**A**

**RESEARCH PROPOSAL**

**ON THE TOPIC:**

**DRINKING WATER QUALITY, SANITATION AND HYGIENE IN SELECTED PRIMARY SCHOOLS IN AKWA IBOM STATE, NIGERIA.**

**WRITTEN BY**

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**SUBMITTED TO**

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**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background to the Study**

Water is the most essential commodity for life sustainabilityand a satisfactory water supply must be available to the human population (WHO, 2011; Biswas*,*2014). Access to safe drinking water is a basic need and is one of the most important contributors to public health (Shamsuzzoha *et al.,* 2018).

Groundwater acts as an important component of natural resources and plays a significant role in many activities such as drinking, cooking, irrigation, and several domestic usages (Proshad*,* 2017). According to Nickson, (2005), one-third of the world’s population rely on groundwater for drinking and other domestic purposes. With the ever-increasing demand for water, the importance of groundwater is increasing at an accelerated rate throughout the world (Biswas, 2014). Unfortunately, the supply of safe drinking water has been compromised by the absence of adequate sanitary infrastructure, where this vital resource is vulnerable to pollution by both natural and anthropogenic activities such as natural geochemical processes, urbanization, industrial development, and agricultural activities (Rahman and Hashem, 2019; Idriss *et al.,* 2020).

According to the report of WHO (2011), 80% of the diseases in the developing countries; Nigeria inclusive, are caused due to water pollution. Furthermore, environmental hazards are responsible for about a quarter of the total burden of diseases worldwide and as much as 30% in regions such as sub-Saharan Africa. As such, 13 million deaths can be prevented every year by making our environments healthier. These facts and figures highlight the impact of environmental factors on public health. More than 2.4 billion people in the world currently lack access to adequate sanitation and are forced to dispose their excreta in unimproved and unsanitary conditions. Those who suffer from this, lack most basic human needs and also tend to be victims of poverty, ill health and an overall poor quality of life, hence raising a concern as underground water is invariably polluted by this activities (WHO, 2013).

In developing countries like Nigeria, the main diseases caused by poor sanitation are; diarrhoeal disease, lower respiratory infections, unintentional injuries, and malaria, schistosomiasis, trachoma and soil transmitted helminthiases (WHO, 2013, 2017). In children under the age of five, one third of all disease is caused by the environmental factors such as; unsafe water and air pollution (WHO, 2010). The poor state of food and water sanitation in the country has been shown to play a significant role in the etiology of food and water borne diseases (WHO, 2012). One of the most significant diseases that arise from poor sanitation is diarrhea and cholera (WHO, 2017). Deaths resulting from diarrhea are estimated to be between 1.6 and 2.5 million every year (WHO, 2012). National records showed that every year, about six hundred thousand (600,000) episodes of diarrhoea occur in children under the age of five which are school children and almost 50 percent of a child being underweight has a direct link to diarrhea (Alabi, 2010).

Similarly, there have been increasing numbers of cases of cholera over the years. From January to December 2010, Nigeria reported 41,787 cases including; 1,716 deaths from 222 Local Government Areas (LGAs) in 18 States of the country (Vanguard, 2013). In addition to the disease burden, Nigeria loses about N455 billion annually which is equivalent to 1.3% of Gross Domestic Product (GDP), due to poor sanitation as reported by water and sanitation program of the World Bank (Vanguard 2013). Most of the affected are young children below the ages of five.

On a global scale, the most affected are children who in most cases lose their lives due to diseases caused by poor sanitation. Several types of cancers have been reported to be linked to the intake of water polluted by toxic metals (Kavcar *et al.,* 2009). For instance, according to Rahman *et al.,* (2016), arsenic (As) mobilization was reported as the major cause of groundwater pollution. The oral and dermal exposure of arsenic (As) contaminated water can cause keratosis, hypertension, developmental effects, cardiovascular diseases, lung disease, kidney failure, liver failure, neurotoxicity, and arsenicosis (Rahman *et al.* 2015, 2016; WHO, 2010). Additionally, chloride comes into the surface and groundwater due to weathering and leaching from the sedimentary rocks (Rahman *et al.* 2016). According to a report by Trivedy and Goel (1984), the chlorine content in the water at the level of 250–500mg/L produces the drinking water utilization causing increased salinity of the water.

Furthermore, microbiological contamination mostly associated with fecal contamination is a major problem in water portability (PCRWR, 2005). In general, microbial contamination of the groundwater and reservoirs is attributed to the leakage of pipelines and unplanned sanitation and drainage. According to a report by Kahlown, (2006), a damage of water pipelines could be a source of bacterial contamination. A leakage of septic tank can also introduce bacteria into the surrounding water sources (Rahman and Rahman, 2018). The literature reported three groups of coliform bacteria (total coliforms (TCs), fecal coliforms (FCs), and *Escherichia coli*) that could be found in water (New York State, Department of Health, 2020). Each species can act as an indicator of drinking water quality and each has a different level of risk. Coliform bacteria are also considered indicator organisms since they signify the possible existence of bacteria that can potentially cause illness through water. The appearance of coliform bacteria in water does not indicate that the consuming water causes infection; however, their existence means the contamination of water through the sources possessing disease-causing bacteria, which can cause serious health implications (Anunonwu, 2009). Some studies (Anunonwu, 2009; Bak *et al.,* 2015; Okon, 2017) reported that drinking water contamination by coliform bacteria significantly increased the occurrence of various water-borne diseases including diarrhea, dysentery, typhoid, and hepatitis A and B. water quantity is as important as water quality. Therefore, it is mandatory to access the quality of drinking water using bacteriological tests, especially the presence of coliforms bacteria in water.

Conclusively, the assessment of drinking water quality in terms of microbial, physiochemical and Health Risk Assessment at primary schools in Akwa Ibom State is of paramount importance since the school going children are considered to be highly vulnerable than the adults.

**1.2 Problem Statement**

A major concern for human health is to drink safe water, especially for growing children because they are more vulnerable to hazardous microbial contamination in drinking water (Dangour *et al.,* 2013). Children who suffer a water-related ill-ness, with poor health remain in a disadvantaged position, reduces learning abilities, and indirectly affect schooling through absenteeism may result in attention deficits and early dropout (Islam *et al.,* 2013). United Nations International Children’s Emergency Fund reported in 2007, many schools and households lack adequate and safe water quality and sanitation (WASH) services in low- and middle-income countries like Nigeria (Jaspe *et al.,* 2012; Alexander *et al.,* 2013) and only 51% of schools had adequate water and 45% had access to sanitation facilities (Montgomery and Elimelech, 2007). It has also been recorded that 1.5–2 million children die each year from water quality and sanitation-related diseases and many more are weakened by illness, pain, and discomfort (Tarrass and Benjelloun, 2007). Soap for handwashing is rarely found in schools in these settings. The use of sanitation facilities, without water and soap for handwashing, may put children studying in such schools at a higher risk of exposure to pathogens (Freeman *et al.,* 2014). Additionally, young children have not fully acquired immunity against some pathogens like pathogenic *E. coli* which may result in serious outcomes including hemolytic uremic syndrome (Lee and Greig, 2010; Bak *et al.,* 2015). School-aged children spend too many hours in and around school facilities, as a result, close monitoring is necessary to improve the school environment. So, schools are a high-risk environment for children and hence, the need to ensure a safe water supply from a reliable source.

**1.3 Justification of the study**

Water quality is as important as water quantity. Adequate quality of drinking water is a human right (WHO, 2017). According to the World Health Organization (WHO, 2017), access to safe drinking water can result in tangible benefits to health. Safety of the water supply is key to public health, especially for children, who generally require greater protection. School children can spend five to six hours a day in primary schools in Nigeria. In this sense, it is essential that this communal space presents favourable environmental conditions to ensure good health practices and quality of life for children as they are the most vulnerable to poor water quality.

The acronym WASH indicates solutions for addressing the emergence and spread of diseases, which includes all-around water use, sanitation, and hygiene. Saying simply, some behaviors need to apply to prevent potential infections. For instance, treating water before drinking, washing hands with soap and running water, and appropriately disposing of human excreta have resulted in diarrheal risk reductions. These behaviors significantly can reduce the chances of getting ill and death, which occurred by inadequate WASH services.

From studies, for the past 20 years, groundwater sources which is a major source of drinking water have increasingly been contaminated by hazardous microbiological agents and chemicals derived from a variety of social, economic and urban activities; therefore, groundwater protection has become essential for researchers and governmental agencies (Park, 2011; Okon, 2017)

A pleasant environment that promotes healthful living and is hazard free is a fundamental right of all Nigerians. There is an increasing national consciousness on the need for judicious management of the Nigerian environment in a sustainable manner. Therefore, ensuring improved Environmental Sanitation standards has become high on the political agenda of Government in the democratic dispensation. This was demonstrated in the creation of the Federal Ministry of Environment to address amongst other things, the problems of poor Environmental Sanitation and one of the essential public health care elements is provision of safe drinking water and sanitation. In addition, the national cost of lost productivity, reduced educational potential and huge curative health costs constitute a major drain on the local and national economy. Besides, a dirty environment with its attendant health consequences, prevailing in most of our cities, can discourage tourists/investors and undermine the economic benefit of tourism to the country. Consequently, wide-ranging actions are required to solve Environmental Sanitation problems in order to reduce and avert their adverse health, economic and developmental effects. Moreover, sufficient information is still scarce in the literature regarding the drinking water quality in the South-south region of Nigeria, which is the highly vulnerable to the natural disasters affecting the groundwater quality that is used as the single source of drinking water supply in this area. Therefore, this study assesses the drinking water quality, sanitation and hygiene in selected primary schools in Akwa Ibom State, Nigeria.

**1.4 Objectives of the study**

The objectives of this study is to;

1. investigate some physicochemical parameters in drinking water at selected primary schools in Akwa Ibom State.
2. evaluate the microbiological parameters in drinking water at selected primary schools in Akwa Ibom State.
3. Assess the Health Risk associated with the drinking water at selected primary schools in Akwa Ibom State.

**CHAPTER THREE**

**MATERIALS AND METHODS**

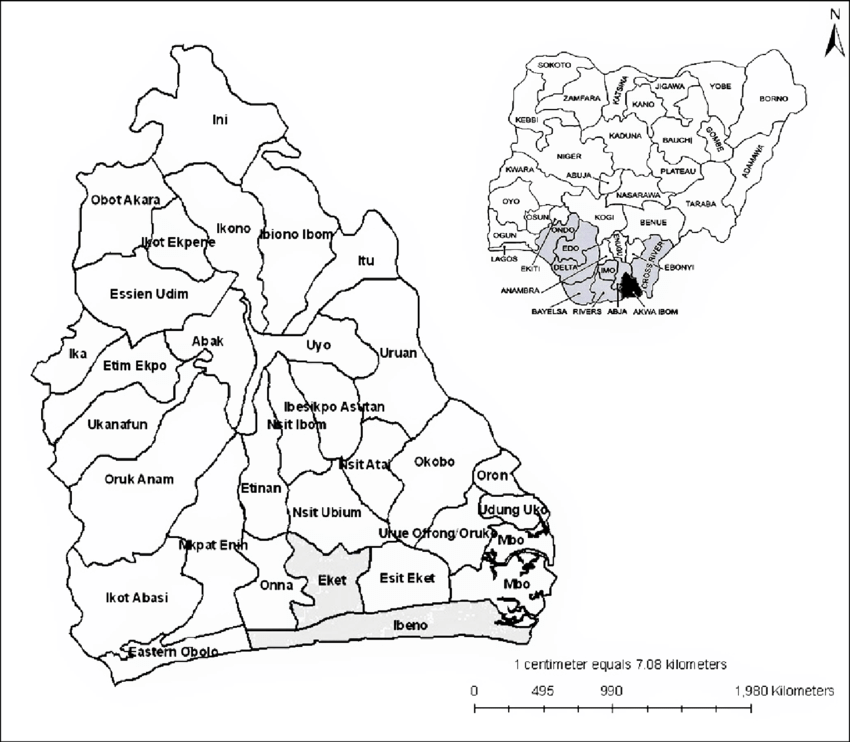
**3.1 Study Area**

The study will be conducted in selected primary schools in Abak, Uyo and Oruk Anam Local Government Area of Akwa Ibom State, Nigeria.

The first school selected for this study will be Government Primary School, Obio Akpa, Oruk Anam Local Government Area, Akwa Ibom State with a bolehole water supply source available in the premises. The school is located between latitude 4030’N and 50 00’N and longitudes 700 30’E and 800 00’E. The climate of the experimental site is a tropical rain forest characterized with high temperature (average of 300C), high rainfall ranging from 2000-3000mm and relative humidity of 70% on average. Rainfall begins around march and finishes around September with a brief dry spell in August known as August Break (FRN, 2007).

The second school selected for this study will be St. Patrick Primary School, Iboko Offot, Uyo located in Uyo local Government Area, Akwa Ibom State, Nigeria. The school source of water is a standard bolehole water. Uyo, the capital of Akwa Ibom State is located between 4030’ and 5030’ North latitude and 7030’ and 8030’ East longitude. The elevation above sea level is 45m. Uyo is located in the equatorial zone, which is wet and dry seasons. The most notable attribute of the equatorial environment is its consistent temperature all year round. The mean monthly temperature is 27OC with little variations in relative humidity around 75-90%. Rainfall begins around march and finishes around September with a brief dry spell in August known as August Break (FRN, 2007).

Annang People School, Utu Abak will be considered the third site for this study with a bolehole water supply source available in the premises. The school is located between latitude 11o N and longitude 7oE. The area is characterized with dense growth of vegetation. Climate of the area is characterized by rainy season (March to October) and dry season (November to February) with a break in August. Rainfall ranges from 2000-3000mm per annum. Temperature ranges from 26oC and 28oC with a relative humidity of 70-90% (Udo, 2020).

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* **Study Area**

**Fig 3.1**: Map Showing Sampling Site

**Source:** Udo, (2020)

**3.2 Sample Collection and Preparation**

The study design is cross-sectional, which aimed at finding out the pH and EC, Fe, As, Cl- content, microbial load and the health risk associated with the drinking water in these areas. Drinking water samples will be collected twice: once in each month of February (dry season) and May (wet season) from the selected schools located in different parts of Akwa Ibom State as earlier discussed in the study area description. A total of 3 (three) drinking water samples will be collected from the 3 representative schools in Uyo, Abak, Oruk Anam Local Government Area of Akwa Ibom State.

The sample volume collected will be 500 ml. Each sample will be partition into five samples.

Three partitions will be stored in the high-density polyethylene (HDPE) bottles following the methods as described by Rahman and Hashem (2019). These three partitions will be considered for the analysis of As, Fe, and Cl-. Prior to the sampling, the HDPE bottles will be cleaned with detergents, washed properly with tap water, and finally rinsed thrice with distilled water.

The fourth partition will be collected in sterilized glass bottles for the bacteriological analysis (Rahman *et al.,* 2015).

For As and Fe analyses, water samples will be filtered in the HDPE bottles through 0.45 mm Millipore cellulose membrane filters (Rahman *et al.,* 2015). Few drops of 1% nitric acid will be added to the samples to avoid possible water quality changes which might be caused by physical, chemical, or biological reactions (Rahman and Hashem, 2019).

All the collected samples will be transferred to the laboratory within 6 hours after sampling and stored at 4oC for subsequent analyses. All the chemicals used in this study will be of analytical grade.

**3.3 Water Analyses**

The drinking water samples from the schools will be analyzed in Akwa Ibom State Ministry of Science and Technology Laboratory for physicochemical parameters (pH, electrical conductivity, As, Fe and Cl elements determination) and microbiological characteristics (total coliform, *E. coli* and heterotrophic bacteria).

***3.3.1 Physiochemical Analyses***

The water pH and electrical conductivity (EC) will be determined on-site using digital pH meter and EC meter, respectively. Prior to use, the meters will be calibrated following the manufacturer’s protocols and verified after measuring each three samples.

A standard titrimetric (Argent metric) method will be used for the determination of Cl‑. Silver nitrate solution (0.0141 N) will be used as a titrant, while potassium chromate will be used an indicator (APHA, 2012). Sodium chloride will be used for determining the strength of silver nitrate.

Arsenic and Fe will be determined using atomic absorption spectrophotometry (APHA, 2012). Multi-element standard solutions will be used for system calibration. The calibration curves with correlation coefficients of more than 0.999 will be accepted for calculating the concentrations of As and Fe. For As measurement, hydride vapor generation (HVG) method will be applied. In order to reduce the As(V) to As(III), 20% potassium iodide solution will be used, whereas arsenic trihydride generation will be carried out with 5M hydrochloric acid and 0.6% sodiumborohydride solutions (APHA, 2012).

For Fe measurement, flame atomization method will be used at the wavelength of 248.3nm (Rahman *et al.,* 2015; Rahman and Hashem 2019). All the solutions will be prepared using double distilled deionized water. All test batches will be evaluated using an internal quality approach and validated based on satisfying the defined internal quality controls.

For each experiment, blank solution, certified reference materials, and samples will be analyzed in duplicate for eliminating the errors and quality control.

***3.3.2 Microbiological Analysis***

Fecal coliform (FC) and total coliform (TC) bacteria will be examined using the membrane filtration method (APHA 2012). Briefly, 100 ml of each water sample will be filtered through a membrane filter paper (0.45 lm pore size) and placed on mFC and mEndo agar plates. Afterwards, the plates will be incubated at 45oC and 37oC for FC and TC, respectively, for 21 ± 3h under aerobic condition (Rahman *et al.,* 2015).

Finally, the observations will be carried out for the appearance of blue and golden red colonies on mFC and mENDO agar plates, which will be later purified and used for bacteriological analysis by determining the colony forming unit (CFU). Both the positive and negative controls will be used to standardize the test.

**3.4 Public Health, Hygiene and Sanitation Condition of Schools**

Observations on public health and safety facilities and drinking water and sanitation facilities in the selected schools will be made by providing a checklist questionnaire sheet as shown in Appendix1. All the data from schools will be tabulated and analyzed.

Health records of primary Health Care centers within the selected school area will also be collected to afford possible comparison with water quality from schools.

**3.5 Health Risk Assessment**

The As risk in drinking water for children consumers at primary schools will be evaluated in term of non-carcinogenic exposure through ingestion and dermal pathways, known as hazard quotient (HQ) using Equation (1) (Proshad *et al*. 2017);

*HQ = ADI ------------------------ (1)*

*RfD*

where, RfD is the oral toxicity reference value (RfD ingestion for As 3.04 x 10-4 mg/L/day, RfD dermal for As 1.23 x 10-4 mg/L/day.

The average daily intake (ADI) in mg/L/day will be calculated using Equation (2)

(Proshad *et al*. 2017);

*ADIingestion = C X IR X EF X ED*

*BW X AT*

where, Cwater indicates As concentration in a sample of water (mg/L), IRwater is the water ingestion rate (1.6 L/day for children), EF is the exposure frequency (365 days/year), ED is the exposure duration (12 years for children), AT is the average age time (4,830 days for children), and BW is the body weight (30 kg for children). Notably, this will act as a guide to our conclusion;

If the HQ is <1, no adverse health effects are expected as a result of exposure.

If the HQ>1, adverse health effects are possible (USEPA. 2011).

The target carcinogenic risks (CR) derived from the intake of As will be calculated using Equation (3) (Proshad, 2017);

CR = 1-exp [(SF X ADI)]

where, SF is the oral slope factor. The oral slope factor (SF) for As is 1.5 mg/L/day. In order to estimate carcinogenic risk, it will be suggested that people in the study area are dependent on groundwater for their drinking and other domestic purposes.

**3.6 Data Analysis**

Multivariate statistical analysis methods in terms of the Pearson’s correlation analysis and the principal component analysis (PCA) will be applied to evaluate the inter-relationship among water quality parameters and interpret the potential sources of contaminants. Statistical analyses will be carried out using the statistical package SPSS 24.0 (SPSS, USA).

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**APPENDIX 1**

**SECTION A: Basic School Related Information**

Please fill as appropriate

1. Location of the school…………………………………………………………
2. Type of school ownership ……………………………………………………..
3. Education Level of the school ………………………………………………..
4. Numbers of Students ……………………………………………………….
5. Numbers of Teachers ………………………………………………………….

**SECTION B: Basic Sanitation Questions**

|  |  |  |
| --- | --- | --- |
| **S/N** | **Basic Sanitation Questions** | **Ratings** |
| 1 | Are there handwashing facilities at school ? | No – 0  Yes - 1 |
| 2 | What is the type of toilet available? | No toilet latrine – 0  Flush - 1  Pit latrine with slab - 2  Pit latrine without a slab -3 |
| 3 | How many toilets are usable at the time of survey ? | 1-5 |
| 4 | Are there separation toilets for males and females (boys and girls)? | No – 0  Yes - 1 |
| 5 | Are there soap and water at the toilets or it's premises? | No – 0  Yes - 1 |
| 6 | How are the toilets? | Clean - 1  Somewhat clean - 2  Not Clean - 3 |
| 7 | Are there separation of toilets for staff and students? | No – 0  Yes - 1 |
| 8 | Number of persons per toilet | 25 persons/toilet - 1  40 persons / toilet - 2  >40 persons/ toilet -3 |
| 9 | Are toilets covered from the side ? | No – 0  Yes - 1 |
| 10 | Are the toilets covered from the roof ? | No – 0  Yes - 1 |
| 11 | What is the nature of the school compound? | Clean - 1  Not clean - 2 |
| 12 | Are there visible excreta (feces) in the premises? | No – 0  Yes - 1 |
| 13 | Is there anybody defecating in the field at the time of the survey? | No – 0  Yes - 1 |