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WATER POLLUTION SCENARIO AT RIVER URAMURUKWA FLOWING THROUGH OWERRI METROPOLIS, IMO STATE, NIGERIA

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ABSTRACT: *Pollution scenario of water from River Uramurukwa was investigated. In both rainy and dry season, 5 water samples each taken from different points were analysed to determine physico-chemical parameters and heavy metals (using Atomic Absorption Spectrophotometer). The investigated physico-chemical parameters for both dry and rainy season respectively ranges from: temperature (32-32.4^oC, 29-29.8^oC), electrical conductivity (15.67-2.00 µS/cm, 7.31-61 µS/cm), pH(5.2-5.7, 5.9-6.7), total dissolved solids (2.67-3.98 mg/L, 3.29-5.33 mg/L) and TSS (4.43-6.64 mg/L,4.88-5.84 mg/L). The analysed major ions were: sodium (Na^+)(1.30-1.67 mg/L, 1.76-2.38 mg/L), potassium (K^+)(0.819-0.898 mg/L, 0.08-1.89 mg/L), magnesium (Mg^{2+})(1.13-2.78 mg/L, 1.23-2.86 mg/L), calcium (Ca^{2+})(22.92-24.6 mg/L, 13.9-43.9 mg/L), nitrate (NO_3^-)(0.91-0.96 mg/L, 0.56-0.97 mg/L), phosphate (PO_4^{3-})(0.34-1.65 mg/L, 1.07-2.17 mg/L) and sulphate (SO_4^{2-})(23.4-24.8 mg/L, 21.02-29.18 mg/L). The investigated heavy metals were: lead (Pb), zinc (Zn)(1.2-2.63 mg/L, 1.60-3.33 mg/L), copper (Cu)(0.13-0.79 mg/L,0.001-0.61 mg/L), iron (Fe)(0.091-0.19 mg/L,0.017-1.97 mg/L), cadmium (Cd)(0.002-0.180 mg/L, 0.002-0.025 mg/L), manganese (Mn)(0.08-1.02 mg/L, 0.008-0.091 mg/L). Temperature, Ec, DO,TDS and TSS were found to compile with WHO guidelines for domestic drinking water except for pH. Cu, Mn, Fe, in the water samples were all within the recommended guidelines of FEPA and WHO for domestic water use. High concentrations of Cd, Mn and Fe were observed at point 2 while all points for Zn and Pb exhibited high concentration. Water quality Index showed the area is unpolluted and safe for use. No ecological risk was observed except for Cd and Pb. PLI was all within recommended limit except for point 2 during the dry season. It should be observed that the River is polluted with Cd and Pb, this are highly toxic metals which can cause serious health damages even at low concentration.*

KEYWORDS: Contamination, Heavy metal, Pollution, River

INTRODUCTION

Surface water bodies are the most important source of water for human activities and are been threatened as a result of development activities. The importance of water to animal and plant cannot be over emphasized. It is needed for both drinking and growth of agricultural produce which sustains life on the earth [Yogendra et al, 2008]. Unplanned urbanization and population growth are among some of the anthropogenic activities responsible for pollution of water bodies. The easy accessibility of the river for waste disposal and industrial wastes has made them very susceptible to pollution, especially by anthropogenic activities [Samarghandi et al, 2007].

Amongst all water pollutant, heavy metal is one of major concern. They are group of contaminant long detected as a threat to human and aquatic lives even at trace concentration. They are known for their toxicity, persistent and bio-accumulating nature in living tissues [Song et al, 2006, Vergas et al, 2001, Ahmed et al, 2010, Duruibe et al, 2007].

Several studies on pollution and quality assessment of rivers and lakes from different nations have been carried out but none specifically involving water at segment of Uramurukwa river. The pollution statuses of ground water supply in some part of Imo river basin were studied. Result revealed that the level of pollution in Owerri is relatively high [Boniface et al, 2013]. The quality of surface water from Owerri municipal with samples collected from Otamiri and Nworie river was investigated by[Okoro et al, 2016], result when compared to the WHO guidelines for drinking water revealed that the two surface water analyzed were unsafe for drinking and requires appropriate treatment before human consumption. Heavy metal and bioload levels of Otamiri river was investigated [Duru et al, 2012]. Result revealed that the heavy metal concentration were low except for Fe at upstream 1. Microbial level of the river was alarming and therefore requires further purification before usage.

The present study therefore aims at investigating the pollution status of water at segment of Uramurukwa river flowing through Owerri Metropolis using various quality assessment models like WQI, Cf, PQI and Er for better data interpretation and to properly deduces the pollution status of the river so as to know if any steps are to be taken during consumption and use of the water from the river.

MATERIALS AND METHODES

Study Area

This study was carried out in Owerri, Imo State from January to August, 2016. Owerri is in the tropical rainforest zone and has two distinct season; the wet and the dry seasons. The wet season starts from April through October with peak occurrence between June and September while dry season commences in November through March annually. It has annual rainfall of 2,250mm — 2,500mm with the relative humidity of about 70-80% and mean temperature of 27°C.

The inhabitants are predominantly Igbos and they are Christians with very few traditionalist and other religion. Their major occupation is farming with few traders and artisans. The farming activities have important bearing on the ecology of the area. Owerri North has a projected population of 176,334 (Census, 2006). As a result of the recent growth in population, the existing social amenities including water supply sources, sewage are being dumped near the river.

Sample collection

Ten water samples were randomly collected from different points in Uramurukwa River. Sampling was carried out for both rainy and dry season and indicated as URW and UDW respectively. 500mL polyethylene sample containers were used to collect water samples from the River. In the field, the containers were rinsed three times with water at the sampling point before collection. pH, TDS, TSS and conductivity of the river water were determined on site. The samples were later stored at 4 ^{o}C in a refrigerator awaiting further analysis. Samples for

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total metal concentrations were acidified with concentrated nitric acid and determined for heavy metal concentration using Varian AA240 Atomic Absorption Spectrophotometer.

Determination of physicochemical parameters of water

Some parameters such as water quality tests which include dissolved oxygen (DO), alkalinity, conductivity, pH and temperature (^{O}C), of these water bodies were measured on site. Water temperature were examined by thermometer (modal LCD portable digital multistem of (-50^{o}C to 150^{o}C). Electric conductivity was measured by Systronic' direct reading conductivity meter (308). Depth of visibility was analyzed by Secchi disc, pH through digital pH meter (HANNA pH ep), and total dissolved solid (TDS) was measured by digital (Hold) TDS meter. DO was measured according to [Ellis et al, 1948]. Sodium, Potassium, Calcium, Magnesium, Sulphate, Nitrate, total alkalinity and phosphate was done by APHA method [APHA, 1989].

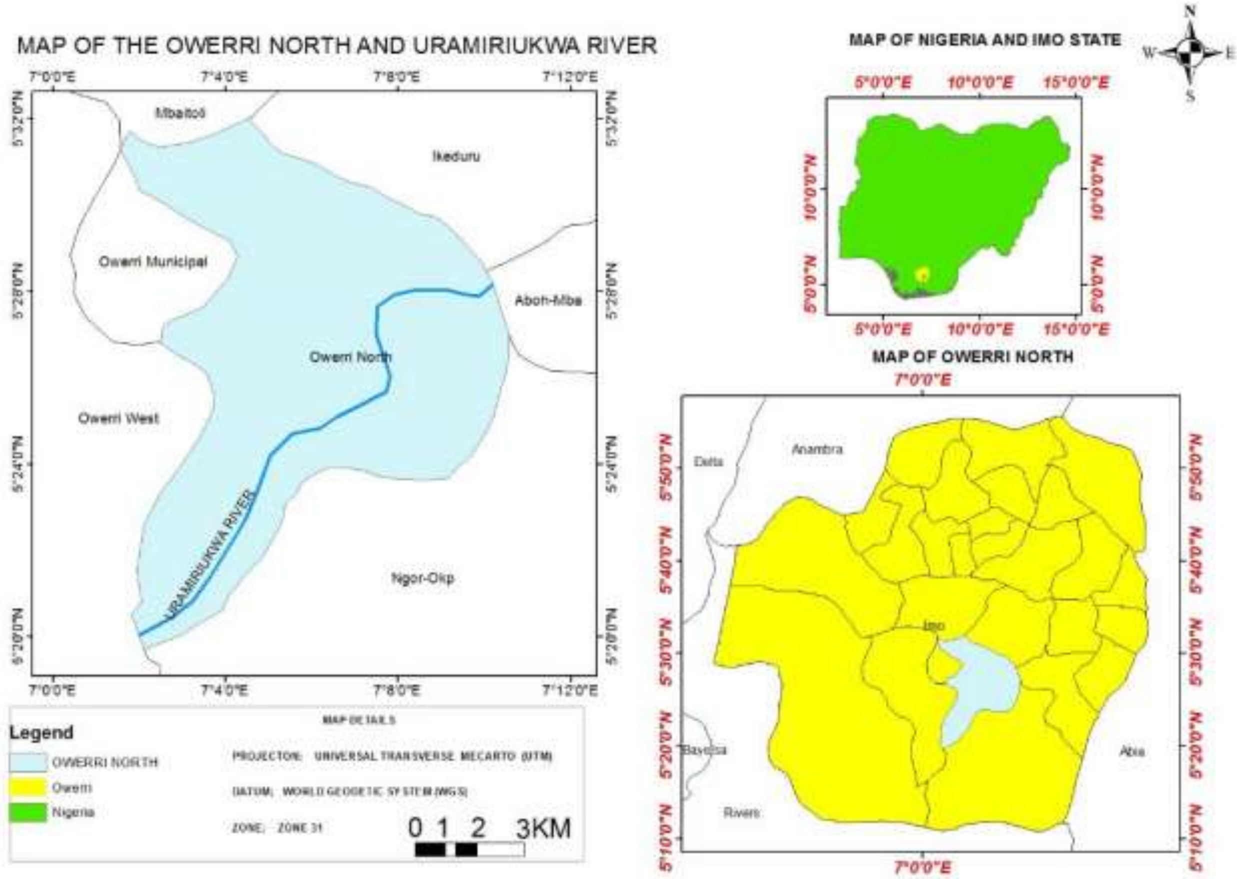

Figure 1: Map of Owerri, showing the study area, the rivers and in the study North

Determination of Heavy Metals:

The concentrations of Mn Pb, Cd, Fe, Zn and Cu in the respective water samples were determined using Varian AA240 Atomic Absorption Spectrophotometer according APHA method.[Apakama et al, 2017].

Data Analysis

The data were calculated for their mean and standard deviation. Pollution assessment models such as contamination factor, pollution load index and ecological risk factor where used to assess the level of contamination of the river. WQI was used to assess the quality of the water for drinking purposes.

Chemometric analysis

Contamination assessment factor: The contamination factor was used to determine the level of individual metal contamination in the water samples. Contamination factor was calculated with the formula below.

$$Cf = \frac{Cmetal}{Cbackground} \qquad 1$$

Where C_f represent contamination factor, C_{metal} represent the concentration of heavy metal and $C_{background}$ represent the background value of metal. (WHO, 2004) guidelines for safe drinking water was taken as the background values for water sample.

Pollution Load Index (PLI): The proposed pollution load index by Tomlinson *et al.* [Tomlinson et al, 1980] for detecting pollution levels in soil was applied to the water samples to detect the level of pollution of heavy metal in the various points. The PLI according to Angula et al, 1996, is able to estimate the metal concentration status and give an idea of the various actions that can be taken to curb the issue. Researchers have, estimated the pollution load index using equation 2.

$$PLI = n\sqrt{C_{f1}\ x\ C_{f2}\ x\ C_{f3}\ x \ldots\ldots C_{fn}} \qquad 2$$

A PLI value of ≥100 indicates an immediate intervention to ameliorate pollution; a PLI value of ≥50 indicates a more detailed study is needed to monitor the site, whilst a value of <50 indicates that drastic rectification measures are not needed.

Ecological risk factor

Ecological risk factor according to [Hakanson, 1980] was applied and was calculated according to equation 3

$$E = T_r\ x\ Pi \qquad \text{and} \qquad Pi = {Cm}/{Co} \qquad 3$$

Where Pi is the single metal pollution index, Cm is the concentration of metal in the sample, Co is the reference value of metal. The reference value of metal is taken from the WHO, 2004 standard for safe drinking water. The toxic response factors for Pb, Cd, Cr, Cu, Zn and Ni and Mn were 5, 30, 2, 5, 1, 5 and 1, respectively [Hakanson, 1980, Xu et al, 2008]

Water Quality Index (WQI): Nine parameters were used in calculating the water quality index. WQI is a numerical expression used to transform large number of variable data into a single number, which represent the water quality level[Bordalo et al, 2006].The WQI is derived from the following formula according to [Naruka et al, 2017]

$$W_i = \frac{K}{S_i} \qquad 4$$

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Where: W_i - Unit weight of chemical factor, K - Constant of proportionality, S_i - standard value of ith parameter (i= 1, 2, 3, 4…………10)

The water quality rating 'qi' expresses the relative value of the parameter in the polluted water with respect to its standard or permissible value. Water quality rating may be derived according to[Naruka et al, 2017].

$$qi = 100\left[\frac{V_i - V_{IO}}{S_i - V_{io}}\right] \qquad 5$$

Where: V : average of measured values season wise, Si : standard value ith of parameter, Vio - ideal value for pure water and it's 0 for all parameters except pH and DO. The above equation becomes:

$$qi = 100(\frac{Vi}{Si}) \qquad 6$$

The following exceptions occurs for dissolved oxygen (D.O) and pH were the Ideal value is given as 14.6 mg/l; and 7.0.mg/l respectively. WQI was calculated according to [Naruka et al, 2017]. The overall WQI is calculated as:

$$\text{WQI} = \sum_{i=1}^{N} q_i W_i \,/\, \sum_{I=1}^{N} Wi \qquad 7$$

The standard values were obtained from World Health Organization (WHO) standard for safe drinking water, 2003. The following indicates the classification of Water Quality Index (WQI) and the quality of water WQI of 0-25: Excellent water quality, 26-50: Good water quality; 51-75: Poor/ moderately polluted water quality; 76-100: Very poor water quality; 101 and above: Unsuitable for drinking purpose[Chatterjee et al, 2002].

RESULT

Physicochemical parameters

Table 1. Physicochemical parameters of water from Uramurukwa in the dry and rainy season

Water Properties	UDW 1	UDW 2	UDW 3	UDW4	UDW5	URW 1	URW 2	URW 3	URW4	URW5	MEAN±SDV	WHO 2003/ 2004
Temp (^{O}C)	31	32	32	32.4	32	29	29.5	28.2	29	29.8	30.49±1.55	20 – 30
Ph	5.7	5.5	5.7	5.5	5.2	6.2	6.7	6.2	5.88	6.6	5.92±0.49	6.5- 8.5
EC (µS/cm)	15.67	27	25	22	27	61	36	36	31	37	31.77±12.3	100
DO (mg/kg)	2.78	2.98	2.85	3.89	2.27	6.86	6.48	5.52	4.12	6.97	4.47±1.82	>5
TDS (mg/L)	3.94	3.84	3.78	2.67	3.98	4.34	4.77	3.29	5.33	4.32	4.03±0.73	250
TSS (mg/L)	4.74	6.64	4.74	4.43	4.44	5.74	5.23	4.98	5.84	4.88	5.17±0.70	50
Na^+ (mg/L)	1.33	1.673	1.37	1.30	1.37	2.33	2.38	1.87	1.76	1.83	1.72±0.39	200
K^+(mg/L)	0.89	0.791	0.898	0.189	0.819	1.89	0.18	1.29	0.192	0.08	0.72±0.58	-

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Mg^{++}(mg/L)	2.23	2.78	2.27	2.22	1.13	2.43	3.21	1.23	2.20	2.86	2.26±0.65	-
Ca^{++} (mg/L)	23.2	24.6	23.8	23.5	22.92	13.9	43.9	27.2	38.8	23.90	26.57±8.58	-
Cu (mg/L)	0.13	0.79	0.53	0.15	0.13	0.61	0.21	0.001	0.001	0.013	0.26±0.28	2
Cd (mg/L))	0.002	0.180	0.072	0.006	0.012	0.025	0.022	0.002	0.002	0.012	0.03±0.05	0.003
Mn (mg/L)	0.08	1.02	0.78	0.085	0.089	0.017	0.078	0.091	0.008	0.008	0.23±0.36	0.4
Zn (mg/L)	2.6	1.2	2.21	2.61	2.63	3.33	2.69	3.62	1.60	2.68	2.51±0.71	1.0
Fe (mg/L)	0.097	0.19	0.191	0.097	0.091	1.097	1.097	0.017	1.97	0.974	0.58±0.66	0.3
Pb (mg/L)	0.127	0.178	0.521	0.123	0.127	2.31	2.06	0.117	1.07	0.147	0.67±0.85	0.01
Nitrate(mg/L)	0.96	0.91	0.92	0.91	0.916	0.96	0.95	0.56	0.79	0.97	0.88±0.12	50
Sulphate(mg/L)	24.8	23.4	24.8	23.98	24.8	24.8	28.25	22.21	21.02	29.18	24.72±2.46	100
Phoshate(mg/L)	0.34	1.65	1.36	1.34	1.37	1.3	2.17	1.87	1.071	1.21	1.37±0.48	5

Table 2: WQI for Uramurukwa river at different sampling points during the dry season

Sampling points	Values of WQI		Category of WQI
	Dry season	Rainy season	
1	32.28	31.51	Good
2	55.23	44.54	Good
3	39.00	39.10	Good
4	49.98	34.69	Good
5	34.31	35.42	Good

The temperature of water depends on its intended use. Temperature of drinking water, according to WHO standard ranges between 20-30ºC [WHO, 2004]. Temperature level observed for both season where found to be within the WHO standard. Though the dry season exhibited a slight increase in temperature, this might be due to the present weather condition of the environment at the point of study.

The pH value in the present study season wise varied from 5.2-5.7 during the dry season and 5.88-6.7 during the rainy season. Both season exhibited a slightly alkaline pH which wasn't in agreement to the standard pH(6.0-8.5) according to WHO guidelines for safe drinking water. The low pH observed during the dry season might be due to the death and decay of some aquatic life forms which releases proteins in form of ammonia. The formed ammonia dissolves in water, drastically affecting the pH and manifesting as low pH (Akubugwo et al, 2011, Akaninwor et al, 2006). Low pH value has a tendency to increase the toxicity of most metals. Similar study was observed by [Duru et al, 2012] for Nworie River.

The electrical conductivity is a measure of total dissolve salts. The Ec can greatly affect the taste of water and the acceptance of the water as portable [WHO, 2004, Pradeep, 1998]. The EC for both seasons in the present study ranges from 15.67 µS/cm to 61 µS/cm. These values were found to be within the WHO standard for safe drinking water.

Dissolve oxygen, is the oxygen present in dissolve form in water bodies [DWAF, 1993]. Its reduction is greatly affected by runoff from agricultural soils containing phosphate and nitrogen compounds or the death and decay of aquatic life forms leading to the release of

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nitrogen compound into water body therefore causing decrease in dissolve oxygen. According to WHO standard, the dissolve oxygen for all points during the dry season were found to be low while dissolve oxygen during the rainy season were found to be slightly above standard. This low DO observed during the dry season can be seen to have a relationship with low pH value. This is an indication that both parameters have and are affected by similar anthropogenic activities. Similar findings were observed by [Duru et al, 2012] for Nworie river with dissolve oxygen been lower than WHO standard.

TDS and TSS is an indication of materials carried in suspension and solid respectively [Njoku et al, 2016]. In the present study, TDS and TSS for both season ranges from 2.67 – 5.33 and 4.43 – 6.64 respectively. These values were found to be lower than the WHO standard for safe drinking water. This is an indication of reduce pollution from runoff of soils around the area.

One of the most stable forms of nitrogen is nitrate. It is the final product during the biochemical oxidation of ammonia and it plays a very significant role in the process of eutrophication [Sharma et al, 2012]. High concentration of nitrate is toxic to water body [Sharma et al, 2009]. Nitrate in the present study for both seasons were all below standard when compared to the WHO standard for safe drinking water.

Sulphate values observed in the present study seasonwise were all below WHO standard for drinking water and domestic water use. Similar findings were observed [Duru et al, 2012] in sulphate values obtained from study carried out on Nworie river. The presence of sulfate in drinking-water can cause noticeable taste, and very high levels might cause a laxative effect in unaccustomed consumers [WHO, 2004].

One of the key nutrients responsible for the fertility of fish ponds is phosphorous [Naruka et al, 2017]. Phosphate at moderate amount is suitable for the growth of plankton [Sharma et al, 2009]. Though maximum phosphate was observed at point 2 during the rainy season, all point showed phosphate levels below WHO standard in the present study. Similar findings were observed in study carried out by [Naruka et al, 2017].

Copper is it an essential nutrient but also a drinking-water contaminant. Copper concentrations in drinking-water vary widely, with the primary source being the corrosion of interior copper plumbing [WHO, 2004]. Cu concentration for both season in the present study were all below WHO standard for drinking water and domestic uses. Flowing river tends to exhibit low level of copper [WHO, 2004]. This might be the cause of the low level of copper observed during the present study. Similar findings were observed in a study carried out by Joshua et al, (2016) on Mvudi River,South Africa.

Cd ranges from 0.002-0.180 and 0.002-0.025 mg/l during the dry and rainy season respectively. Point 1 during the dry season and point 3 and 4 during the rainy season exhibited values below WHO standard. But all other points, showed values higher than stated standard with the maximum value occurring during the dry season (0.180). This might be due to the deposition of used batteries in water bodies. Cd, been a non-essential element is highly toxic to marine and fresh water aquatic life [Joshua et al, 2016].

Mn ranges from 0.08-1.02 and 0.008-0.091 during the dry and rainy season respectively. According to WHO standard value for Mn, All points season wise showed low level of Mn except for point 2 which had the maximum level of Mn. Both Cd and Mn exhibited maximum values at point 2, which might indicate deposition of used batteries into water body as Cd and

Mn are found in batteries. At high concentration, Mn can constitute a nuisance with a characteristic metallic taste and staining properties [Ljung et al, 2007]. Neurotoxicity has been implicated for adults over 50 years who drink Mn-rich water [Kondakis et al, 1989].

The minimum and maximum levels of Zn observed during dry and rainy season in the present study were 2.63 and 3.62mg/l respectively. At a taste threshold concentration of about 4mg/L, Zinc imparts an undesirable astringent taste to water [Casimir et al, 2015]. According to FEPA standard, all points showed high values of Zn concentration.

The maximum and minimum values of Fe observed during the dry and rainy season were 0.19, 1.097 mg/l respectively. Values obtained for Fe were all within standard as stated by WHO except for point 1 and 2 which showed values exceeding standard. Iron is one of the most abundant metals in the Earth's crust. It is found in natural fresh waters at levels ranging from 0.5 to 50 mg/litre. Iron may also be present in drinking-water as a result of the use of iron coagulants or the corrosion of steel and cast iron pipes during water distribution [WHO, 2004]. This high level of Fe observed during the rainy season might be due to the fact that most mineral deposit on the soil may have high level of iron, therefore runoff from deposit may contaminate the water.

Pb values obtained for both seasons were all above WHO standard for safe drinking water. Contamination of lead in river may be as a result of the dissolution of lead from the soil and earth crust. Pb is both a toxic and non-essential metal having no nutritional value to living organisms. No amount of Pb is considered safe in drinking water. Similar study was observed in a research carried out by Joshua et al, (2016) on Mvudi River,South Africa.

Contamination Factor

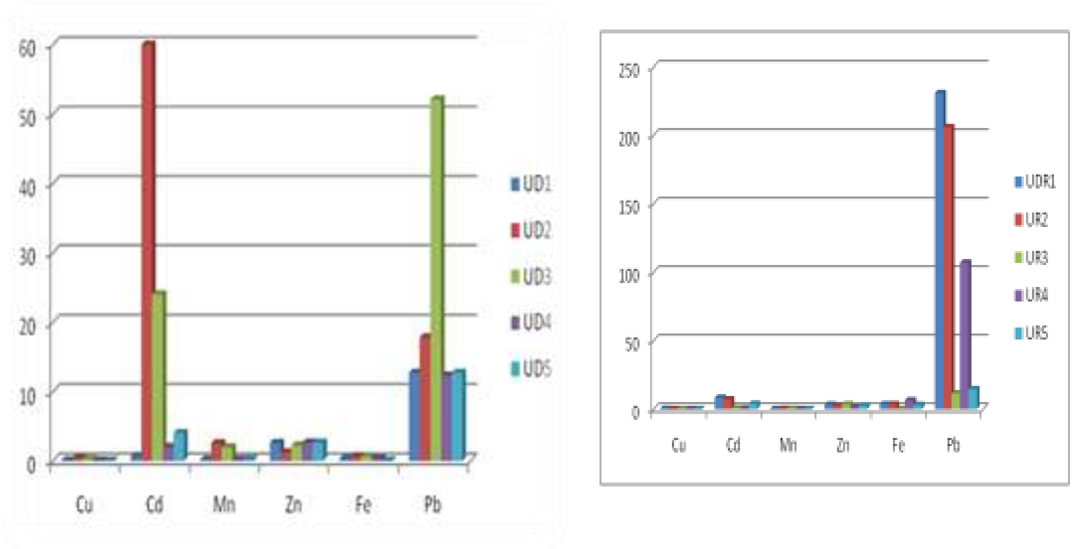

Fig 1: Contamination factor of heavy metals at different point during the dry and rainy season

The contamination factors were categorized according to Mathias et al, (2016). Values < 1 are low contamination, 1≤CF<3 are moderately contaminated, 3≤ CF ≤ 6 are considerably contaminated and ≥ 6 very highly contaminated. Contamination factor of both dry and rainy

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season for all metals were evaluated. Low contamination factor was exhibited by both Cu and Fe during the dry season whereas Cu and Mn exhibited low contamination factor during the rainy season. Cd at point one showed low contamination factor during the dry season, point UD2 and UD3 were very highly contaminated and point 4 and 5 were moderately and considerably contaminated respectively. During the rainy season, Cd at point 1 and 2 were very highly contaminated, point 3 and 4 had low contamination and point 5 was considerably contaminated. Low contamination was exhibited by Mn at point 1,4 and 5 while point 2 and 3 were moderately contaminated during the dry season. All points for Mn during the rainy season showed low contamination. Zn for all point during the dry season exhibited a moderately contamination factor whereas during the rainy season, moderate contamination was shown at point 2,4 and 5 while point 1 and 3 were considerably contaminated. All point for both season for Pb were very highly contaminated. In fig 1, Cd and Pb were conspicuous during the dry season while in fig 2, Pb was conspicuous during the rainy season. Leaching of soils close to busy highways into water bodies is one probable source of lead pollution in the lake or river (USEPA, 2003).

Pollution Load Index (PLI)

All point during the dry season exhibited low pollution load index (<50), except for point 2 and 3 showing PLI>100. This is an indication that immediate intervention to ameliorate pollution is needed. While during the rainy season, the PLI values were all within accepted limit.

Ecological risk factor

The ecological risk factor is describe using the following terminologies $Er_i<40$, low potential ecological risk, $40\leq Er_i<80$, moderate potential ecological risk, $80\leq Er_i\times 160$, considerable potential ecological risk, $160\leq Er_i<320$, high potential ecological risk, $Er_i\geq 320$, very high ecological risk. All metal with exception to Cd and Pb pose no ecological risk to the environment for both seasons.

Table 4: Computed ecological risk factor of Uramurukwa river for both seasons

	Dry Season					Rainy Season				
Points	Cu	Cd	Mn	Zn	Pb	Cu	Cd	Mn	Zn	Pb
1	0.325	20.01	0.2	2.6	63.5	1.525	249.99	0.043	3.33	1155
2	1.975	1800	2.53	1.2	89	0.525	219.99	0.195	2.69	1030
3	1.325	720	1.95	2.21	260.5	0.0025	20.01	0.228	3.62	58.5
4	0.375	60	0.213	2.61	61.5	0.0025	20.01	0.02	1.60	535
5	0.325	120	0.223	2.63	63.5	0.0325	120	0.02	2.68	73.5
$\sum Er_i$	4.325	2720.01	5.116	11.25	538	2.088	630	0.506	13.920	2852

Water Quality Index

The WQI is a single mathematical equation that incorporates data from various water quality parameters thereby expressing the health of a waterbody with numbers [Yogendra et al, 2008]. The estimated WQI in the present study were found to be categorize under good water quality. Similar findings were observed by [Abdul et al, 2010], were the WQI of Dokan Lake were found to be within good water quality to poor water quality from 2000 to 2009 with values 53.18 to 101.26 respectively. Due to the foregoing observation of the physiochemical parameter, it can be said that the water exhibit low level of eutrophication, owing to the high level of DO and low level of nitrate and phosphate. It could also be concluded that the water is good for domestic use due to the low level of sulphate. The general physiochemical parameter of the water is therefore in line with the low value of WQI observed and the characterization of the water as good.

CONCLUSION

The investigated water sample form Uramurukwa river using various quality assessment models showed that the water is majorly polluted with Cd and Pb. Water quality parameters of water from Uramurukwa river according to the stated category used for classification were found to be of 'good quality'. Results obtained for ecological risk factor showed that all points had low ecological risk in terms of all metals except for Cd and Pb. The present study therefore aurge that necessary steps should be taken to reduce or prevent the contamination of the water from Pb and Cd. If not taken, water from Uramurukwa river is unsuitable for dinking.

RECOMMENDATION

Despite the good quality of the water base on WQI which is in accordance to the physiochemical parameters observed, the water was found to be contaminated with heavy metals with the most conspicuous been Pd and Cd. It is for this reason I recommend further research on the heavy metal content of Uramurukwa river so as to avoid serious health risk involve during consumption.

REFERENCES

Abdul Hameed M. Jawad Alobaidy, Haider S. Abid, Bahram K. Maulood, (2010), Application of Water Quality Index for Assessment of Dokan Lake Ecosystem, Kurdistan Region, Iraq, *Journal of Water Resource and Protection*, 2, 792-798

Ahmad, J.U.; Goni, M.A. (2010), Heavy metal contamination in water, soil, and vegetables of the industrial areas in Dhaka, Bangladesh. Environ. *Monit. Assess*, 166, 347–357.

Akaninwor, J.O., and Egwim, O, (2006), *JNES* ,3 (3): 174-182

Akubugwo, E.I. and Duru, M. K. C, (2011), *Global Research Journal of Science* ,1: 48-53.

Angula, E. (1996), The Tomlinson Pollution Index applied to heavy metal, Mussel–Watch data: A useful index to assess coastal pollution. *Sci. Total Environ*, 187, 19–56.

Apakama N. Chukwuemeka , Verla E. Ngozi , Ihenetu S. Chukwuemeka, Verla A. Wirnkor,(2017), Physicochemical properties and selected metals in soils of Ohaji-Egbema, Imo State, Nigeria, *WNOFNS* 10, 39-48

APHA (1989). Standard methods for the examination of water and waste water. *American Public Health Association, Washington*, D.C. (17th Ed.), 1452.

B. C. Okoro, R. A. Uzoukwu and C. K. Ademe, (2016), Investigation of surface water quality in Owerri municipal, Imo State, Nigeria for human consumption, arpn *Journal of Engineering and Applied Sciences*, vol 11, no 13.

Print ISSN: 2056-7537(print), Online ISSN: 2056-7545(online)

Bordalo A.A., Teixerra R. and Wiebe W.J. (2006). A water quality index applied to an international shared river basin: the case of Douro River. *Environ. Manage*, 38(6), 910-920.

Casimir E. Gimba, George I. Ndukwe, Elaoyi D. Paul, James D. Habila, Lamis A. Madaki, (**2015),** Heavy Metals (Cd, Cu, Fe, Mn and Zn,) Assessment of Groundwater, In Kaltungo LGA, Gombe State, Nigeria, *International Journal of Science and Technology* Volume 4 No. 2,

Chatterjee C. and Raziuddin M. (2002). Determination of Water Quality Index (WQI) of a degraded river in Asansol industrial area(West Bengal). *Nature, Environ. and Poll. Tech.*, 1(2), 181-189

Department of Water Affairs and Forestry, Water Quality Gudeline, volume 4, The Government printers Press.1993.

Duru, Majesty, K.C., Nwanekwu, Kenneth, E., Adindu, Eze, A., and Odika, Prince,C.,(2012), Heavy metal and bioload levels of Otamiri river, Owerri, Imo State, Nigeria, Archives of *Applied Science Research*, 4 (2):1002-1006

Duru, Majestyand Nwanekwu, Kenneth,(2012) Physicochemical and microbialstatus of Nworie River, Owerri, Imo State, Nigeria, *Asian Journal of Plant Science and Research*, , 2 (4):433-436

Duruibe, J.O.; Ogwuegbu, M.O.C.; Egwurugwu, J.N. (2007), Heavy metal pollution and human biotoxic effects. *Int. J. Phys. Sci*, 2, 112–118.

Ellis M.M., Westfall B.A. and Ellis M.O. (1948). Determination of water quality Fish and flora of surface and ground water. *J. plant Sci.*, 6, 453-438.

Hakanson, (1980), an ecological risk index for aquatic pollution control, a sedimentological approach, water res 14: 975-1001.

Ijeh Boniface Ikechukwu1 and Onu Nathaniel Nze, (2013) , Assessment of pollution levels of groundwater in parts of Imo River Basin, South Eastern Nigeria, *International Journal of Water Resources and Environmental Engineering*, Vol. 5(4), pp. 194-202

J. K. Pradeep, (1998) "Hydrogeology and Quality of Ground Water around Hirapur, District Sagar (M.P.)," *Pollution Research*, Vol. 17, No. 1,, pp. 91-94.

Joshua N. Edokpayi , John O. Odiyo 1, Oluwaseun E. Popoola and Titus A. M. Msagati ,(2016), Assessment of Trace Metals Contamination of Surface Water and Sediment: A Case Study of Mvudi River,South Africa, *Sustainability*, 8, 135.

K.Yogendra and E.T Puttaiah, (2008), determination of water quality index and suitablility of an urban waterbody in shimoga town, Karnataka, the 12th world lake conference pp 342-346

Kondakis, X.G.; Makris, N.; Leotsinidis, M.; Prinou, M.; Papapetropoulos, T. (1989), Possible health effects of high manganese concentration in drinking water. *Arch. Environ. Health*, 44, 75–178

Ljung, K.; Vahter, M. (2007), Time to Re-evaluate the Guideline Value for Manganese in Drinking Water? *Environ. Health Perspect*, 115, 1533–1538.

Mathias O. Nweke and Stephen N. Ukpai (2016). Use of Enrichment, Ecological Risk and Contamination Factors with Geoaccumulation Indexes to Evaluate Heavy Metal Contents in the Soils around Ameka Mining Area, South of Abakaliki, Nigeria. *Journal of Geography, Environment and Earth Science International* 5(4): 1-13

Naruka Sheetal and Sharma Madhu Sudan, ((2017),Water quality assessment of Rajsamand Lake, Rajasthan, India, *International Research Journal of environmental science* Vol. 6(6), 22-28.

Njoku Tony, R.F1, Ebe, T.E, Ihejirika, C.E, Ejiogu, C.C and Uyo, C.N,(2016) "Assessment of Physicochemical and Microbial Load of Nworie River Owerri, Imo State, South-Eastern Nigeria.", *Journal of Mobile Computing & Application, PP 29-37*

Samarghandi, M.; Nouri, J.; Mesdaghinia, A.R.; Mahvi, A.H.; Nasseri, S.; Vaezi, F. (2007), Efficiency Removal of Phenol, Lead and Cadmium by Means of UV/TiO2/H2O2 Processes. *Int. J. Environ. Sci. Technol*, 4, 19–26.

Sharma V., Sharma R., Malera H. and Sharma M.S. (2009). Zooplanktonic diversity and trophic status of Mahi dam is relation of physico-chemical characteristic of its water. *Poll. Res.*, 28(4), 571-576.

Sharma V., Verma B.K. and Sharma M.S. (2012). Zooplanktonic and fish fauna of lake Pichhola in relation to its trophic status. *J. Environ. Sci. Comp. Sci. and Eng. And Tech.*, 1(3), 301-310.

Song, M.; Chu, S.; Letcher, R.J.; Seth, R. (2006) Fate, partitioning, and mass loading of polybrominated diphenyl ethers (PBDEs) during the treatment processing of municipal sewage. *Environ. Sci. Technol*, 40, 6241–6246.

Tomlinson, D.L.; Wilson, J.G.; Harris, C.R.; Jeffrey, D.W. (1980), Problems in the assessment of heavy metal levels in estuaries and the formation of a pollution index. *Helgolaender Meeresunter*, *33*,566–575.

Vergas, V.M.F.; Migliavacca, S.B.; De Melo, A.C.; Horn, R.C.; Guidobono, R.R.; De Sa Ferreira, I.C.F.; Pestana, M.H.D. (2001), Genotoxicity assessment in aquatic environments under the influence of heavy metals and organic contaminants. *Mutat. Res*, 490, 141–158.

World Health Organization (WHO), "Guidelines for Drinking-Water Quality," 3rd Edition, World Health Organization (WHO), Geneva, 2004

Xu ZQ, Ni SJ, Tuo XG. (2008), Calculation of heavy metals toxicity coefficient in the evaluation of potential ecological risk index. *Environ Sci Tech*.;31:112–5.

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