WELL WATER QUALITY ASSESSMENT USING WATER QUALITY INDEX IN WARRI METROPOLIS, DELTA STATE, NIGERIA

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ABSTRACT: *Well water samples from sixteen locations were collected and analysed within Warri metropolis to ascertain their quality using water quality index (WQI). The WQI was determined based on thirteen physico-chemical parameters. All the physico-chemical parameters of the well waters analysed were within standard regulatory limits. The water quality rating and water quality index (WQI) of the sixteen locations range from 23.61 (Ovwian) to 32.95 (Ugbomro) indicating the water quality to be of good quality. Most of the well water sampled are used for drinking purposes and as a result are provided with casing on the side called "rings" while the top is usually provided with a cover and are locked to prevent stray objects and other unwated materials from entering the well. This provides a good protection and prevention mechanisn for all the well waters. Overall the results indicate that the different well waters samples analysed from Warri Metropolis are safe for human consumptions therefore may not need further treatment.*

KEYWORDS: Well water, Warri metropolis, Water quality index, parameters, physic-chemical

INTRODUCTION

One of the most essential resources on earth is water, hence all life on both land, air and even in aquatic medium requires it for sustenance. About 97% of water is found in the ocean, while only about three percent are vailable as freshwater. Due to population growth and industrialization, there has been an upsurge demand for freshwater in the last few decades (Yisa and Jimoh, 2010). This demand has led to the use of ground water not only for its wide spread occurrence and accessibility but also for its constituent good quality which makes it ideal supply of drinking water (UNESCO, 2000).Groundwater is easily the most important component of the hydrological cycle, an important source of potable water in Africa and constitutes about two thirds of the freshwater resources of the world (Chapman; 1996). Surface waters generally are prone to contamination and are generally poor in quality (Okeola *et. al,* 2010), while goundwater waters on the other hand are more reliable for domestic, industrial, agricultural irrigation and other needs (Okeola *et al*, 2010; Haruna *et al*, 2008 and Shymala *et al*, 2008).

According to Hill (2004) more than one quarter of the world population depends on groundwater for drinking and other basic needs. According to Henry and Heinke (2005) groundwater is naturally replenished by surface water from precipitation, streams and rivers and generally not as susceptible to pollution as surface water; but once polluted it is to restored back to its pristine state. Groundwater is generally abstracted as well water (Open surface drilling) or as borehole (drilling with pipe). It is considered as one of the purest forms of water available in nature as it meets the overall demand for rural and semi-rural people (Tyagi *et.*

al, 2007; Fasunwon *et. al*, 2008). It provides a reasonably constant supply for domestic use, livestock and irrigation, which is not likely to dry up under natural conditions thereby buffering the effects of rainfall variability across seasons (Hamil and Bell, 1986; Calow *et al*., 2011; David, 2011).

In the last few decades, the growth of scale industries has caused serious concerns regarding the susceptibility of groundwater contamination due to discharge of waste materials. Towns and cities which lack efficient waste treatment and disposal systems, indiscriminate dump waste materials into surface waters and drainage and these in turn found their way into underground water sources through seepages especially shallow wells as are found in most cities in Nigeria especially Warri. Well water contamination occurs when surface pollutants, dissolved in water, percolate down through the soil, rendering the water unsafe and unfit for human use (Agbaire and Oyibo, 2009). How much pollutant reaches well groundwater depends on soil type, pollutant characteristic and the distance (Hill, 2004; Hornsby, 2009; Aremu *et al*., 2011; Ezeribe *et al*., 2012). World population cannot be sustained without access to safe water (Braunstein, 2007). It is therefore important to conjunctly consider both water quality and quantity in water resources management (Xinghui *et al*., 2009).

Contamination of well water renders the resource unsuitable and unfit for it intended uses either for domestic and industrial purposes (Holmes, 2007). Reducing or eliminating any intended health risks associated with either direct or indirect use of water is the major aim of water quality management (Udom *et al.,* 2002). Enacting standards and guidelines in water quality stem from the need to protect human health (Minh *et al*., 2011; Akpoveta *et al*., 2011; Silderberge, 2003). Inadequate protection and disposal of unreatment wastes has led to the contamination of natural water sources by many dissolved substances such as bacteria, viruses, heavy metals, nitrates and salt have and these have polluted such water supplies in many cities and towns (Singh and Mosley, 2003).

MATERIALS AND METHODS

Description of study area
Warri is located between latitudes 50 30′ and 50 35′ N `and longitudes 50 29′ and 50 48′ E. It is about 50 km away from the shores of the Atlantic Ocean and within the oil rich province of western Nigeria. It is a flat land with very gentle slope towards River Warri and its tributaries that empty their water into the Atlantic Ocean. The study area enjoys a tropical climate with well demarcated rainy and dry seasons. The dry season is from November to April while the rainy season is usually from May to October of every year.

Sample Collection and Analysis
The well water samples were collected from sixteen (16) different sampling locations (Figure 1) which are Ogunu, Air port road, Ovwian, Otokutu, Opete, Ugbomoro, Jeddo, Ubeji, Effurun, Aladja, Eboh, Okuvo, Ekpan, NPA, Agbarho, Warri and analysed for 13 physio-chemicals parameters by following established procedures. Samples were collected every month for six months from July to December 2017. pH, electrical conductivity, dissolved oxygen, temperature, and total dissolved solids parameters were monitored at the sampling site (i*n-situ*) while the other parameter such as turbidity, total suspended solids, faecal coli form, sulphate, chlorides, nitrates, and biochemical oxygen demand were analysed in the laboratory (e*x-situ*) as per the standard procedures of APHA (1999). Thirteen important

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recommended standard parameters of drinking water quality by World Health Organisation (WHO, 2010) were used to calculate the water quality indrx (WQI). Also, the water quality index (WQI) of each community studied was determined to ascertain the suitability of the water for domestic purposes in the area.

This index was adopted because it has enjoyed wide usage amongst researchers and allows for the comparison of the water quality in different areas (Egborge, 1994).
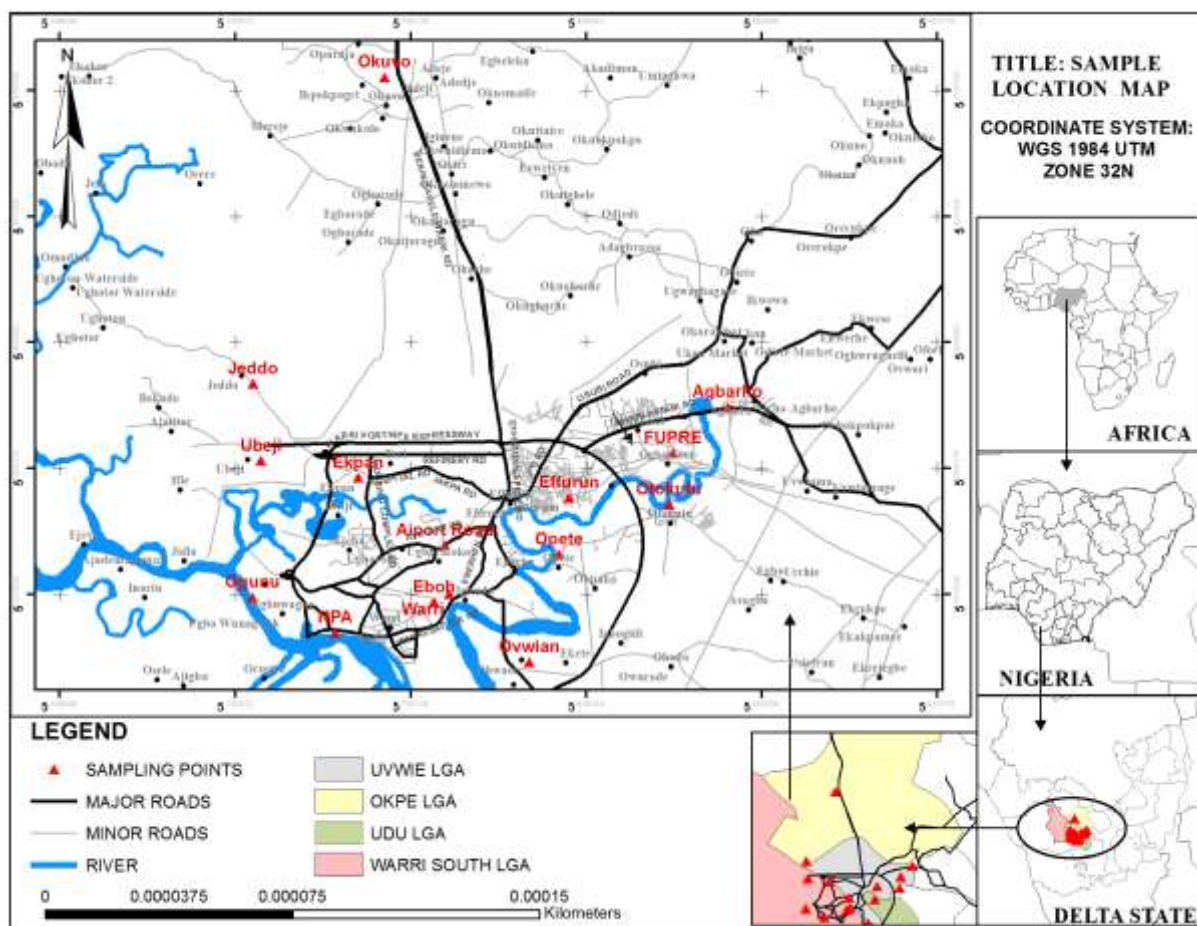

Figure 1: Warri metropolis showing locations where samples were collected

The quality rating or sub-index (qn) was calculated using the following formula:

$Q_n = 100 (V_n – V_{io})/(S_n – V_n)$ - - - - - - - - - (1)

Where:

Q_n = quality rating for the nth water quality parameter

V_n = estimated value of the nth parameter at a given sampling point

S_n = standard permissible value of the nth parameter

V_{io} = ideal value of nth parameter in pure water.

The unit weight was calculated by a value inversely proportional to the recommended standard value S_n of the corresponding parameter.

$W_n = K/S_n$ - - - - - - - - - - - (2)

Where:

W_n = unit weight for the nth parameter

S_n = standard value for the nth parameter

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K = constant for proportionality

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly

$$WQI = \Sigma q_n W_n - - - - - - - - - - (3)$$

Where:

WQI = water quality index

Σ = summation

q_n = quality rating for the nth water quality parameter

W_n = unit weight for the nth parameter

Water Quality Rating

The water quality index rating describes the range which each of the calculated water quality index falls into (Chatterrji and Raziuddin, 2002).. The water quality is rated as Excellent, Good, Poor, Very poor and unsuitable/ unfit for drinking. As shown in Table 1. Calculated WQI of 100 and above indicates that the water is unfit for drinking while low calculated index indicates excellent water fit for drinking.

Table 1: Water quality index rating table

Water Quality Index (WQI)	Description
0 – 25	Excellent
26 – 50	Good
51 – 75	Poor
76 – 100	Very poor
>100	Unfit for drinking

RESULTS AND DISCUSSION

A summary of the result obtained from the analysis carried out on the sampled well water are presented in Table 2, while Table 3 shows comparison between obtained results and standard drinking water quality from Nigeria Industrial Standards (NIS, 2007) and World Health Organisation (WHO, 2010). The temperature varied from 25.7°C – 29.7°C with a mean value of 28.03 ±1.02 °C. The pH were all generally acidic ranges from 5.54 to 6.8. Most of the well water samples pH falls below the recommended regulatory standards. Only six out of the sixteen sampling stations were within the acceptable regulatory limit. Turbidity, total suspended solids, total dissolved solids and conductivity values were all low and within regulatory standards. The well water at Nigerian Port Authority (NPA) has the highest value of 282 mg/l but still below the WHO standard. The oxygen and oxygen demanding parameters (DO and BOD), nutrients and chlorides values were also low and within recommended limits.

The microbiological analyses of the water indicate that faecal colifom microbial loads were not found in all the sixteen sampling points. This indicates minimal level of microbial load in all the well waters which makes the water suitable for drinking purpose and other intended uses without any further treatment.

Table 2: Summary of results from well waters in Warri Metropolis

Parameter	Otokutu	Ovwian	Opete	Ugbomro	Airport Rd	Aladja	Eboh	Okuvo	Ekpan	Ubeji	Jeddo	Ogunu	NPA	Effurun	Agbarho	Warri
pH	5.73	5.54	5.59	5.56	6.72	5.57	6.64	6.58	5.81	5.61	6.43	6.7	6.65	5.89	5.86	6.8
Cond.	184	602	361	224	214	557	362	164	534	342	317	379	564	316	174	215
TDS	92	301	181	112	107	274	179	82	268	171	159	190	282	159	87	108
Temp.	27.2	27.6	25.7	26.7	28.3	27.4	28.9	29.4	28.6	29.2	27.4	27.7	28.7	29.2	27.9	28.7
Turbidity	0	0	0	2.7	0	0	0	0	0	0	0	0	0	0	0	0
TSS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.O	2.76	2.06	2.88	2.06	3.2	2.68	2.87	2.96	2.74	2.8	3.3	2.6	3.45	2.47	4.53	3.67
B.O.D	1.6	1.5	1.6	1.4	1.6	1.3	1.4	1.5	1.4	1.5	1.7	1.3	1.6	1.2	1.2	1.5
Nitrate	2.35	3.6	2.95	2.53	2.13	3.25	2.14	1.86	2.66	2.81	2.75	2.92	2.53	3.38	2.97	1.74
Chloride	47.5	68.88	33.3	19	26.41	21.64	67.5	14.57	45.6	47.8	63.3	33.3	45.1	23.75	11.88	16.6
Phosphates	0.17	0.1	0.91	0.12	1.72	2.85	2.14	2.96	0.94	0.32	0.13	0.28	0.36	0.16	0.16	0.2
Sulphate	25	26	25.5	24.9	31.57	14	25.4	22.31	25.8	26.8	28	25	33.4	20.51	12.73	14.1
Faecial coliform	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Comparison of sampled data average to regulatory standards

Parameter	Mean	S,d.	NIS (2007)	WHO (2010)
Temperature (°C)	28.04	1.022	Ambient	24 - 30
pH	6.11	0.508	6.5 – 8.5	6.5 – 8.5
Turbidity (NTU)	0.17	0.675	5	40
Conductivity (uScm⁻¹)	344.3	149.36	1000	1000
DO (mg/l)	2.94	0.609	N/A	5
Total Nitrate (mg/l)	2.66	0.528	50	50
Total Sulphate (mg/l)	23.81	5.906	100	250
TDS (mg/l)	172.0	74.29	500	500
TSS (mg/l)	0.0	0.0	5	
BOD (mg/l)	1.46	0.150	N/A	50
Faecal Coli form	Nil	Nil	10	Nil
Phosphate	0.85	1.006	N/A	10
Chloride	36.6	19.02	250	250

Tables 3 and 4 show the quality rating and water quality index (WQI) of the sixteen locations which range from 23.61 (Ovwian) to 32.95 (Ugbomro) indicating the water quality to be of good quality for drinking purpose. This observation may be low intrusion from contaminants. It should be also noted that most if not all well water sampled are used for drinking purposes and as a result most of the well are provided with casing on the side called "rings" while the top is usually provided with a cover and are locked to prevent stray objects and other unwated materials from entering the well. This provides a good protection and prevention mechanisn for all the well waters.

Table 3: Calculated value of quality rating from the various well water sampling sites

Parameter	Otokutu	Ovwian	Opete	Ugbomro	Airport Rd	Aladja	Eboh	Okuvo	Ekpan	Ubeji	Jeddo	Ogunu	NPA	Effurun	Agbarho	Warri
pH	7.97	7.72	7.78	7.74	9.36	7.76	9.25	9.16	8.09	7.81	8.95	9.33	9.26	8.2	8.16	9.47
Temp	2.96	3.01	2.8	2.91	3.08	2.98	3.15	3.21	3.11	3.18	2.98	3.02	3.13	3.18	3.04	3.13
Turbidity	0	0	0	10.8	0	0	0	0	0	0	0	0	0	0	0	0
Cond	0.018	0.036	0.032	0.022	0.021	0.056	0.036	0.016	0.053	0.034	0.032	0.038	0.056	0.032	0.017	0.022
D.O	11.04	8.24	11.52	8.24	12.8	10.72	11.48	11.84	10.96	11.2	13.2	10.4	13.8	9.88	18.12	14.68
TDS	0.037	0.12	0.072	0.045	0.043	0.11	0.072	0.033	0.107	0.068	0.064	0.076	0.113	0.064	0.035	0.043
Nitrate	0.094	0.144	0.118	0.101	0.085	0.13	0.086	0.074	0.106	0.112	0.11	0.117	0.101	0.135	0.119	0.07
Chloride	0.076	0.11	0.053	0.03	0.042	0.038	0.103	0.013	0.073	0.076	0.101	0.053	0.072	0.038	0.02	0.027
TSS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulphate	0.04	0.042	0.041	0.04	0.051	0.022	0.041	0.041	0.041	0.068	0.045	0.041	0.053	0.033	0.02	0.023
B.O.D	6.4	6	6.4	5.6	6.4	5.2	5.6	6	5.6	6	6.8	5.2	6.4	4.8	4.8	6
Phosphates	0.17	0.1	0.91	0.12	1.72	2.85	2.14	2.96	0.94	0.32	0.13	0.28	0.36	0.16	0.16	0.2
ΣWnqu	28.81	25.546	29.73	35.65	33.6	29.86	31.96	33.35	29.08	28.87	32.41	28.56	33.35	26.52	34.49	33.67
ΣWn	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082	1.082
ΣWnqu/ΣWn	26.62	23.61	27.48	32.95	31.06	27.6	29.54	30.82	26.88	26.68	29.96	26.39	30.82	24.51	31.88	31.11

Table 4: Summary of calculated WQI of the sampled well waters

Samples	Water Quality Index	Quality
Ubeji well water	26.68	Good
Aladja well water	27.6	Good
NPA well water	30.82	Good
Okuvo well water	30.82	Good
Airport road well water	31.06	Good
Eboh well water	29.54	Good
Ekpan well water	26.88	Good
Jeddo well water	29.96	Good
Otokutu well water	26.62	Good
Ovwian well water	23.61	Excellent
Opete well water	27.48	Good
Ugbomro well water	32.95	Good
Ogunu well water	26.39	Good
Effurun well water	24.51	Excellent
Agbarho well water	31.88	Good
Warri well water	31.11	Good

Most of the wells were located far from propable contaminants sources like open drainages and domestic wastewater receptacles (septic tanks). Overall the results indicate that the

different well waters samples analysed from Warri Metropolis are provide safe drinking water for human consumptions therefore may not need further treatment.

CONCLUSIONS

From the information deduced from this study using water quality index, all the Well water samples were found to be suitable for human consumption and other domestic purposes.

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