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THE EXTANT VARIABILITY AND USABILITY STATUS OF THE GREAT KWA RIVER, SOUTHERN NIGERIA BASED ON ITS PHYSICOCHEMICAL CUM BACTERIOLOGICAL PARAMETRIC DISCRETIZATION.

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Abstract

Samples of water were obtained from nine (9) points along the Great Kwa River, South-South, Nigeria, to ascertain the current usability status of the river. Standard approaches were employed to analyze various physical, chemical and bacteriological parameters such as Dissolved Oxygen, temperature, turbidity, total dissolved solids, nitrate, ammonia, potential hydrogen, electrical conductivity, calcium, sulphate, sodium, potassium, Biochemical Oxygen Demand and Chemical Oxygen Demand, alkalinity, THB and Total Suspended Solids. From the analyses conducted, pH values ranged from 3.37 – 7.39; Sodium ranged from 0.0074 mg/l – 0.135 mg/l; Potassium from 0.059 mg/l – 0.235 mg/l; Salinity from 0.08 mg/l – 0.7 mg/l; Conductivity from 0.03 – 0.05; Ammonia from 0.103 mg/l – 0.139 mg/l; Turbidity ranged from 0.124 – 0.222NTU;TSS from 0.8 – 1.96; TDS from 0.4 – 1.6; Temp from 25℃ – 27.7℃; DO from 1.5 mg/l – 5.6 mg/l; Alkalinity from 3.06 – 13.6; Calcium from 0.14 mg/l – 1.062 mg/l; Total Heterotrophic Bacteria was from 229CFU – 287CFU; BOD from 10 mg/l – 34.4 mg/l; COD from 16.25 mg/l – 65.8 mg/l; Phosphorus from 0.06 mg/l – 26.13 mg/l while Nitrate ranged from 0.13 mg/l – 0.28 mg/l. The results revealed inadequacy in very basic potability parameters. In clear terms, no sampling point analysis met the WHO (2011) standard for potability and other rudimentary utilization apart from washing and recreational activities in part. From the foregoing, it could be deduced that the Great Qua River is threatened. It is therefore recommended that Government agencies saddled with the responsibility of the protection of the environment be detailed to carryout enlightenment programs and advocacy to sensitize the people on the importance of the river water in preservation of the aquatic floras and faunas. There should also be stringent laws and punitive measures against the use of chemicals and explosives in fishing.

Keyword: Physicochemical, bacteriological, potability, sampling, catchment

1.0: Introduction

1.1: Pollution and its effects

The most essential commodity or substance in the world is water. This is basically due to its importance to life and even non-life activities. Water is seen today as a life sustenance and survival liquid, liquid gold, oil of the 21st century, etc. (WHO, 2011). But human activities have occasioned water corruption and shortage. It is therefore of major importance not only to have an acceptable and accessible amount, but also to have the water whose quality is considered safe for human, animal and plant ingestion and activities. This is not only vital to promised public health, but it is also indispensable to environmental protection and sustainable development assurance (Eze, et al., 2012).

The quality of water is defined in terms of its physical, chemical and biological parameters, and ascertaining its quality is critical before use for several envisioned purposes. A major role in water quality evaluation is to determine whether or not the water quality meets stipulated defined aims for designated uses, to describe water quality at all scales, as well as examine trends in periods. One standard method of evaluating water quality is based on a comparison of experimentally determined parameter values with existing guidelines. In many cases, the use of this approach allows proper documentation of water corruption sources and may be vital for inspecting legal acquiescence. However, it does not readily give an overall view of the spatial and temporal trends in the overall water quality in a watershed (Parma, 2010).

One of the difficult tasks facing environmental managers is on how to transmit their understanding of multifaceted environmental data into information that is understandable and useful to technical and policy-making individuals as well as the general public.

The health of the aquatic ecosystem is largely determined by the quality of their habitat, which, of course, is the water.

The anthropogenic expulsions constitute a relentless pollution source, thereby reducing the water quality. Anthropological activities are the key factors influencing the quality of water. Environmental pollution of water resources has become a major global issue. Developing economies like Nigeria have been suffering from the impact of pollution due to poor socio-economic growth associated with the exploitation of natural resources (Niemi *et al*., 1990). Water is considered as the highest risk to the world due to increase in demand as well as increase in pollution (EC, 1991; Global Risks, 2015).

Water pollution is the presence of matter or energy whose nature, location or quantity produces undesired environmental effects. It is either man-made or man-induced alteration of the physical, biological and radiological integrity of water. This therefore means that raising the level of substance(s) in the water environment to a level the water becomes unsuitable for its desired purposes is water pollution. Water exists in nature in three forms: rain (atmospheric) water, surface water and underground (sub-surface) water. The surface water exists in abundance in some areas as rivers, streams, ponds, rivulets or lakes. This water source is usually polluted by animal, human faecal wastes, domestic – landfill, sewage, pesticides, fertilizers, waste refuse, industrial hydrocarbon/oil, leachates from refuse dumpsites, industrial wastes and toxic materials, etc. (Ojelabi, 2001).

Sources of water pollution are broadly grouped into point sources and nonpoint sources. Point sources are defined as localized discharges of contaminants and include industrial and municipal wastewater outfalls, septic tank discharges, and hazardous- waste spills. Nonpoint sources of pollution include contaminant sources that are distributed over large, areas or are a composite of many point sources, including runoff from agricultural operations, the atmosphere, and urban storm runoff. Surface runoff that collects in storm sewers and discharges via a pipe is still considered nonpoint-source pollution since it originates as diffuse runoff from the land surface. Pollution loads from nonpoint sources are commonly called diffuse loads. The most widespread nonpoint-source pollutants in the United States are eroded sediments, fertilizers, and pesticides, associated primarily with agricultural operations.

Much of the pollution in waterways is caused by nonpoint-source pollution as opposed to point-source pollution. Horton (1965) reported that nonpoint sources were the principal contributors to pollution in 76% of lakes and reservoirs in the United States that failed to meet water-quality standards, and USEPA (1997d) reported that nonpoint sources impaired 65% of streams and 45% of estuaries in the United States that failed to meet water-quality standards.

Writing on water policy reform, Cookey (2001), submitted that Industrial Pollution has gradually changed the quality of water bodies in Nigeria. He observed that many towns and villages in the country have suffered adversely from water pollution resulting from toxic waste which affect the environment in number of ways. He outlined some of the pollutants to include battery manufacturing, paints, plastics, chemical fertilizers, textile industries and oil industries. He noted that the oil refineries/producing companies are among the biggest water polluters in the country.

The objectives of this work was to critically examine the water quality parameters along the sectional stretch of the Great Kwa River to ascertain the water quality standards, portability possibilities and/or otherwise, applicability for various uses – irrigation, domestic use, animal use, etc. as well as to turn complex water quality data into information that is understandably usable by other researchers, engineers and the general public.

2.0: Materials and Methods

2.1 Study Area

Figure 1: Location map of Great Qua River

The Great Kwa River is one of the major tributaries of the Cross River Estuary. It takes it rise from the Oban Hills in Nigeria, flows southwards and discharges into the Cross River Estuary around (Latitude $4^0$45'N; Longitudes $8^0$20'E). The lower reach of the river drains the eastern coast of the Calabar Municipality, the lower Great Kwa is characterized by semi-diurnal tides and extensive mud flats and drain the eastern coast of the city of Calabar. The river is known for the dramatic kwa falls in Cross River National Park. It is an important river to the people since most of them are mostly farmers and fishermen. Hence, their dependence on the Great Qua for transportation from one village to another, for irrigation, for fishing, drinking and dredging of sand for commercial and building purposes.

The Great Kwa River is a tidal stream with a unidirectional flow which is turbulent during the flood season. It has an average width of about 45m at its zone of transportation during the flood season. This reduces to around 30m during dry season at the neck of its series of meanders. The depth of the river varies from point to point with the maximum depth of about 20m occurring at the peak of the flood season. The major activities in and around the river includes sand dredging activity, fishing, swimming and washing. There is also the activity of dumping of wastes, while some of the shoreline residents defecate directly into the river.

2.2 Sample Collection

Table 1: Location, latitude, longitude and sampling points

Location	Sample Points	Latitude (N)	Longitude (E)
The Great Qua River Atimbo, Akpabuyo, LGA, CRS	Point 1	+32,43⁰30'91	54⁰73'92"
	Point 2	+32,43⁰32'46"	54⁰72'24"
	Point 3	+32,43⁰34'91"	54⁰84'43"
	Point 4	+32,43⁰36'76"	54⁰93'13"
	Point 5	+32,43⁰34'95"	54⁰90'24"
	Point 6	+32,43⁰34'35"	54⁰90'24"
	Point 7	+32,43⁰32'45"	54⁰85'32"
	Point 8	+32,43⁰30'01"	54⁰79'60"
	Point 9	+32,43⁰27'52"	54⁰71'84"

Source: UTM reading, 2021

For this study, all samples were selected to cover a wide range of variables and key point which represent the water quality of the river. Water samples from nine sites located along the Great Qua River were collected. The collection points are shown in the table above. Water sample were collected for physicochemical analysis in high density polyethylene bottles prewashed with detergent and were rinsed at the river site at each point before collection of samples from nine different points at the Great Qua River. The water sample was collected in 200ml sterilized borosilicate glass bottles for physicochemical and bacteriological analyses. All analyses were done following the standard method of APHA (2005) and guide manual. Various physicochemical parameters such as pH, EC, Temp. and DO were measured *in situ* using the DO - meter. Each of the containers was clearly marked and labeled.

2.3 Sample Preservation

Each of the samples was carefully preserved in an ice-packed cooler to maintain a steady state and temperature. These samples were subsequently stored at 4^0C for as short a time as possible before analysis to minimize physicochemical changes.

2.4. Bacteriological Sample Preparation and Analyses

All sediment samples were sorted to remove broken bottles, waste polyethylene bags, pieces of cloth, broken bottles and sticks, after which 10g of each was weighed into 250 mL Erlenmeyer flask containing 90 mL of sterile distilled water as diluent. For water samples, 10 mL of sample was measured into similar flask containing same amount of diluent. Each sample was diluted by 10-fold dilution in series. Three different dilutions were plated in triplicates by the pour plate technique of Harrigan and McCance (1990) onto freshly prepared Tryptic soy agar for enumeration of total aerobic cultivable bacteria and on freshly prepared Eosin methylene blue (EMB) agar for total coliform enumeration. Plates were incubated at 30C for 24hr. Discrete colonies were enumerated by means of a colony counter and analysed by one-way analysis of variance model using GraphPad Prism 8 software. The set of samples earmarked for microbiological analysis was analysed within 12h of collection at the Environmental Microbiology and Biotechnology laboratory of the University of Calabar.

2.5 Physicochemical Analysis

The physicochemical water quality was measured in terms potential hydrogen (pH), electrical conductivity (EC), total dissolved solids (TDS), Turbidity (T), Dissolved Oxygen (DO) Calcium (Ca), Potassium (K), Nitrite (NO_2), Total Suspended Solids (TSS), Temperature (T), Alkalinity (AL). All analyses were conducted according to American Public Health Association Standard Methods (APHA, 2005; 2009). Internationally accepted standards were used for all the analyses.

3.0: Results and Discussions

3.1 Results

Table 2: Physicochemical Parameters of the Catchment

POINTS	1	2	3	4	5	6	7	8	9
pH	7.35	7.37	7.34	7.34	7.31	7.39	7.38	3.37	3.37
SODIUM	0.0074	0.063	0.133	0.145	0.158	0.025	0.119	0.079	0.076
POTASSIUM	0.127	0.112	0.215	0.211	0.235	0.059	0.189	0.117	0.115
SALINITY	0.3	0.08	0.2	0.24	0.3	0.18	0.25	0.7	0.4
CONDUCTIVITY	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.05	0.05
AMMONIA	0.104	0.135	0.139	0.106	0.105	0.106	0.139	0.103	0.1032
TURBIDITY	0.124	0.222	0.195	0.232	0.236	0.205	0.201	0.198	0.207
TSS	1.35	1.64	1.85	1.76	1.91	1.78	1.96	1.89	0.8
TDS	1.1	1.3	1.4	1.2	1.5	1.3	1.6	1.51	0.4
TEMP. (0C)	27.3	27.6	27.6	26.8	26.4	27.6	25	27.4	27.7
DO	5.4	5.6	5.5	5.5	5.6	3.1	3.2	2	1.5
ALKALINITY	5.1	13.6	3.4	4.08	5.1	3.06	4.25	11.9	6.8
CALCIUM	0.248	0.14	0.164	0.14	0.176	0.192	1.062	0.148	0.164
THB	275	273	254	229	242	287	251	273	265
BOD	24.25	20.5	14.55	26.6	34.4	25.2	16.3	14	10
COD	37.4	42.6	65.8	60.6	52.1	30.3	20.9	18.5	16.25
PHOSPHATE	0.09	0.07	0.06	21.52	25.29	26.17	24.91	23.22	22.16
NITRATE	0.13	0.15	0.17	0.19	0.2	0.22	0.25	0.27	0.28

POINTS	1	2	3	4	5	6	7	8	9
TEMP. (0C)	27.3	27.6	27.6	26.8	26.4	27.6	25	27.4	27.7

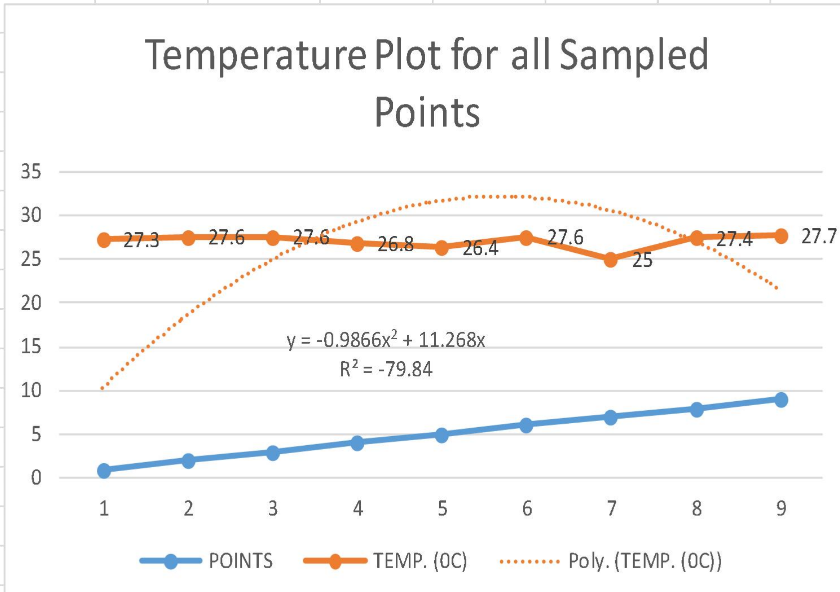

Fig 2: Temperature Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
pH	7.35	7.37	7.34	7.34	7.31	7.39	7.38	3.37	3.37

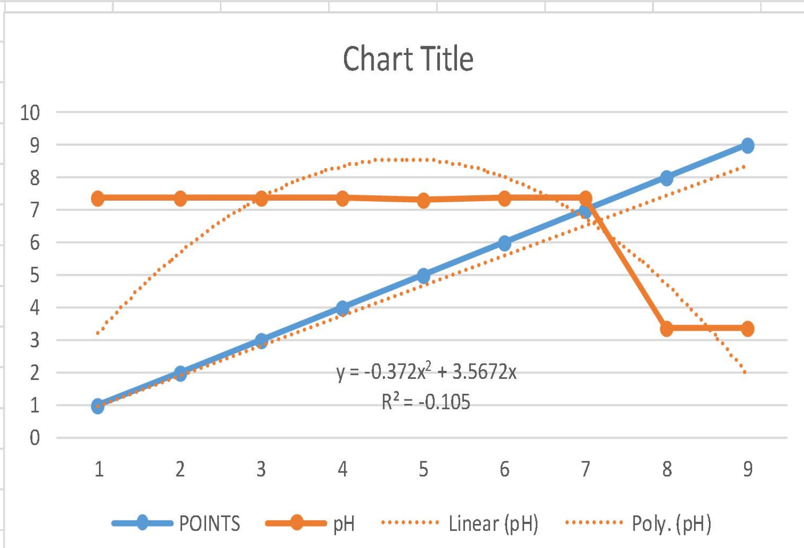

Fig 3: pH Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
TURBIDITY	0.124	0.222	0.195	0.232	0.236	0.205	0.201	0.198	0.207

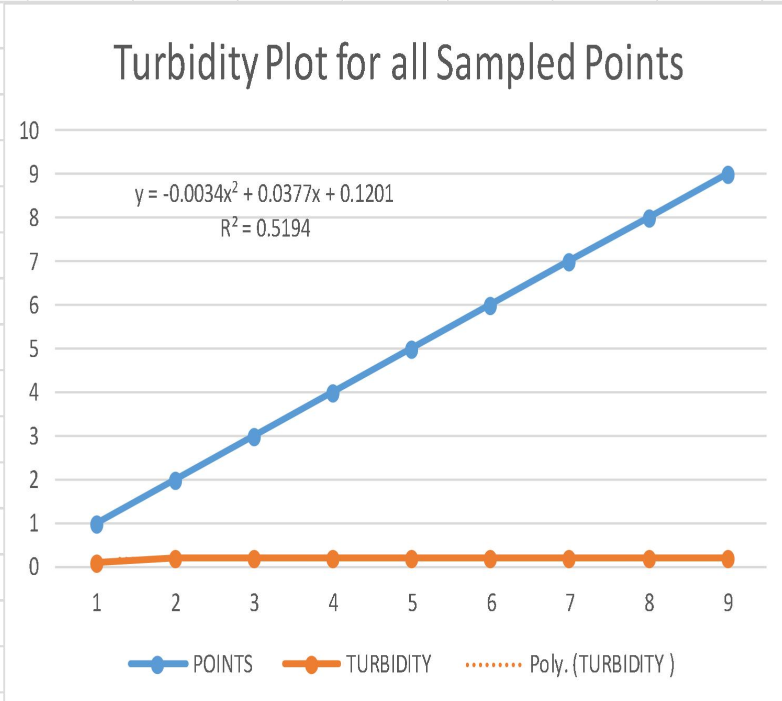

Fig 4: Turbidity Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
CALCIUM	0.248	0.14	0.164	0.14	0.176	0.192	1.062	0.148	0.164

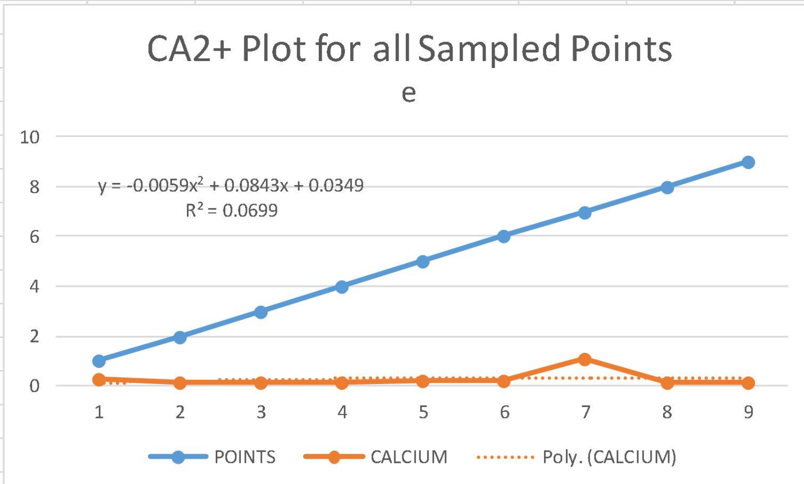

Fig 5: Calcium Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
TDS	1.1	1.3	1.4	1.2	1.5	1.3	1.6	1.51	0.4

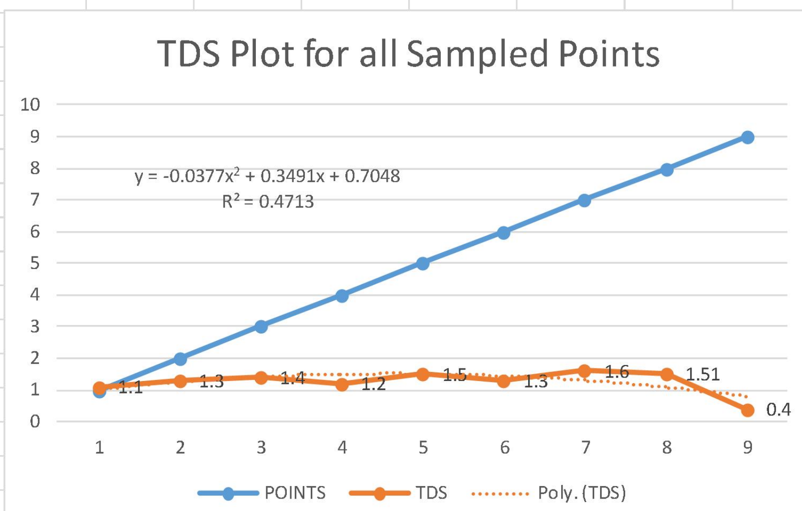

Fig 6: TDS Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
DO	5.4	5.6	5.5	5.5	5.6	3.1	3.2	2	1.5

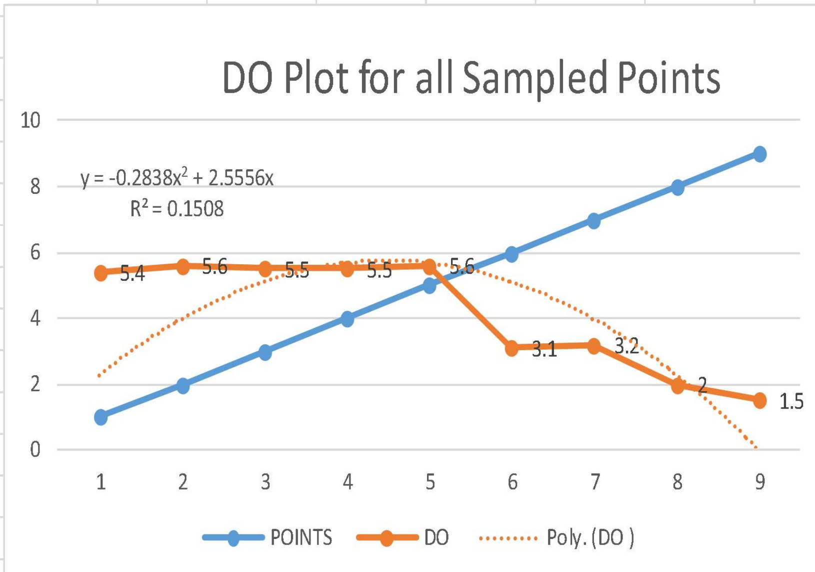

Fig 7: Dissolved Oxygen Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
BOD	24.25	20.5	14.55	26.6	34.4	25.2	16.3	14	10

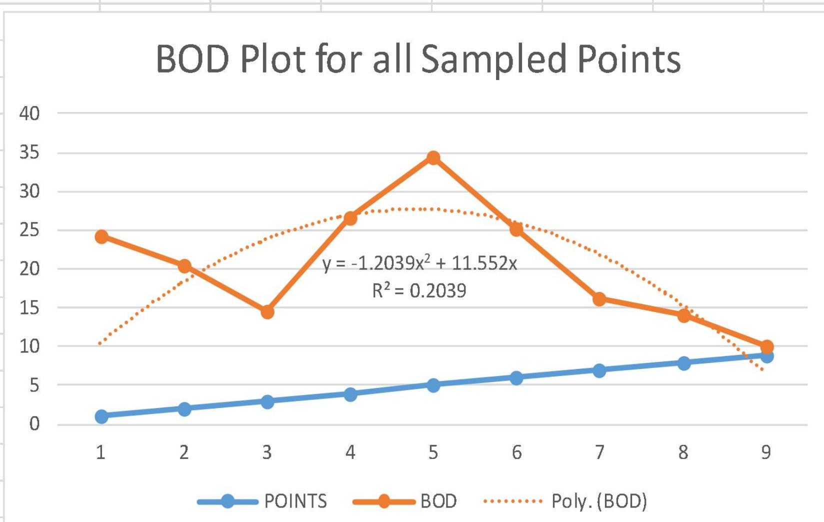

Fig 8: BOD Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
SODIUM	0.0074	0.063	0.133	0.145	0.158	0.025	0.119	0.079	0.076

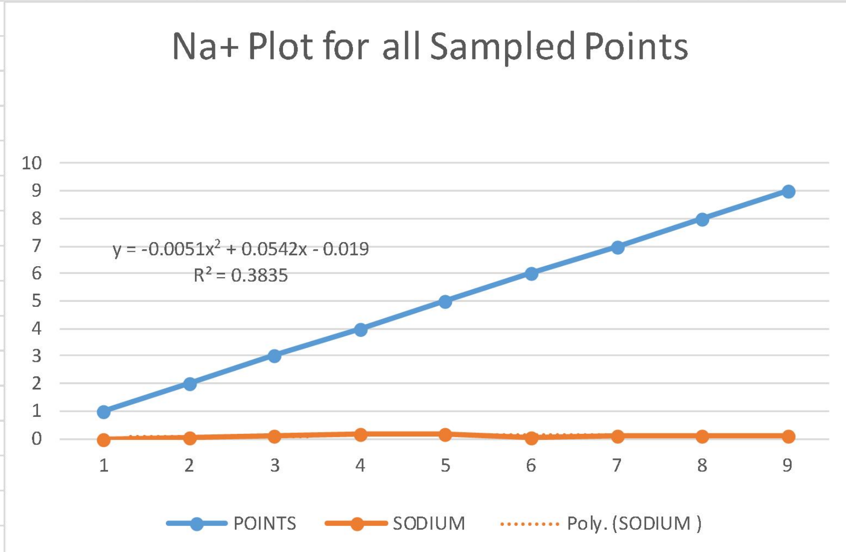

Fig 9: Sodium Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
POTASSIUM	0.127	0.112	0.215	0.211	0.235	0.059	0.189	0.117	0.115

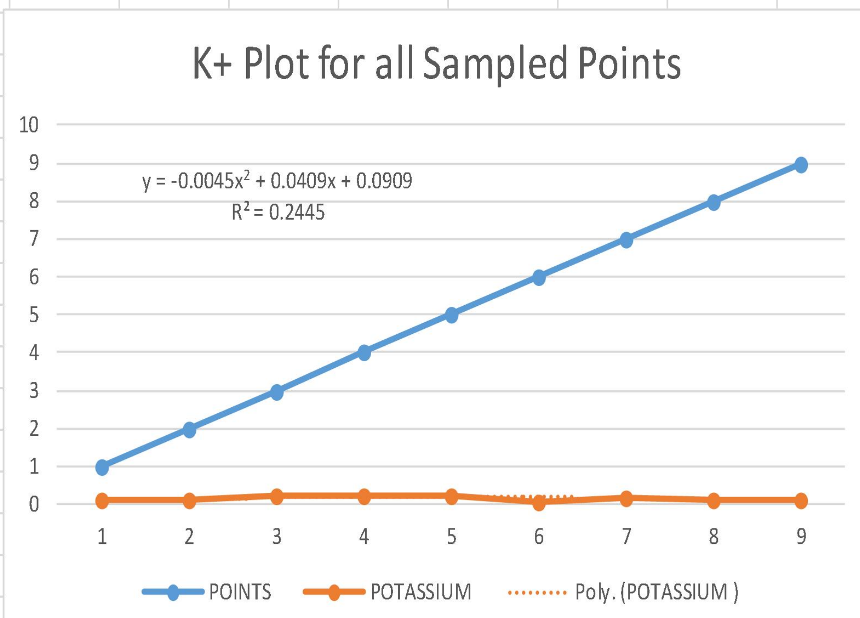

Fig 10: Potassium Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
ALKALINITY	5.1	13.6	3.4	4.08	5.1	3.06	4.25	11.9	6.8

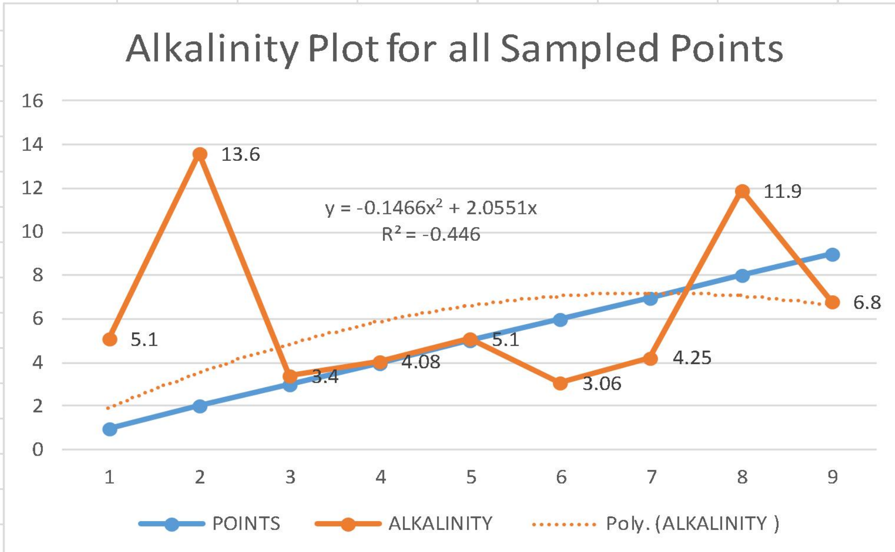

Fig 11: Alkalinity Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
TSS	1.35	1.64	1.85	1.76	1.91	1.78	1.96	1.89	0.8

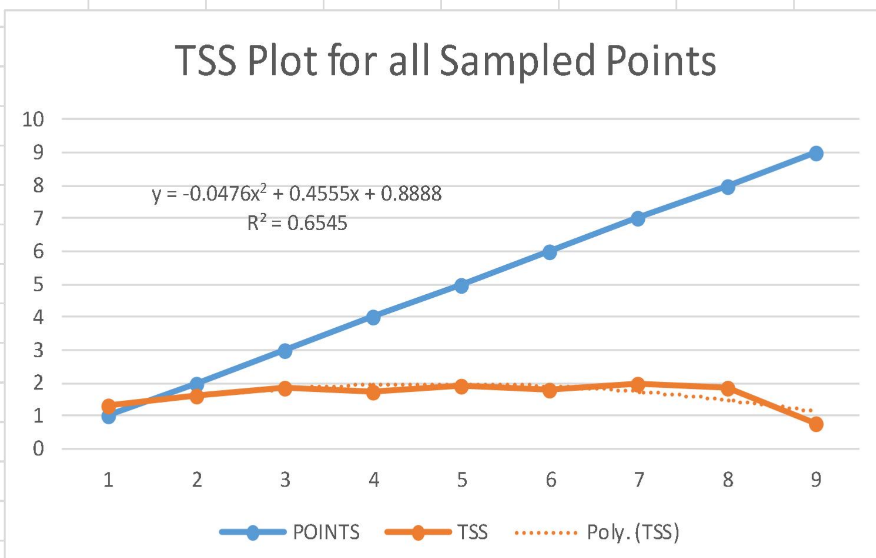

Fig 12: TSS Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
AMMONIA	0.104	0.135	0.139	0.106	0.105	0.106	0.139	0.103	0.1032

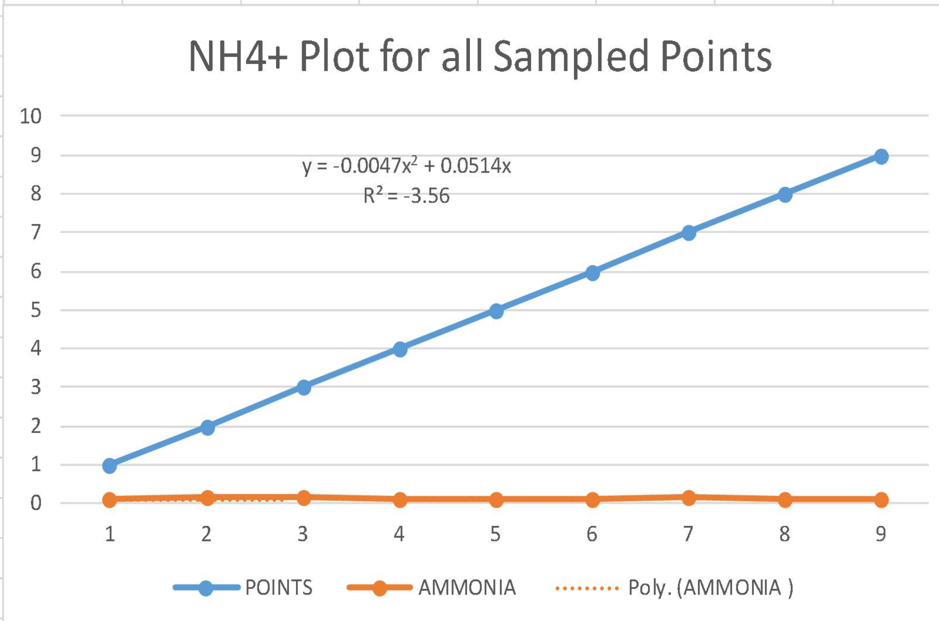

Fig 13: Ammonium Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
CONDUCTIVITY	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.05	0.05

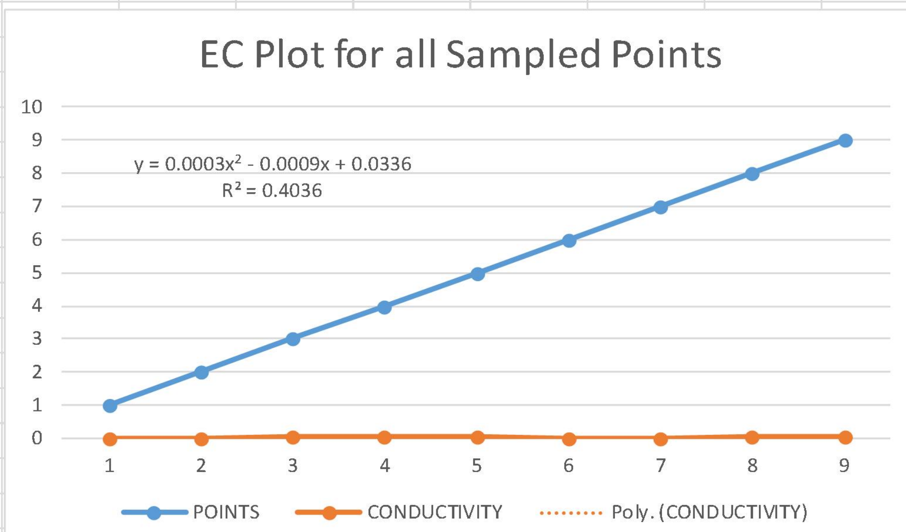

Fig 14: Electrical Conductivity Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
PHOSPHATE	0.09	0.07	0.06	21.52	25.29	26.17	24.91	23.22	22.16

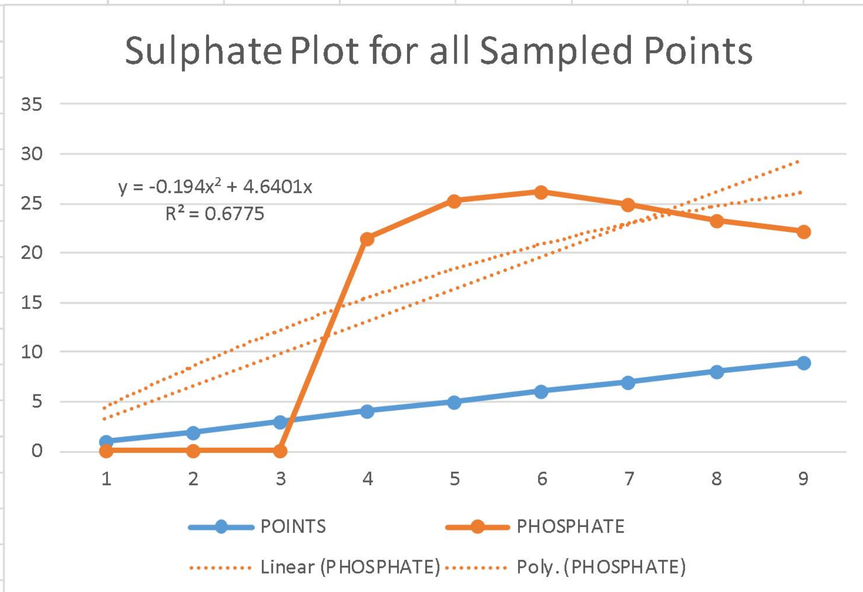

Fig 15: Sulphate Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
COD	37.4	42.6	65.8	60.6	52.1	30.3	20.9	18.5	16.25

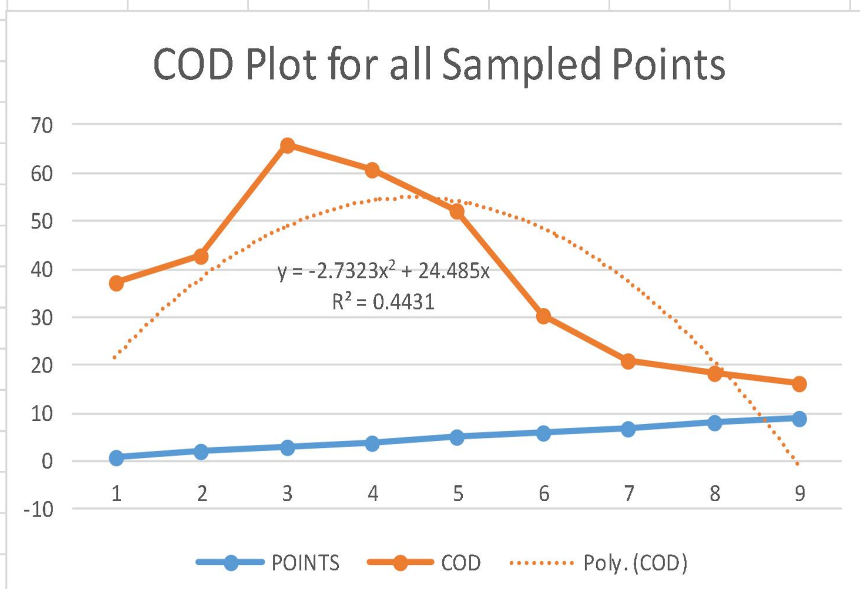

Fig 16: COD Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
SALINITY	0.3	0.08	0.2	0.24	0.3	0.18	0.25	0.7	0.4

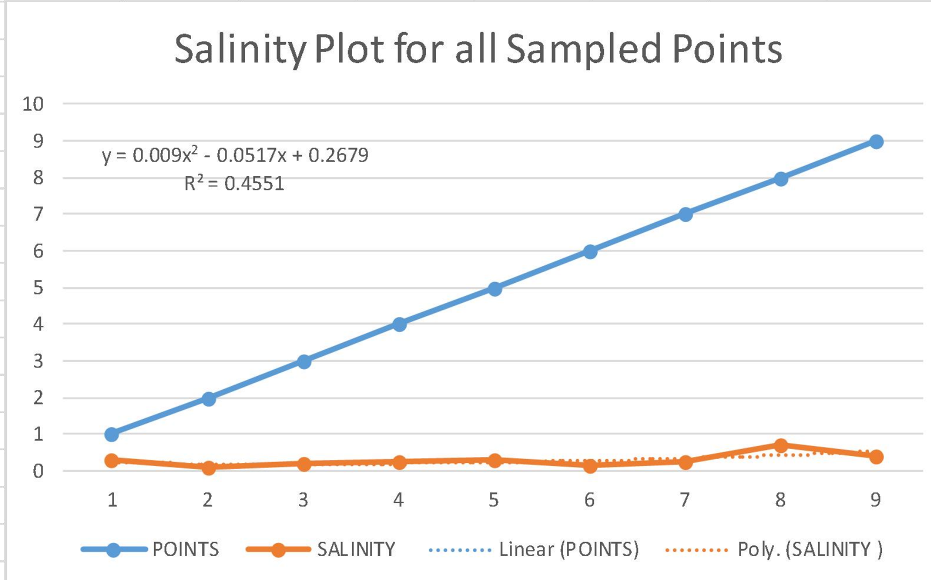

Fig 17: Salinity Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
NITRATE	0.13	0.15	0.17	0.19	0.2	0.22	0.25	0.27	0.28

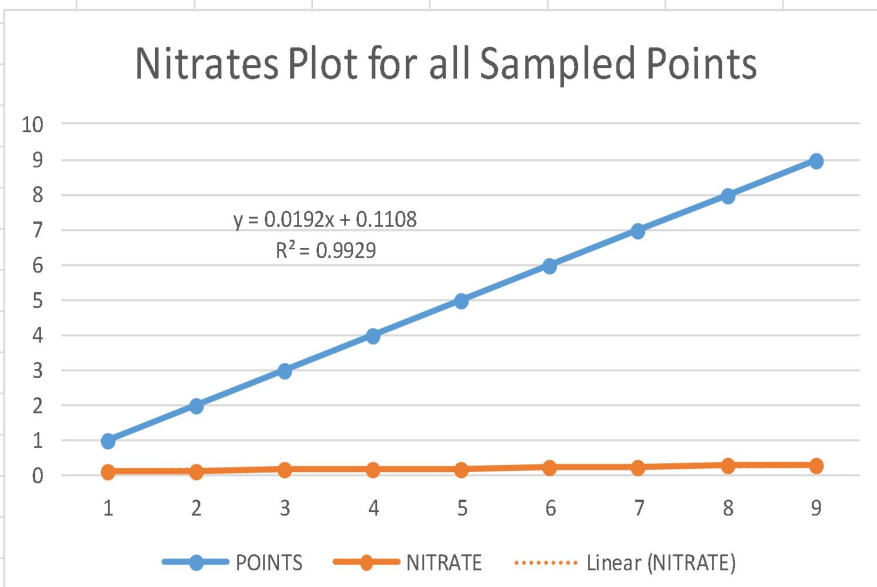

Fig 18: Nitrate Plot for All Points Sampled

POINTS	1	2	3	4	5	6	7	8	9
THB	279.33	264	259.33	234.67	221.33	284.67	258.33	265.33	275.33

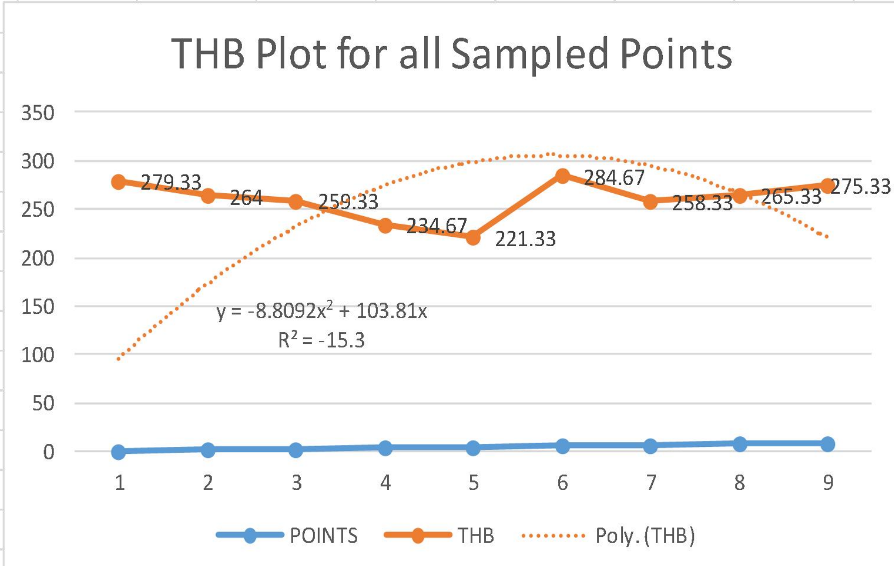

Fig 19: Total Heterotrophic Bacteria Plot for All Points Sampled

3.2 Discussions

Figures 2 to 19 show the various plots of all parameters sampled. The sampling was done from 9 designated points along the length of the river. The coordinates of the sampled points are as shown in table 1 and figure 1 above.

The least temperature of 25.0^0C was recorded at point 7. This may have resulted from the presence of water plants, which formed shades and led to reduction in the water temperature. The average minimum and maximum temperatures ranged between 25.0^0C and 27.7^0C. These temperatures are within the WHO recommended limits of 24^0C – 28^0C.

The pH values recorded at the different stations showed values that ranged from 3.37 – 7.39 The highest value of 7.39 was recorded at station 6 and the lowest pH value of 3.37 was recorded at stations 8 and 9. When compared to the World Health Organization recommended range of 6.5-8.5 for potable water (WHO, 2011), the values for the catchment, apart from stations 8 and 9, were within the guidelines. Points 8 & 9 showed level indicative of acidity, which may be due to the deposition of acid forming substances. The water was found to be capable of sustaining an aquatic ecosystem as a pH of 5 and below is what considerably reduces the productivity of aquatic ecosystem. A high pH increases the toxicity in water while low pH enhances the toxicity of Hydrogen Sulphide (H_2S) and Cyanide, (Jones, 1964).

Turbidity measures the murkiness of the water. It is a measure of the dispersion of light in a column of water due to suspended matters. The cloudier the water appears, the higher the turbidity. The least turbidity value

0.124 Nephlometric Turbidity Units (NTU) was recorded at point 1. It might be that this portion of the river experience higher flow velocity, thereby reducing turbidity. The highest value of 0.232 NTU was obtained at point 5. It may be that this portion experience low flow which led to growth in aquatic flora and hence, high turbidity (Lelininger, 1982, Zahraa et al, 2012).

The calcium values for the different points ranged between 0.14mg/l and 0.248mg/l. The least value of 0.140mg/l was recorded at point 2 and the highest values of 0.248 was recorded at point 1. A comparison of the values obtained with the values recommended by World Health Organization (WHO, 1985) and (FEPA, 1991), showed that the values were lower than the international permissible limit of 75-200mg/l for calcium. This water when ingested, might likely induce weak bones and poor tooth formation.

The Total Dissolved Solids (TDS) values for individual points ranged between 0.400 – 1.600mg/l. The highest value of TDS was recorded at point 7 and the lowest value was recorded at point 9. This may be as a result of low anthropogenic activities at point 9. The low average values obtained makes the water suitable for aquatic organisms and fishing. The TDS values were very low compared to the WHO (2011) recommended standard of $800.0e\text{-}^{4}$. Low TDS are indicators of low erosive actions in the area. TDS is a vital parameter which imparts an unusual taste to water and makes it less potable (Mohamed, 2012).

The Dissolved Oxygen (DO) values for the individual sampling points ranged between 1.5 to 5.6mg/l. The least value of 1.5mg/l was recorded at point 9, while the highest values of DO were recorded at points 2 & 5. WHO (2011), prescribed a range of 3-7mg/l. This accounts for the high yield of fish and other aquatic organisms' population being experienced in the river for most parts of the year. It has been observed that when the concentration of TDS in waste water is high, the ability of such water to absorb oxygen is reduced. (kMohammed and Zahri, 2012)

The BOD value obtained at the different points ranged from 10.0 – 34.4 mg/l. The least value 16.0mg/l was recorded at point 9 and the highest value of 34.4mg/l was recorded at point 5. The BOD values are indications of high biochemical activities. Due to high level of human activities, there was a high level of decomposition of organic materials such as leaves, cassava peals, domestic food items, etc at location 5. However, all the BOD values were higher than the World Health Organization and FEPA standards of 4-10ppm, indicating high level of pollution of the water, (WHO, 1971, FEPA, 1991). Water having BOD value of less than 4mg/l is deemed reasonably clean, while the one with BOD greater than 10mg/l is deemed polluted (Teras, 1975; Toms 1975). The greater the BOD, the more rapidly oxygen is depleted in the river and less oxygen will be available to the aquatic lives.

The sodium values for individual sampling points ranged between 0.0074mg/l – 0.076mg/l. The least of 0.007mg/l was recorded at point 9. All the values obtained when compared with the World Health Organization recommended value of 200mg/l were low and far from the acceptable limit. Thus, this is an advantage for iron work and pluming work because of the anticipated reduction in corrosion. However, for aquatic and human lives with moderate to high demand for sodium consumption, the water may not be fit for drinking because of the health benefit of sodium.

The K^+ values for the individual sampling points ranged between 0.059 – 0.215mg/l. The least value of 0.059mg/l was recorded at point 6 and the highest of 0.215mg/l was recorded at point 3. All recorded values were low when compared with the WHO recommended value of 200mg/l. This was considered a great disadvantage for potability and for aquatic floras and faunas.

The alkalinity values of the individuals sampling point ranged from 3.40 mEq/l– 11.90 mEq/l. The least value of 3.40, was recorded at point 3 and the highest value of 11.90, was recorded at point 10. The values were very low compared to WHO recommended standards of 500. This is not necessarily a problem, but it can lead to ammonium ion build up due to lack of alkalinity.

The Total Suspended Solids values for the individual sampling points ranged from 0.800mg/l – 1.960mg/l. The recorded values, when compared with the WHO recommended standard of 0.75ppm, were found to be above the permissible limit. This was a disadvantage to the river as this can prevent oxygen absorption, promote cloudiness of the river which may be disadvantageous to aquatic life as well as recreational activities along the river.

Ammonia values for the individual sampling points ranged from 0.104mg/l – 0.139mg/l. When the values were compared with the WHO recommended standards of 1.5mg/l, the values fell below WHO's standard. Ammonia is quite toxic to aquatic life; it causes stress and damages gills and other tissues. Thus, fishes exposed to impermissible levels of ammonia overtime are susceptible to bacterial infection and poor growth.

The values of electrical conductivity for the individual sampling points ranged from 0.03 – 0.05. The least value of 0.03 were recorded at points 1, 2, 6, 7, while the highest values were recorded at points 8 and 9. The values were compared with the recommended WHO standard of 400, and there were very low or below the WHO's standard rating. This indicates low ions and conductivities exchange. It shows low rate of dissolved salt, inorganic chemical, low temperature as well as low degree of chemical runoff from agricultural and aquaculture activities. This is an advantage to the aquatic life.

The phosphate values for the individual sampling points ranged from 0.06mg/l – 26.17mg/l. The least value of 0.06 was recorded at point 3 while the highest value of 26.17 was recorded at points 6. The values when compared to the WHO recommended range of 500 were very low, indicating low eutrophication of the river and harmful algal bloom. This naturally results in increase in oxygen which is very essential for growth in aquatic life.

The Chemical Oxygen Demand values for the sampling points values ranged from 16.25 – 65.8. The least value of 16.25 was recorded at point 9 while the highest value of 65.8 was recorded at point 3. When the values were compared with the recommended WHO standard of 120ppm, the values were low. This militated against microbial growth in the river. It also indicated low presence of all forms of organic matter, both biodegradable and non-biodegradable.

The THB value for individual sampling point ranged between 221CFU – 279.33CFU. The least values of 221 was recorded at point 5 while the highest value of 279.33 was recorded at point 1. These values are within the WHO recommended limit of 250CFU, except for sampling point 1 that is above the WHO's standard. This may be as a result of high human activities at that point such as domestic activities, agricultural activities and high rate of deposition of human wastes. This can be a breeding ground for non-dangerous bacteria such as legionella or E. coli which can cause foul-taste in the water.

The salinity values for the individual sampling points values ranged between 0.0800mg/l – 0.700mg/l. The least value of 0.0800 was recorded at point 7. When compared with the WHO recommended standards for drinking water, values were low. This is good for aquatic life. Salinity affects the quality of water for drinking and irrigation. High level of salinity can lead to death of aquatic life, reduction in plant production and undesirable taste in drinking water.

The nitrate value for the individual sampling points ranged from 0.2mg/l – 0.28mg/l. The least values of 0.2mg/l was recorded at point 5 while the lightest value was recorded at point 9. Values were found to be low when compared with WHO recommended standard of 50mg/l. Nitrate is an undesirable ion in water. Hence, high level of it will affect the river water and aquatic life. Nitrate can be harmful especially for babies, and can cause blue-baby-syndrome (methemoglobinemia).

4.0: Conclusion and Recommendations

Water quality is vastly dependent on the physical, chemical and microbiological conditions of the stream. This study revealed that the Great Kwa River is vulnerable to physicochemical as well as bacteriological compromise. The results revealed inadequacy in very basic potability parameters. In clear terms, no sampling point analysis met the WHO (2011) standard for potability and other rudimentary utilization apart from washing and recreational activities in part. From the foregoing, it could be deduced that the Great Qua River is threatened.

It is therefore recommended that there is an urgent need for continuous monitoring of the river water and identifying the pollution sources to protect the river from further threat.

Even though a flowing river should be self-cleansing, there is need to educate the shoreline dwellers not to defecate into the river because of its attendant problems. Government agencies saddled with the responsibility of the protection of the environment should be detailed to carryout enlightenment programs and advocacy to sensitize the people on the importance of the river water in preservation of the aquatic milieu. There should be stringent laws and punitive measures against the use of chemicals and explosives in fishing.

References

American Public Health Association Standard (APHA), 2005.

Cookey, P (2001), *water policy reform; earth watch publication No. 2* Cookey Environmental Public Health Services (CEPHS) Publications, Port Harcourt, Nigeria, PI.

EC (European Council) (1991) *Consolidated Text produced by the CONSLEG* system of the office for official publications of the European Communities council directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the member states (75/440/EEC) office for official publications of the European communities CONSLEG: 1975L044031/12/991.

Eze, S. and Madumere I. (2012). *Physicochemical and microbiology analysis of water bodies in Uturu, Abia State, Nigeria,* Annual Joint Scientific Conference, 1, 50-65.

Federal Environmental Protections Agency, FEPA (1985) *National Interim Guidelines and standards for Environmental Pollution Control in Nigeria Delta.*

Federal Environmental Protections Agency, FEPA (1991) *National Interim Guidelines and standards for Environmental Pollution Control in Nigeria Delta*, pp 54-58.

Global Risks (2015) *World Economic Forum*. http://reports.weforum.org/global-risks-2015/part-1-global-risks-2015/introduction Accessed 10 May, 2015. WHO (2011) Guideline for drinking water quality, 4th ed. World Health Organization, Geneva.

Horton, R. K., "*An index number system for rating water quality*" Journal of the water pollution control federation, 37 (3) 300-305. 1965.

Jones, J. R. E. (1964). *Fish & River Pollution*. Burthworths London. P74.

K. Mohamed Sheriff and Zahir Hussain, (2012). Adv. Appl. Sci. Res., 27 (4) 475-480.

Lehninger, A. L., (1982). *Principles of Biochemistry, School of Medicine*, the John Hopkins University. CBS Publication and Distribution, Delhi, India, p85.

Niemi GJ, Devore P, Detenbeck N, Taylor D, Lima A (1990). *Overview of case studies on recovery of aquatic systems from disturbance*. Environ Manag 14:571-587.

Ojelabi, E. O, 2001. *Water supply scheme to rural Nigeria*: community, private sector and government participation in improving water supply. Water front publication. Lagos, Nig. 1(1) p 13-14.

Pamar K, Parma V (2010). *Evaluation of water quality index for drinking purposes of river* subermarekha in singublum district, Int J Environ Sci 1:17-81.

Taras, M.J. (1975). *Water Analysis. Department of Water Supply*, Deteriot Michigan, p81.

Toms, R. G. (1975). *Management of River Quality in River Ecology* (Studies in Ecology vol. 2) Whitton, B. A. Blackwell (Eds) *Scientific Publications,* Osweymead, Oxford London, p101.

WHO (1971). *International Standards for Drinking Water* – World Health Organization Phib (3rd ed.) Geneva.

World Health Organization (2011). *WHO Guidelines for Drinking Water*, 4th edition. http://www.who.int.

World Health Organization (WHO) 2011. *Guideline for Drinking Water Quality*, Geneve: WHO Press, 4th ed.

Zahraa, A, Abdul-Rahman, A, Abdul-Hameed, M.J, (2012). Journal of Al-Nahrain University, 15(1) 119-126.

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