Hydrochemical Assessment and Characterizationof Selected Boreoles Water in Onopa, Azikoro and Agbura Axis of Atissa in Yenagoa Metropolis of Bayelsa State, Nigeria

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ABSTRACT

Groundwater is now the major source of domestic, commercial and industrial source of water for residents of major cities all over the world. Residents in Yenagoa metropolis also depend heavily on boreholes water for their daily needs. The aim of this study was to assess the physicochemical and heavy metals characteristic of selected boreholes water in Onopa, Azikoro and Agbura communities of Attisa Clan in Yenagoa metropolis of Bayelsa State. Parameters analysed include: EC, TDS, TSS, TH, pH, TA, Cl, F, NO_3, SO_4, PO_4, DO, COD, BOD, Ca. Heavy metals include Mg, Fe, Cd, Cr, Cu and Pb. Evaluation of WQI and HPI was also undertaken. Results show that all the physicochemical parameters were within the standard limit of (WHO). WQI evaluation revealed that all the water samples have excellent quality for drinking with respect to physicochemical qualities. However, HPI evaluation revealed that the waters are not safe for drinking with respect to heavy metal pollution significantly influenced by high Cadmium concentration in most of the samples. It is concluded that Cadmium is a heavy metal of concern in the study area and that regular monitoring of drinking water should be undertaken in order to protect public health and wellbeing.

Keyword: *Groundwater, quality, boreholes, parameters and assessment.*

1.0 INTRODUCTION

1.1 Background of the study

Access to potable water continues to be a challenge to many people around the world, even though water is one of the most essential resources for human existence. Available records show that 75% of the earth is consist of water ((Ohimain and Angaye, 2014). However, the problem of shortage of drinking water remains an unanswered question

((Ohimain and Angaye, 2013). Available statistical data indicates that about 1.0 to 1.2 billion people in the world do not have access to drinking water (Nkamare, 2012 and Idoko, 2010). (Idoko, 2010 and Amangabara and Ejenma, 2012) also reported that in Africa, about 300 million persons lack access to drinking water. Nigeria is not left out of the lack of drinking water quagmire, as cities such as Aba, Ibadan, Kano and Port Harcourt etc., continues to experience non availability of pipe born water (Ekong., Jacob and Ebong, 2012).

(Ekong., Jacob and Ebong, 2012; Amadi *et al*., 2012 and Angaye e*t al*., 2015). Identified factors responsible for the exacerbation of shortage of drinking in Nigeria to include; rapid urbanization, increasing population, increasing agricultural and industrial activities. Though provision of accessible and affordable safe drinking to the public is the responsibility of government but this has not happened as expected. Hence many people resort to boreholes for the provision of water for their domestic, agricultural, industrial and commercial needs.

In Yenagoa like in many other cities in Nigeria, boreholes are the major source of drinking and commercial water for residents. Some of the boreholes are drilled in location very close septic tanks, waste dump sites etc. without consideration to public health concern. Waste dump sites and septic tanks are source of underground water contamination. Tariwari *et al*., 2015 reported that in Yenagoa, sometimes suck away of toilet system is located close to ground water sources (i.e submergible pump head). This poses a serious health risk of water born disease.

Furthermore, Bayode., lurunfem and Ojo, (2012) reported that wastes dumped at dumpsites over the years are expected to have biodegenerated and generate leachates which could become point source of pollution into soil and groundwater This paper presents the analytical results of the laboratory analysis of selected boreholes water in Onopa , Azikoro and Agbura communities in Attisa Clan in Yenagoa metropolis of Bayelsa State. Water quality index based on the weighted arithmetic water quality index approach has been used to evaluate the potability of the respective water samples.

2.0 MATERIALS AND METHOD.

2.1 Study area.

The study area is three communities of Onopa, Azikoro and Agbura in Atissa of Yenagoa Local Government Area in Bayelsa State. Atissa Clan (District) is situated in the heart of Yenagoa the capital of Bayelsa state, which was created in 1996 by the military government of late general Sani Abacha. Yenagoa town is situated between Longitude 60 15^{l} East of the Greenwich meridian and Latitude 40 55^{l} North of the Equator. This location put Yenagoa firmly on the Equatorial climatic belt which is characterized by high temperature, humidity and heavy rainfall. The mean monthly temperature of Yenagoa is between 26^{o}C and 28^{o}C. The regular land and sea breeze influence by the Atlantic Ocean provide a moderation of the high daily temperature of the area. The annual rainfalls are heavy in the area, recording between 3,000mm and 3,500mm. The relative humidity in the area is high all through the year, recording between 80% and

85%. This is due to the availability of water everywhere in the area and constant heating due to high temperature.

2.2 Method

2.2.1 Water sample collection and analytical procedure.

Twenty (22) water quality parameters were analysed from each water sample that was collected. The parameters are physical and inorganic chemical water parameters of concern required to be regularly monitored according to the Nigeria Drinking water quality standard. Boreholes water samples were collected from 9 different boreholes located in the three communities of Onopa, Azikoro and Agbura in Atissa Clan in Yenagoa metropolis. All water samples were collected in prewashed high density polypropylene (HDPP) bottles following standard method as contained in World Health Organization (WHO) standard guideline for water quality sampling and analysis

2.2.2 Analytical procedures.

pH measurements was carried out using table top digital pH meter. The pH meter was standardized with standard buffer solution. The Electrical Conductivity (EC) of water sample was determined using digital EC meter. Heavy metals were analysed with Atomic Absorption spectrophotometer. Salinity (SA), Total Hardness (TH), Total Alkalinity (TA), Chloride (Cl) and Fluoride (F), Nitrate (NO_3), and Sulphate (SO_4) were determined by titrimetric method following standard analytical procedures of (WHO).While, Total Dissolved Solid (TDS), Total Suspended Solid (TSS) were determined by gravimetric method. Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) were measured by electrochemical method (WHO).

2.3 Data analysis.

2.3.1 Groundwater quality index (GWQI)

The groundwater quality index (GWQI) which reflects the composite influence of the different water parameters was evaluated using the weighted arithmetic water quality index equation

$[(WQI\ (Qi = 100[Vi\text{-}v0]/[si\text{-}v0])(\ Wi=k/s_i \quad k= 1/\sum 1/s_i)]$.

(1)Where,

This method was adopted because it incorporate the most commonly measured water quality parameters prescribed by water standards.

2.3.2 Heavy metals Pollution Index (HPI)

The heavy metal pollution Index (HPI) was be evaluated using the equation of Mahan et al. (1996)

$$[(HPI=\sum_{ni} = \sum Qi\ WI/\sum Wi)$$

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3.0 RESULT AND DISCUSSIONS

3.2 Results

Results of the laboratory analysis of boreholes water from Onopa, Azikoro and Agbura and a summary of water quality index assessment based on the weighted Arithmetic water quality index are presented in Table 3.1

Table 3.1: Results of boreholes water quality analysis and summary water quality evaluation based on weight Aritmetic water quality index for Onopa**,** Azikoro **and** Agbura**.**

Parameter	Onopa			Azikoro			Agbura			**Drinking Water Standards**	
	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	NSDQW	WHO
EC	401.0	604.0	451	130.0	144.0	140.50	225.0	163.0	179.0	1000	
TDS	200.50	302.00	276.63	65.0	72.0	70.80	112.50	81.50	104.75	500	1000
TSS	0.02	0.03	0.03	0.10	0.12	0.12	0.08	0.06	0.08		
TH	62.00	70.00	68	36.0	31.0	32.30	78.0	47.0	55.0	150	
pH	6.4	7.94	7.04	7.80	6.20	6.6	6.0	7.9	6.5	6.5-8.5	
TA	100.0	95.0	96	60.0	55.0	57.0	82.0	78.0	79		
Cl	55.0	98.0	105	10.0	9.0	9.60	14.0	18.0	17.0	250	250
F	0.96	0.85	0.93	0.75	0.60	0.71	1.40	0.79	1.10	1.5	1.5
NO_3	0.121	0.123	0.123	0.134	0.136	0.136	0.132	0.130	0.21	50	10
SO_4	1.20	1.23	1.22	2.54	2.56	2.49	1.43	1.19	1.31	100	250
PO_4	2.01	1.99	2.0	3.59	3.55	3.65	2.72	2.70	2.54		
DO	3.10	3.58	3,22	3.64	3.39	3.54	3.74	3.98	3.92		
COD	113.15	130.67	126.29	132.86	123.74	130.54	136.51	145.27	138.70		
BOD	66.81	77.24	69.42	78.44	73.06	74.41	80.60	85.77	81.89		
Ca	28.64	50.10	44.74	6.712	6.148	6.60	8.481	10.055	8.87	25	
∑Wi											0.9821
∑QiW	0.1247	0.2827	0.1304	0.1024	0.2982	0.0943	0.1574	0.1076	0.1312		
WQI	**0.1247**	**0.2827**	**0.1304**	**0.1024**	**0.2982**	**0.0943**	**0.1574**	**0.1076**	**0.1312**		

The water quality characterization and rating of the drinking suitability of the water sampled collected from **Onopa, Azikoro** and **Agbura** as per the weighted Arithmetic water quality index method are presented in Table 3.2

Table 3.2: Water Quality Rating as per Weight Arithmetic Water Quality Index Method for water from Onopa, Azikoro and Agbura.

WQI Value	**Grading**	**Rating of water quality**	**Communities**	**Rating of water quality of the various sampling points**		
0 – 25	A	Excellent water quality		Point 1	Point 2	Point 3
26 – 50	B	Good water quality	**Onopa**	Excellent water quality	Excellent water quality	Excellent water quality
51 – 75	C	Poor water quality	**Azikoro**	Excellent water quality	Excellent water quality	Excellent water quality
76 – 100	D	Very poor water quality	**Agbura**	Excellent water quality	Excellent water quality	Excellent water quality
Above 100	E	Unsuitable for drinking				

The results of the computation of the Heavy metal pollution index (HPI) of the boreholes water samples from **Onopa**, **Azikoro** and **Agbura** are presented in Table 3.3.

Table 3.3: Heavy metal pollution index (HPI) of water samples from Onopa , Azikoro and Agbura

	Onopa			**Azikoro**			**Agbura**			$\mathbf{W_i = \frac{k}{Sn}}$
	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	
Mg	14.32	25.05	17.00	3.356	3.074	3.25	4.241	5.028	4.44	
Fe	0.30	0.30	0.32	0.294	0.390	0.366	0.196	0.254	0.22	0.007
Cd	0.029	0.031	0.030	0.046	0.032	0.036	0.019	0.010	0.001	0.7
Cr	0.00	0.001	0.001	0.002	0.001	0.002	0.004	0.001	0.003	0.042
Cu	0.0160	0.126	0.10	0.039	0.029	0.037	0.020	0.030	0.16	0.0021
Pb	0.024	0.014	0.017	0.021	0.011	0.019	0.041	0.036	0.039	0.21
$\sum Wi$										0.9621
$\sum Qi\ WI$	727.78	753.55	721.86	1118.30	770.77	880.93	530.23	309.62	106.03	
$\sum Qi\ WI/\sum Wi$	756.	783.15	750.	1,166.20	801.13	915.65	551.12	321.82	110.21	
HPI	**756.45**	**783.15**	**750.30**	**1,166.20**	**801.13**	**915.65**	**551.12**	**321.82**	**110.21**	

3.2 Discussions.

In this study, physicochemical and heavy metals concentration in selected boreholes water collected from the study area e.i. Onopa, Azikoro and Agbura all in Attisa Clan (District) inYenagoa metropolis were analysed in accordance with international analytical guidelines and standard. Parameters analysed include: EC, TDS, TSS, TH, pH, TA, Cl, F, NO_3, SO_4, PO_4, DO, COD, BOD. Results of the laboratory analysis are presented in Table 3.1. The results indicate that EC range between 604 μscm^{-1} and 130 $\mu scm^{-1,}$ TDS range between 70.80 mg/l and 302 mg/l TSS range between 0.02 mg/l and 0.12 mg/l, TH range between 31.0 mg/l and 78.0 mg/l, pH range between 6.0 and 7.94, TA range between 55.0 mg/l and 100 mg/l, Cl range between 9.0 mg/l and 105 mg/l, F range between 0.60 and 1.40, NO_3 range between 0.121 mg/l and 0.136 mg/l, SO_4 range between 0.19 mg/l and 2.56 mg/l, PO_4 range between 1.99 mg/l and 3.65 mg/l, DO range between 3.10 mg/l and 3.98 mg/l, COD range between 113.15 mg/l and 145.27 mg/l, BOD range between 66.81mg/l and 85.77mg/l. The results show that all the physicochemical parameters measurements are below the Nigerian standard for drinking water quality (NSDQW) and the World Health Organization (WHO, 2017) permissible limits.

The results of the heavy metals analysis presented in Table 3.3, show that the metals concentrations are as follows; Ca range between 6.148 mg/l and 50.10 mg/l, Mg range between 3.25 mg/l and 25.05 mg/l, Fe range between 0.196 mg/l and 0.390 mg/l, Cd range between 0.001mg/l and 0.046 mg/l, Cr range between 0.0 mg/l and 0.004 mg/l, Cu range between 0.016 mg/l and 0.126 mg/l, while Pb range between 0.011 mg/l and 0.039 mg/l.

Results of Water quality index evaluation based on Weight Arithmetic Water Quality Index method using nine parameters commonly used to determine drinking water quality i.e. EC, TDS, TH ,pH, Cl , F, NO_3, SO_4 and Ca are also presented in Table 3.1. The results show that the water from Onopa have WQI of 0.1247 at Point 1, 0.2827 at point 2 and 0.1304 at point 3. Water at points 1, 2 and 3 in Azikoro have WQI of 0.1024, 0.2982 and 0.0943 respectively. While boreholes water at points 1, 2 and 3 in Agbura have WQI of 0.1574, 0.1076 and 0.1312, respectively. The WQI categorization presented in Table 3.2 show that all the boreholes water sample collected have excellent quality for drinking. This can be attributed to treatment given to the boreholes water before distribution for use, as boreholes water in Yenagoa are commonly subjected to treatment due to the menace of iron oxide in water frequently experience in Bayelsa State. Based on the water quality index rating, all the boreholes water analysed are classified as excellent for drinking. The results of this study varies with the results of Koinyan., Nwankwo and Eludoyin (2013) on groundwater qualities in Epie communities also in Yenagoa metropolis

The results of Heavy metal pollution index (HPI) evaluation are presented in Table 3.3.The results indicate that Onopa has HPI of 756.45, 783.15 and 750.30 at points 1, 2, and 3 respectively, showing they are all above the critical value of 100.The results also show that water sampled at Azikoro have HPI values of 1,166.20, 801.13 and 915.65 at

points 1, 2 and respectively. While Waters sampled at Agbura have HPI of 551.12, 321.82 and 110.21 at points 1, 2 and 3 respectively. This results indicates that all boreholes water sampled in all the locations (points) have HPI value exceeding the critical value of 100 (Prasad and Singita, 2008; Prasad and Mondal, 2008 in Alagoa and Eguakun, 2020). The results imply that the boreholes water sampled are unsafe for consumption with respective to heavy metal pollution. The high HPI recorded are attributed to the influence of Cadmium and lead (Pb) especially Cadmium which concentration exceeded the recommended limit of (0.003) in most of the water samples. This result agree with Ebo and Eremasi (2022a) who reported similar results in Igbogene to Akenfa axis of Epie Clan.The results of PHI evaluation are significantly lower than the results reported by (Alagoa and Eguakun, 2020)

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 **Conclusions**

Routine monitoring of drinking water quality is a key requirement of the Nigeria drinking water quality standard in order to protect public health and wellbeing. Results of the study has shown that many of the physicochemical parameters of the water samples analysed are within the limit recommended by the Nigeria drinking water quality standard (2017). Water quality index evaluation showed that the water quality of all boreholes have excellent quality for drinking with respect to physicochemical parameters. All the heavy metals concentration analysed are also within the standard limit except for Cadmium and Lead which exceeded the limit in some samples and these significantly influenced HPI. The low concentration of heavy metals and other physicochemical parameters recorded in this study might have been influenced by water treatment applied by the boreholes owners.

4.2 **Recommendations.**

Based on the findings of this study, the researchers wish to recommend as follows:

I. Monitoring of boreholes water quality in yenagao should be a regular practice.
II. Government should set up an investigation team to understand the menace of Cadmium and Lead occurrence in ground water in Bayelsa state.
III. Borehole owners and Yenagoa residents should be educated on the health risk of high Cadmium and Lead concentration in boreholes water

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