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1.1 Introduction

Water is one of the vital and abundant natural resources on earth. It is a universal solvent (Eboatu & Okonkwo, 1999) as such all life on earth depends on water for survival and sustenance. The usage however, depends on the quality and volume of water available. It is used for agricultural, domestic, industrial, recreational and environmental activities. The presence of any surface water in a given area and their quality is an indicator of the socio-economic conditions, environmental conditions and awareness, as well as the attitude of its users (Kumar *et al.,* 2017).

Water pollution has therefore become a growing concern over the last century as more and more wastes are being disposed of in our water ways that requires evaluation and revision of water re-source policy at all levels (Ashok *et al.,* 2013). Water pollution is often as a result of increased human population and urbanization which create issues in

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the aquatic ecosystem and hurting the animals and plant life, as well as human life that rely on it for survival (Egereonu *et al.,* 2012). Sadly the issue of water pollution (Fakayode, 2005) is even more severe in third world countries where there is no way to properly dispose of poisonous chemicals/materials and polluted water cannot easily be cleaned or treated.

Water according to Okieimen *et al.,* 2012 is considered polluted when there is change in its composition and condition making it less suitable for any or all of the functions and purposes in its natural state. Sources of polluted water may be from oil tankers and oil refineries, garbage from construction sites, city streets and residential lawns, improper disposal of hazardous materials from garbage disposal companies, chemical spills and improper chemical disposal, sewage leaks and agricultural runoffs (Tripathi *et al.,* 2015). According to WHO, 1994 water intended for human consumption must be free from harmful micro-organism, toxic substances, excessive amount of minerals and organic matter

In Nigeria, there is heavy dependence on surface water resources due to increased population which in turn result to deforestation, damming of rivers, destruction of wet-lands, mining, exploration, and agricultural activities, energy use, accidental water pollution and poor waste treatment practices, as well as subsequent destruction of river catchments. All of these however, decrease quality of surface water.

The research therefore seeks to evaluate the quality of some surface water in some communities of Odukpani L.G.A., Cross River State to ascertain the extent of contamination.

1.2 Study Area

Odukpani (New netim) and Akamkpa (Etankpini, Oberekai, Mfamosing and Abiati) Local Government Area (LGA) are two of the LGAs in Southern Senatorial District of C.R.S (Table 1 & Figure 1).

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Table 1: Study Site and Location with Latitude and Longitude of Surface Water Sample Points

S/N	Area/Location	Sampled LGA	Sample ID.	Coordinates	
				Latitude	Longitude
1	Etankpini	Akamkpa	SP1	5.12924	8.34343
2	Oberekia		SP2	5.10052	8.34206
3	Abiati		SP3	5.11009	8.42789
4	Mfamosing		SP4	5.09351	8.48162
5	New netim	Odukpani	SP5	5.11249	8.39527

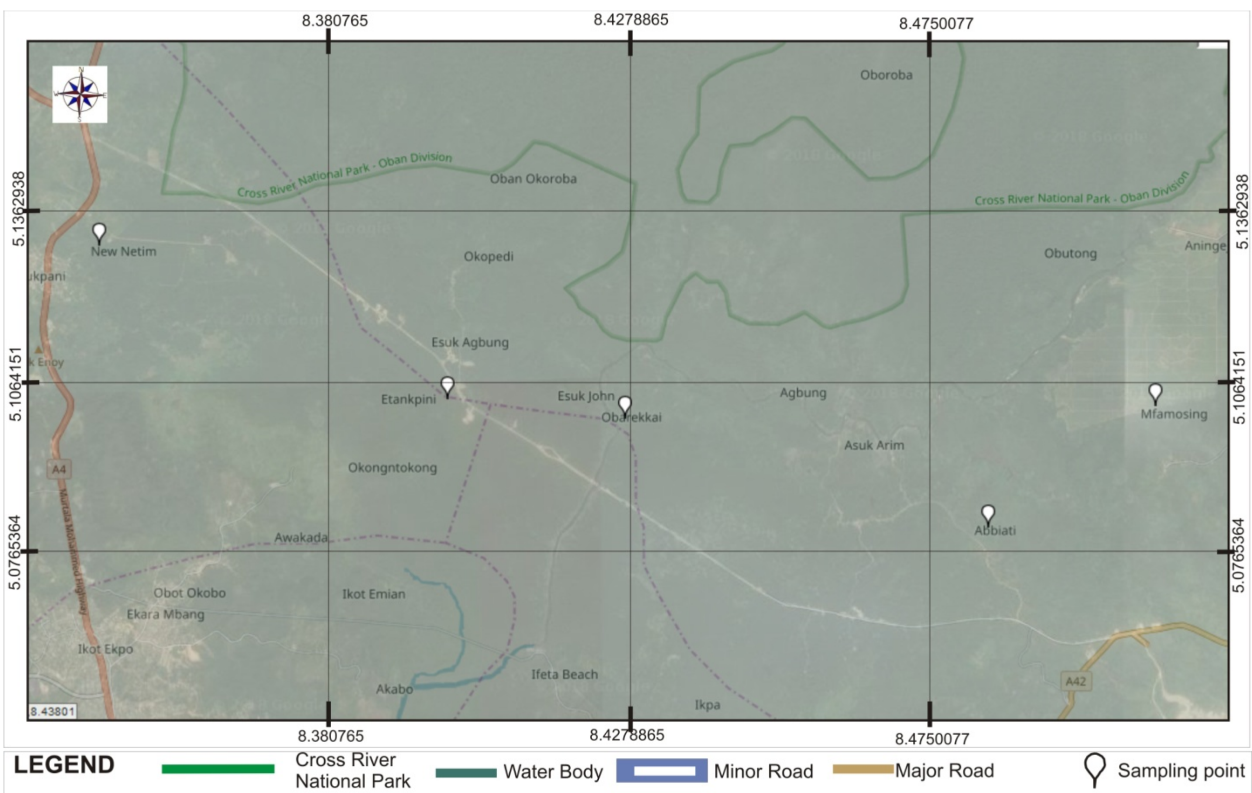

Fig 1: Map of study area showing communities where surface water samples were collected

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2.0 Materials and method

2.1 Collection of Water Samples

Water samples were obtained from five different rivers in some communities of Odukpani and Akamkpa LGA. The rivers are Inyang-Aka river, Erukut river, Enang river, Oberekia river and Abiati river respectively. Strategic sampling was carried out before collection so as to obtain true representation of the area under study. Three water samples each were collected from different points of each sample station, and sensory examination was done *in-situ*. Water samples were then transferred into one liter plastic containers which were washed thoroughly, rinsed with de-ionized water, and labeled appropriately for easy identification. The labeled cans were fixed, corked immediately and then preserved in a refrigerator for analysis.

2.2 Determination of Physico-chemical Parameters

Calibrated Hanna digital meter (HI 2215-02 & HI 9813-6) were used to analyzed for Colour, pH, Temperature, Conductivity, Turbidity, Total Dissolved Solids (TDS) and Dissolved Oxygen (DO), while calcium and potassium concentrations were obtained using Atomic Absorption Spectrophotometer (AAS 300) and Gas Chromatography Mass Spectrophotometer (GCMS 5890 Series II) all in Mifor Consult Laboratory, 55 Marian Road-Calabar, Cross River State.

2.3 Statistical analysis

All data generated through analysis of water was analyzed statistically using Statistical Packages for the Social Sciences (SPSS) for two way ANOVA. Significance among sites was tested at 0.05 probability level.

3.0 Result and Discussion

Result of the study as presented shows slight variations among the sampling sites. The concentrations obtained are mean of three replicates. All results were also observed to be within recommended standard by World Health Organization/Federal Ministry of Environment (WHO/FMEnv) for drinking. However, according to the report of Egereonu *et al.,* 2012 water is considered safe if the concentrations of undesired substances do not exceed the WHO safe limit. The mean concentrations and WHO/FMEnv limit of specific parameters in the water samples are shown in Table 2.

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Table 2: Mean Values of Physico-chemical Parameters of Selected Surface water in Odukpani and Akamkpa LGA

Parameter/Sample Station	SW1	SW2	SW3	SW4	SW5	Regulatory Bodies	
						FMEnv Limit	WHO Limit
						Drinking Water	Drinking Water
Colour	Light yellow	Light yellow	Light yellow	Light yellow	Light yellow	-	-
pH	6.38	6.86	6.9	7.20	7.39	6-8	6.5-8.5
Temperature (oC)	28.2	26.8	29.9	26.1	28.5	30	35
Conductivity (µS/cm)	0.54	0.1	0.12	0.46	0.11	-	1400
DO (mg/l)	2.27	3.75	3.92	3.12	2.51	6	5
Turbidity (NTU)	6.3	6.9	7.1	6.5	6.8	10	5
Total Dissolved Solids (mg/l)	70	67	73	78	76	500	1200
Calcium (mg/l)	30.4	35.7	27	33.1	29	200	75
Potassium (mg/l)	2.21	3.03	2.82	2.12	3.69	10	12

Colour

All water samples were light yellowish in colour. This slight change in colour (Fakayode, 2005) could be attributed to the presence of suspended and dissolved particles in the sampled water rivers.

pH

mean concentrations of pH recorded across the various sites were within WHO/FMEnv recommended standard for drinking water (Table 2). However, SW1 –SW3 had concentration with the same range, whereas SW4-SW5 had similar concentration. Statistically, there was no significant difference in the concentration of pH among sites at $p<0.05$

pH of water generally is influence by geology of catchments area and buffering capacity of water (Kumar *et al.,* 2010) controls the chemical state of many nutrients including dissolved oxygen, phosphate, nitrate etc. due to this effect, aquatic organisms are affected by pH changes as their metabolic activities are pH dependent.

The low pH recorded for the various rivers could be attributed to dilution effect of rain water during rainy season (Fakayode, 2005 and Tripathi *et al.,* 2015). pH Nonetheless, has no direct adverse effects on health (Kumar *et al.,* 2017); however, higher values of pH hasten the scale formation in water heating apparatus and also reduce germicidal potential of chloride results in the formation of trihalomethanes, which are toxic in nature and cannot support aquatic life.

Temperature

Mean temperature recorded for this parameter ranged from 28.2 ^{o}c-29.9 ^{o}c (Table 2). The result however, showed little or no variation among study sites. Result of ANOVA revealed also a statistically non-significant difference ($p<0.05$) between study locations. These values fall within the WHO/FMEnv safe limits for drinking.

One important aspect of water temperature is its effect on the solubility of gases, such as oxygen (Ikomi, & Enuh, 2000). More gas can be dissolved in cold water than in warm water. Animals, such as salmon, that require a high level of dissolved oxygen will only thrive in cold water. Increased water temperature according to Vijith, 2007 also leads to increase photosynthetic rate of aquatic plants and algae, which in turn lead to increased plant growth and algal blooms and can be harmful to the local ecosystem. A change in water temperature however, can affect the general health of the aquatic organisms, thus changing the quality of the river/stream.

Conductivity

Result of conductivity analysis revealed mean concentration ranging from 0.10µS/cm to 0.54µS/cm. ANOVA result showed also no statistically significant difference ($p<0.05$) between study locations. These concentrations were within WHO/FMEnv recommended standard.

Conductivity indicates the presence of dissolved solids and contaminants especially electrolytes (Okoye & Nyiakagha, 2009). The more the ions in the solution the higher the conductivity. In the report of Ratna, 2007 conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate and phosphate anions or sodium, magnesium, calcium, iron and aluminum cations. Other possible sources of increase conductivity concentration could be natural enrichment in electrolytes, phenomena of mineralization or weathering of sediments (Okoye & Nyiakagha, 2009).

Dissolved Oxygen (DO)

The result of DO analysis across the sampling points and sites revealed slight variation in concentration (Table 2). Result of ANOVA revealed a statistically non significance difference ($p<0.05$) between study locations. These values fall within the accepted safe limits for drinking and aquatic water and corresponded with report of Vijith 2007.

Dissolved oxygen is an important indicator of a water body's ability to support aquatic life (Okieimen, *et al.,* 2012). As reported by Carpenter *et al.*, 1998 fish breathe by absorbing dissolved oxygen through their gills. Oxygen enters water by absorption directly from the atmosphere or by aquatic plant and algae photosynthesis. Waters with no DO (i.e. anaerobic condition) or very low DO exhibit odour and other aesthetic problems, making it unfit for drinking (Kazi *et al.*, 2009). DO is removed from water by respiration and decomposition of animal matter. Water from all sampling location is however, considered safe for drinking and would support aquatic life.

Turbidity

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Result of turbidity test showed a mean concentration of 6.3NTU to 6.9NTU (Table 2). This result revealed slight variation in concentration among sites, but are however, slightly higher than WHO acceptable limit of 5NTU and within FMWNv limit of 10NTU. Result of ANOVA revealed no significant difference among sampling locations ($p<0.05$).

Vijith, 2007 defines turbidity as a measure of water clarity which determines how far light can travel in water. Light is necessary for the growth of aquatic plants, which serve as food for fishes and other aquatic animals. Water with high turbidity, reduces oxygen level which eventually leads to death of aquatic organisms.

As reported by Jain *et al.*, 2010 the greater the amount of total suspended solids in water, the murkier it appears and the higher the measured turbidity.

This increase in mean value of turbidity recorded for this study could be due to the presence of phytoplankton; particulate like clay and silts from run offs during rainfall and re-suspended bottom sediments, increased flow rate, floods and movement of fish in these water bodies.

Total Dissolved Solids (TDS)

Result of TDS analysis recorded a mean concentration of 63mg/l to 78mg/l (Table 2). This result revealed little or no variation among sampling locations. Result of ANOVA analysis showed there was no significant difference ($p<0.05$) in the concentration of TDS among study locations. However, the recorded concentrations were within WHO/FMEnv recommended limits (Table 2).

In the works of Kumar *et al.*, 2017 excess dissolved solids in any water body create an imbalance due to increased turbidity, and thus cause suffocation to aquatic life even in the presence of high dissolved Oxygen. Similarly, Egereonu *et al.*, 2012 reported Water with high residue to be less palatable and may induce an unfavourable physiological reaction and may even result to gastrointestinal irritation, as well as constipation to humans. Outside the health implication, high TDS concentration may also be aesthetically unsatisfactory for bathing and washing (Ikomi & Enut, 2000).

Calcium (Ca)

Result of Ca analysis recorded a mean concentration of 63mg/l to 78mg/l (Table 2). This result revealed little or no variation among sampling locations. Result of ANOVA analysis showed there was no significant difference ($p<0.05$) in the concentration of TDS among study locations. However, the recorded concentrations were within WHO/FMEnv recommended limits (Table 2).

Calcium has been reported by Vijith, 2007 to be fifth most abundant element in the earth crust and is very important for human cell physiology and bones. According to the report of Kazi *et al.*, 2009 about 95% calcium in human body is stored in bones and teeth. Although deficiency of calcium in humans causes rickets, poor blood clotting, bone fracture etc, excess of calcium causes cardiovascular diseases in the human.

Potassium (K)

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Similarly, mean concentration of K analysis ranged from 2.12mg/l to 3.69mg/l (Table 2). This result revealed little or no variation among sampling locations. Result of ANOVA analysis showed a non-significant difference ($p<0.05$) in the concentration of TDS among study locations. However, the recorded concentrations were within WHO/FMEnv recommended limits (Table 2).

Result of this study however, is in agreement with the report of Jain *et al.*, 2010 which states that although potassium is extensively found in igneous and sedimentary rocks, its concentration in natural waters is usually quite low. This may be due to the fact that potassium minerals offer resistance to weathering and dissolution.

Potassium is however vital for human body functions like heart protection, regulation of blood pressure, protein dissolution, muscle weakness, heart rhythm disorder etc, the concentration needed in human body ranged between 110 to 140 g (Kumar *et al.,* 2017).

4.0 Conclusion

Rapid industrialization and urban development results in deterioration of water quality. The average values of all physiochemical were found within the permissible limits of the WHO/FMENv guideline for drinking water except for turbidity that recorded slight increment above the WHO limit of 5NTU. However, regardless of the result which compares favourably well with the acceptable limit, there is need to establish sewage treatment plants in areas so that untreated sewage as well as agricultural activities common to these areas does not contaminate the water bodies. Hence, regular and quantified monitoring of geochemical characteristics of the surface water will be useful for sustainable water management.

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