Water Quality Index Assessment of Eweh River in Khana Local Government Area, Rivers State, Nigeria

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Research Article

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ABSTRACT

Water is an essential requirement for human, industrial development and sustainability. It has been used over time for several purposes. This study aims to assess the surface water quality of the eweh river using water quality index in Eweh community in ken-khana, Khana local government area, rivers state. Samples were collected upstream, midstream, and downstream for 3 months, morning, evening and a total of 36 samples were achieved within this period. The samples were analysed for physiochemical parameters, heavy metals, and microbial content using a standard method of analysis. The results showed pH ranging from 4.40-5.00, temperature 27.6˚C-28.9˚C, Alkalinity 3 mg/l-19 mg/l, hardness 0.30 mg/l-0.35mg/l, Total Dissolved Solids (TDS) 9 mg/l-10 mg/l, chloride 1.0 mg/l-1.5 mg/l, calcium 0.10 mg/l-0.15 mg/l and magnesium <0.001 mg/l. For nutrient levels, phosphate ranged from 0.08 mg/l-0.024 mg/l, sulphate <1.0 mg/l and nitrate <0.05 mg/l. Heavy metal concentrations revealed manganese <0.002 mg/l, lead <0.01 mg/l; iron 0.109 mg/l-0.267 mg/l. The microbial contents also showed Total Coliform Bacteria (TCB) to be 2.0 cfu/ml downstream; Total Heterotrophic Bacteria (THB) ranged from 32 cfu/ml-430 cfu/ml across the stream while Fecal Coliform Bacteria (FCB) were not detected. The values obtained for the water quality parameters were below the standard set by the World Health Organization (WHO) apart from THB and TCB. The surface water was found to be fresh, soft, and slightly acidic. The water quality index calculated at the three stations across the river shows that upstream are excellent while midstream and downstream are good as their water quality indices are within 0–25 and 25–50 classifications respectively. This surface water should be treated for pH and its microbial content for potability. Further studies are recommended for seasonal variations in the water quality characteristics. Awareness should be created to enlighten the people of eweh on the effects of water contamination and pollution.

Keywords: Parameters; Pollution; Contamination; Surface; Hardness

INTRODUCTION

Water is an essential requirement for human and industrial developments; it is also used directly and indirectly by many people for several purposes. Water in general plays a vital role in the maintenance of plants and animal life. Owing to the presence of water in cells and body fluids, such as blood, human beings are approximately 60%-75% water. The variety of water sources brings about different degrees of impurities. The presence of impurities therefore, reduces the use to which the water may be deployed. Sources of water contamination or pollution include leachate from landfill/refuse dumpsite, industrial liquid effluent, domestic waste, agricultural waste, salt water intrusion, oil pollution and geological formation [1].

Water plays a very vital role in the development of a stable society, since human being can exist for days without food but few days without water may lead to death. Potable water in developing countries especially Nigeria in particular is susceptible to toxins as a result of water pollution. As human population and development in modern technology increases, the risk for water contamination also increases [2]. However, two major sources whose quality are assessed by chemists are the surface waters (dams, streams, rivers, ponds and lakes) and ground water (wells and boreholes). Reason being that surface water is prone to contamination and it was reported that surface water is generally poor in quality.

The niger delta region is one of the largest wetland in the world. Some rural inhabitants take what they can from the creeks, ponds and rivers. Water analysis are focal and imperative in surface water investigation by monitoring both the water level, trends of the water quality parameters that are influenced by the geological formations and the anthropogenic activities in a given area [3]. Water quality monitoring has one of the highest priorities in environmental protection policy. The main objective of this policy is to control minimize the incidence of pollutant-oriented problems and to provide water of appropriate quality to serve various purposes such as drinking water supply , irrigation water. Indiscriminate disposal coupled with bad land practices are common scene that can easily pollute surface water and consequently degrading the water quality.

Surface water sources in pristine environments are always of better quality when compared to those prone to anthropogenic influences. Surface waters are the best sinks for several point and non-point sources of pollution such as waste water from agricultural and industrial processes, storm runoff. Continuous and sustainable access to potable water supply remains a challenge to millions of people around the world. This problem is exacerbated in rural areas of most developing countries due to the lack of water supply, infrastructure or inadequate supply of potable water. So, these reasons make the people in rural areas to take what they can from creeks, ponds and rivers.

Hence, the intake of untreated and inadequately treated water remains a major disease burden to public health. Most studies performed on the quality of surface and ground water fail to present the results in the simplest form possible to policy makers and concerned citizens about the state of their water resources. The problem is to overcome the results that are reported in the Water Quality Index (WQI). Thus, complex water quality parameters investigated on water resources can be combined in a simple mathematical equation to generate results which are easy to understand by policy makers who may not be specialist. Water quality index thus transforms a large number of water quality data into a single number [4]. It aids the understanding of water quality issues by integrating complex data and generating a score that describes water quality status. Most people in eweh community depend on this river for various activities such as bathing, fishing, washing of farm tools like wheelbarrow, garri bags and still fetch this water for drinking. Owing to these activities in the river, it is imperative to determine the quality of the water by assessing physical, chemical and microbial or bacteriological qualities of this river for the benefit of the people of Eweh community (both old and young) and their neighbouring town.

Study area

This research work was carried out in Eweh river popularly known as Maapiuri (Figure 1). Maapiuri is located in wiibaa in Eweh community in ken-khana of Khana local government area which is among the 23 local government in rivers state of Nigeria. The area is known for agricultural activities like farming and fishing [5]. The river serves as fishing, washing, bathing and as potable water for most people in the community. The river is also known for its medicinal power because of the leaves that fall and rest on the water, so people travel from far and near to get this water for drinking.

Clearing of this river is usually done in January-April, where the water is being cleared by the use of raffle palms to make a tractor-like machine which is used to push the mud underneath the water and are carried to the other side of the river to make ridge, after this is done, the water becomes black but after series of rainfall the water is clean again, the fishes left reproduces; so before August-December, fishing can be done. However, for a long time, this has not been done.

Figure 1. Map of the study area showing Eweh river (Maapiuri).

MATERIALS AND METHODS

Samples for physicochemical analysis were collected in 75 cl plastic bottles, a total of 36 bottles were used, and the samples for microbiology and metals were collected in sterile bottles. Surface water samples were collected from up-, middle- and down-streams for 3 months, morning, evening and a total of 36 samples were obtained. The samples were used to carry out various physicochemical measurements. On field measurements such as salinity, electrical conductivity, temperature, total dissolved solids and pH were obtained using multi-parameter water quality laboratory instrument. Water samples for heavy metals determinations were preserved by addition of 2 ml concentrated HNO_3. All samples were preserved in ice chest and taken to laboratory for analysis. Laboratory measurements were determined using standard methods and procedures of American public health association, American water works association, water environment federation [6]. Amongst the chemical parameters analyzed for, sulphates, nitrates, phosphates and their levels were estimated by spectrophotometry. Total Alkalinity (TA), Total Hardness (TH and chloride (Cl^-) concentrations were determined by titration. Heavy metals (Fe, Mn and Pb) were quantified using atomic absorption spectrophotometer 200 model after digestion of sample. Calibration of the equipment was done before measurement. For Total Heterotrophic Bacteria (THB), aliquots of 0.1 ml of selected dilutions were inoculated separately on duplicate nutrient agar plates. The inoculated plates were incubated at 37˚C for 24 hours and colony forming units counted thereafter taking cognizance of the dilution factor while for total and faecal coliform bacteria, pour plate technique was used.

Data analysis and interpretation

Average values were obtained for each parameter and compared with World Health Organization (WHO). Weighted arithmetic Water Quality Index (WQI) method was used and the result obtained was compared with the ratings. This method has been widely used by various scientists [7]. Using the most commonly measured water quality variables. The calculation involves the use of the following mathematical equation:

$$\mathrm{WQI} = \frac{\sum Q_n W_n}{\sum W_n}$$

Where Q_n is the quality rating scale for each parameter for the water quality parameter.

W_n is the unit weight for each water quality parameter.

$$Q_n = 100\left[\frac{V_n - V_0}{S_n - V_o}\right]$$

Where V_n is observed value (i.e. estimated concentration parameter in the analyzed water).

V_o is the ideal value, if this parameter is pure water.

$V_0=0$ (except pH=7.0).

S_n is the recommended standard value of parameter by WHO.

$$W_n = {}^{K}/_{S_n}$$

Where K=1.

RESULTS AND DISCUSSION

The result of statistical summary of mean and standard deviation of levels of surface water quality parameters of Eweh river is presented in Table 1. Table 2 shows the water quality index rating. While Tables 3-5 reveal the output of the calculations of water quality index carried out on water quality parameters.

pH is related to acidity and alkalinity of the water and is one of the most important water quality parameters. The result showed for pH concentration from the study area (Eweh river) [8]. Midstream has the least pH value with mean of 4.40 ± 0.282 while upstream has the highest value with mean of 4.48 ± 0.282 which is slightly acidic. The pH results show that the Eweh river is slightly acidic and below the permissible limits of 6.5-8.5 WHO. Low pH encourages dissolution of metals, it promotes colour, acidity and more likely to be contaminated. Prolonged intake of acidic water may lead to cancer or cardiovascular damage, including the contraction of blood vessels and reduction in oxygen supply even at mild levels according to health experts.

Table 1. Statistical summary of levels of surface water parameters of Eweh river.

S.No	Parameters	Sampling stations			WHO
		Upstream	Midstream	Downstream	
1	pH	4.80 ± 0.28	4.40 ± 0.00	4.45 ± 0.07	6.5-8.5
2	Temperature (˚C)	28.9 ± 0.71	27.6 ± 0.07	27.8 ± 0.071	30
3	Turbidity (NTU)	0.75 ± 0.21	1.10 ± 0.00	1.25 ± 0.21	5
4	Conductivity (µS/cm)	12.5 ± 0.71	13.5 ± 0.71	13.5 ± 0.71	500
5	Salinity (ppt)	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.04
6	Hardness (mg/l)	0.35 ± 0.07	0.35 ± 0.07	0.30 ± 0.14	500
7	Total dissolved Solids (mg/l)	9.50 ± 0.71	10.0 ± 0.00	10.0 ± 0.00	600
8	Alkalinity (mg/l)	19.0 ± 4.24	6.00 ± 0.00	3.00 ± 1.41	500
9	Chloride Cl^- (mg/l)	1.25 ± 0.35	1.00 ± 0.00	1.00 ± 0.00	250
10	Sulphate (mg/l)	<1.00	<1.00	<1.00	200
11	Nitrate (mg/l)	<0.05	<0.05	<0.05	10
12	Phosphate (mg/l)	0.08 ± 0.02	0.28 ± 0.07	0.24 ± 0.13	0.5
13	Manganese (mg/l)	<0.002	<0.002	<0.002	0.1
14	Calcium (mg/l)	0.13 ± 0.03	0.14 ± 0.02	0.13 ± 0.04	100
15	Magnesium (mg/l)	<0.001	<0.001	<0.001	30
16	Iron (mg/l)	0.22 ± 0.07	0.18 ± 0.09	0.19 ± 0.08	5
17	Lead (mg/l)	<0.01	<0.01	<0.01	0.01
18	TCB (cfu/ml)	0	0	2	0.2
19	THB (cfu/ml)	231 ± 281.40	175 ± 77.78	136 ± 90.51	<100
20	FCB (cfu/ml)	0	0	0	0

Table 2. Water quality rating as per weight arithmetic water quality index method.

WQI	Status	Grading
0-25	Excellent	A
26-50	Good	B
51-75	Poor	C
75-100	Very Poor	D
100 and above	Unsuitable for Drinking	E

Table 3. Water quality index for upstream.

Parameters	WHO standards (S_n)	$1/S_n$	$\Sigma 1/S_n$	$K=1/(\Sigma 1/S_n)$	$W_n=K/S_n$	Ideal value (V_o)	Mean conc value (V_n)	V_n/S_n	$V_n/S_n*100=Qn$	WnQn
pH	8.5	0.1176	27.5726	0.0363	0.0043	7	4.8	0.5647	56.4706	0.2409
Temperature (˚C)	30	0.0333	27.5726	0.0363	0.0012	0	28.9	0.9633	96.3333	0.1165
Turbidity (NTU)	5	0.2	27.5726	0.0363	0.0073	0	0.75	0.15	15	0.1088
Conductivity (μS/cm)	500	0.002	27.5726	0.0363	0.0001	0	12.5	0.025	2.5	0.0002
Salinity (ppt)	0.04	25	27.5726	0.0363	0.9067	0	0.01	0.25	25	22.6674
Hardness (mg/l)	500	0.002	27.5726	0.0363	0.0001	0	0.35	0.0007	0.07	0
Total dissolved solids (mg/l)	600	0.0017	27.5726	0.0363	0.0001	0	9.5	0.0158	1.5833	0.0001
Alkalinity (mg/l)	500	0.002	27.5726	0.0363	0.0001	0	19	0.038	3.8	0.0003
Chloride Cl^- (mg/l)	250	0.004	27.5726	0.0363	0.0001	0	1.25	0.005	0.5	0.0001
Phosphate (mg/l)	0.5	2	27.5726	0.0363	0.0725	0	0.08	0.16	16	1.1606
Calcium (mg/l)	100	0.01	27.5726	0.0363	0.0004	0	0.13	0.0013	0.13	0
Iron (mg/l)	5	0.2	27.5726	0.0363	0.0073	0	0.22	0.044	4.4	0.0319

Table 4. Water quality index for midstream.

Parameters	WHO standards (S_n)	$1/S_n$	$\Sigma 1/S_n$	$K=1/(\Sigma 1/S_n)$	$W_n=K/S_n$	Ideal value (V_o)	Mean conc value (V_n)	V_n/S_n	$V_n/S_n*100=Qn$	WnQn
pH	8.5	0.1176	27.57	0.04	0.0043	7	4.4	0.5176	51.7647	0.2209
Temperature (˚C)	30	0.0333	27.57	0.04	0.0012	0	27.6	0.92	92	0.1112
Turbidity (NTU)	5	0.2	27.57	0.04	0.0073	0	1.1	0.22	22	0.1596
Conductivity (μS/cm)	500	0.002	27.57	0.04	0.0001	0	13.5	0.027	2.7	0.0002
Salinity (ppt)	0.04	25	27.57	0.04	0.9067	0	0.01	0.25	25	22.6674
Hardness (mg/l)	500	0.002	27.57	0.04	0.0001	0	0.35	0.0007	0.07	0
Total dissolved solids (mg/l)	600	0.0017	27.57	0.04	0.0001	0	10	0.0167	1.6667	0.0001
Alkalinity (mg/l)	500	0.002	27.57	0.04	0.0001	0	6	0.012	1.2	0.0001
Chloride Cl^- (mg/l)	250	0.004	27.57	0.04	0.0001	0	1	0.004	0.4	0.0001
Phosphate (mg/l)	0.5	2	27.57	0.04	0.0725	0	0.28	0.56	56	4.062
Calcium (mg/l)	100	0.01	27.57	0.04	0.0004	0	0.14	0.0014	0.14	0.0001
Iron (mg/l)	5	0.2	27.57	0.04	0.0073	0	0.18	0.036	3.6	0.0261

Table 5. Water quality index for downstream.

Parameters	WHO standards (S_n)	$1/S_n$	$\Sigma 1/S_n$	$K=1/(\Sigma 1/S_n)$	$W_n=K/S_n$	Ideal value (V_o)	Mean conc value (V_n)	V_n/S_n	$V_n/S_n*100 = Qn$	WnQn
pH	8.5	0.1176	27.57	0.04	0.0043	7	4.45	0.5235	52.35	0.2234
Temperature (˚C)	30	0.0333	27.57	0.04	0.0012	0	27.8	0.9267	92.67	0.112
Turbidity (NTU)	5	0.2	27.57	0.04	0.0073	0	1.25	0.25	25	0.1813
Conductivity (µS/cm)	500	0.002	27.57	0.04	0.0001	0	13.5	0.027	2.7	0.0002
Salinity (ppt)	0.04	25	27.57	0.04	0.9067	0	0.01	0.25	25	22.6674
Hardness (mg/l)	500	0.002	27.57	0.04	0.0001	0	0.3	0.0006	0.06	0
Total dissolved solids (mg/l)	600	0.0017	27.57	0.04	0.0001	0	10	0.0167	1.67	0.0001
Alkalinity (mg/l)	500	0.002	27.57	0.04	0.0001	0	3	0.006	0.6	0
Chloride Cl^- (mg/l)	250	0.004	27.57	0.04	0.0001	0	1	0.004	0.4	0.0001
Phosphate (mg/l)	0.5	2	27.57	0.04	0.0725	0	0.24	0.48	48	3.4817
Calcium (mg/l)	100	0.01	27.57	0.04	0.0004	0	0.13	0.0013	0.13	0
Iron (mg/l)	5	0.2	27.57	0.04	0.0073	0	0.19	0.038	3.8	0.0276

The temperature detects the degree of hotness or coldness of a substance. The temperatures of the river from the study are for 3 days showed no specific difference (27.6-28.99) indicating homogenous chemical behaviour in the water characteristics. Alkalinity is the water capacity to resist changes in pH that will make the water acidic. The results of alkalinity from the study area showed (3.00 mg/l-19.00 mg/l) as $CaCO_3$ is low and below the permissible limits. They are mostly due to the bicarbonate contents. Hardness is the ability of water to lather on the application of soap. The hardness level ranged from 0.30 mg/l-0.35mg/l with corresponding means of 0.30 ± 0.141 mg/l-0.035 ± 0.071 mg/l. The levels of hardness were lower compared to the WHO permissible limits which indicate that the water is soft. Total Dissolved Solids (TDS) measure all dissolved substances in the water. The results from the study area show TDS ranges from 9 mg/l-10 mg/l. These values are lower than the WHO permissible limits of 200 mg/l and with a mean of 10 ± 0.000 mg/l. The results obtained from conductivity, salinity, turbidity and TDS of the study area indicate that the river water is fresh and soft with slight acidity [9].

The concentration of chloride from the study is relatively low, the low concentration (1.0 mg/l-1.5 mg/l) indicates that the aquifer recharge is high due to the high rainfall on the 2nd and 3rd day of sampling. There is no contact with water of marine origin or leaching from the upper soil layers.

The nutrient levels show that sulphate is low (<1.0 mg/l) which could be related to removal of sulphate by sulphur bacteria in the sub-surface water. Concentration of phosphate for middle and downstream (0.24 mg/l) with mean value of 0.24 ± 0.127 mg/l which is higher than upstream (0.08 mg/l) with mean value of 0.08 ± 0.021 mg/l indicate absence of phosphorus containing mineral in the river. These values are below 0.5 mg/l permissible limit. Nitrate concentration for all the days were <0.05 mg/l.

The metals analysed show that manganese values <0.002 mg/l at the three points. Lead (Pb) <0.01 mg/l. Calcium concentration ranges from 0.10-0.15 mg/l with mean values of 0.13 ± 0.021 mg/l-0.14 ± 0.035 mg/l. Magnesium concentration <0.001 mg/l. Iron concentration ranges from 0.109 mg/l-0.267 mg/l with mean values 0.18 ± 0.075 mg/l- 0.22 ± 0.065 mg/l. These values are below 5.00 mg/l permissible limit [10].

The results for the microbial content analysis showed total heterotrophic bacteria (THB) is >100 cfu/ml WHO permissible limit across the river. The Total Coliform Bacteria (TCB) value is 2.00 cfu/ml at downstream of the river. This is >0.2 cfu/ml limit of WHO. Faecal Coliform Bacteria (FCB) were not present in all the samples.

CONCLUSION

The water quality index calculated at the three stations across the river shows that upstream are excellent while middle and down streams are good as their water quality indices are within 0–25 and 25–50 classification respectively. This shows that the water is good for human consumption taking into consideration that the acidity and THB are controlled for potability. This study shows that the surface water in Eweh is fresh, soft, slightly acidic and low to moderate dissolved solids. The microbial content showed that the river is loaded with total heterotrophic bacteria. The water quality index shows that the water is fit for consumption. This shows that the water is good for human consumption taking into consideration that the acidity and THB are controlled for potability.

CONFLICTS OF INTEREST

The authors declare no competing financial interest.

REFERENCES

1. Alam R, et al. Assessment of surface water quality around a landfill using multivariate statistical method, sylhet, bangladesh. Environ Nanot Monit Manage. 2021;15:100422.
2. Ubechu BO, et al. Assessment of physicochemical characteristics of groundwater around an unlined landfill in aba, southeastern nigeria. J Res Environ Earth Sci. 2021;7:76-82.
3. Aralu CC, et al. Polycyclic aromatic hydrocarbons in soil situated around solid waste dumpsite in awka, nigeria. Tox Rev. 2023;42:122-131.
4. Aralu CC, et al. Impact of solid waste leachates on soil and edible plants within unlined dumpsite in awka, anambra state. Amer J Chem. 2020;10:11-18.
5. Aralu CC, et al. Assessment of heavy metals levels in soil and vegetables in the vicinity of unlined waste dumpsite in nnewi, anambra state nigeria. J Chem Soc Niger. 2020;45:687-696.
6. Aralu CC, et al. Toxicity and distribution of polycyclic aromatic hydrocarbons in leachates from an unlined dumpsite in nnewi, nigeria. Int J Environ Anal Chem. 2022;83:121-126.
7. Laniyan TA, et al. Health risk assessment of heavy metal pollution in groundwater around an exposed dumpsite in southwestern nigeria. J Heal Pollut. 2019;9:191210.
8. Egbueri JC. Assessment of the quality of groundwaters proximal to dumpsites in awka and nnewi metropolises: A comparative approach. Int J Energy Water Res. 2018;2:33-48.
9. Aralu CC, et al. Pollution and water quality index of boreholes within unlined waste dumpsite in nnewi, nigeria. Discov Wat. 2022;2:14.
10. Deng Y, et al. Spatial distribution and risk assessment of heavy metals in contaminated paddy fields-a case study in xiangtan city, southern china. Ecotoxic Environ Saf. 2019;171:281-289.