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Original Research Article

Evaluation of Pollution Status of Great kwa River Calabar, Cross River State, Nigeria

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ABSTRACT

This study was specially designed to evaluate the water pollution status in Kwa River Calabar, Cross River State. The objectives of the study are, to examine the causes of pollution in the study area, examine the effects of water pollution on the inhabitance of the study area, to determine the physico-chemical and bacteriological parameters of the study area.To proffer solutions and control measures for water pollution in the Great Kwa River. The hypotheses for the study were as follows. There is no statistically significant difference in the physic-chemical characteristics of water samples in the wet and dry seasons from the Kwa River. The findings indicate that H_1: x = y i.e. there is significant relationship between the physic-chemical characteristic of wet and dry seasons since the calculated f is 2.281137 and p-value is 0.028836 thus, we reject the null hypothesis and accept the alternative hypothesis. H_0: There is no statistically significant difference between bacteriological characteristics of water samples in the wet and dry seasons from the Kwa River, H_1: There is statistically significant difference in the bacteriological characteristics of water samples in the wet and dry seasons. The null hypothesis is a hypothesis of no difference of the form. H_0: x – y i.e. there is no significant relationship between the bacteriological characteristics of wet and dry seasons since the calculated f is 0.287.877 and p-value 0.953932, thus we reject the alternative hypothesis and accept the null hypothesis.

KEY WORDS: Evaluation, Pollution, Status and Kwa River.

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INTRODUCTION

Water pollution is a global problem which requires evaluation and revision of water resource policy at all levels. It has been suggested that water pollution is the leading worldwide cause of global public health threat, placing people at risk for a host of diarrhea and other diseases as well as chemical intoxication Hughes & Koplan, (2005). Most of the water bodies are polluted as a result of some anthropogenic activities such as agricultural activities, artisanal fisheries activities, lack of waste treatment facilities, and heavy rains washing human and industrial wastes into the rivers. These constitute the primary pollutants (Omole, and Longe, 2008; Pejman, 2009; Iwara et al., 2012). The composition of these effluents from the human factor varies, effluents from industries which contains acids, hydrocarbons and atmospheric depositions, whereas those from agricultural runoff contains large amount of nitrogen compound and phosphorus from fertilizers, pesticides, salts, poultry wastes as well as runoff from abattoir Omole and Longe *et al.,* (2008). As a result of all these, most of the freshwater bodies all over the world are getting polluted, thus decreasing the portability of water from these rivers.

Rivers serve multiple uses, most of them being critical to human settlement and survival. Such uses include portable water abstraction, fisheries exploitation, transportation, irrigation, animal husbandry, water abstraction and recreation (Omole and Longe et al., 2008).

The Great Kwa River is one of the major tributaries of the Cross River Estuary. It takes its rise from the Oban Hills in Nigeria, flows southwards and discharges into the Cross River Estuary.Apart from artisanal fisheries which targets mainly the macrobrachium human activities within the Great Kwa Catchment is limited to small scale farming and aquaculture. With increasing population pressure associated with the export free zone status of Calabar, human settlement and industrial layouts are spreading rapidly into the freshwater of Great Kwa River (Eze and Effiong, 2010).

In addition to the acute problems of population growth in third world countries, developing countries also struggle to cope with pollution problems.WHO and UNEP(1991) asserted that, every year biological and chemical agents in the human environment such as air, water, and land causes premature death of millions of people, mostly infants. Therefore, water quality is essential and has become an issue of environmental concern because of its vital roles. Also, a case study of Oban Hills, in Aningeje community, Calabar Municipality Local Government Area of Cross River State, Nigeria has shown that, over 100 people die of water related illness every day, and that 60% of the water bodies in the study area is polluted as at 2007, half of the population had no access to safe drinking water(Ekpoh,2008).

Onweluzo & Akugbazie, (2010) explained that water of good quality is of basic importance to human physiology and man's existence depends very much on its availability. An average man of (53kg – 63kg body weight) requires about 3 liters of water in liquid and in food daily to keep the body healthy (Abua, and Ajake 2014; Digha and Abua 2005, Okonko et al., 2008). Etim et al., (2013), affirms that, this fact apparently accounts for why water is regarded as one of the most indispensable substance in life, like air. Umeh et al., (2005), says that increase in human population extended an enormous pressure on the provision of safe drinking water especially in developing countries like ours.

According Okeke & Oyebande, (2009), opined that typhoid fever, diarrheal, hepatitis and cryptosporidiosis are the major water borne diseases common in a polluted water environment. Njoku, (2012) also noted that, communicable diseases which are transmitted by water include, bacteria viral, and protozoa infections.

The increase of outbreak of water related diseases such as cholera, dysentery, diarrhea and typhoid may be connected with the water quality in the area. By and large, this research is focused on the assessment of pollution status of the Great Kwa River in Cross River State.

Aim and Objectives of the Study

The aim and objective of this study is:

(a) To examine the different causes of pollution in the Great Kwa River

(b) To determine the effects of pollution on the inhabitants of the study area

(c) To determine the physico-chemical and bacteriological parameter of the Great Kwa River

(d) To provide solutions or control measures for water pollution in the Great Kwa River.

Statement of Hypothesis

The underline hypotheses are constructed to guide and direct the research:

H_0: There is no statistically significant difference in the physico-chemical characteristics of water samples in the wet and dry seasons from the Kwa River

H_1: There is statistically significant difference in the physico-chemical characteristics of water samples in the wet and dry seasons from the Kwa River

H_0: There is no statistically significant difference in the bacteriological characteristics of water samples in the wet and dry seasons from the Kwa River

H_1: There is statistically significant difference in the bacteriological characteristics of water samples in the wet and dry seasons from the Kwa River

Study Area

The Southeastern Nigeria, the Great Kwa River water shed which was originally covered by tropical rainforest has now become a believer of various agricultural extractive and industrial activities in Calabar Municipal Local Government.

The Great Kwa River is one of the major tributaries of the Cross River Estuary. It takes its course from the Oban Hills in Aningeji, Community in Cross River State, Nigeria which flows southwards and discharges into the Cross River Estuary around Latitude 4 45N and Longitude 8^0 70^0E of the equator. The lower researches of the river drain the eastern coast of the Calabar Municipality, the capital of Cross-River State of Nigeria, (Ekpoh, 2008).

Location and Extent

The area Calabar Municipality is located at the South Eastern part of Cross River State in Nigeria. It is between longitude 20^0E and latitude 4^0 45^0N of the equator.

The town is flanked by the Great Kwa River in its South and it has a common boundary with Odukpani, Calabar South and Akpabuyo Local Government Area in its North, West and East respectively.

The geology of the study area comprises the tertiary sandy deposits of fluno marine origin which are overlaid by quaternary silty and clayed alluvium, eroded from Oban Hills in the outstanding. This characteristic poorly consolidated non-cohesive and porous rock formation permits large accumulation of ground water with slight variation of difference rainfall regimes, Ekpoh, (2008).

The study area is marked as a highly undulating, rugged topography comparism dissected regular terrain of weather, sheep, ridges and deep troughs the attitude vary from about 10 – 65 meters, about sea level with sharp gradation down slope the site lies within the Calabar flank geosynclines which extends from the southern margins of the Oban Massif in the eastern hinge line of the Niger Delta in the West structural, the Chariot ocean transform faults separates the Calabar flank basin from the Niger Delta Basin. Rocks of Cenomenians age occur only north of Calabar, which unite together to form the Odukpani group, Ekpoh (2008).

The climatic condition of the study area, is one that is however influenced by the interaction of two air masses, one originating from the Atlantic Ocean (tropical Maritime) MT, and the other dry dusty tropical continental (CT) air mass originating from the Shara Desert. These two air masses alternate seasonally with each other, but the tropical maritime (MT) domineering influence over the area because of the nearness of the area to the sea which has an effect on the annual rainfall in the area.

Rainfall is therefore very high in this region. With an annual rainfall of over 200mm to 3000mm, the region is ranked the highest among stations receiving heavy precipitation in the coastal zone of Nigeria, (Ekpoh, 2008). The temperature of the area falls below 19^{0c} with an average of 27^{0c} annually. The relative humidity is usually between 80-100 percent and a vapour pressure of an average of 29 Millibar annually, (Ekpoh, 2003).

The vegetation of the study area is a typical tropical rainforest and it is characterized by these layer canopies with the emergent trees. It is a closed canopy forest (60 – 100) species per sqkm) with 3 – 4 layers, the canopy weight of this forest is between 25 – 50m tall with emergent trees up to 100m high the trees had buttress smooth bark and columnar roles. Truck stemmed woody climbing plants (leaves) were common as well as epiphytes and other herbs. (Ekpoh, 2008).

The 2006 census determined the population of the Calabar Municipal Council area of Cross River State of Nigeria was 59,000. (NPC, 2006).

There are two main ethnic groups from the indigenous population and these are the Quas and Efiks. However, because of its cosmopolitan status there abound people from all parts of the state in Nigeria in the city. (NPC, 2006).

FIG. 1: Map of Great Kwa River (Study Area).

Source: *Geographic Information System (GIS) Laboratory, Department of Geography and Environmental Science, University of Calabar.*

MATERIAL AND METHODS

Water samples will be collected from the three mentioned points for a period of two months (once per week) with ragolis plastic containers prior to sample collection. The three plastic containers were thoroughly washed and sun dried before collecting the samples. The ragolis plastic containers were rinsed twice with the water sample (river) to be collected. The sampling containers were afterward been labeled with dates at collection sources (points). Thereafter, collected water sample were taken to the laboratory for analysis of the aforementioned physicio-chemical and bacteriological (caliform content and total heterotrophic bacteria) parameters. Prior to analysis, collected sample were stored in a cooler at 4^0c.

The purposive sampling will be used to choose three points along the river. The point includes: discharge point (DP), upstream (US), and Downstream (DS).

Data obtained from the laboratory were to be analyzed using descriptive statistics. The table, simple percentages, charts and means (average). Anova statistics was used to test the hypothesis. The values were compared with the World Health Organization (WHO) standards to drinking water to determine its likely effect on human health.

DISCUSSION OF FINDINGS

Table 1 presents result of the physic-chemical and bacteriological analysis of Kwa River samples of dry and wet seasons.The table 1 shows the physico-chemical and bacteriological analysis of Kwa River.

Result of the analysis for the bacteriological parameters during the wet season indicates that, the total coliform/10ml for the four samples varies between 153 to 196. Sample one has a value of 153cfu/100ml, sample two has a value of 165cfu/100ml, sample three with a value of 196cfu/100ml and sample four has value of 178cfu/100ml. It was observed that, the highest concentration occurs in sample three. The results of the total coliforms indicate that all the values were above the World Health Organization (WHO) standard for drinking water. However, the values indicate a very serious health implications on the inhabitant who relies on this source of water for domestics uses. Moreso, the result of the analysis indicates that the feacal coliform for the four samples varies from between 140 to 171. This shows that, the highest concentration occurs in sample three. Above all, the results of total bacteria count, colifrom and salmonella – shigella count were above WHO standard for drinking water. This indicates serious health implication on the users of the water body.

Results of bacteriological parameter analysis during the dry season indicates that the total colifrom count/100ml for the samples varies between 205cfu to 212cfu. Sample one has a value of 205cfu, sample two has 210cfu, sample three 209 and sample four has 212cfu. It was observed that the high concentration occurs in sample four. The results further indicate that, all the samples were above the WHO standards for safe drinking water. This indicates serious health implications on inhabitants. The results of feacal coliform count, salmonella – shigella count, total bacteria and E-coli count also varies. For total bacteria count it varies between 143cfu to 160cfu. Salmonella – Shigella count varies between 71cfu to 90cfu and E-coli count varies between 43cfu to 50cfu and the total feacal coliform count varies between 163cfu to 179cfu with each and every sample varying in its count but at the end of it was observed that in the four samples of each of the bacteriological parameters were above the WHO standard of drinking water.Comparing the bacteriological characteristics of both wet and dry season it was observed that the values of the bacteriological parameter value of each the samples, during the dry season was more concentrated than the wet season.

Table 1: Physio-chemical & bacteriological analysis of Kwa River Samples Analysis result of both wet and dry seasons

		Wet Season					Dry Season			
		S_1	**S_2**	**S_3**	**S_4**	**WHO**	**S_1**	**S_2**	**S_3**	**S_4**
S/N	**Parameter/Unit**									
1	Appearances	**Objectional**	**Objectional**	**Objectional**	**Objectional**	**Clear**	**Objectional**	**Objectable**	**Objectable**	**Objectable**
2	Colour	20	20	20	20	<5	>7	>71	>70	>72
3	Temperature (O^oc)	27.0	27.01	27.0	27.02	2.5^0c	29.9	28.8	30	30.1
4	P^H	5.44	5.45	6.68	6.66	6.5-8.5	6.82	6.9	70	7.2
5	Turbidity (NTU)	5.02	5.07	43.0	5.22	<5	19.3	20.01	20.3	20.5
6	Conductivity (us/cm	14.31	16.13	17.48	17.25	1000	64.6	64.9	65	65.9
7	Dissolved oxygen (DO)	7.0	7.00	9.0	8.01	0	13.0	13.5	14.1	14.5
8	Total Dissolved Solid (TDS)	8.59	8.47	10.49	9.36	500	38.76	39.01	140.1	40.5
9	Total Suspended Solid (TDS)	0.02	0.01	0.01	0.03	0	0.563	0.665	0.720	0.81
10	Total Iron (Mg/L) fe	0.71	0.73	1.75	0.74	0.3	1.86	1.91	1.89	1.90
11	Total Hardness	17.1	17.1	17.1	17.1	150	34.2	34.5	35.4	35.7
12	Total Alkalinity (mg/L)	7.43	7.42	7.70	1.86	100	7.94	8.01	8.74	8.77
13	Manganese(mg/L)	0.12	0.13	0.46	0.36	0.1	0.285	0.289	0.389	0.390
14	Magnesium (mg/L)	10.3	10.20	11.5	10.35	150	9.50	20.05	20.50	20.55
15	Calcium (mg/L)	6.80	6.76	5.6	5.78	200	14.70	15.01	15.70	16.75
16	Nitrate (mg/L)	3.40	3.48	14.7	14.06	0.2	4.50	5.50	5.40	6.40
17	Nitrate (mg/L)	0.23	0.36	1.66	1.00	30	0.30	0.40	0.35	0.45
18	Ammonia (mg/L)	0.80	0.96	1.20	1.47	0.4	0.70	0.80	0.75	0,85
19	Ammonium (mg/L)	0.42	0.48	0.80	0.78	0.5	0.55	0.68	0.59	0,70
20	Sulphate (mg/L)	4.50	4.90	15.9	14.06	400	6.90	7.09	7.90	7.95
21	Phosphate (mg/L)	1.85	3.00	5.02	4.25	3.5	3.05	3.07	4.04	4,09
22	Fluoride (mg/L)	0.16	0.42	0.76	0.67	1.5	0.34	0.36	0.39	0.40
23	Copper (mg/L)	0.21	0.28	0.70	0.58	1	0.72	0.77	0.75	0.80
24	Zinc (mg/L)	1.08	2.03	2.55	2.40	3	2.02	2.05	3.02	3.03
25	Total coliform count 100L	153cfu	165cfu	196cfu	178cfu	0	205cfu	210cfu	209cfu	212cfu

26	Feacal coliform count 100L	140cfu	152cfu	171cfu	168cfu	0	163cfu	169cfu	173cfu	79cfu
27	Total E coliform	168cfu	173cfu	202cfu	197cfu	0	143cfu	150cfu	149cfu	160cfu
28	Salmonella-Shigella	74cfu	80cfu	125cfu	160cfu	0	71cfu	79cfu	85cfu	90cfu
29	Total E-coliform	51cfu	58cfu	76cfu	64cfu	0	43cfu	45cfu	47cfu	50cfu
30	Sodium, Nat	6.00	6.88	1.20	1.25	200	9.02	10.01	11.02	11.05
31	Potassium, K^+	1.9	10.40	10.00	10.01	10-12	1.10	2.10	1.9	2.12
32	Chlorine, Cl_2	10.05	10.40	10.10	10.9	0.5	10.22	10.25	10.23	10.27
33	Chromium, Cr^{6+}	10.06	10.08	10.06	10.09	0.04	16.00	18.02	20.01	19.00
34	Arsenic, AS	10.00	10.08	10.10	10.02	3.00	10.60	10.09	10.12	10.14
35	Salinity, Nacl	18.00	16.00	10.00	19.02	38-28	18.00	16.00	10.00	14.00
36	Magnesium hardness	12.00	10.00	10.01	10.02	12	12.20	17.00	16.01	10.12
37	Calcium Hardness	17.00	10.02	10.02	10.03	12	10.10	12.00	9.00	14.10

Test of null hypothesis 1 (physico-chemical characteristics)

Table 2: shows the results of Analysis of Variance (ANOVA) on eight (8) water samples collected from Kwa River. (See Table 1). The data considers the values of the physicochemical parameters detected from water samples collected. Four samples 1, 2, 3 and 4 were collected in the wet and dry seasons respectively.

Table 2: ***Results of Analysis of Variance (ANOVA) on wet and Dry Seasons water samples collected from kwa River for the Physico-chemical Analysis ANOVA***

Summary for wet and dry seasons samples

Groups	*Count*	*Sum*	*Average*	*Variance*
Sample 1 wet season	31	227.5	7.33871	49.28065
Sample 2 wet season	31	236.85	7.640323	45.86314
Sample 3 wet season	31	292.55	9.437097	83.02482
Sample 4 wet season	31	250.35	8.075806	49.18681
Sample 1 dry season	31	418.748	13.508	309.9311
Sample 2 dry Season	31	441.744	14.24981	312.9981
Sample 3 dry season	31	605.319	19.52642	892.4775
Sample 4 dry season	31	452.04	14.58194	323.0959

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4123.442	7	589.0632	2.281137	0.028836	2.047864
Within Groups	61975.74	240	258.2322			
Total	66099.18	247				

This is meant to test Null hypothesis (H_O) which states that "there is no statistically significant difference in the physico-chemical characteristics of surface water samples in the wet and dry seasons from the Kwa River". The alternative hypothesis states that: "there is statistically significant difference in the physico-chemical characteristics of surface water samples in the wet and dry seasons from the Kwa River".

The "Sum of squares" showed in table 2 shows the sum of squared deviation about some quantities. "Df" shows the value associated with a test statistics that is used in determining the observed. The mean square indicates the sum of squares divided by the degree of freedom. From the F-value we can observe the ratio of two mean squares. When F-value is large and the significance level is small (typically smaller than 0.05 or 0.01) the null hypothesis can be rejected. In other words, a small significance level indicates that the results probably are not due to random chance. The "Sig-value" however shows the conditional probability that a relationship as strong as one observed in the data set would be present, if the null hypothesis were true. It is often called the P-value. Consequently, a look at table 2 shows a F-value of 2.281137 and a P-value of 0.028836. Since the F-value is large and the P-value is lower than 0.05 significance level, there is a statistically significant difference. Thus we reject the Null hypothesis (H_O) which states that: "there is no statistically significant difference in the physico-chemical characteristics of surface water samples in the wet and dry seasons from the Kwa River". We thus accept, the alternative hypothesis (H_1), which states that: "there is a statistically significant difference in the physico-chemical characteristics of surface water samples in the wet and dry seasons from the Kwa River". We can assume that the differences in the seasons, and invariably the differences in the volume of run-off water, as well as the quantity of water in the river channels tend to cause a difference in the level of concentration of the physic-chemical parameters. This could reduce concentration levels, due to rapid run-off, although transportation of pollutants from land into the rivers may also be high. During the dry season the reduction in the quantity of water in the river channel and the evaporation rate tend to increase the level of concentration of the physic-chemical parameters detected.

Test of Hypothesis II (Bacteriological Characteristics)

Table 3 displays the results of the Analysis of Variance (ANOVA) for data collected on the bacteriological parameters from water samples collected from the same Kwa River, during the dry and wet seasons. This result is meant to test the Null hypothesis (Ho) II, which states that: "there is no statistically significant difference in the bacteriological characteristics of surface water samples in the wet and dry seasons from the Kwa River". The alternative hypothesis (Hi) states that: "there is statistically significant difference in the bacteriological characteristics of water samples in the wet and dry season from the Kwa River"

Table 3: ***Results of the Analysis of Variance (ANOVA) on the Bacteriological Characteristics of Sampled Water from the Kwa Rivers during the Wet and Dry Seasons***

ANOVA: WET and DRY Season Bacteriological

Summary

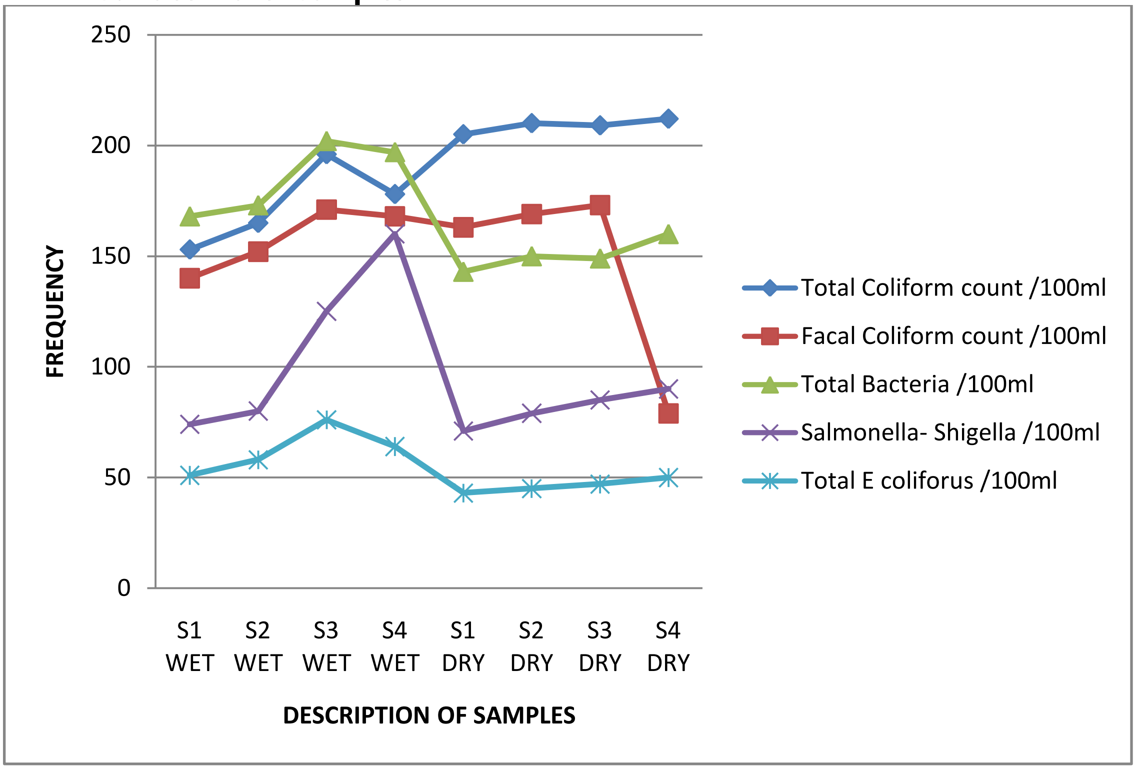
Groups	*Count*	*Sum*	*Average*	*Variance*
wet 1	5	586	117.2	2657.7
wet 2	5	628	125.6	2786.3
wet 3	5	770	154	2820.5
wet 4	5	767	153.4	2688.8
dry 1	5	625	125	4452
dry 2	5	653	130.6	4536.3
dry 3	5	663	132.6	4332.8
dry 4	5	591	118.2	4382.2

ANOVA

Source of Variation	***SS***	***Df***	**MS**	***F***	***P-value***	***F crit***
Between Groups	7218.375	7	1031.196	0.287877	0.953932	2.312741
Within Groups	114626.4	32	3582.075			
Total	121844.8	39				

It was observed from table 3 that, the F-value is 0.287877, while the P-value is 0.953932. This observation is not significant, since the P-value is higher than 0.05 confidence level. Thus we reject the alternative hypothesis, which states that: "there is a statistically significant difference in the bacteriological characteristics of surface water samples in the wet and dry seasons from the Kwa River". We can then accept the null hypothesis II. Based on this observation, we can assume that irrespective of the season (wet or dry) the frequency of bacteriological organisms found in the river water tend not to vary significantly. Figure 2 graphically present data on frequency of Bacteriological organisms detected in the wet and dry seasons.

Figure 2: Frequency of Bacteriological Organisms Detected in the Wet and Dry Seasons Surface Water Samples



We can gain even better insights into the data collected on the physico-chemical parameters of wet season only by looking at table4. The P-value is 0.70478, while the F-value is 0.46853. P- value is higher than 0.05. Thus, there is no statistically significant difference in the physico-chemical parameters in the four (4) water samples collected in the wet season.

Table 4*: Anova Results for Physico-chemical Parameters in Surface water Sample collected in the Wet season ANOVA*

Summary for wet season samples

Groups	Count	Sum	Average	Variance
Sample 1 wet season	31	227.5	7.33871	49.28065
Sample 2 wet season	31	236.85	7.640323	45.86314
Sample 3 wet season	31	292.55	9.437097	83.02482
Sample 4 wet season	31	250.35	8.075806	49.18681

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	79.89216	3	26.63072	0.46853	0.70478	2.680168
Within Groups	6820.662	120	56.83885			
Total	6900.555	123				

In table 5, the ANOVA results for Physico-chemical Parameters in Surface water Sample collected in the Dry Season is shown. It was observed that, the same no significant difference in the physico-chemical parameters determined within the four (4) water samples. The result indicates an F-value of 0.507678 and P-value of 0.677725. These shows that there is no statistically significant difference in the physico-chemical characteristics of the water samples collected from Kwa River in the dry season, as earlier observed in the wet season.

Table 5: ANOVA Results for Physico-chemical Parameters in Surface water Sample collected in the Dry Season ANOVA

Summary: dry season samples

Groups	*Count*	*Sum*	*Average*	*Variance*
Samples 1 Dry season	31	418.748	13.508	309.9311
Sample 2 Dry season	31	441.744	14.24981	312.9981
Sample 3Dry season	31	605.319	19.52642	892.4775
Sample 4Dry Season	31	452.04	14.58194	323.0959

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	700.0254	3	233.3418	0.507678	0.677725	2.680168
Within Groups	55155.08	120	459.6256			
Total	55855.1	123				

RECOMMENDATIONS

The physico-chemical and bacteriological analysis carried out in this work demonstrates that the changes in the level of pollution of each parameter are due to direct discharge of waste effluents from human and chemicals used during artisanal fishing.

It is therefore recommended that:

- The results of the physico-chemical and bacteriological analysis of Great Kwa River could be helpful in the management of the river for its water quality improvement.
- There is the need for all fishermen to collaborate law enforcing agencies ensure that the River water quality is not polluted.
- Anthropogenic influences within the catchment should be prohibited.
- There should be a public educated on the effects of industrial wastes disposal and the agricultural runoff into the River.
- Government should ensure periodic monitoring of the effluent discharge into the river and defaulters should be seriously punished.
- A vigorous health education programme, possibly through mass media and other local accessible media should be used in educating people about the health hazard of river pollution outcomes.

CONCLUSION

The Great Kwa River is one major sources of drinking water supply for the communities around Calabar Municipality.The result of the study reveals that the area is not free from bacteriological and physic-chemical pollution. However, care must be taken to ensure that the quality of water is maintained. The need for this arises as a result of activities in the area such as farming and animal husbandry. These activities have the potentials capable of polluting the river water. Thus, there is a need for proper monitoring and regular assessment of its quality to prevent the outbreak of water-borne diseases.

REFERENCES

Abua, M. A., Ajake, A. O. (2014). Water Quality Status around Animal Dung in Adiabo Catchment of Odukpani Local Government Area of Cross River State, Nigeria.

Amadi, A. N. (2012). Quality Assessment of Aba River using Heavy Mental pollution Index.

Barry, A. O. & Ekpoh, B. E. (2008). Environmental Continuity and Change. St. Paul Publishing Company, Calabar.

Charles, A. P. (2002). “Marine microbes digest plastic Nature (Macmillan).

CRSWB L. T. O. (2011). Quality Control Laboratory, Calabar, Nigeria.

Digha, O. N. & Abua, M. A. (2015). Assessment of pollution status of Ikwette stream at Obudu Cattle Ranch Bottom Hill, Cross River State, Nigeria. A paper in press.

E. R. Akpan, J. O. Offem, A. E. Nya. “Baseline ecological studies of the Great Kwa River, Nigeria 1: Physio-chemical Studies.

Edem, S. O. (2012). The effect of water pollution on the people of Okirika L.G.A. Rivers State p. 26 – 37.

Ekpoh I. J. (2005). Waste management and control in Nigeria.

ENIROPOL, (2014). Effect of water pollution, Lagos Nigeria.

Etim, E. E. Odoh, A. U. S. D. & Lawal, U. (2013). Water quality index for the Assessment of water quality sources in the Niger Delta Region of Nigeria, frontiers in science 3 (30:89 – 95).

Eze, B. E. & Abua, M. A. (2003). Water Resources Management; Ushie printers and Publishing Co. Ltd.

Eze, Eze Bassey; Effiong, Joel (September, 2010). “Morphometric parameters of the Calabar River Basin: Implication for Hydrologic Processes”.

Hughes, J. M. & Koplan, J. P. (2008). Saving life through Global safe water. *Journal of Emerging Infections Diseases,* 11 (10) 163 – 1637.

Moeset (1999). The integrated River basin management. *Environmental Engineering and Management Journal* 2, 4, 377 – 395.

Nation Pollution Census, NPC (2006).

NEST (2005). Nigeria’s Threatened Environment Index Printers Ltd, Ibadan Nigeria.

Njoku, A. A. (2012). Quality Assessment of Aba River using Heavy Metal pollution Index

American Journal of Environment Engineering. 2 (1), 4 – 49.

NSDWQ (2007). Nigeria standard for drinking water quality, Abuja.

Okeke, I. C. & Oyebande, L. (2009). Water Resources Challenges in Nigeria: Pathways to water security and sustainability improving integrated surface water and groundwater resources management in a vulnerable changing world. IAHS publication 330, 13116.

Okokon, I. O. Ogunjobi, A. A; Adejoye, A. P. Ogunnus, T. A. & Olasogba, M. C. (2008). Comparative Studies and Microbial Risk Assessment of different water samples used for processing frozen sea foods in Lora – Olopa, Lagos State Nigeria. *African Journal of Biotechnology.* 7 (6): 2902 – 2907.

Omole, D. O. & E. O. Longe, (2008). An assessment of the impact of abattoir effluent on River Illo, Ota, Nigeria.

Onweluzo, J. C. 7 Akuagbazie, C. A. (2010). Assessment of the Quality of Bottled and Sachet Water sold in Nsukka *Town Agric Science Journal of Tropical Agriculture Food, environmental and Extension.* 9 (2): 100-110.

Umeh, C. N., Okorie, O. I., Emesiani, G. A. (2005). Towards the provision of safe drinking water. The bacteriological quality and safety sachet water in Awka, Anambra State. In the book of abstract of the 29th annual. Conference and General meeting on microbes as agents of sustainable development, organized by Nigeria society for microbiology (NSM), University of Agriculture, Abeokuta, pp. 22.

WHO (2007). World Health Organization Standard for drinking water Geneva.