Determination of Water Quality Index and Seasonal Variation of the Physicochemical Properties of Ajali River, Enugu State

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***Abstract*: - This research was conducted to assess the water quality of Ajali River in Enugu state. The weighted arithmetic water quality index was calculated by combination of the required physicochemical parameters which are, pH, temperature, E.C, turbidity, T.D.S, T.SS, T.H, BOD, DO, alkalinity, sulphate, nitrate, and chloride. The River was sampled monthly from January 2017 to June 2017 and parameters analyzed according to APHA standard methods. The mean values for temperature from April to June ranging from 30.3 to 32.1 is higher than the permissible limit recommended by WHO thereby making Ajali River slightly polluted. Also, D.O. mean values 7.47, 7.01, and 5.17 for January, February and March respectively were all higher than the WHO recommended standard values. Except the above mentioned parameters, the mean values of all parameters tested were within the WHO recommended standard limits. The overall water quality index values are 38.566, 43.755, 57.7, 59.80, 60.55, and 62.39 for January, February, March, April, May, and June respectively. These values show that water is least deteriorated in the months of January and February signifying a grade of B which is good and highly deteriorated as the months progress with a grade of C which is poor. The result of the analysis showed that the river gets polluted as the rainy season approaches and the water thus is not safe for drinking and domestic use. It is recommended that effective treatment measures should be applied to augment the river water quality.**

***Keywords* – Augment, permissible limit, physicochemical parameters, pollution, Water quality index**

I. INTRODUCTION

Water quality is fundamental for good river health. It sustains ecological process that support native fish populations, vegetation, wetlands and birdlife.

The causes of pollution and deterioration of rivers can be attributed to complex industrial processes, rural/urban effluents and atmospheric precipitation (3).These water deteriorating agents such as agricultural run-offs from farms and ditches, sewages and atmospheric depositions are dependent on season (4).

Ajali River and its environment is a host to several establishments and industries such as Ama Breweries. Therefore, there is a possibility of potentially polluted run offs from poorly managed waste to find its way into the river. The design of water quality monitoring programs are always complex and sometimes hard to understand by individuals inhabiting the environment. Due to large amounts of water quality data and its complex way of reporting methods, the public and layman finds it difficult to understand and thus cannot put it into use. Water quality index (WQI) is one of the most effective tool used to ascertain the quality status of a surface water. It makes use of a single value, just like a grade to express overall quality of a river (23). It is easier and simple for communicating information on water quality to a layman, concerned citizens and policy makers.

II. MATERIALS AND METHODS

Sample Collection

Sampling points were selected along the upstream and downstream region of the Ajali River. Sampling was carried out in triplicate on each sampling point monthly from January to June 2017. The water samples were collected from the river in three sets of 1Litre polyethylene bottles (pre-washed with acid, rinsed with deionized water and labeled accordingly) and amber bottles for BOD and DO determination. The grab sampling technique was employed. This was done by dipping the polyethylene bottles below the water surface, ensuring that the mouth of the bottle faces the water current.

Methods: The analysis was done according to the methods in (5). The pH, temperature, turbidity and electrical conductivity were determined in-situ. Table 1.0 summarizes the water quality parameters, the analytical method and instrument used for the analysis.

Table 1.0: Water Quality Parameters and Analytical Methods Used

Parameter	Analytical method	Instrument
pH	Potentiometry	Digital JENWAY model- 3505 glass electrode pH meter
Temperature	in-situ measurement	JENWAY digital portable JDS470 thermometer
Turbidity	Nephlometry	HANNA LP-2000 turbid meter
EC	in-situ measurement	HANNA HI8733 Conductivity meter
TDS	Gravimetry	Filtration weighing and drying apparatus
TSS	Gravimetry	Filtration weighing and drying apparatus
TH	EDTA titration	Titration apparatus
DO	Winkler's method	BOD bottle and titration apparatus
BOD	5-days Bottle incubation at 20^oC	BOD bottle and titration apparatus
Alkalinty	Titration	Titration apparatus
Sulphate	Nephlometric method	Turbidimeter
Nitrate	UV Spectrophotometry	PD303 UV Spectrophotometer
chloride	Argentometric titration	Titration apparatus

III. RESULT

Table 2.0: pH Values of Ajali River from January-June 2017

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	7.10	7.30	7.10	7.00	6.90	6.90	7.04	0.46	6.5-8.5
February	8.15	8.01	7.98	7.80	7.86	7.90	7.95	0.37	6.5-8.5
March	7.20	7.50	6.90	6.80	6.80	7.10	7.05	0.29	6.5-8.5
April	8.06	8.50	8.02	8.11	8.38	8.05	8.18	0.17	6.5-8.5
May	8.10	8.05	8.15	8.20	8.15	8.43	8.18	0.15	6.5-8.5
June	8.05	8.20	8.15	8.31	8.20	8.35	8.21	0.22	6.5-8.5

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 3.0: Temperature Values in (◦C) of Ajali River from January-June 2017

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	20.3	20.4	20.4	20.3	20.4	20.6	20.40	0.00	25.0
February	19.4	19.3	19.0	19.1	19.0	19.2	19.17	0.02	25.0
March	25.8	25.0	26.0	25.0	25.0	26.0	25.4	0.12	25.0
April	30.6	30.3	30.4	30.3	30.0	30.4	30.3	0.03	25.0
May	29.5	30.7	30.9	31.0	30.9	31.2	30.7	0.23	25.0
June	30.5	31.0	30.9	33.7	34.1	32.5	32.1	0.54	25.0

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 4.0: Turbidity Values of Ajali in (NTU) River from January-June2017**.**

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	1.02	1.05	1.00	0.95	1.00	1.04	1.01	0.16	5.00
February	1.45	1.38	1.31	1.10	1.27	1.15	1.28	0.19	5.00
March	1.40	1.80	1.85	2.10	1.90	1.95	1.83	1.65	5.0
April	1.08	1.96	1.01	0.98	0.96	1.00	1.16	0.55	5.00
May	1.15	1.20	1.17	1.21	1.21	1.20	1.19	0.24	5.00
June	1.19	1.09	1.23	1.54	0.93	1.16	1.19	0.30	5.00

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3

Table 5.0: Electrical Conductivity values in (ʋs/cm) of Ajali River from January-June 2017

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	147.0	138.0	140.0	173.0	132.0	170.0	150.0	23.4	1000
February	99.5	100.3	101.5	98.7	100.8	99.4	100.0	5.48	1000
March	100.0	120.0	111.5	98.0	98.5	100.0	104.6	7.98	1000
April	75.6	74.6	96.7	201.0	96.4	231.0	129.2	45.7	1000
May	250.0	245.0	250.0	211.0	215.0	209.0	240.0	25.8	1000
June	326.0	354.0	353.0	320.0	335.0	352.0	340.0	12.5	1000

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 6.0: Total Dissolved Solid Values in (mg/l) of Ajali River from January-June 2017**.**

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	52	63	70	48	50	62	57.5	4.54	500
February	78	78	76	89	85	89	82.5	12.87	500
March	58	75	70	96	100	95	82.3	7.90	500
April	160	190	150	260	250	280	215.0	45.05	500
May	239	205	247	255	248	246	240.0	10.61	500
June	290	321	297	215	208	229	260.0	8.50	500

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 7.0: Total Suspended Solid Values in (mg/l) of Ajali River from January-June 2017.

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	28.00	30.00	32.00	29.00	30.00	31.0	30.00	0.95	500
February	29.00	29.00	33.00	35.00	34.00	35.0)	32.50	0.90	500
March	28.00	25.00	25.00	20.00	28.00	25.00	25.16	2.78	500
April	14.00	13.00	19.00	14.70	14.9	14.70	15.05	5.75	500
May	18.30	19.50	21.00	19.80	20.00	21.40	20.00	1.05	500
June	25.50	24.35	20.10	25.0	27.30	27.75	25.00	6.08	500

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 8.0: Total Hardness Values in (mg/l) of Ajali River from January-June 2017.

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	91.0	97.0	95.0	93.0	93.0	94.0	93.9	4.56	300
February	135.0	129.0	108.0	115.0	109.0	129.0	120.9	2.45	300
March	101.5	112.8	100.7	120.0	185.8	173.4	132.3	5.20	300
April	161.6	151.8	121.2	282.5	184.4	192.5	182.3	2.05	300
May	178.0	190.0	162.0	205.0	198.0	183.0	186.0	3.44	300
June	207.0	198.5	190.3	195.6	195.0	183.6	195.0	1.95	300

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 9.0: BOD Values in (mg/l) of Ajali River from January-June 2017.

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	1.75	1.80	1.95	1.73	1.84	1.92	1.83	0.07	5.00
February	2.12	2.20	2.05	2.51	2.48	2.68	2.34	0.19	5.00
March	2.98	3.50	2.78	3.80	4.30	3.00	3.39	0.46	5.00
April	0.80	0.50	0.70	0.40	0.40	0.70	0.58	0.03	5.00
May	0.73	0.81	1.00	0.31	0.45	0.36	0.61	0.54	5.00
June	0.93	0.88	0.72	0.95	0.70	0.87	0.72	0.16	5.00

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 10.0: Dissolved Oxygen Values in (mg/l) of Ajali River from January-June 2017.

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	7.40	7.95	7.36	7.30	7.70	7.11	7.47	0.08	5.0
February	7.00	6.89	6.87	7.05	7.11	7.14	7.01	0.10	5.0
March	5.88	4.30	4.98	5.20	5.66	5.00	5.17	0.95	5.0
April	1.95	2.81	2.50	2.75	1.50	1.50	2.16	0.82	5.0
May	1.98	1.78	2.00	2.35	2.18	2.51	2.31	0.68	5.0
June	2.00	1.97	2.15	1.88	1.89	1.93	1.97	0.09	5.0

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 11.0: Alkalinity Values in (mg/l) of Ajali River from January-June 2017**.**

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	30.50	30.00	30.00	28.40	29.30	27.30	29.25	1.30	120
February	32.00	30.58	30.14	35.30	32.40	32.18	32.10	2.10	120
March	23.00	23.50	19.50	20.50	19.80	19.00	20.88	0.90	120
April	45.00	48.00	48.00	40.00	47.00	47.00	45.50	3.05	120
May	70.00	65.30	83.20	60.50	63.60	66.90	68.25	2.85	120
June	88.78	77.23	80.01	73.10	70.41	79.05	77.26	3.98	120

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 12.0: Sulphate ion Values in (mg/l) of Ajali River from January-June 2017.

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	112	105	108	110	109	113	109.50	5.78	150
February	128	144	128	135	140	117	132.00	9.05	150
March	82	124	82	124	124	120	109.33	10.45	150
April	116	129	135	196	191	185	128.50	24.68	150
May	130	143	135	127	120	136	132.00	4.80	150
June	143	121	139	154	160	150	144.49	7.35	150

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 13.0: Chloride ion Values in (mg/l) of Ajali River from January-June 2017**.**

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	40	34	37	32	35	32	35.00	3.07	250
February	48	43	47	38	32	35	40.60	2.90	250
March	55	60	60	47	45	50	52.83	3.55	250
April	35	40	50	55	75	100	59.16	12.54	250
May	58	60	62	63	65	60	61.25	2.65	250
June	71	66	60	66	64	66	66.88	4.08	250

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 14.0: Nitrate Values of in (mg/l) Ajali River from January-June 2017**.**

Periods	U1	U2	U3	D1	D2	D3	Mean	SD	WHO Standard
January	8.15	7.90	7.15	7.13	7.95	7.74	7.67	0.98	45.0
February	8.98	8.98	9.10	9.95	10.21	10.85	9.67	1.02	45.0
March	9.40	12.20	8.60	10.90	10.00	12.80	10.65	2.05	45.0
April	0.41	0.86	0.69	0.95	1.23	0.91	0.45	1.58	45.0
May	1.09	0.99	1.18	1.33	1.06	1.10	1.13	0.89	45.0
June	1.49	1.58	1.73	1.98	1.75	1.61	1.69	0.09	45.0

Key: U1, U2, U3 = Upstream samples 1.2 and 3. DI, D2, D3= Downstream samples 1, 2 and 3.

Table 15.0: Calculated Weighted Arithmetic W.Q.I of Ajali River from January to June 2017.

PERIODS	QnWn	Wn	W.Q.I	GRADE	RATING
January	31.046	0.805	38.57	B	Good
February	35.250	0.805	43.76	B	Good
March	46.339	0.805	57.56	C	Poor
April	48.140	0.805	59.80	C	Poor
May	48.744	0.805	60.55	C	Poor
June	50.220	0.805	62.39	C	Poor

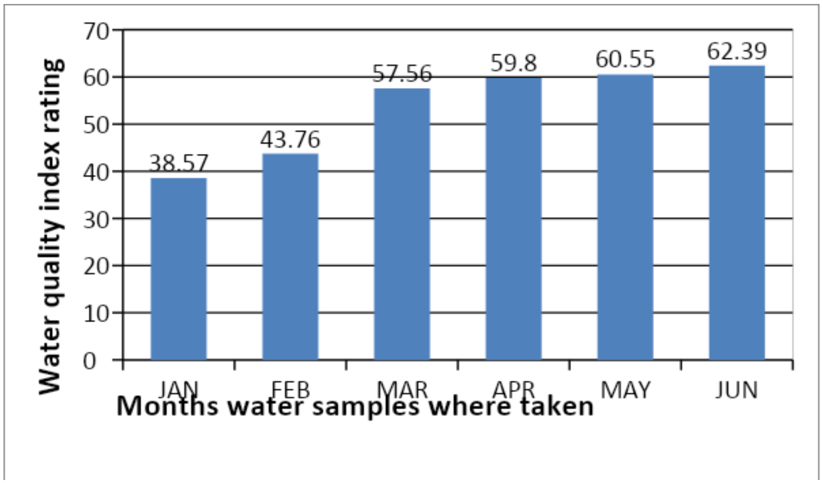

Fig. 1.0. Plot of ranges of values of WQI of Ajali River January – June 2017

IV. DISCUSSION

The pH value is the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water sample. However, a low pH value below 4.0 will produce sour taste. A pH range of 6.5-8.5 is normally acceptable as per guidelines suggested by WHO. Reference (20) Noted that high or low pH value in a river has been reported to affect lives and alter the toxicity of the pollutant in one form or the other. In this present study, the fluctuation of pH in the samples range from 7.04 to 8.21 as shown in table 2.0.

The range of this measured values fell within the WHO standard of 6.5 -8.5. The pH value recorded from April to June shows that they are alkaline, thus indicating that the river water is usually more alkaline during the rainy season. The minimum pH recorded was 7.02 in February and the maximum is 8.2 in June. The river water is usually more alkaline because of the presence of carbonates and hydrogen carbonates. According to (19), high pH value in water body is due to increased metabolic activities of autotrophs, because in general, they utilize the CO_2 and liberate O_2, thus reducing the H^+ concentration. He also reported that water bodies with high pH are more suitably productive than low pH value.

Temperature is an important factor which influences the chemical and biological characters of the aquatic system (1). The knowledge of the temperature of water body is significant because different aquatic organization shows different behavioral changes at different temperature (2). Surface temperature values are seasonal according to (7). This correlates with the mean temperature obtained in this study which is 20.4°C, 19.17°C, 25.4°C, 30.3°C, 30.7°C, and 32.14°C for January, February, March, April, May and June respectively. Table 3.0 explains the temperature values obtained from this study. This shows that the surface water temperature values are seasonal and depends on the climatic condition at a particular period. The temperatures recorded on April, May and June were higher than the 25°C WHO recommended standard. This may be attributed to waste of thermal industries and organic waste discharges where upon the microbial decomposition, yield some heat that intensifies the temperature. The lowest mean temperature was recorded on February while the highest was recorded on June. This study is comparable to (15) who reported high temperature of 27-30°C during wet season than dry season temperature of 19-24°C.

Measurement of turbidity reflects the transparency in water. It is caused by some substances present on suspension in water. In natural river water, it can be caused by clay, silt, organic matter and other microscopic organisms. The mean turbidity obtained for all the water samples fall within 1.01-1.19NTU as seen in table 4.0.This values are within the WHO recommended value of 5.00 NTU for domestic and agricultural purposes (22). Turbidity has direct bearing on the light penetration of water and depends upon suspended matter and dissolved colored substances including sewage (6). The higher the turbidity value, the lower the visible light will penetrate into the water. The low turbidity values obtained in this study indicate that the river has low suspended solids and debris. Which float in water.

Electrical conductivity measures the water's ability to conduct electric current. From table 4.4, the electrical conductivity analyzed ranges from 100-340ʊs/cm which is below the limit of 1000u$/cm set by (22). From the values obtained in this study, there is a decrease in EC measured from January to march. This is similar to the observations made by (8) who studied the seasonal variation of Sribodlaka River. The authors observed slightly high EC values during the wet season. The electrical conductivity gotten in May and June which is the peak of wet season are generally higher than other months. This observation could be attributed to increase in amount of solid substance due to volume of water during wet season as a result of increase in run offs getting into the water bodies. It could also be as a result of farming activities during these months. EC serves as the water capability to transmit electric current. It serves as tool to assess the purity of water (14). Reference (17) reported a high conductivity values too during wet season compared with dry season.

Total dissolved solid is due to the presence of calcium, magnesium, sodium, potassium, bicarbonate, and chloride and sulphate ions in water (16). In this study, the TDS mean value recorded as shown in table 6.0 are; 57.5, 82.5, 82.3, 215.0, 240.0, and 260.0mg/l for January, February, march, April, May and June respectively. These values show that there was a rise in TDS as rainy season approaches, although they are less than 500mg/l standard of WHO which is generally satisfactory for domestic and industrial uses. The observed increasing TDS value observed is a good indicator of intensive anthropogenic activities, cloth washing and garbage dumping along the course of the river.

The undissolved matter in the water body is measured as total suspended solid. The mean value for TSS recorded ranges from 15.05mg/l to 32.5mg/l. Table 7.0 shows the total suspended solid values of the analyzed water samples. These values are far less than the recommended WHO maximum permissible limit of 500mg/l. This shows that there are no much suspended inputs from run offs into the river.

Hardness of water is objectionable from the view point of water use for laundry and domestic purposes. Since it consumes a large quantity of soap. Based on this present study, hardness of water varied from 93.9 to 195mg/l as shown in table 8.0. Except the T.H recorded in January (93mg/l), all recorded in the rest of the months are more than 100mg/l, indicating that they are moderately hard water as classified by (9). The higher values might be as a result of increase in the amount of rainfall which dissolves more chemicals hence increasing their concentration in water. Very hard water is not good for drinking as it is associated with rheumatic pains and goiter (16). It is not also suitable for use in industrial boilers and can bring about high consumption of soap for domestic purposes for the inhabitants around Ajali River.

BOD gives the quantitative index of the degradable organic substances in water and is used as a measure of waste strength and organic pollution in water quality monitoring. The BOD obtained in this present study is recorded in table 9.0. The mean BOD obtained from this work ranges from 0.58-2.39mg/l. These are low compared to the WHO recommended permissible limit of 5.0mg/l. the low BOD values obtained from this work is either that the water is clean or that the organisms have been killed by toxic pollutants.

Dissolved oxygen in water reflects the physical and biological process prevailing in water. It is influenced by aquatic vegetation. The mean values for dissolved oxygen obtained are 7.47, 7.01, 5.17, 2.16, 2.13 and 1.97mg/l for January, February, March, April, May and June respectively as recorded in table 10. From the result, the mean DO from January to march showed that the water body was reasonably oxygenated and hence quite adequate for aquatic life, while that of April to June signifies a decrease in the dissolved oxygen which can be correlated to the high temperature recorded in April, May and June. Low dissolved oxygen value is usually associated with organic pollution (13).

Alkalinity of surface water is primarily a function of carbonate and hydroxide content of water. It is a measure of the capacity of water to neutralize acid inputs (20). Table 4.10 shows the alkalinity values obtained in this study. The alkalinity measured in this study ranges from 20.88 to 77.26mg/l. The highest alkalinity 77.26mg/l was recorded during the rainy season (June) while the lowest is recorded in March. According to (11), alkalinity contributes to the stability of water and controls its aggressiveness to pipes and appliances.

The concentration value of sulphate from this study ranges from 109.3 to 144.5mg/l as shown in table 12. The values above are within the WHO maximum limits. Toxicity of sulphate is usually not an issue, except at very high concentration where it can interfere with uptake f other nutrients. The sulphate concentration was low during dry season and high during rainy season. Similar trends were observed by (21) who assessed the water quality parameters in Kolhapur.

Chloride in excess imparts a salty taste to water. In this study, Chloride ion concentration ranges from 35.0 to 66.8 mg/l. This values fall below the WHO permissible limit of 250mg/l. Chloride is essential to plants in very low amounts, however, it can cause toxicity to sensitive crops at high concentration (12). The chloride concentration was highest in June and lowest in January. The high chloride content recorded in June maybe attributed to flow of sewage into the river. Similar results were obtained by (10). The concentration of nitrates in the sample fall within 0.85-10.65mg/l as shown in the table. These values are far less compared to (22) standard value of 45mg/l. This could be as a result of rare agricultural activities such as excessive manuring, or low permeability and porosity of the formation in the area concerned. It can be said that fertilizer being the major source of nitrates is usually not applied by the farmers in this area and therefore, diseases caused by nitrates (methane globinaemia or blue babies) will likely not be found in this area (18).

Water quality indices have been primarily developed to reflect changes in physicochemical quality of surface water. Table 15.0 presents the calculated water quality index of Ajali River from January to June 2017. Values of water quality index in March, April, May and June is rated as poor. This may reflect the discharge of pollutants to the surface water from domestic sewers, storm water discharge , industrial wastes and other sources, all of which if not treated, can have some significant effect of both short term and long term duration on the quality of Ajali river.

V. CONCLUSION

Using water quality indices is considered as a simple method for primary recognition of river water quality. It is concluded from this study as shown by the result that Ajali River has a significance of deterioration, especially during rainy season. A comparative assessment of the water quality parameters with WHO reveals that all the parameters are within the maximum permissible limits except temperature and dissolved oxygen. The use of index of water quality does not only assess changes of water quality over time and space, but also evaluate successes and shortcomings of domestic policy and international treaties designed to protect aquatic resources The study provides valuable insight into the status of the overall suitability of Ajali River based on the water quality index values. The value of W.Q.I for January and February fall under the "GOOD" category and are acceptable for drinking and domestic use while that of march to June fall under the "POOR" category which is not acceptable for drinking purposes.

VI. RECOMMENDATION

The water quality index used in this study does not encompass all the water quality parameters**.** A particular river or water body may receive a good water quality index score (grade), and yet have water quality impaired by constituents not included in the index. For example, in a case where physicochemical parameters (pH , conductivity, total hardness etc.) are used to calculate the water quality index without consideration for faecal coliform and Escherichia coli (E.coli) which are microbial indicators relevant to skin contact and potable water supply, such water may receive a good grade (score) and yet, on-site conditions tell a different story.

Therefore we recommend that an expanded weighted arithmetic water quality index that would encompass all the water quality parameters, (both physical, chemical and biological) be created and used to monitor Ajali River. The quality rating should be compared with the outcome of this present work, so as to ascertain if the parameters not included in this weighted Arithmetic WQI has an impact on the final rating result of Ajali River.

REFERENCES

[1] Addo, M.A., Okley, G.M., Affum, H.A., Acquah, S., Gbadageo, L.K. and Senu, J.K. (2011). *Level of Some Heavy Metals in Water and Sediments of Kpeshie Lagoon, La-Accra, Ghana*. Research Journal of Environment and Earth Science. 3(5): 487-497

[2] Agbazue, V.E., Ewoh, J.C., Madu, C.N., Ngang, B.U., Otuu, F.C., Ezeasor, C.I. and Nnadi, V.E. (2017). *Comparative Analysis of Physiochemical and Micorbial Parameters of Water Samples from Oro-Obor and Ayo Rivers in Enugu South, Enugu State Nigeria.* Journal of Applied Chemistry. 10(9): 59-54

[3] Aremu, M.O.,Atolaye, B.O., Shagye, D., and Moumouni, A. (2007). *Determination of Trace Metals in Tilapia Zilli and Clarias Lazera Fishes Associated with Water and Soil Sediment from River Nasarawa In Nasarawa* State, *Nigeria*. International Journal of Multi Resource, 3[1]: 159-168

[4] Ami, G.and Arvind, S., **R** (2014). *Water Quality Index of Machi River, Vadodara, Gujarat.* International Journal of Engineering Development and Research. 3(1): 3214-3219.

[5] APHA. (1998) American Public Health Association. *Standard Methods for the Examination of Water and Waste water Examination.* 16th Edition, American Public Health Association, Washington D.C, U.S.A.

[6] Edimeh, P.O., Eneji, I.S., Oketunde, O.F.and Sha'Ator, R. (2011). *Physiochemical Parameters and Some Heavy Metals Content of River Inacholo and River Niger in Idah, Kogi State*. Journal of Chemical Society of Nigeria. 36[1]: 95-101.

[7] Eyankware, M.O and Obasi, P.N (2014). *Physicochemical Analysis of Water Resources in selected Part of Oji River and Its Environment, Enugu State, South Eastern Nigeria*. International Journal of Innovation and Scientific Research. 10(1): 171-178

[8] Etim, E.E., Odoh, R., Itodo, A.U., Umor, S.D., and Lawal, U.M. (2013). *WaterQuality Index for the Assessment of Water Quality from Different Sources in the Niger Delta Regional of Nigeria.* Frontiers in Science, volume 3[3]: 89-95

[9] Environmental Protection Agency (2001). *Parameters of Water Quality. Environmental Protection Agency.* http://doi.org/10.1017/CB09781107415324.004. Acessed: 23/05/2018

[10] Fakayode, S.O., (2005*). Impact Assessment of Industrial Effluent on Water Quality of the receiving Alaro River in Ibadan*. Ageam-Ragel 10: 1-3.

[11] Igbal, J., Mumtaz, M., Mukhtar, J., Igbal, T., Mahmood, S.and Rasaq, A. (2010). *Particle Size Distribution Analysis and Physiochemical Characterization of Chenab River Water at Marala Head Works, Pakistan*. Journal of Botany. 42[2]: 1153-1161.

[12] Mass, E.V. (1990). *Crop Salt Tolerance Inc*. Agricultural Assessment and Management Manual. Tanji, K.K. (Ed). ASCE, New york. 262-304.

[13] Matter, G. (2014). *A Study on Physiochemical characteristics to assess the Pollution Status of River Ganga in Uttarakhand.* 7[3]: 210-217.

[14] Murugesan, A., Ramu, A and Kanna, N. (2006). *Water Quality Assessment from Uthamapalayam Municipality in Theni District. Tamid Nadu, India.* Pollution Research. 25:163-166

[15] Namrata, S. (2010*). Physiochemical Properties of Polluted Water of River Ganga at Varanasi*. International Journal of Energy and Environment. 1(5): 823- 832.

[16] Orakwue, F.C., Ojiako, E.N. and Ezelioha, N.C. (2011). *Physiochemical Studies and Bacteriological Assay of Rural water Resources (Boreholes) in Unubi, Nnewi South Local Government of Anambra State, Nigeria*. Anachem Journal 5[1]: 964-968.

[17] Otukune, T.V and Biukwu, C.O (2005). *Impact of Refinery Effluent on Physicochemical Properties of a water body on Niger Delta*. Journal of Applied Ecology Environmental Resources. 3:61-72

[18] Okeke, O.C., Okeke, A.U.G., Mmuo, V.E., Okoye, O.G and Chime B.C. (2013). *Quality Assessment of Ground Water from Shallow Aquifier in Awka Town, Anambra State.* 8th Annual International Conference. Anachem Exhibition. 1-5.

[19] Ogbu, K.C., Ebenebe, C.I., and Abajaue, M.C., (2016*). Physicochemical Characteristics of Ama Brewery Effluent and its receiving Ajali River in Udi, Enugu Stat*e. Research International. 13(2): 135-140

[20] Osunkiyesi, A.A.(2012). *Physicochemical Analysis of Ogun River within Two Locations (Akin-Olugbadeand Lafenwa) in Abeokuta, Ogun State,* Nigeria. Journal of Applied Chemistry 1(4): 24-27.

[21] Patil, V.and Parikh, P. (2013). *Assessment of Seasonal Variation in Water Quality of River Mini, at Sindihrot, Vodora, India*. International Journal of Environmental Sciences. 3(5): 1424-1436.

[22] WHO (2011). *Guidelines for Drinking Water Quality*. www.who.int/water_sanitation_health/publications/2011/dwg_chapters/en/.: 27/05/2018.

[23] Yogendra, K., Puttaiah, E.T, (2008. Determination of Water Quality Index and Suitability of an urban water body in Shimoga town, India. Proceedings of Taal: The 12TH World Lake Conference.