A Comparative Assessment of Water Quality Index (WQI) and Suitability of River Ase for Domestic Water Supply in Urban and Rural Communities in Southern Nigeria

Ushurhe Ochuko
Delta State Institute of Continuing Education
Ughelli, Delta State, Nigeria

Origho Thaddeus
Department of Geography, College of Education
Warri, Delta State, Nigeria.

Ohwohere – Asuma Oghenero
Department of Geology, Delta State University
Abraka, Nigeria

Ewhuwhe – Ezo John
Delta State Institute of Continuing Education Ughelli
Delta State, Nigeria.

Abstract

The study compares the water quality index and suitability of River Ase for domestic water supply in urban and rural communities situated along the course of the river. Water samples were collected from four communities between January 2011 and December 2011. Several physico-chemical and biological parameters were analysed in line with WHO (2010). The results showed that variation exist in the concentration of the physico-chemical parameters between urban and rural communities in the area as a result of anthropogenic activities of man. Thus, higher concentrations of pH were recorded in the urban communities when compared to the rural communities, as all other parameters were within the WHO (2010) threshold for drinking water quality. Also the urban communities recorded a lower water quality index (WQI) of between 20-50 as against the rural communities of between 51-70. The paper recommends the addition of alkaline materials to the water, routine monitoring of human activities and testing of the river water from time to time in order to address impairments and safeguard human health.

Keywords: comparative, assessment, water quality index, River Ase, domestic, urban, rural.

Introduction

Every living thing needs water. Man must always have an adequate supply of potable water for his various daily needs. Specifically, man needs water for drinking, cooking, bathing, washing, agricultural purpose, manufacturing and industrial purposes. Water is equally used for the disposal of sewage. In the developed nations of the world, the average domestic use of water including that for all purposes per person is 180-230 litres per day. An average daily use per person of 450 litres is not uncommon particularly in the highly industrialized countries. While in Nigeria, the average domestic consumption by individual is 2.25 litres per day as against 115 litres per head per day by the World Health Organisation (Ayoade, 1988; Chima, Nkemdirim and Iroegbu, 2009). A source of clean and safe drinking water is through the government water supply or pipe borne water. Since this source is erratic and cannot meet our daily needs, many of the inhabitants of most rural and urban communities in most developing countries of the world especially Nigeria turn to the construction and digging of shallow wells to fetch water and collecting water from streams and rivers, which in most cases is not clean (Efe, 2005; Ushurhe, 2007; Ushurhe and Origho, 2009).

The need for safe water for mankind and to prevent water borne diseases, in order to safeguard human health led to the determination of the water quality of most water bodies for human use. The quality of water is the degree of its potability and is determined by the amount and level of physico-chemical, microbial and heavy metals found in it. Water for domestic purposes should be free from all these substances in order for it to be potable for human use vis-à-vis, prevent water borne diseases. The water quality index (WQI) which assesses the suitability of water quality for domestic purposes was adopted. It incorporates data from multiple water quality parameters into a mathematical equation that rates the nature of water bodies with numbers to determine their suitability for human consumption.

River Ase is a tributary of the Forcados River, the western branch of the River Niger in the Niger Delta region of Southern Nigeria. River Ase marks the geological boundary of the Somberairo-Warri formation and the middle belts of the upper Deltaic plains of the Niger Delta (Arimoro, Ikomi and Efemuna, 2007) The river is approximately 292 kilometers in length (Arimoro, Ikomi and Efemuna, 2007). The river flows through freshwater swamp and swampy forests of the Niger Delta region of Nigeria and through such settlements as Asaba – Ase, Ase, Ibredeni, Ivorogbo, Awah, Ibrede, Igbuku, Ashaka, Umusedeli, Kwale, Osemele, Iselegu, Obetim-Uno and Obikwele (Ushurhe, 2013). These communities depend on the supply of water from this river, hence the need to assess the quality of water in order to safeguard human health for socio-economic development.

Prevailing Trend

There has been a growing concern among the inhabitants of the area served by River Ase as to the quality of water obtained from the river. Some of the inhabitants complained that the quality of water varies with the seasons. It is of low quality during the rainy season and of high quality during the dry season; so also is the turbidity of the water and the amount of suspend solids. While others were of the view that the quality of water is the same throughout the year and along the course of the river. Conversely, most of the inhabitants of the area depend on this river for their domestic and other uses but based on its availability to the neglect of its quality.

To many of them in some of the communities, the water is not good for consumption; but the cost and far distance to alternative sources make them still depend on the water from the river. Also, some are of the view that the quality of the water and its seasonality causes water borne diseases in the area, affects the growth and production of fish, irrigation and other agricultural activities. It is based on the aforementioned uncertainties that the study assesses the water quality and suitability of River Ase for domestic water supply in urban and rural communities in the area in order to answer and proffer solutions to the unanswered questions posed by the people.

Aim and Objectives of the Study

The study aimed at a comparative assessment of the water quality and suitability of River Ase for domestic water supply in urban and rural communities in Southern Nigeria. The specific objectives are:

1. Assess the water quality index (WQI) of the water obtained from the communities located along the course of the river.
2. Ascertain the quality of water based on the water quality index (WQI) of each community.
3. Compare the quality of water (based on the water quality index (WQI)) from urban and rural communities in the area.
4. Ascertain if the quality of water from the river is suitable for domestic water supply in the area.
5. Suggest ways on how to improve on the quality of water from the river and hence achieve sustainable water supply for the urban and rural communities in the area.

Hypothesis

Given the aim and objectives of the study the following hypothesis is spelt our:

Ho: The quality of water from River Ase does not differ significantly from approved standard for domestic purposes.

Research Methods and Procedures

The study is an empirical research that adopted both experimental design and expost-facto design. The experimental design involves field survey, collection of water samples from communities located in the upstream and downstream of the river and laboratory analysis of the water samples collected.

While the expost-facto design draws a relationship between the physico-chemical parameters of the water and their effects on domestic purposes in the area.

The systematic and simple random sampling techniques were adopted for the study. The systematic random sampling technique was used for the collection of water samples in the upstream and downstream of the river; while the simple random sampling technique was used for choosing the settlements along the course of the river. The communities chosen for the study were Obikwele and Osemele in the upstream and Kwale and Ashaka in the downstream of the river. Obikwele and Osemele are rural communities, while Kwale and Ashaka are urban communities. The rationale for choosing these communities was for adequate representation of both rural and urban communities in the area.

For the study, four (4) sampling points (2 in the upstream and 2 in the downstream) along four (4) communities in the course of the river were studied from January, 2011 to December, 2011. A total of forty-eight (48) water samples were collected. This represents one (1) sample each in the months of January to December 2011.

The method of data collection was through direct field collection of water samples from the upstream and downstream of the river at varied measured distances using the topographical map of the area as a guide (Kwale sheet 78, Federal surveys, 1970). The water samples were collected from the surface and sub-surface of the river. The water samples were collected early in the morning between 7 am – 10 am (Dunn et al, 2007) to reduce the effect of temperature on the collected samples. The water samples were collected using sterilized 2 litre plastic cans fitted with information tags for identification. Plastic cans were securely corked and stored in ice packed container before transporting them to the laboratory. This was done within six hours of collection.

Water quality parameters such as pH, electrical conductivity, temperature, TDS, DO, Nitrate, COD, Alkalinity, Phosphate, HCO_3, chloride, sulphate, total coliform, sodium, calcium and zinc were analysed using Atomic Absorption Spectrophotometer, Digital meters, Standard Plate Count, in addition to titration methods. The results obtained were compared with WHO (2010) threshold for drinking water quality. Also, the water quality index (WQI) of each community studied was determined to ascertain the suitability of the water for domestic purposes. 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).

In the study, for the calculation of water quality index, sixteen (16) parameters were used. The WQI was calculated using the standard for drinking water quality approved by the World Health Organisation (2010). The weighted arithmetic index method used by Akoteyon et al (2011) in a similar study in line with Brown et al (1972) was applied for the calculation of the WQI of the water samples. Further quality rating or sub-index (qn) was calculated using the following formula:

$$Qn = 100\,(Vn - Vio)/(Sn - Vn) \quad (1)$$

Where:
Qn = quality rating for the nth water quality parameter
Vn = estimated value of the nth parameter at a given sampling point
Sn = standard permissible value of the nth parameter
Vio = ideal value of nth parameter in pure water.

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

$$Wn = K/Sn \quad (2)$$

Where:
Wn = unit weight for the nth parameter
Sn = standard value for the nth parameter
K = constant for proportionality

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

$$WQI = \sum qnWn / \sum Wn \quad (3)$$

Where:
WQI = water quality index
$\sum$ = summation

qn = quality rating for the nth water quality parameter
Wn = unit weight for the nth parameter
The posited hypothesis was tested using the analysis of variance (ANOVA) statistical technique. The analysis of variance (F-ratio test) is a standard parametric technique that enables researchers to test for the significance of differences or variation between three or more sample means; hence its application for this study.

Results and Discussion

The results of the physico-chemical analysis of the water samples collected and analysed for Kwale, Ashaka, Obikwele and Osemele are shown in tables 1, 2, 3 and 4; while the statistics and calculated water quality index (WQI) for each of the communities sampled is shown in tables 5, 6 (Kwale); 7, 8 (Ashaka); 9, 10 (Obikwele); 11 and 12 (Osemele); with a summary of water quality index (WQI) in tables 13 and 14.

The mean water quality for Kwale ranges between 28.76^{0}C for temperatures to 0.76mg/l for phosphate. However, electrical conductivity recorded the highest standard deviation of 10.09 and pH the lowest standard deviation of 0.31 (see table 5). The pattern of relative variation of the coefficient of variation (C.V) showed that all the examined water parameters are heterogeneous; hence there is need for a routine monitoring of the water. Furthermore, all the surface water parameters examined at Kwale are within the WHO (2010) permissible limit for drinking water quality. Also, the calculated water quality index (42.80) falls within the range of 25-50 designated as “bad” for human consumption according to Brown et al (1972) as reported by Ohwo (2009) (see tables 6, 13 and 14). The calculated water quality index (WQI) further corroborates the analyzed physico-chemical parameters of the river with respect to WHO (2010) standard for drinking water quality. However, pH concentration in the area should be reduced with the addition of alkaline solution.

Table 1: Results of Physico-Chemical Analysis (Kwale)

S/N	Field code	pH	Elec. Conduc. (us/cm)	Temp (^{0}c)	TDS (mg/l)	DO (mg/l)	NO_3N (mg/l)	COD (mg/l)	Alkalinity (mg/l)	Total phosp (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Coliform (count/100)	Na (mg/l)	Ca (mg/l)	Zn (mg/l)
1	JAN.	5.92	20.66	28.90	10.70	7.00	3.10	3.46	0.00	0.66	0.00	4.00	0.90	1.00	5.50	2.00	3.34
2	FEB.	6.00	20.61	28.60	9.76	6.90	3.20	13.40	0.00	0.52	0.10	3.46	0.86	1.00	6.00	2.50	3.42
3	MAR.	6.10	21.42	28.00	9.42	7.00	3.10	3.42	0.26	0.46	0.09	2.42	0.74	1.40	6.00	2.15	3.30
4	APRIL	6.90	39.20	28.20	21.01	4.80	0.80	10.20	18.00	0.90	21.96	7.00	4.00	2.20	2.50	2.80	1.12
5	MAY	7.00	40.20	28.30	21.00	4.50	0.85	12.88	16.00	0.86	20.90	7.24	4.24	3.90	2.46	2.46	1.00
6	JUNE	6.69	42.43	28.20	20.00	4.40	0.81	12.40	15.00	0.76	20.96	7.30	5.00	3.00	2.31	2.30	1.00
7	JULY	7.01	40.46	26.00	16.00	4.20	0.82	10.46	16.00	0.70	15.46	6.44	5.02	2.00	2.04	2.14	1.00
8	AUG.	6.56	18.00	29.00	11.00	3.20	0.42	10.20	15.00	0.86	16.00	5.24	4.24	3.00	2.04	1.46	1.05
9	SEPT.	6.40	18.00	30.20	11.10	2.80	0.03	10.10	14.00	0.90	17.08	5.00	2.00	2.00	4.20	3.50	1.25
10	OCT.	6.45	18.20	29.68	9.20	6.90	0.03	7.05	15.00	0.96	18.00	6.00	2.20	1.00	4.00	3.40	1.20
11	NOV.	6.42	17.62	29.04	9.00	6.82	0.02	10.00	14.00	0.84	16.00	6.14	2.10	2.80	3.75	3.20	1.22
12	DEC.	5.90	20.22	29.00	8.10	6.85	0.01	3.50	7.00	0.76	8.00	5.20	2.00	1.60	4.01	3.40	1.20
	$\bar{X}$	6.45	26.42	28.76	13.02	5.45	1.10	8.92	10.86	0.76	12.87	5.45	2.78	2.08	3.73	2.66	1.68

Source: Fieldwork, 2011.

Table 5: Statistics of Physico-Chemical Parameters at Kwale

Parameters	Mean ± SD	CV (%)	WHO Std
pH	6.45 ± 0.310.61	4.8	6.5 – 8.5
EC	26.42 ± 10.0912.58	38.19	100
Temperature	28.76 ± 0.660.03	2.29	29.8
TDS	13.02 ± 4.816.03	36.94	500
DO	5.45 ± 1.531.86	28.07	5
Nitrate	1.10 ± 1.221.19	110.91	10
COD	8.92 ± 3.53	39.57	100
Alkalinity	10.86 ± 6.69	61.60	50
Phosphate	0.76 ± 0.17	22.37	100
HCO_3	12.87 ± 5.49	42.66	50
Chloride	5.45 ± 1.492.30	27.34	250
Sulphate	2.78 ± 1.55	55.76	200
Coliform Count	2.08 ± 0.88	42.31	5
Sodium	3.73 ± 1.440.89	38.61	200
Calcium	2.66 ± 0.59	22.18	75
Zinc	1.68 ± 0.96	57.14	3

Source: Fieldwork, 2011.

Table 6: Calculated water quality index for Kwale.

Parameters	Observed Values	Standard Value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqu
pH	6.45	8.5	0.118	126.83	-4.166
EC	26.42	100	0.01	26.42	0.264
Temperature	28.76	29.8	0.034	96.51	3.281
TDS	13.02	500	0.002	2.604	0.005
DO	5.45	5	0.20	109	21.80
Nitrate	1.10	10	0.10	11.00	1.10
COD	8.92	100	0.01	8.92	0.089
Alkalinity	10.86	50	0.02	21.72	0.434
Phosphate	0.76	100	0.01	0.76	0.0076
HCO_3	12.87	50	0.02	15.74	0.515
Chloride	5.45	250	0.04	2.18	0.0872
Sulphate	2.78	200	0.005	1.39	0.00695
Coliform Count	2.08	5	0.01	41.6	0.042
Sodium	3.73	200	0.005	1.865	0.0093
Calcium	2.66	75	0.013	2.747	0.036
Zinc	1.68	3	0.33	54.33	17.93
			∑Wn = 1		∑ Wnqn = 42.80
WQ1 = ∑ Wnqn / ∑ Wn = 42.80					

Source: Fieldwork, 2011.

At Ashaka, temperature recorded the highest mean value of 27.96^0C with a standard deviation of ± 1.01 and a coefficient of variation of 3.60%; followed by electrical conductivity with a mean value of 24.78us/cm and a standard deviation of ± 7.34 and a coefficient of variation of 29.60%. nitrate recorded the lowest value of 0.98mg/l with a standard deviation of ± 1.09 and a coefficient of variation of 11.20%. Thus, all the examined values are heterogeneous, hence there is need for routine monitoring of the water. Furthermore, all the examined water quality parameters with the exception of pH are within the WHO (2010) drinking water quality standard (see tables 2 and 7). Moreso, the result of the calculated water quality index (46.30) falls within the range of 25-50 designated as “bad” as shown in table 8 and table 13. This implies that the water in the vicinity of Ashaka is not good enough for human consumption, unless purification of the water is carried out to improve on the pH concentration of the water.

Table 2: Results of Physico-Chemical Analysis (Ashaka).

S/n	Field code	pH	Elec. Conduc. (us/cm)	Temp (^{0}c)	TDS (mg/l)	DO (mg/l)	NO3 N (mg/l)	COD (mg/l)	Alkalinity (mg/l)	Total Phosp (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Coliform (count/100)	Na (ppm)	Ca (ppm)	Zn (ppm)
1	JAN.	5.85	20.42	28.70	10.64	7.20	3.07	13.50	0.10	0.59	0.01	4.05	0.82	0.00	5.36	2.64	3.32
2	FEB.	5.90	19.46	28.54	10.04	7.02	2.60	3.26	0.10	0.56	0.01	5.06	0.92	0.40	5.34	3.20	3.26
3	MAR.	5.95	20.42	28.01	9.64	6.96	2.64	3.24	1.25	0.62	0.01	6.42	0.53	0.00	6.10	3.16	3.25
4	APRIL	7.36	34.60	28.00	20.30	5.00	0.80	10.20	26.00	0.59	30.10	6.12	4.00	1.00	2.40	2.76	0.66
5	MAY	7.20	34.10	29.00	22.30	4.79	0.82	12.82	25.00	0.69	29.42	6.24	4.06	2.00	2.36	2.74	0.65
6	JUNE	7.10	25.26	28.60	21.04	4.76	0.83	11.46	24.00	0.69	30.21	6.15	4.04	1.00	2.40	2.52	0.56
7	JULY	7.15	41.69	29.00	20.16	4.50	0.72	10.46	22.00	0.94	22.60	6.24	3.20	2.00	2.00	2.16	1.36
8	AUG.	6.40	19.00	27.00	11.10	4.20	0.21	5.21	20.00	0.46	15.00	6.00	5.04	2.00	3.00	3.20	0.76
9	SEPT.	5.30	19.00	27.00	10.10	4.85	0.01	6.31	11.00	0.85	14.00	4.00	2.01	0.00	4.45	3.45	1.20
10	OCT.	5.35	20.00	27.00	9.05	8.40	0.02	6.42	11.02	0.86	13.00	4.00	6.01	2.40	4.45	3.46	1.24
11	NOV.	5.42	16.04	26.00	9.05	8.75	0.03	5.06	10.20	0.70	12.00	5.00	5.01	3.00	4.45	3.24	1.20
12	DEC.	5.45	17.42	28.70	7.10	8.30	0.04	3.45	5.00	0.54	6.02	4.25	3.20	1.00	5.25	3.24	1.20
	$\bar{X}$	6.20	24.78	27.96	13.46	6.23	0.98	7.63	12.97	0.67	14.37	5.29	3.24	1.23	3.96	2.98	1.56

Source: Fieldwork, 2011

Table 7: Statistics of Physico-Chemical Parameters at Ashaka

Parameters	Mean ± SD	CV (%)	WHO Std
pH	6.20 ± 0.76	12.7	6.5 – 8.5
EC	24.78 ± 7.34	29.60	100
Temperature	27.96 ± 1.01	3.60	29.8
TDS	13.46 ± 5.42	40.27	500
DO	6.23 ± 1.63	26.16	5
Nitrate	0.98 ± 1.09	111.2	10
COD	7.63 ± 3.67	48.16	100
Alkalinity	12.97 ± 9.64	74.3	50
Phosphate	0.67 ± 0.12	17.91	100
HCO_3	14.37 ± 11.13	77.43	50
Chloride	5.29 ± 0.98	18.53	250
Sulphate	3.24 ± 1.73	53.40	200
Coliform Count	1.23 ± 0.99	80.49	5
Sodium	3.96 ± 1.39	35.10	200
Calcium	2.98 ± 0.42	13.42	75
Zinc	1.56 ± 1.02	65.38	3

Source: Fieldwork, 2011

Table 8: calculated water quality index for Ashaka

Parameters	Observed Value	Standard Value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
pH	6.20	8.5	0.118	-34.78	-4.10
EC	24.8	100	0.01	24.78	0.25
Temperature	27.96	29.80	0.034	93.83	3.19
TDS	13.46	500	0.002	2.69	0.005
DO	6.23	5	0.20	124.6	24.92
Nitrate	0.98	10	0.10	9	0.90
COD	7.63	100	0.01	7.62	0.076
Alkalinity	12.97	50	0.02	25.94	0.52
Phosphate	0.67	100	0.01	0.67	0.007
HCO_3	14.37	50	0.02	28.74	0.50
Chloride	5.29	250	0.004	2.116	0.008
Sulphate	3.24	200	0.005	1.62	0.008
Coliform Count	1.23	5	0.01	24.6	0.25
Sodium	3.96	200	0.005	1.98	0.010
Calcium	2.98	75	0.013	3.97	0.05
Zinc	1.56	3	0.38	52	19.76
			∑Wn = 1		∑Wnqn = 46.30
WQ1 = ∑Wnqn/∑Wn = 46.30					

Source: Fieldwork, 2011

The results in table 3 and 9 revealed that temperature recorded a mean value of 27.43^{0}C and a standard deviation of ± 0.36, followed by alkalinity with a mean value of 13.77mg/l and a standard deviation of ± 12.8 at Obikwele phosphate recorded the lowest mean value of 0.12mg/l and a standard deviation of ± 0.17. On the pattern of relative variation, the result of the coefficient of the variation varies from 1.13% to 141.67%. Furthermore, all the parameters examined in the area are within the WHO (2010) approved standard for drinking water quality. Also, the result of the calculated water quality index (58.05) as shown in table 10 falls within the range of 50-70, designated as "medium" for water quality status of the area (see tables 13 and 14).

Table 3: Result of Physico-Chemical Analysis (Obikwele)

S/n	Field code	pH	Elec. Conduc. (us/cm)	Temp (^{0}c)	TDS (mg/l)	Do (mg/l)	NO_3N (mg/l)	COD (mg/l)	Alkalinity (mg/l)	Total Phosp (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Coliform (count/100)	Na (ppm)	Ca (ppm)	Zn (ppm)
1	JAN.	5.83	10.87	28.80	5.89	12.00	1.40	1.26	0.00	0.05	0.00	3.00	0.90	0.00	2.30	1.80	1.87
2	FEB.	5.70	10.90	28.70	5.70	12.30	1.45	1.35	0.05	0.03	0.00	2.75	0.92	0.00	2.20	1.82	1.85
3	MAR.	5.90	12.00	27.10	6.05	12.40	1.25	1.30	2.10	0.02	0.02	2.72	0.90	0.00	2.10	1.50	1.80
4	APRIL	7.10	14.50	26.70	9.10	6.80	0.02	6.12	25.00	0.02	30.50	2.00	1.00	3.00	1.04	1.40	1.12
5	MAY	7.20	14.75	26.90	9.20	7.00	0.03	6.00	26.00	0.04	33.40	2.20	0.99	2.80	1.00	1.36	1.10
6	JUNE	7.25	14.90	27.00	9.30	7.15	0.02	6.00	27.24	0.04	32.40	2.21	1.00	0.00	1.02	1.46	1.10
7	JULY	7.30	15.00	27.10	9.45	8.00	0.01	5.00	28.00	0.06	30.00	2.21	0.96	0.00	1.00	1.40	0.96
8	AUG.	7.42	15.22	27.25	9.55	9.00	0.02	5.81	27.00	0.04	29.00	2.20	0.86	1.00	0.96	1.20	0.94
9	SEPT.	7.40	14.95	27.20	10.50	8.00	0.01	6.15	26.00	0.05	26.00	2.10	0.76	2.75	0.69	1.01	1.20
10	OCT.	5.95	11.07	27.25	6.00	11.45	1.06	1.20	1.75	0.47	0.01	3.25	1.00	0.00	2.15	1.07	1.84
11	NOV.	6.00	11.25	27.60	5.90	12.30	1.23	1.22	2.10	0.52	0.03	3.00	0.95	1.00	2.20	1.70	1.74
12	DEC.	5.82	10.86	27.50	5.00	12.00	1.20	1.20	0.00	0.06	0.01	3.04	0.92	0.00	2.25	1.72	1.80
	$\overline{X}$	6.57	13.17	27.43	7.64	9.87	0.64	3.55	13.77	0.12	15.11	2.56	0.93	0.88	1.58	1.45	1.44

Source: Fieldwork, 2011

Table 9: Statistics of Physico-Chemical Parameters at Obikwele

Parameters	Mean ± SD	CV (%)	WHO Std
pH	6.57 ± 0.74	11.26	6.5 – 8.5
EC	13.37 ± 1.84	13.76	100
Temperature	27.43 ± 0.59	2.10	29.8
TDS	7.64 ± 5.26	38.85	500
DO	9.87 ± 2.27	22.99	5
Nitrate	0.64 ± 0.63	98.44	10
COD	3.55 ± 2.31	65.07	100
Alkalinity	13.77 ± 12.8	92.96	50
Phosphate	0.12 ± 0.17	141.67	100
HCO_3	15.11 ± 15.20	100.60	50
Chloride	2.56 ± 0.41	16.02	250
Sulphate	0.93 ± 0.07	7.53	200
Coliform Count	0.88 ± 1.19	135.23	5
Sodium	1.58 ± 0.62	39.24	200
Calcium	1.45 ± 0.28	19.31	75
Zinc	1.44 ± 0.39	27.08	3

Source: Fieldwork, 2011

Table 10: Calculated water quality index for Obikwele

Parameters	Observed Value	Standard Value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
pH	6.57	8.5	0.118	-22.78	-2.63
EC	13.37	100	0.01	13.37	0.133
Temperature	27.43	29.8	0.034	92.05	3.13
TDS	7.64	500	0.002	1.528	0.0031
DO	9.87	5	0.20	197.4	39.48
Nitrate	0.64	10	0.10	6.4	0.64
COD	3.55	100	0.01	3.55	0.0355
Alkalinity	13.77	50	0.02	27.54	0.551
Phosphate	0.12	100	0.01	0.12	0.0012
HCO_3	15.11	50	0.02	30.22	0.604
Chloride	2.56	250	0.004	1.024	0.041
Sulphate	0.93	200	0.005	0.465	0.0023
Coliform Count	0.88	5	0.01	17.60	0.18
Sodium	1.58	200	0.005	0.79	0.004
Calcium	1.45	73	0.013	1.933	0.025
Zinc	1.44	3	0.33	48	15.84
			$\sum Wn = 1$		$\sum Wnqn = 58.05$
WQ1 = $\sum Wnqn / \sum Wn$ = 58.05					

This implies that the water is fairly good for human consumption. This assertion corroborates the physic-chemical parameters of the water examined with respect to the WHO (2010) standard for drinking water quality.

Table 4: Result of Physico-Chemical Analysis (Osemele)

S/n	Field code	pH	Elec. Conduc. (us/cm)	Temp (^{0}c)	TDS (mg/l)	DO (mg/l)	NO3N (mg/l)	COD (mg/l)	Alkalinity (mg/l)	Total Phosp (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Coliform (count/100)	Na (ppm)	Ca (ppm)	Zn (ppm)
1	JAN.	5.80	10.80	28.75	5.80	11.15	1.35	1.20	0.00	0.06	0.00	2.80	0.72	15.00	1.95	1.82	0.92
2	FEB.	5.90	12.00	28.72	5.75	12.10	1.40	1.21	0.00	0.12	0.02	2.15	0.82	5.00	2.00	1.75	1.00
3	MAR.	6.25	12.75	28.00	5.95	13.00	0.82	1.32	6.50	0.05	0.20	2.20	0.85	5.00	1.75	1.70	1.00
4	APRIL	7.25	14.75	26.90	9.02	6.50	0.04	5.92	21.00	0.02	35.10	2.25	1.00	4.00	1.05	1.44	1.20
5	MAY	7.24	14.90	27.00	9.05	6.75	0.03	6.20	24.00	0.12	34.14	2.24	1.21	2.00	1.04	1.33	1.22
6	JUNE	7.25	14.90	27.00	9.21	7.02	0.03	5.92	25.10	0.03	32.60	2.20	0.95	1.60	1.10	1.32	1.24
7	JULY	7.10	14.78	26.90	10.00	8.15	0.01	6.00	27.80	0.05	31.40	2.15	0.72	1.20	1.06	1.14	1.01
8	AUG.	7.22	14.85	27.16	9.75	7.25	0.04	5.92	26.75	0.01	30.04	2.04	0.92	3.25	0.92	1.10	0.76
9	SEPT.	7.20	14.70	27.40	10.76	7.20	0.03	5.75	23.00	0.02	22.00	2.32	0.84	3.77	0.98	1.20	1.46
10	OCT.	6.12	12.00	27.60	5.92	13.15	1.66	1.40	0.92	0.46	0.04	2.70	0.82	5.00	2.42	1.70	1.26
11	NOV.	5.85	10.90	27.62	5.82	13.15	1.05	1.30	0.75	0.35	0.04	2.00	0.85	0.00	2.15	1.77	1.25
12	DEC.	5.75	10.70	28.72	4.82	12.00	1.30	1.22	0.05	0.20	0.03	2.10	0.92	10.00	2.00	1.80	1.00
	$\overline{X}$	6.58	13.17	27.65	7.65	9.79	0.65	3.61	12.99	0.12	15.47	2.26	0.89	4.65	1.54	1.51	1.11

Source: Fieldwork, 2011

Table 11: Statistics of Physico-Chemical Parameters at Osemele

Parameters	Mean ± SD	CV (%)	WHO Std
pH	6.58 $\pm$ 0.62	9.42	6.5 – 8.5
EC	13.17 $\pm$ 1.77	13.44	100
Temperature	27.65 $\pm$ 0.59	2.13	29.8
TDS	7.65 $\pm$ 2.06	26.93	500
DO	9.79 $\pm$ 2.70	27.58	5
Nitrate	0.65 $\pm$ 0.64	98.46	10
COD	3.61 $\pm$ 2.35	65.10	100
Alkalinity	12.99 $\pm$ 11.84	91.15	50
Phosphate	0.12 $\pm$ 0.14	116.67	100
HCO_3	15.47 $\pm$ 15.71	101.55	50
Chloride	2.26 $\pm$ 0.26	11.50	250
Sulphate	0.89 $\pm$ 0.085	9.55	200
Coliform Count	4.65 $\pm$ 3.97	85.38	5
Sodium	1.54 $\pm$ 0.52	33.77	200
Calcium	1.51 $\pm$ 0.24	15.89	75
Zinc	1.11 $\pm$ 0.15	13.50	3

Source: Fieldwork, 2011

Table 12: calculated water quality index for Osemele

Parameters	Observed Value	Standard Value (Sn)	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
pH	6.58	8.5	0.118	-21.88	2.58
EC	13.17	100	0.01	13.17	0.13
Temperature	27.65	29.8	0.034	92.79	3.15
TDS	7.65	500	0.002	1.53	0.0031
DO	9.79	5	0.20	195.8	39.16
Nitrate	0.65	10	0.10	6.5	0.65
COD	3.61	100	0.01	3.61	0.036
Alkalinity	12.99	50	0.02	25.98	0.52
Phosphate	0.12	100	0.01	0.12	0.0052
HCO_3	15.47	50	0.02	30.94	0.62
Chloride	2.26	250	0.004	0.904	0.036
Sulphate	0.89	200	0.005	0.445	0.0022
Coliform Count	4,65	5	0.01	93	0.93
Sodium	1.54	200	0.005	0.77	0.0039
Calcium	1.51	75	0.013	2.01	0.026
Zinc	1.11	3	0.33	37	12.21
			∑Wn = 1		∑Wnqn = 54.92
WQ1 = ∑Wnqn/∑Wn = 54.92					

Source: Fieldwork, 2011

Table 13: Water quality index categories

Water Quality Index	Description
0 – 25	Very Bad
25 – 50	Bad
50 – 70	Medium
70 – 90	Good
90 - 100	Excellent

Source: Ohwo (2009), after Brown et al (1972)

Table 14: Summary of water quality index (WQI), settlement by settlement along the course of River Ase.

S/N	Settlements	0 – 25 Very Bad	25 – 50 Bad	50 – 70 Medium	70 – 90 Good	90 – 100 Excellent
1	Kwale	-	42.80	-	-	-
2	Ashaka	-	46.30	-	-	-
3	Obikwele	-	-	58.05	-	-
4	Osemele	-	-	54.92	-	-

Source: Fieldwork, 2011

As shown in tables 4 and 11, temperature recorded the highest mean value of 27.65^0C and a standard deviation of ± 0.59 and a coefficient of variation of 2.13% at Osemele. This is followed by bicarbonate mean values of 15.47 and a coefficient of variation of 101.55%. The lowest mean value of 0.12mg/l was recorded for phosphate with a standard deviation of 0.14 and a coefficient of variation of 116.57%. The values in table II showed that all the examined surface water parameters are heterogeneous. Furthermore, all the examined water parameters fell within the permissible water quality standard (WHO, 2010).

Also, the result of the calculated water quality index (54.92) falls within the range of 50 – 70, classified as 'medium' in terms of water quality categorization (see tables 12,13 and 14). The calculated WQ1 is corroborated by the physico-chemical parameters of the water samples examined in the area as they are in line with the WHO (2010) threshold for drinking water quality, hence the water in the area is good for human consumption with some amount of purification.

Test of Hypothesis

The hypothesis which states that, "the quality of water from River Ase does not differ significantly from approved standard for domestic purposes", was tested using the analysis of variance (ANOVA) statistical technique. The test was conducted using the one way ANOVA analysis on the variation of the approved standard quality of water from River Ase for domestic purposes.

Table 15: ANOVA (Domestic purposes)

	Sum of squares	Df	Mean square	F	Sig
Between Groups	106063.919	3	35354.640	4.617	.005
Within Groups	581971.143	76	7657.515		
Total	688035.062	79			

Table 15 shows that the calculated F(4.617) is greater than the critical table(2.72) at $P<0.005$ and thus, the model is significant. Therefore, we accept the alternative hypothesis which states that the quality of water from River Ase differs significantly from approved standard for domestic purposes.

Findings

A comparative assessment of the water quality index (WQI) and suitability of River Ase for domestic water supply in urban and rural communities in Southern Nigeria revealed that:

1. There is variation in the physico-chemical and biological indices in the parameters examined between urban and rural communities situated along the course of the river.
2. Higher concentration of pH was recorded in the urban communities (Kwale and Ashaka) than in the rural communities (Obikwele and Osemele). This can be contributed to the high rate of industrial activities exacerbated by the presence of oil propecting firms at Kwale and Ashaka as opposed to Obikwele and Osemele in the area.
3. The water quality index (WQI) shows that the rural communities of Obikwele and Osemele recorded a higher WQI of 58.08 and 54.92 as against 42.80 and 46.30 recorded in the urban communities of Kwale and Ashaka respectively.

Recommendations

Arising from the research findings, the following recommendations are made:

1. There should be addition of alkaline materials to the water especially in the urban areas to reduce the pH concentration of the water.
2. Human activities along the course of the river should be monitored especially wastewater generation by oil prospecting firms in the area.
3. The water from the river should be tested from time to time to see whether the physico-chemical and biological parameters of the water are increasing or decreasing.

Conclusion

The spatial pattern of the water quality index of the sampled settlements showed that the quality of water is higher at the upstream than at the downstream as settlements at the upstream fell between 50-70 range considered as medium in terms of water quality index classification while at the downstream, the quality fell between 25-50 considered as "bad" according to Brown et al (1972) as reported by Ohwo (2009). Also, the quality of water in the rural communities is better than the quality of water examined in the urban communities situated along the course of the river. However, the water from the river should be purified through the addition of alkaline materials to reduce the high concentration of pH and other trace elements found in it in order to upgrade its quality for domestic consumption.

References

Akoteyon, I. S; Omotayo, A.O; Sodadoye, O. and Olaoye, H. O. (2011) "Determination of water quality index and suitability of urban river for municipal water supply in Lagos, Nigeria", *European Journal of Scientific Research*, 54 (2): 263-271.

Arimoro, F. O; Ikomi, R. B and Efemuna, E. (2007) "Macro invertebrate Community Patterns and Diversity in Relation to Water Quality Status of River Ase, Niger Delta, Nigeria, "*Journal of Fisheries and Aquatic Science*", 2(5): 337 – 344.

Ayoade, J. O. (1988) *Tropical Hydrology and Water Resources,* London and Basingstoke, Mc millan.

Chima, G.N; Nkemdirim, V. U; Iroegbu A. N. (2009) "Water Demand and Supply in Umuahia Urban, Abia State: Critical Study, "*knowledge Review"*, 18(1): 9-15.

Dunn, R. J. K; Ali, A; Lemekert, C.J; Teasdale, P. R. and Welsh, D. T. (2007) "short-term variability of physico-chemical parameters and the estimated transport of filterable nutrients and chlorophyll – a in the urbanized Commbalah Lake and Coombabah Creek System, Southern Moreton Bay, Austraha, "*Journal of Coastal Research*, 50:1062 – 1068.

Efe, S. I. (2005), "Quality of water from Hand Dug Wells in Onitsha Metropolitan Area of Nigeria, "*The Environmentalist*, 25:5-12.

Egborge, A. B. M. (1994) *Water Pollution in Nigeria: Biodiversity and Chemistry of Warri River,* Benin City, Ben Miller Books Nigeria Limited.

Federal Surveys, Nigeria, Sheet 78, Kwale (1970) Lagos, Nigeria Geological Surveys.

Ohwo, O. (2009) "The Spatial Pattern of water Supply and Management in Warri – Effurun Metropolist, Delta State University, Abraka, Nigeria, "Unpublished PhD Thesis, Delta State University, Abraka, Nigeria.

Ushurhe, O. (2007) "The impact of septic Tank Effluent on the quality of water from Hand Dug wells in Ughelli, Delta State, Nigeria, Unpublished M.Sc. Dissertation, Delta State University, Abraka, Nigeria.

Ushurhe, O. (2013) "Comparative Assessment of the Seasonal Variation in the Quality of water from Rivers Ase, Warri and Ethiope in the Niger Delta Region of Nigeria, "*International Journal of Innovative Environmental Studies Research*, 1(1): 7 – 20.

Ushurhe, O. and Origho, T. (2009) "The Prevalence of Water Borne Diseases as a result of the impact of septic tank effluent on the quality of water from hand dug well in Ughelli, Delta State, Nigeria, *Nigeria Journal of Research and Production*, 14(2) 121 – 138.

World Health Organisation (2010) International Standard for Drinking Water Guidelines for Water Quality, Geneva.