heavy metals can be described as shown by O'ehlenschlager (2002) in Table 2 below.

Table 2: Effects of Heavy metals (According to O'ehlenschlager, 2002)

Heavy metals	Effects
Cadmium	It negatively affects the liver, kidney, lung, bone, placenta, brain and central nervous system, haematological and immunological effects.
Chromium	Chromium effects occur in the lung, liver, kidney, gastrointestinal track, break down in circulatory system as well as lung infection.
Arsenic	Inorganic arsenic is considered carcinogenic and is related mainly to lung, kidney, bladder and skin disorders.
Lead (ph)	The exposure to lead may cause retardation in children and kidney disease in adults. It can lead to hypertension and cardiovascular disease, accumulate in bones for years, then causing pregnancy problem, lactation problem.
Mercury	This is a toxic element that accumulates in fish and when the fish is taken it can cause cancer.
Nickel	Respiratory disorder, cancer, skin disorder (nickel eczema).

From the above exposure, the people of Okposi area may suffer the following diseases; skin irritation, lung failure, brain damage, kidney failure, cardiac collapse amongst other diseases.
According to Lars (2003), Cadmium exposure from living irrigation and agriculture occurred in Japan in 1950s, and Itai disease was discovered. This is combination of Ostcomalocia and Osteoporosis.

DRAINAGE, CLIMATE AND GEOLOGY

According to Reilly (2007), the drainage of the area is dendritic and consists of small ephemeral streams. The streams generally flow in the N-S direction into Asu River. Asu River controls the drainage of the study area (Okoro et al.,2014). Flow of Asu River during the dry season is near zero implying a negligible base flow contribution (Okoro et al., 2014). Other streams and small rivers that contribute to the drainage are Asumabom River, River Ahe, River Azuu, River Ovum, River Enu and River Oshi. Saline springs and lakes occur within a relatively narrow belt which extends NE, SW direction such as Okposi Salt Lake and Ubili Salt Lake.

GEOLOGY

According to Nwajide 1990, the study area is underlain by the Asu River group and Ezeaku formation. The ASU River group is the oldest sedimentary rock in Southeastern Nigeria (Simpson, 1954). It is exposed in Abakaliki shale. These rocks are overlain by Ezeaku formation. There is no sharp distinction in boundary of the two Formations. According to Fayose and Ola (1990), the area is underlain by shale, sandstone, siltstone, sandy-shale and limestone. Three lithographic units were identified in the area during study. These units strike in the North East - South West direction and dipping in the South East direction with dips ranging between 17^0 - 45^0.

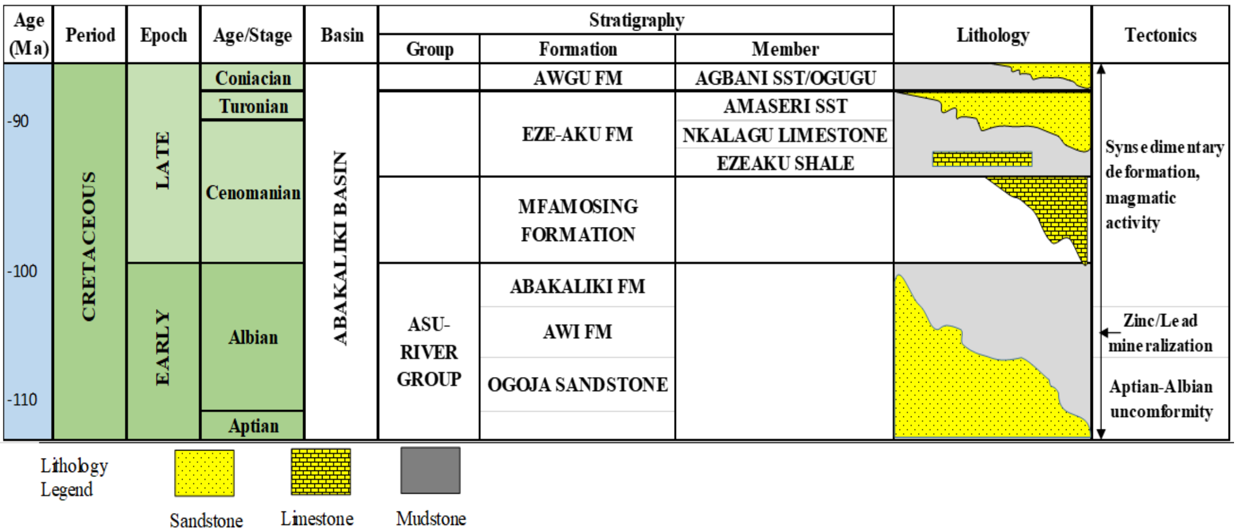

Fig. 2: Stratigraphic column of the Abakaliki Basin (Modified from Ekwenye et al., 2017)

Table 3: Stratigraphy of the study area (Nwachukwu, 1972)

Age	**Formation**	**Unit**	**Lithology/ Lithofacies**
Turonan	Ezeaku	C: Dark grey shales	Darl flaggy and hard shales. Contains minor bands of sandstone with highly indurated limestone.
		B: Sand stone, silt stone	Sandstone, whitish and calcareous siltstones and interbedded with mudstone.
Albian	Asu River Group	A light grey shales	Shales light grey in colour. Contains fine grained micaceous sandstone and sandy-shales.

The geologic map of the area is shown in Fig. 3 (After Murat, 1972).

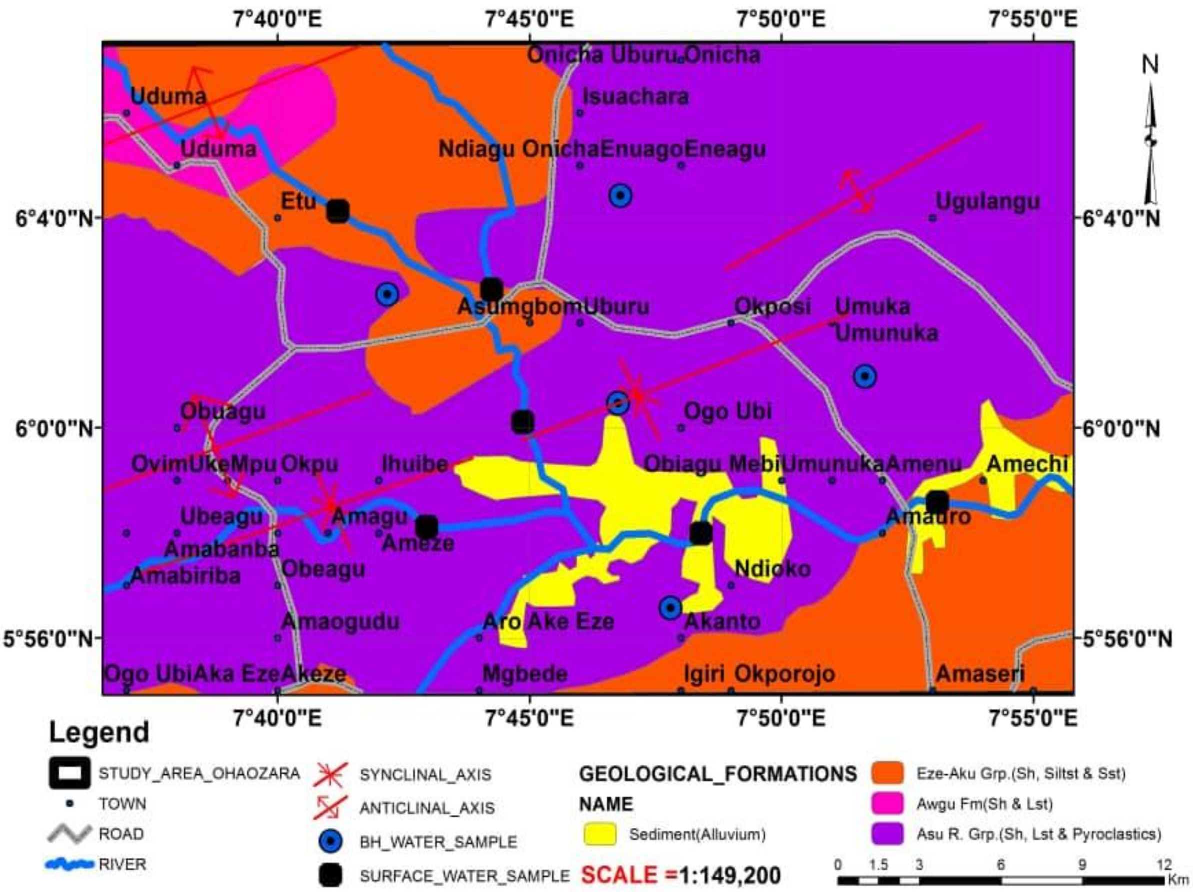

Fig. 3: Geologic map of the area (After Murat, 1972)

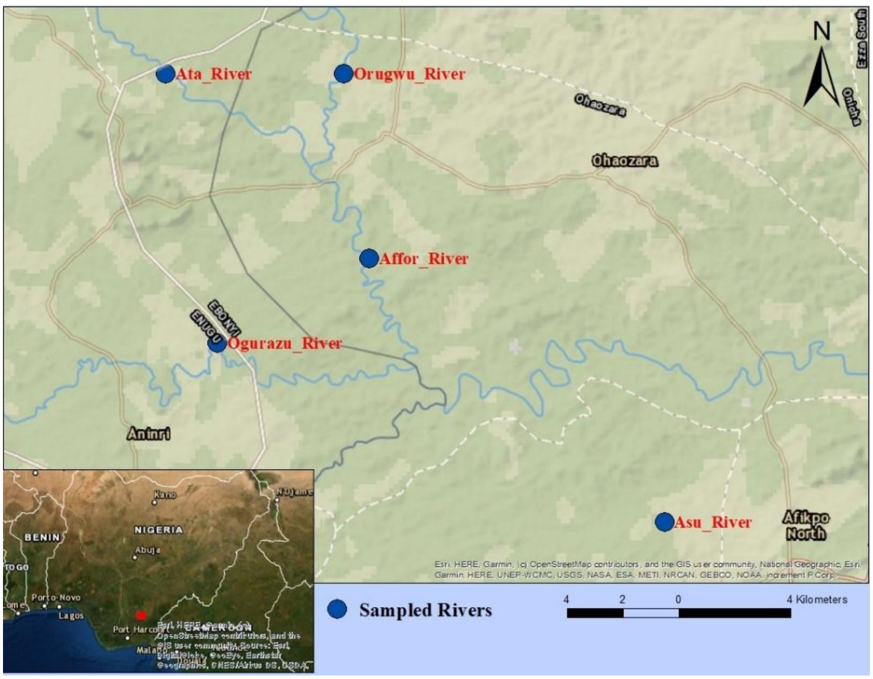

Fig. 4: Sampled Rivers within the Study Area

METHODOLOGY

Laboratory Analysis

Atomic absorption spectrophotometer was used in the identification of heavy metals.

Table 3 indicates the results of heavy metals in surface water samples.

Table 3: Results of heavy metals distribution

Parameters, ppm	A	B	C	D	E	Standard
	Ata River	Orugwu River	Ogurazu River	Affor River	ASU River	WHO 2006
Arsenic, AS ppm	ND	ND	ND	ND	ND	.02
Cadmium (Cd)	ND	.002	ND	ND	.003	.003
Chromium (Cr)	.00022	.0032	.0025	.019	.0023	.05
Copper (Cu)	.0039	.0051	.0043	.033	.0045	2.00
Mercury (Ag)	ND	ND	ND	ND	ND	.006
Molybdenum (Mo)	ND	ND	ND	ND	ND	.07
Nickel (Ni)	ND	ND	ND	ND	ND	.07
Lead (Pb)						.01
Zinc (Zn)	.089	.126	.081	.033	.047	0.01-0.05
Zircon (Zr)	ND	ND	ND	ND	ND	-

ND: Not Detected

From the Table 3, the variation and distribution of heavy metals at Ata River, Orugwu River, Ogurazu River, Affor River and Asu River for Chromium were measured in part per million (ppm) as .00022, .0032, .0025, .019 and .0023 respectively. Reference to Table 3 shows those not detected and general distribution. The heavy metals detected are within the permissive limit of WHO (2006) standard for drinking water. Fig 4 shows the bar chart distribution of heavy metals. Geographic Information System (GIS) was used in plotting the variation map of the locations (Fig. 5, 6, 7 and 8).

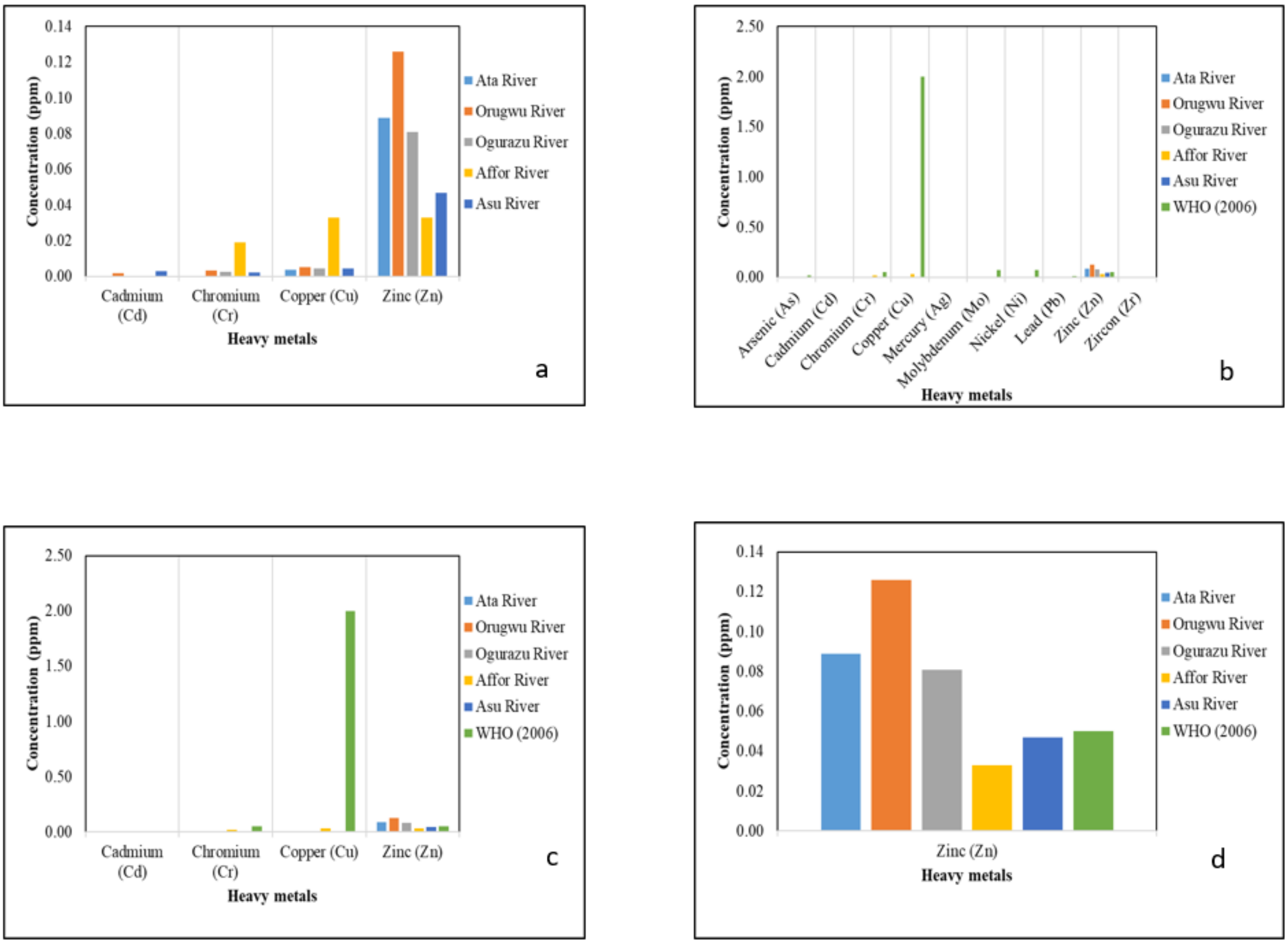

Fig 4: Variations of heavy metals

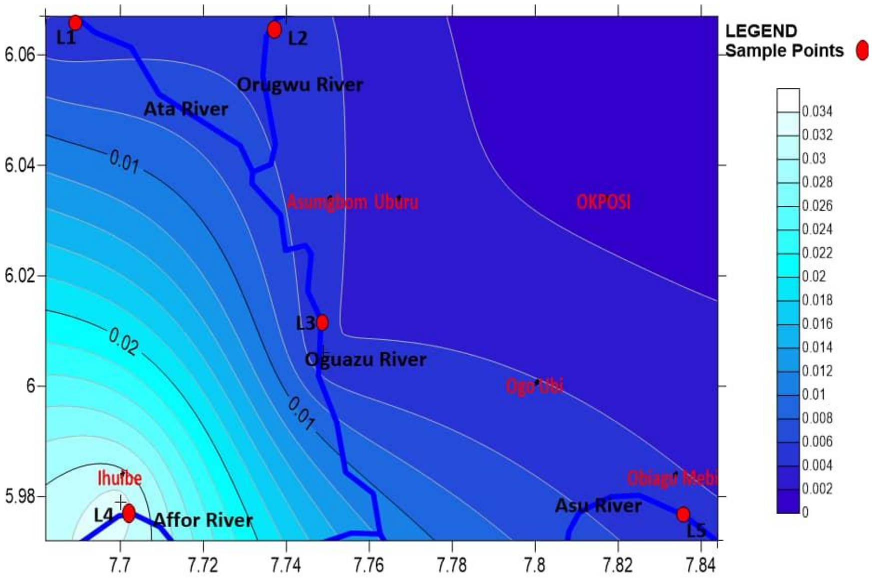

Fig 5: Concentration Distribution Map of Cu

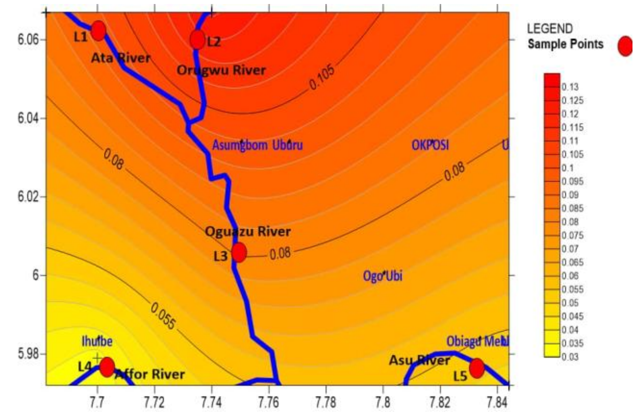

Fig 6: Concentration Distribution Map of Zn

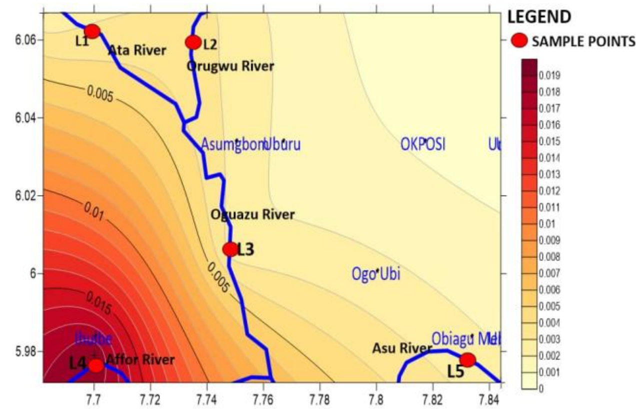

Fig 7: Concentration Distribution Map of Cr

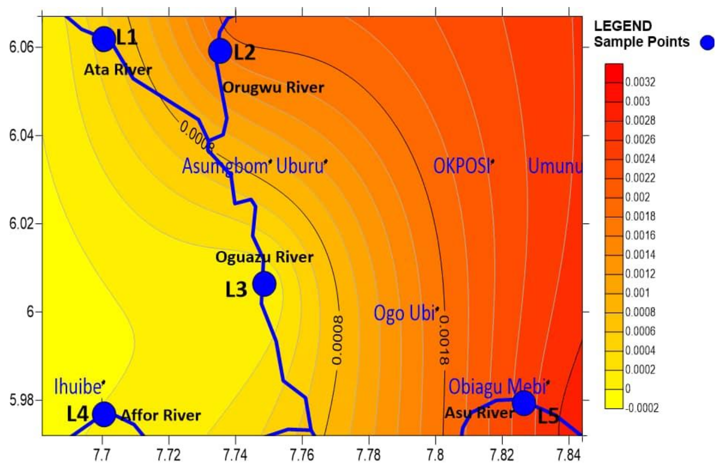

Fig 8: Concentration Distribution Map of Cd

CONCLUSION

Since heavy metal is harmful to human health and could lead to stunted growth of plants and disruption of balance in the ecosystem, effort should be made to prevent its increase by observing all environmental rules.

RECOMMENDATIONS

Though the heavy metals have not accumulated in the standard that it may not be injurious, it may accumulate to dangerous dimension in future. In order to ensure sustainable development of the surface water resource in Okposi area of Ohaozara Local Government of Ebonyi State, conventional water treatment methods should be used to treat the heavy metal levels before the water is used for domestic purposes. Periodic measurement and monitoring of the concentration of the aspects of groundwater is required to forestall pollution impacts. Sensitization of the populace on good practices with respect to waste disposal. Finally, an engineered land fill should be built and installed in the area in order to forestall and check the dumping of wastes illegally and in a rampant way.

REFERENCES

Daka, E.R. and Hawkins, S.J. (2004). Tolerance to heavy metals in LittoringSaxatilis from a metal contaminated site in the Isle of man *Journal of Marine Biology Association UK* 84393 – 400.

Ekwenye, O. C., Nichols, G., Nwajide, S. C., Obi, G. C., & Onyemesili, O. C. (2017). An insight into the Eocene tide-dominated estuarine system: implications for palaeoenvironmental and sequence stratigraphic interpretations. Arabian Journal of Geosciences, 10(16), 371.

Essa, K.A. (1999). The ugly trace element, effects screening and treatment. East Medit. *Health J.,* **5**(4): 798 – 802.

Fayose, E.A. & Ola, P.S. (1990). Radiolarian occurrences in the Ameki type Section, eastern Nigeria. *Journal of Mining and Geology.* 1990:26:75 -80.

Khlifi & Hamza-Chaffai, A. (2010). Head and neck cancer due to heavy metal exposure via tobacco smoking band professional exposure: A review. Toxicology and applied pharmacology, 248, 71-88.

Marais, S. Fernando Garcia de Costa & Maria de Lourdes Pereira (2014). Heavy metals and human health: Env. Health Emerging Issues and practice achieved from Research gate. 227-246.

Murat, R.C. (1972). Stratigraphy and Paleogeography of the cretaceous and lower national environmental policy Institute 2000. Assessing the bioavailability of metals in soil for use in human health risk assessment, metal task for force report.

Nwachukwu, S.O (1972) The tectonic evolution of the southern portion of the Benue trough. Geological Magazine. 1972;109(5):411- 419.

Nwajide, C.S. (1990). Cretaceous sedimentation and paleography of the central Benue trough in: The Benue Trough Structure and evolution (Ed). C.O. Ofoegbu).

Obaje, N.G. (2009). Geology and mineral resources of Nigeria. Springer-VerlagBerlg Berlin Heidelberg 57-65.

Obasi, P.N. & Akudinobi, B.E.D. (2015). Geology, water types and facie Evolution of the Ohaozara Saline lake areas of Ebonyi State, *Nigerian international Journal of Scientific and Research Publication.* **5** (9), 1-8 ISSN 2250 -3153 www.ijsrp.org.

Obi, G.C., Okogbue, C.O. &Nwajide, C.S. (2001). Evolution of the Enugu Cuesta: a tectonically-driven erosional process. *GlobalJournal of Pure and Applied Sciences.* 2001:7:321-330.

O'ehlenschlager, J. (2002). Identifying heavy metals in fish: Safety and quality issues in fish processing, Bremner, H.A. (Ed) , pp 95-113, Woodhead publishing Limited, 978-Cambridge.

Okeke, H.C. Orajaka, I.P. Okoro, I. Onuigbo, EN (2014). Biomarker evolution of the oil generative potential of organic matter in the upper Maastrichtian Strata Anambra basin South Eastern Nigeria. *Journal of African Sciences.*

Okoro, A.U. and Igwe E.O. (2014). Lithofacies and depositional environment of the Amasiri sandstone, Southern Benue Trough. *NigerianJournal of African Earth Science Elsevier. 179-190.*

Reilly, C. (2007). Pollutants in food metals and metalloids in Mineral Components in food, Szeifer P. and Nriagu J.O. Edition. Pp 363-388.

Salem, E.M., Ewelida A.E. & Farag (2000). Heavy metals in drinking water and their Environmental Impact on human health Cairo University Egypt: 542-556.