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Heavy Metals Contaminations in Amaogwugwu River from the Headstream to the Downstream, Ohuhu- Umuahia Abia State , Nigeria

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Abstract
This study analyzed the effects of heavy metals concentrations of Pb, Cd, Zn, Cr , Ni, Co in the Amaogwugwu River Drainage basin from its headstream, midstream up to the downstream and in both surface and groundwater and the water is used for may purpose including water supply, fishing and agriculture mainly irrigation. Based on above pH average water in the study area can be interpreted as slightly alkaline and still within permissible limits of all the three standards/guidelines. EC with above average also shows that all the water their value falls within the three guidelines. Samples from both surface and groundwater in the studied area have ranges and means of: Co ranges from 0.11 -21.24 ppb and average of 2.26 ppb , Ni ranges from 0.26 - 37.01 ppb and average of 7.37 ppb , Cu ranges from 0.17 - 640.93 ppb and average of 37.62 ppb, Zn ranges from 15 - 408 ppb and average of 115.03 ppb, As ranges from 0.09 - 2.3 1ppb and average of 0.62 ppb ,Pb ranges from 0.16 - 834.38 ppb and average of 29.82 ppb , Cr ranges from 0.16 - 5557.35 ppb and average of 419.58 ppb ,Cd ranges from 0.04 - 1.64 ppb and average of 0.21 ppb. EC. It is therefore recommended that concentrations level in crops grown with these waters needs to be investigated. Again it is confirmed that probably this may be one of the reasons for the drop in fish catch from midstream up to the downstream especially in area like Umuagwu which is known for its fishing, Okpuala and even Ngbagoro in Umuahia North local government of Abia state.
Keywords: Levels, Concentrations, Heavy Metals, Surface Water, Midstream

Introduction

It is known that quality of water required depends on the purpose it is meant to serve (Todd, 1980, Egboka, 1986, Ezeigbi, 1998, Anudu, *et al*., 2008). Indeed, our daily activities from both domestic and industry release wastes and effluents in to our environment. Unfortunately these are being absorbed by soils and thereby taken by plants or into water bodies and the water is been used for irrigation. These effluents are in turn utilised by plants, this continues until it gets to man himself again through food chain resulting into problems of water contamination causing outbreaks of different kind of diseases like water borne or heavy metals in fact taken by man of cancer etc.

Distribution of heavy metals is governed by the properties of the metal and influences of environmental factors (Klifi and Hamza - Chaffai, 2010). It is known that 30 out of the 92 naturally occurring elements are potentially toxic to humans and these are caused by either natural or anthropogenic and of concern here is by industries rather called industrial discharge. It is also known that contamination chain of heavy metals follows a cyclic order: Industry, atmosphere, soil, water, foods and human. Although the toxicity is a function of concentrations but heavy metals even at a relatively low limits can cause adverse effect. This stressed the need especially in developed countries on the exposure, intakes and absorption by humans. Practical implication of this trend in developed countries led to impositions of new and more restrictive regulations (European Commission, 2006; Figuero, 2008). work was done by the Federal Ministry of Environment in 2001 (F.M.E.) that found Cd 0.007; Pb (0.014); Cr,(0.11); Fe, (0.6); Mn 0.01; Ca, (0.0) all in ppm near Umuegwu bridge.

In Abia industries discharge their effluents into the Umuegwu River and drains there up to the Amaogwugwu wetland which is a wild refugee as well as one of the food baskets of Nigeria. The river flows from the foot slopes of the Imo and passes through Umudiawa draining their residential and industrial effluents and carrying them to the influent Amaogwugwu wetlands. This research focuses on determining the levels of concentrations of heavy metals (Cd, Co, Pb, Ni, Cr and As) in both groundwater and surface water from upstream, to midstream where the industries are located. It is also aimed to find whether the contamination caused by Umuahia metropolis reaches the Amaogwugwu Wetlands.

Materials and methods

The study area covers the present Abia state occupying a land area of about 12,285Km^2 approximately 1.3% 0f whole Nigeria It lies within latitudes 10^0 45I- 12^0 30IN and longitudes 8^0 43I- 10^0 10IE. The river has a total length of 1,124 km, and its drainage basin is....? Km. The River flows through normal non polluted areas of

Nigeria, with exception to Umuahia metropolis, where from it drains most of its pollutants. Amaogwugwu River flows from the foot of the Imo rocks of the eastern Nigerian Crystalline Shield under the effluent regime. Wells and boreholes samples were collected with a clean plastic bucket (as recommended by Davies, 1994). Samples from Boreholes were pumped for several minutes with the view of flushing out stagnating water in pipe, in order to sample the water coming from the formation.

Water samples were taken into plastic bottle containers of 120 ml and were all rinsed two times with the sampled water before filling them. Before tightening them, field parameters instantaneously such as (temperature, pH, Electrical Conductivity, TDS depth of wells and elevations) were measured for all the collected samples. Samples were then tightened and kept in a cooler with ice throughout the period of sampling. The bottles were clearly labelled. Water samples were taken randomly from different parts of the study area from the upstream side of the river in Okpuala up to the Amaogwugwu Wetland, ending in Ohuhu of Umuahia north Local Government Area of Abia State. The samples were taken simultaneously and categorised into surface water and groundwater water samples, rock samples, and sediments from stream channel. All the samples were packaged and transported to the partner technology international Laboratory Aboloma port Harcourt, River state for the determinations of heavy metals in water, sediments and rocks. In the laboratory for the heavy metals determination in water samples Inductively Coupled Plasma Mass Spectrometry Model 330 was used.

Results and Discussion

Table 1 gives the values of the physical parameters measured in the field. The values of electrical conductivity (EC) ranges between 7 and 1 59US/cm with mean average of 29.5uS. whereas for pH values obtained ranges between 6.52 and 8.7 with an mean average of 7.17, temperature ranges from between 69.2 and 194 ^{0}F with mean total average of 88^{0}F. Elevations from the study area ranges between f 343 and 880 masl with mean total of 472.69masl. Based on above pH average water in the study area can be interpreted as slightly alkaline and still within permissible limits of all the three standards/guidelines.EC with above average also shows that all the water their values falls within the three guidelines. All samples from both surface and groundwater in the studied area have ranges and mean of these listed: Co ranges from 0.11-21.24 ppb and average of 2.26 ppb , Ni ranges from 0.26 - 37.01 ppb and average of 7.37 ppb , Cu ranges from 0.17 - 640.93 ppb and average of 37.62 ppb, Zn ranges from 15 - 408 ppb and average of 115.03 ppb, As ranges from 0.09 -2.31ppb and average of 0.62 ppb ,Pb ranges from 0.16 - 834.38 ppb and average of 29.82 ppb , Cr ranges from 0.16 - 5557.35 ppb and average of 419.58 ppb ,Cd ranges from 0.04 - 1.64 ppb and average of 0.21 ppb

From above averages determined form the study area shows that all the waters are higher than the standards and guidelines which means the water is strongly polluted for domestic and even irrigation system of agriculture and the threat of the metals in water either consumed or for irrigation it means there is need for further research to determine also levels of these heavy metals in crops grown from these water in a way called biomagnifications in crops grown with these waters (table2). The samples were categorised majorly by surface and groundwater in three locations.

Groundwater

***Upstream from* Amaogwugwu**

Co, of range from 0.11 - 5.21 ppb and average of 1.34 ppb, Ni ranges from 2.03 - 21.86 ppb and average of 6.62 ppb, Cu, ranges from 1.86 - 25.49 ppb and average of 7.96 ppb, As ranges from 0.09 - 0.39 ppb with an average of 0.25 ppb, Cd, ranges from 0.33 - 1.64 ppb and average of 0.63 ppb, Pb, range from 1.8 - 30.04 ppb and average 7.69 ppb Cr ranges from 2.26 - 4.59 ppb and average of 3.58 ppb.

Midstream groundwater

Co, of range from 0.16 - 1.82 ppb with an average of 0.61 ppb, Ni ranges from 2.75 - 9.15 ppb and average of 5.50 ppb, Cu, ranges from 5.27 - 64.95 ppb and average of 23.03 ppb, As ranges from 0.09 - 1.58 ppb and average of 0.47 ppb, Cd, ranges from 0.04 - 0.09 ppb and average of 0.05 ppb, Pb, range from 2.62 - 834.38 ppb and average 80.63 ppb Cr ranges from 2.86 - 16.4 ppb and average of 7.41 ppb.

Downstream Groundwater

Co ranges from 0.6 - 21.24 ppb and average of 5.20 ppb, Ni ranges from 2.29 - 37.09 ppb and average of 11.47 ppb, Cu, ranges from 3.32 - 640.93 ppb and average of 137.55 ppb, Zn ranges from 15 - 124 ppb and average of 75.2 ppb, As ranges from 0.09 - 2.27 ppb and average of 0.64 ppb, Cd, ranges from 4.73 - 192.69 ppb and average of 48.43 ppb, Pb, ranges from 2.18 - 42.69 ppb and average 12.91 ppb, Cr ranges from 1.83 - 80.18 ppb and average of 42.51 ppb.

Surface water

Upstream* Amaogwugwu *River

Co, ranges from 0.14- 9.7 and average of 2.43 ppb, Ni ranges from 2.17 - 4.76 ppb and average of 3.01 ppb, Cu, ranges from 1.79 - 4.83 ppb and average of 2.80 ppb, Zn ranges from 32 – 95 ppb and average of 55.6 ppb, As ranges from 0.24 - 0.36 ppb and average of 0.31 ppb, Cd, ranges from 0.09 - 0.54 ppb and average of 0.24 ppb, Pb, range from 2.3 - 6.17 ppb and average 3.44 ppb, Cr ranges from 2.69 - 3.69 ppb and average of 3.27 ppb,

Midstream (*Amaogwugwu *metropolis)
Co, with range between 1.41 - 5.39 ppb and average of 3.87 ppb, Ni ranges from 5.35 - 22.76 ppb and average of 13.98 ppb, Cu, ranges from 6.02 - 113.38 ppb and average of 55.89 ppb, Zn ranges from 59 – 242 ppb and average of 117 ppb, As ranges from 0.12 - 2.31 ppb and average of 1.26 ppb, Cd, ranges from 0.09 - 0.54 ppb and average of 0.24 ppb, Pb, range from 3.93 - 17.69 ppb and average 10.19 ppb, Cr ranges from 61.38 - 5557.4ppb and average of 2353.7 ppb.

Downstream* Amaogwugwu *River
Co, of range from 0.25 - 1.93 and average of 1.23 ppb, Ni ranges from 0.26 - 4.59 ppb and average of 2.89 ppb, Cu, ranges from 0.17 - 7.17ppb and average of 3.6 ppb, Zn ranges from 62 – 118 ppb and average of 88 ppb, As ranges from 0.33 - 0.67 ppb and average of 0.52 ppb, Cd, ranges from 0.04 - 0.08 ppb and average of 0.06, Pb, range from 0.16 - 5.13 ppb with an average 2.41 ppb. Cr ranges from 0.16 - 30.88 ppb and average of 9.08 ppb.

Conclusions and Recommendations

This study brings the light of hydro geochemistry of water in the Amaogwugwu River. Both surface and groundwater from upstream (background not polluted), midstream (pollution area) and downstream (extent of pollution) shows that the pollution has reached up to the downstream. Levels in both waters show that the falls to higher side and pass the guidelines and standards in both surface and groundwater in the study area. Also based on pH and EC water is slightly alkaline but still within tolerable limits and EC. It is therefore recommended that concentrations level is also needed to be found in crops grown with these waters. Again it is confirmed that probably this may be one of the reasons for the drop in fish catch from midstream up to the downstream especially in area like Umuagwu which is known for its fishing, Ngbagoro and even Umuahia town in Umuahia North local government of Abia state.

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Tables

Table1: Results of Field Measurements on Locations, Time, pH, TDS, Elevations and Depth to Water table from wells and boreholes where possible

Sample Number, Name of Location and Type	Locations	Time	Temp. (^{0}F)	pH	TDS	Elev. (m)	Depth
01. Umuagbagwo (BH)	10^0 45' 01.3''N 08^0 43 49.2E	11:10 am	79.7	6.52	010	880	12.53
02. Umuagbagwo (SW)	10^0 43' 59.0''N 08^0 44' 41.1''E	12:49pm	84.6	7.28	007	875	
03. Okpuala (SW)	10^0 47' 43.2''N 08^0 46'504''E	3:00pm	84.5	7.28	020	616	
04. Okpuala (BH)	11^0 07'36.7''N 08^0 34'33.8''E	8:52am	82.8	6.68	025	589.7	7 casing
05. Umuokoko (SW)	11^0 17'47.4''N 08^0 35'58.8E	9.45pm	75.15	7.02	020	517.6	
06. Umuokoko (BH)	11^0 15'45.4''N 08^0 33'54.2''E	10:42am	83.0	6.63	019	554.5	
07. Umuokosoronye (BH)	11^0 37 27.8''N 08^0 21'58.7''E	1:00pm	83.9	6.54	011	468.1	
08. Umuokosoronye (SW)	11^0 37'27.7''N 08^0 21'39.4''E	1:25am	74.3	7.38	007	459.8	
09. Umudiawa (SW)	11^0 50'51.0''N 08^0 29' 39.2''E	'2:20pm	82.0	7.42	008	428.4	
010. Umudiawa (BH)	11^0 50'46.1''N 08^0 29 '39.6''E	2:35am	81.7	6.79	008	434.2	
011. Umukabia (BH)	12^0 08' 02.8''N 09^0 09'51.2''E	8:32pm	78.9	6.93	012	380.3	
012. Umukabia(SW)	12^0 21'40.4''N 09^0 55'16.8''E	9:52am	85.2	6.78	017	357.8	
013. Umuihe(BH)	12^0 21' 55.0''N 09^0 55' 12/1''E	10:05pm	75.2	7.44	010	346.9	
014. Umuihe(SW)	12^0 30' 40.4''N 10^0 09'45.8''E	11:20am	86.5	7.67	013	343.2	
015. Ngbagoro(BH)	12^0 30' 42.2''N 10^0 09'41.6''E	11:32amm	84.8	6.78	012		
016. Ngbagoro (SW)	12^0 07' 35.4''N 08^0 10'07.5''E	8:10pm	69.2	7.77	008	380.3	
017. Ekeoba (BH)	12^0 26'30.9''N 10^0 01' 59.2''E	12:25pm	86.0	6.78	013		
018. Ekeoba (SW)	11^0 47 '56.6''N 08^0 49'59.3''E	7:59am	71.3	8.70	010	403	
019. Umuagwu (BH)	11^0 47' 56.8''N 08^0 49' 58.9''E	7:15pm	80.3	8.50	012		
020. Umuagwu (SW)	11^0 50'51.4''N 08^0 30' 34.7''E	9:00am	70.8	7.44	072	427.4	

Table2: Summary and comparison of studied parameters in the studied water samples on heavy metals with WHO (2011)

Parameter	Unit (ppb)	EPA (2004)	NIS (2007)	WHO (2011)	The Studied Area work (Range) ppb	Mean from the worked Area (ppb)	Remark
Co	ug/L				0.11 - 21.24	2.26	
Ni	ug/L	0.07	-	0.02	0.26 - 37.01	7.37	Above limit
Cu	ug/L				0.17 - 640.93	37.62	
Zn	ug/L	0.1	5	3	15 - 408	115.03	Above
As	ug/L			0.05	0.09 - 2.31	0.62	Slightly high
Cd	ug/L			0.005	0.04 - 1.64	0.21	Slightly high
Pb	ug/L	0.01	15	10	0.16 - 834.38	29.82	Above limit
Cr	ug/L				0.16 - 5557.35	419.58	

EPA (2004) and NIS (2007) Guidelines for drinking water

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