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ASSESSMENT OF THE PHYSICAL AND CHEMICAL WATER PROPERTIES IN IKOT OKORO RIVER BASIN, ORUK ANAM LOCAL GOVERNMENT AREA

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Abstract

Background: *The people of Ikot Okoro and surrounding communities in Oruk Anam Local Government Area, Akwa Ibom State, lack access to potable water sources and are solely dependent on the Ikot Okoro River drainage basin for domestic and commercial use. Consumption of poor-quality water poses significant health risks to the population.*

Objective: *This study assessed the quality of water in the Ikot Okoro River drainage basin for domestic purposes.*

Methods: *Water samples were collected from five geo-referenced points within the Ikot Okoro River drainage basin during both wet and dry seasons, resulting in a total of ten samples. Physical, chemical, and microbiological analyses were conducted. Physicochemical parameters were determined using standard methods, including the pour plate method and EDTA titration method. Results were compared with World Health Organisation (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ) guidelines.*

Results: *Most of the physical and physicochemical parameters were within the permissible limits of WHO and NSDWQ standards. However, nickel and phosphate concentrations were above the approved limits in some samples.*

Conclusion and Recommendation: *The presence of elevated nickel and phosphate levels indicates potential contamination of the river water. It is recommended that a mini water scheme be established to provide safe drinking water, and that improved sanitary facilities be provided to enhance hygiene and sanitation in the area.*

Keywords: Assessment, Physiochemical Properties, Water Quality, Sanitation, Ikot Okoro

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NTRODUCTION

Freshwater is precious to all living things; humans cannot live without it, and human activities have profound impact on the quantity and quality of freshwater available. Aquatic environments are exposed to various types of pollutants such as

heavy metals, pesticides, detergents, petroleum products, and other materials. In addition, industrial, agricultural and medical wastes may lead to negative impacts on public health and biodiversity. Water pollution occurs in both rural and urban areas of most developing nations like Nigeria. Surface water pollution entails the introduction of foreign substances by man capable of causing harm to man, hazard to other living organisms, or interference with the legitimate use of the environment into the surface water bodies (Ojo et al., 2012).

A safe, reliable, affordable, and easily accessible water supply is essential for good health, but for several decades almost 1 billion people in developing countries have lacked access to such a supply. A poor water supply impacts health by causing acute infectious diarrhoea, repeated or chronic diarrhoea episodes, and non-diarrhoeal disease, which can arise from chemical species such as arsenic and fluoride. It can also affect health by limiting productivity and the maintenance of personal hygiene (Ojo and Ochieng, 2012). Reasons for the limited progress towards universal access to an adequate water supply include high population growth rates in developing countries, insufficient rates of capital investment, difficulties in appropriately developing local water resources, and the ineffectiveness of institutions mandated to manage water supplies (in urban areas) or to support community management (in rural areas) Udoessien (2003).

The concept of stream water quality is defined by the natural properties of the body of water or the tropic level, and the current or potential use of the water and the related quality requirement (Bordalo, Nilsumrachit, and Chalermuat, 2015). Thus, the use to which water is put dictates the quality parameters to be measured and the degree of sensitivity of quality control; for instance, the World Health Organisation (WHO) has set standards for drinking water with its physical and biochemical characteristics (WHO, 1984). The properties of water do vary, affecting its value and usefulness. It is, however, not the absolute amount of dissolved material that matters, but also the type of chemical compound and the pH of water. Water that is safe for drinking, that supports wholesome marine life, that is fine for irrigation of land, and for recreation can be said to be of good quality (Eze, 2010).

Globally, water is used for industrial, agricultural and other purposes. Hence, its usefulness depends solely on the intended purpose. For instance, water which is suitable for swimming or bathing may not be fit for human consumption. Also, water that is salty may not be fit for human

consumption but may be useful for irrigation, while water that cannot support aquatic life may be very useful for cooling power plants (Ogunmodede and Ajayi, 2014). This implies that water obtained from different sources may have different qualities and may serve different purposes.

Generally, water quality is examined according to the following four categories: physical properties, chemical characterisation of water, biological investigations and physicochemical examination. Physical properties include the study of colour, conductivity, temperature, odour, turbidity, foam, thermal properties, and hardness. Chemical characterisation of water will reveal how water quality is affected by the presence of inorganic and organic chemicals (Emere and Dibal, 2013). The various components which are present in major concentrations in potable water are aluminium, barium, boron, fluoride, bromide, iodine, nitrate, nitrite, phosphates, polyphosphates, iron, manganese and other trace elements. Other important properties are acidity/alkalinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and nitrogen from ammonia, nitrites and nitrates. Biological investigations in water quality may be due to the presence of pathogenic bacteria and certain fungi, and the physiochemical examination defines the physiochemical factors that affect water quality, which are mainly chemical agents such as chlorine, sulphur dioxide, hydrogen sulphide, etc. (FEPA, 1990).

In Ikot Okoro and the surrounding communities in Oruk Anam Local Government Area, the major source of water supply for both domestic and commercial uses is from the river and the few streams close to the river. In the Ikot Okoro Community as well as Oruk Anam Local Government Area, the challenges of water faced by people cannot be overemphasised. These problems, which cut across the issue of distance covered to access surface water points, seasonal variation in groundwater aquifers, and the inability of Government to provide for water needs of the people, have remained contending issues in this area; hence, the necessity to assess the physiochemical and microbial properties of this water source in the community to ascertain if it meets the approved standards, especially for domestic uses. Domestic water quality that does not meet approved standards has adverse effects on the health of the people and the productivity of the economy. There are several human activities that are taking place in the study area, such as farming, among others (Ogunmodede and Ajayi, 2014). These activities bring upon the people

diseases like diarrhoea, dysentery, typhoid and cholera; such health problems may eventually promote high infant mortality and prolonged ill-health.

The economic activities have some significant effect on the people. In the area of agriculture, such as cultivation of different crops, Oruk Anam people engage in farming and cultivate a range of crops including yam, cocoyam, palm fruit, and cassava. These are mainly for subsistence; as such family unit mainly cultivate that which would be enough to feed the household. Again, the increased variety of food crops which result in an increase of food production. Hence, the people are able to feed themselves, which subsequently leads to increase in population among the people. Animal Husbandry for stock breeding and the varieties of domestic animals like Dogs, Goats, and Poultry were raised for economic use. Hunting also had some effect in the society of Oruk Anam people, they help in keeping the entire community safe by hunting and killing of wild beasts.

MATERIALS AND METHODS

Study Area

Oruk Anam Local Government Area is in Akwa Ibom state, South-south geopolitical zone of Nigeria. Oruk Anam LGA lies between latitude $4^0 39^{I} 46.7^{II}$ - $4^0 59^{I} 30.57^{II}$ N and longitude $7^0 31^1 5.85^{11}$ - $7^0 47^1 51.11^{11}$E. It is bordered by the Ikot Abasi, Mkpat Enin, and Ukanafun LGAs (https://www.findlatitudeandlongitude.com). The LGA comprises of several towns and villages which include Ikot Okoro, Ibianga Village, Ikot Afanga, Ikot Ntuk, Obio Akpa, Ekparakwa, Inen Nsai, and Ntak Ibesit etc. The estimated population of Oruk Anam LGA is put at 171,837 inhabitants with the area mostly inhabited by members of the Annang ethnic affiliation (Population Census, 2006). The Annang language is spoken in the LGA while the religion of Christianity is primarily practised in the area. Notable landmarks in Oruk Anam LGA include the General Hospital at Ikot Okoro and the Local Government Headquarters in Ikot Ibritam.

Oruk Anam LGA has an average temperature of 25°C and has several rivers and tributaries flowing through its territory (weatherspark.com). The LGA witnesses two major seasons, which are the dry and the rainy seasons, with the latter usually characterised by frequent and mostly heavy showers. Oruk Anam LGA is a hub for fishing, with the area's rivers and streams being rich in seafood. A number of crops such as plantain, coconut, and vegetables are grown in the LGA. Other viable economic activities engaged in by the people of Oruk Anam LGA include trade, craftsmanship and

lumbering. Oruk Anam in Akwa Ibom falls within the tropical zone with a dominant vegetation of green foliage of trees and shrubs. It constitutes a major chunk of the nation's oil-palm belt. The climatic conditions allow for favourable cultivation and extraction of agricultural products such as palm produce, cassava, yam, plantain, banana, maize and timber. There are basically two types of agriculture practised in Oruk Anam: small-scale peasant farming and estate farming for growing cash crops. The Atlantic coastline stretches 129km from Oron in the East to Ikot Abasi in the West.

Economic activities of Oruk Anam people are Agriculture, Fishing, Hunting, Local Industries, and oil production, among others. These occupations were determined by the geographical organisation of the people or natural resources. These economic activities have a significant effect on the people; in agriculture, for example, Oruk Anam people engage in farming and cultivate a range of crops, including yam, cocoyam, palm fruit, and cassava. These are mainly for subsistence; as such, family units mainly cultivate that which would be enough to feed the household. Again, the increase of variety of food crops which result to the increase in food production. Hence, people were able to feed themselves, which subsequently led to an increase in population. Animal husbandry for stock breeding and the varieties of domestic animals like dogs, goats, and Poultry were raised for economic use. Hunting also had some effect in the society of Oruk Anam people; it helped keep the entire community safe by hunting and killing wild beasts.

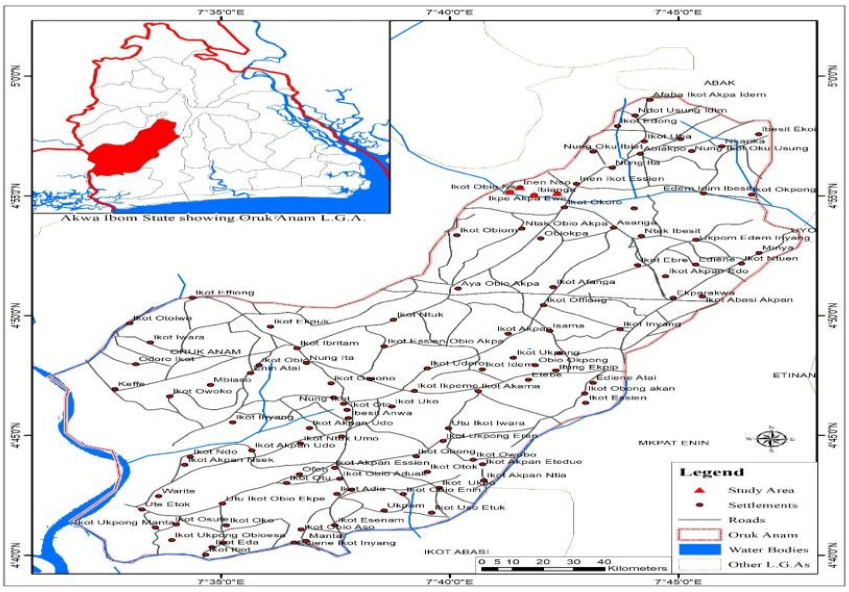

Figure 1: Oruk Anam Local Government Area showing the Study Area
Source: Cartography and Map Library Studio, Department of Geography and Natural Resources Management, UNIUYO.

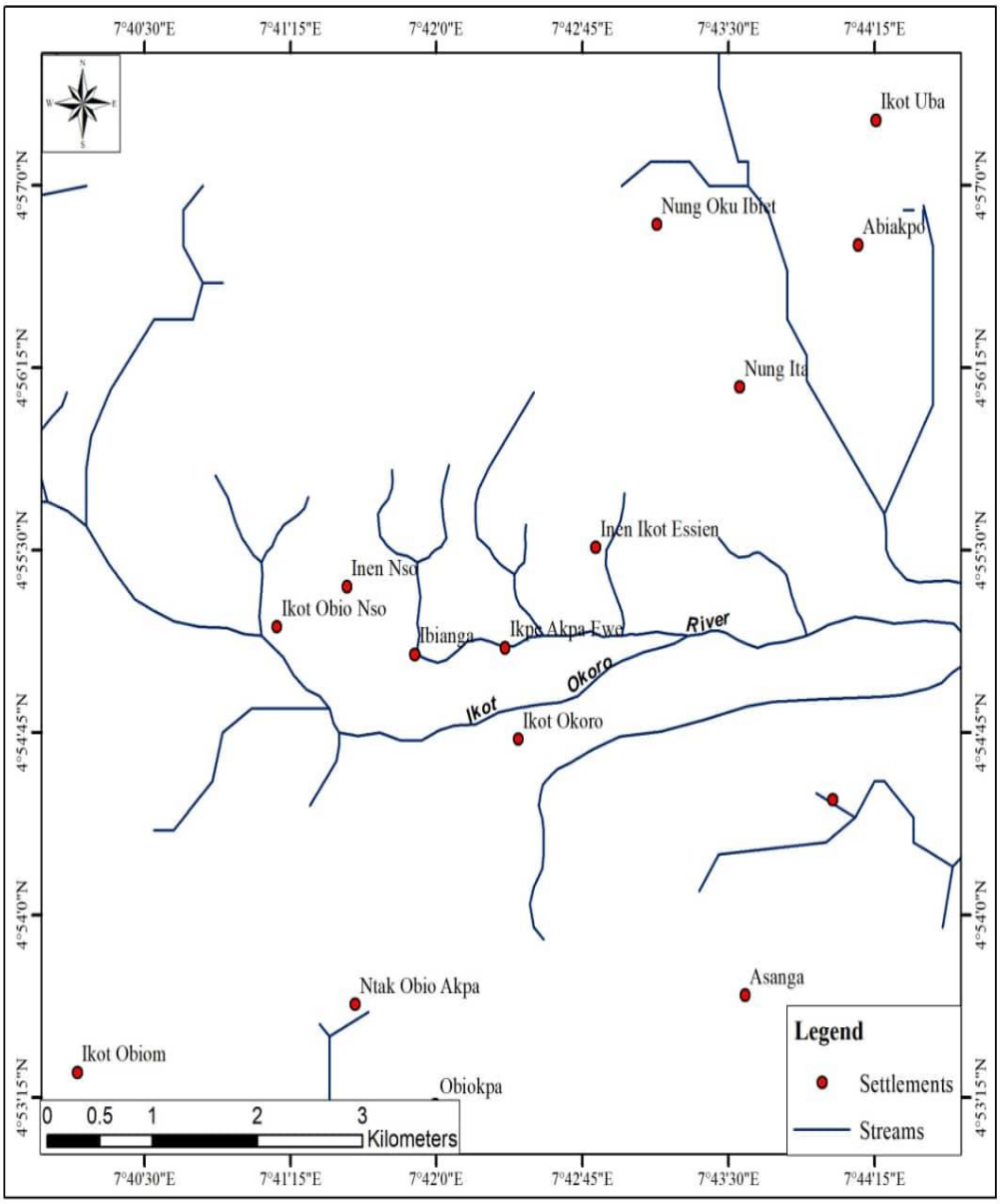

Figure 2: Ikot Okoro River Drainage Basin
Source: Cartography and Map Library Studio, Department of Geography and Natural Resources Management, UNIUYO.

Sampling Method

Warm water was used to pre-sterilise the sampling containers. At each sample point, samples for physical, chemical and microbiological parameters were collected in a sterilised two (2) litres plastic container, which was covered and labelled $WS_1$to WS5 to represent the different sample points. Preceding the sample collection, the container was

thoroughly washed with the water sample to be sampled. The movable meters were calibrated and standardised according to the directions by the manufacturers for proper instrumentation and reactions.

First and foremost, the water was sampled by rinsing the two (2) litres plastic container with water of the location to be sampled and water sample was fetched from the sample point into the sample container. For microbiological, physical and chemical analysis, water samples were taken from the different sample points of the stream, which also serve as drinking water sources in the study area. The stream water temperature values were taken insitu using mercury-in-glass broth thermometer. Water pH was measured using a portable pH meter, SUNTEX Model TS -2. The procedure of sample collection was repeated at all sampling points with different sample containers used. The water samples were collected at different water locations. Samples collected in the field were all transferred into an ice cube cooler and transported to the laboratory for analysis of physical, chemical and microbiological parameters. The samples were preserved in the laboratory by refrigeration process and were analysed within the limits of the "holding time".

Two sample seasons were employed- the wet and dry seasons- considering the changes in seasons which may affect the parameters. Samples were collected in two different seasons. The wet season's samples were taken in September 2025, while the dry season's samples were taken in February 2026. A total of two sampling sessions were carried out at geo-referenced sample locations. At the end of every sampling season, laboratory analysis commenced within the limits of the respective "holding time" of the collected samples the chemical, physical and microbiological variables of their respective.

RESULTS AND DISCUSSIONS

Physicochemical analysis was carried out for both wet and dry seasons for the assessment of physical and chemical properties of Ikot Okoro river drainage basin. Several parameters, as in Table 5.1, were determined during the analysis. The physical properties discovered during the analysis for both seasons were Temperature, Turbidity, Electrical Conductivity and Salinity. Temperature recorded a high mean value of 29.0^{o}C during dry and a very low mean value of 15.3^{o}C during wet season. Turbidity recorded a mean value of 1.75NTU during dry season and 1.44NTU during wet season. The mean value for Electrical Conductivity was 10.42µs/cm during dry

season and mean value of 6.92µs/cm for wet season. There was no trace of Salinity for both dry and wet seasons. The chemical parameters include Total Dissolved Solids (TDS), Total Hardness, Alkalinity, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Calcium Hardness, Iron, Sulphate, Chloride, Copper, Zinc, Nickel, Nitrite, Nitrate, Ammonia and Phosphate. pH recorded a higher mean value of 4.54 during the wet season and a low mean value of 4.18 during the dry season. Total Dissolved Solids recorded a high mean value of 3.9 mg/l during the wet season and a low mean value of 3.1mg/l during dry season.

Table 1: Physicochemical Parameters in Water Samples of Ikot Okoro River drainage basin during Wet and Dry Season

Variables (Wet Season)	Ph	Temperature	Turbidity	Electricity Conductivity	Salinity	TDS	Total Hardness	Alkalinity	DO	BOD	Calcium	$Fe3^{+}$	SO_4^{2}	Cl^{-}	Cu^{2+}	Zn	Ni	NO_3	NO_2	NH_3	PO_4^{3}
Unit		^{o}C	NTU	µs/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
WS_1	4.58	16.9	1.33	9.31	0.00	3.5	36.0	22.8	1.5	2.5	52.0	0.001	0.001	0.60	0.01	0.01	0.78	0.08	0.008	0.00	0.01
WS_2	4.35	15.0	2.59	5.57	0.00	2.7	52.0	22.8	3.9	2.7	42.0	0.001	0.007	0.30	0.14	0.02	1.48	0.01	0.001	0.00	0.01
WS_3	4.49	13.9	1.13	6.65	0.00	3.1	42.0	14.4	3.7	2.9	44.0	0.001	0.001	0.01	0.09	0.01	1.31	0.01	0.004	0.00	55.0
WS_4	4.53	15.7	1.03	6.71	0.00	3.2	52.0	16.8	5.4	2.7	66.0	0.001	0.001	0.01	0.26	0.02	0.01	0.07	0.005	0.00	44.0
WS_5	4.75	14.9	1.14	6.34	0.00	3.0	44.0	18.0	5.7	3.0	28.0	0.000	0.001	0.50	0.01	0.00	0.31	0.03	0.010	0.00	106
Mean	4.54	15.3	1.44	6.92	0.00	3.1	45.2	19.0	4.0	2.8	46.4	0.008	0.002	0.28	0.10	0.01	0.78	0.04	0.006	0.00	41.0
Minimum	4.35	13.9	1.03	6.34	0.00	2.7	36.0	14.4	1.5	2.5	28.0	0.000	0.001	0.01	0.01	0.00	0.01	0.01	0.001	0.00	0.01
Maximum	4.75	16.9	2.59	9.31	0.00	3.5	52.0	22.8	5.7	3.0	66.0	0.001	0.007	0.60	0.26	0.02	0.78	0.08	0.010	0.00	106
Range	0.40	3.0	1.56	2.97	0.00	0.8	16.0	37.2	4.2	0.5	38.0	0.001	0.006	0.05	0.25	0.02	0.77	0.07	0.009	0.00	105.9

Variables (Dry Season)	pH	Temperature	Turbidity	Electrical Cond	Salinity	TDS	Total Hardnes	Alkalinity	DO	BOD	Calcium	Fe^{3+}	SO_4^{2}	Cl^-	Cu^{2+}	Zn	Ni	NO_3	NO_2	NH_3	PO_4^{3}
Unit		°C	NTU	µs/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
WS_1	4.40	29.4	1.01	13.44	0.00	5.0	90.0	4.8	0.6	0.08	38.0	0.050	0.001	0.60	0.36	0.00	0.01	0.01	0.006	0.01	0.08
WS_2	4.18	29.3	0.59	9.39	0.00	3.5	20.0	9.6	0.6	0.09	14.0	0.270	0.010	0.01	0.01	0.01	1.01	0.04	0.002	0.00	0.09
WS_3	4.27	29.1	3.82	11.13	0.00	4.2	58.0	7.2	0.7	0.09	50.0	0.020	0.001	0.02	0.01	0.01	1.38	0.01	0.010	0.00	0.09
WS_4	4.01	29.3	0.94	9.26	0.00	3.4	48.0	7.2	0.7	0.09	56.0	0.001	0.001	0.05	0.18	0.18	0.01	0.01	0.007	0.00	0.09
WS_5	4.04	29.2	2.41	8.90	0.00	3.3	48.0	7.2	0.8	0.09	60.0	0.001	0.001	0.01	0.01	0.01	0.59	0.01	0.001	0.00	0.09
Mean	4.18	29.3	1.75	10.42	0.00	3.9	52.8	7.2	0.7	0.09	43.6	0.342	0.003	0.14	0.11	0.04	0.60	0.02	0.005	0.02	0.09
Minimum	4.01	29.1	0.59	8.90	0.00	3.3	48.0	4.8	0.6	0.08	14.0	0.001	0.001	0.01	0.01	0.00	0.01	0.01	0.001	0.00	0.08
Maximum	4.40	29.4	3.82	13.44	0.00	5.0	90.0	9.6	0.8	0.09	60.0	0.270	0.010	0.60	0.36	0.18	1.38	0.04	0.010	0.01	0.09
Range	0.39	0.3	3.23	4.54	0.00	1.7	42.0	4.8	0.2	0.01	46.0	0.269	0.009	0.59	0.35	0.18	1.37	0.03	0.009	0.01	0.01

Source: Akwa Ibom Water Board Corporation (2026)

Table 1 above shows an explicit analysis of the physical and chemical variables of Ikot Okoro River drainage basin in Oruk Anam Local Government Area of Akwa Ibom State. The physical variables investigated during this research work were Temperature, Electrical Conductivity, Turbidity and Salinity with each of them possessing a different unit of measurement. Temperature has degrees Celsius (^{0}C) as its unit of measurement; electrical conductivity has µs/cm as its unit; turbidity has NTU and Salinity mg/l, respectively. Of all the physical variables, temperature possessed the highest mean value, with Salinity having the least during the wet and dry seasons. Temperature recorded a low mean value of 15.3^{o}C during the wet season and a high mean value of 29.3oC during dry season. This is because during wet season, water temperature is always very low and very high during dry season. Electrical Conductivity recorded 6.92µs/cm for the wet season and 10.42µs/cm for the dry season. Turbidity was 1.44 NTU for the wet season and 1.75 NTU for dry season. Turbidity is a measure of the cloudiness of water caused by suspended matter, which can be mineral (silt or clay). These suspended matters impede light transmittance through the water and consequently hinder photosynthetic processes in aquatic plants.

The chemical variables investigated were pH, Alkalinity, Dissolved Oxygen, Total Dissolved Solids, Total Hardness, Biochemical Oxygen Demand, Calcium Hardness, Iron, Sulphate, Nickel, Zinc, Nitrate, Nitrite, Ammonia, Phosphate, Copper and Chloride. pH has no unit of measurement but was recorded as 4.54 and 4.18 for wet and dry seasons, respectively. The pH values indicate that the water samples were strongly acidic, with pH values <7. These values do not

fall within the set standards for potable water of WHO and NSDWQ. The reason for the acidity of pH was traced to pollution. Point source pollution is a common cause that decreases the pH level of the stream water when there is involvement with chemicals. The chemicals came from agricultural runoff and wastewater discharge to decrease the pH level of the water. Alkalinity recorded a very high mean value 19.0mg/l during wet season and a low mean value of 7.2mg/l during dry season. Dissolved Oxygen recorded 4.0mg/l mean value during wet season and 0.7mg/l mean value during dry season.

The Total Dissolved Solid had a mean value of 3.1mg/l during wet season and a mean value of 3.9mg/l during dry season. The total hardness recorded 46.4mg/l for wet season and 43.6mg/l during dry season. The mean value for Biochemical Oxygen Demand was 2.8mg/l for wet season and 0.09mg/l for dry season. Calcium Hardness recorded 46.4mg/l as a mean value during wet season and 43.6mg/l as a mean value during dry season. Iron recorded 0.0008mg/l for wet season and 0.342mg/l for dry season as its mean values. Sulphate had 0.002mg/l during wet season and 0.003mg/l during dry season as mean values. Nickel made a mean value of 0.78mg/l for wet season and a mean value of 0.60mg/l for dry season. Zinc recorded 0.01mg/l and 0.04mg/l for wet and dry season respectively as mean value. Nitrate recorded 0.04mg/l during wet season and 0.02mg/l during dry season. Nitrite had a mean value of 0.006mg/l for wet season and 0.005mg/l for dry season. Ammonia recorded 0.00mg/l for wet season and 0.02mg/l for dry season respectively as mean values. Phosphate had 41.0mg/l for wet season and 0.09mg/l for dry season. Copper recorded 0.10mg/l for wet season

and 0.11mg/l for dry season. Chloride recorded 0.28mg/l as a mean value for wet season and 0.14mg/l as a mean value for 0.14mg/l for dry season.

CONCLUSION AND RECOMMENDATIONS

The physical and chemical properties were carefully assessed, and a total of four physical and seventeen chemical parameters were identified for each season, and the same was repeated for the other season. These parameters were assessed from the water samples taken from the ten locations of both wet and dry seasons. Since no one, no society and no nation can survive without water, it is vehemently recommended that the Government and other concerned authorities come to the aid of these communities in the study area by establishing at least a mini water scheme in this community for the provision of good quality drinking water. Frameworks for water pollution control should be constructed along the water ways to reduce contaminants' flow during runoffs since pollution of the water source is caused principally by runoff during rainy or wet season. Good sanitary facilities should be established for members of this community so as to reduce the rate of defecation into the water body. This to a certain extent will help to improve the sanitary and hygiene condition of the area.

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