WATER SANITATION AND HYGIENE (WASH) IN REMOTE AREAS OF CROSS RIVER STATE: A CASE STUDY OF AGOI COMMUNITIES, YAKURR LOCAL GOVERNMENT AREA.

Prof. Eze Bassey Eze
Department of Geography and Environmental Science, University of Calabar.
zezebas@yahoo.com

&

Inyang Ojeje Williams
Department of Geography and Environmental Science, University of Calabar.
inyang.williams@yahoo.com

ABSTRACT

This study investigated household water supply, sanitation, and hygiene practices in Agoi, Yakurr Local Government Area, Cross River State, Nigeria. A survey design was used to gather data on drinking water sources, physicochemical and bacteriological parameters, open defecation status, toilet facilities, and the influence of household socioeconomic activities on hygiene practices. A well-structured questionnaire was administered to 396 households in Agoi-Ekpo and Agoi-Ibami, and laboratory analysis was conducted to assess water quality. The study found that eleven sources of drinking water were found in the two communities, including boreholes, lakes, streams, and rainwater. Surface water was used more frequently than groundwater for drinking and other uses, and colonies had high coliform bacterial concentrations. A higher percentage of households (76.7%) defecate on pit latrines and wooden/block toilets, while farms did not have access to toilets. The study recommends government and private investment in water supply, boiling water, construction of protected pit latrines, and provision of WASH facilities by household heads and government.

KEY WORDS: WASH, Sanitation, Hygiene, Remote, Yakurr.

1.0 Introduction

WASH stands for water, sanitation, and hygiene taken together. Since the three main challenges are interconnected, they collectively form a rising sector. Despite being separate fields of endeavor, one depends on the other's existence. For example, without toilets, fundamental water sanitation practices cannot be carried out. Furthermore, handwashing and other hygienic measures cannot be done without water. Both rural and urban regions receive their clean water supplies from the WASH sector. Additionally, it serves to maintain proper sanitation and encourage hygiene in businesses, health facilities, schools, and communities. Water accessibility promotes cleanliness and sanitation. The health of a person is at risk from unclean water, inadequate sanitation, and poor hygiene.However, disease and death will be decreased by having enough access to water, sanitary facilities, and basic hygiene habits. For the purpose of enhancing people's health and socioeconomic well-being, WASH has to be given top priority in all contexts, including rural and urban communities, workplaces, schools, marketplaces and health facilities.

The disparity in access to water supply between rural and urban areas in Cross River State and Nigeria at large is a significant concern. Rural communities face challenges in accessing water sources, and the lack of access to safe and clean water has led to a higher incidence of water-related diseases. Efforts are needed to address this disparity and ensure that all communities have access to safe and clean water (Opara, 2006).A Nigerian study found that water quality was better in urban areas than in rural areas, with the rate of water contamination estimated to be 40% in urban areas as opposed to 60% in rural areas (Eja, Arikpo and Akpan, 2006).

Studies have shown that there is a significant disparity in access to piped water supply between rural and urban areas in Cross River State. For instance, a study conducted in some rural communities around Calabar, Cross River State, found that only 4.4% of rural water users had access to piped water supply, compared to a higher percentage in urban areas (Opara, 2006). Research also shows that water, sanitation, and hygiene (WASH) services are better provided in urban areas than in rural areas, with the percentage of the population in urban and rural areas in sub-Saharan Africa that had piped water on premises in 2015 being 33% and five per cent, respectively(WHO/UNICEF, 2015), cited in Ohwo (2019).

Access to safe and adequate WASH facilities is a fundamental human right, essential for maintaining human health, dignity, and well-being. However, in rural areas, WASH facilities are often limited, inadequate, or non-existent, leading to significant health, economic, and social consequenceswith 25% of rural dwellers lacking access to improved water sources (WHO, 2022). Lack of WASH practices in rural areas lead to a higher incidence of water-related diseases, such as diarrhoea, dysentery, stomachache, worms, and scabies. Children are the most affected by these diseases, and the impact is felt in terms of lost school hours and days, as well as loss of labour and general discouragement.

The COVID-19 pandemic has further underscored the need for improved WASH infrastructure and services in rural areas, with a significant increase in handwashing facilities and sanitation services reported in some regions (Berihun, Adane, Walle, Abebe, Alemnew, Natnael, Andualem, Ademe, Tegegne, Teshome and Berhanu, 2022). Despite progress, significant disparities persist, with rural areas lagging behind urban areas in terms of WASH access and services (WHO, 2022). Addressing these disparities requires a sustainable commitment to improving WASH infrastructure, services, and practices in rural areas.

This research work aims at analyzing water supply, sanitation and hygiene practices in Agoi, a rural and remote area in Yakurr Local Government Area of Cross River State, Nigeria. Specifically, the objectives are to; identify the various drinking water sources in Agoi, Yakurr Local Government Area, Cross River State, Nigeria; compare the physicochemical and bacteriological parameters of the water sources with WHO standard; investigate the status of open defecation in the study area using the available toilet facilities and investigate the impact of socio-economic activities on hygiene practices among the people in the study area.

2.0 Conceptual Framework

2.1 The Concept of Remoteness

The concept of remoteness has been studied and developed by various researchers and scholars across different fields, including geography, sociology, economics, and public health. This paper is limited to geographical remoteness and public health remoteness.

Geographical Remoteness, cited in Benesova, Novotny and Franke (2008) was propounded by Walter Christaller (1933) in his book "Die zentralen Orte in Süddeutschland" (Central Places in Southern Germany) where he introduced the concept of "central places" and discussed the relationship between population, economy, and geography. Public Health Remoteness on the other hand was first propounded by Rudolf Virchow (1848) in his publication "Report on the Typhus Epidemic in Upper Silesia" where he linked poverty, poor living conditions, and lack of access to healthcare to the spread of typhus in remote areas (McNeely,2002). Jordan, Roderick, Martin and Barnett (2004) in their publication "Distance, rurality and the need for care: access to health services in South West England", studied the relationship between remoteness and health outcomes, highlighting the challenges of accessing healthcare in remote areas. They concluded that, remoteness affects access to healthcare in rural areas.

Remoteness is a significant factor in accessing Water, Sanitation, and Hygiene (WASH) services in rural Cross River State, Nigeria. Rural communities in Cross River State face challenges in accessing improved water sources, sanitation facilities, and hygiene practices due to their geographical remoteness. Geographical remoteness in rural Cross River State increases the distance between communities and WASH infrastructure, making it difficult to access clean water, sanitation facilities, and hygiene services.Addressing remoteness as a factor in WASH in rural Cross River State requires innovative solutions, including decentralized WASH systems, community-led total sanitation approaches, and mobile WASH services. Additionally, investing in WASH infrastructure, promoting hygiene practices, and increasing access to clean water and sanitation facilities can help reduce the disparities in WASH access faced by remote communities in rural Cross River State.

3.0 Materials and Methods

3.1 Study Area

Agoi, situated in Yakurr Local Government Area (LGA) of Cross River State, Nigeria, comprises two communities: Agoi-Ekpo and Agoi-Ibami. Yakurr LGA is geographically located between latitudes 5°40' and 6°N and longitudes 7°55' and 8°33'E, covering a land area of approximately 48 km2 (4,800 hectares) (Enang, 2009). The LGA shares borders with Abi to the northwest, Biase to the southwest, Akamkpa to the southeast, and Obubra to the northeast (Figure 1). Yakurr LGA consists of ten settlements in the central region of Cross River State, including Idomi, Ugep, Mkpani, Ekori, Nko, Assiga, Inyima, Ikpeti, Agoi-Ekpo, and Agoi-Ibami. This research paper focuses on Agoi-Ekpo and Agoi-Ibami, the most remote communities in Yakurr LGA, which have limited access to government attention and services.

Agoi's climate is similar to other villages in Yakurr LGA, with an average temperature of 25°C and heavy rainfall between June and August. The drainage pattern is dendritic, with small streams converging into larger rivers. The area's geology and topography are uniform, consisting mainly of sedimentary rocks, which explains the lack of erosion. The landscape is low-lying and undulating, with some steep slope hills. The local economy relies on forest biomass, agriculture, and small-scale commercial activities. Residents engage in farming and utilize forest resources, with limited access to toilets, leading to open defecation.

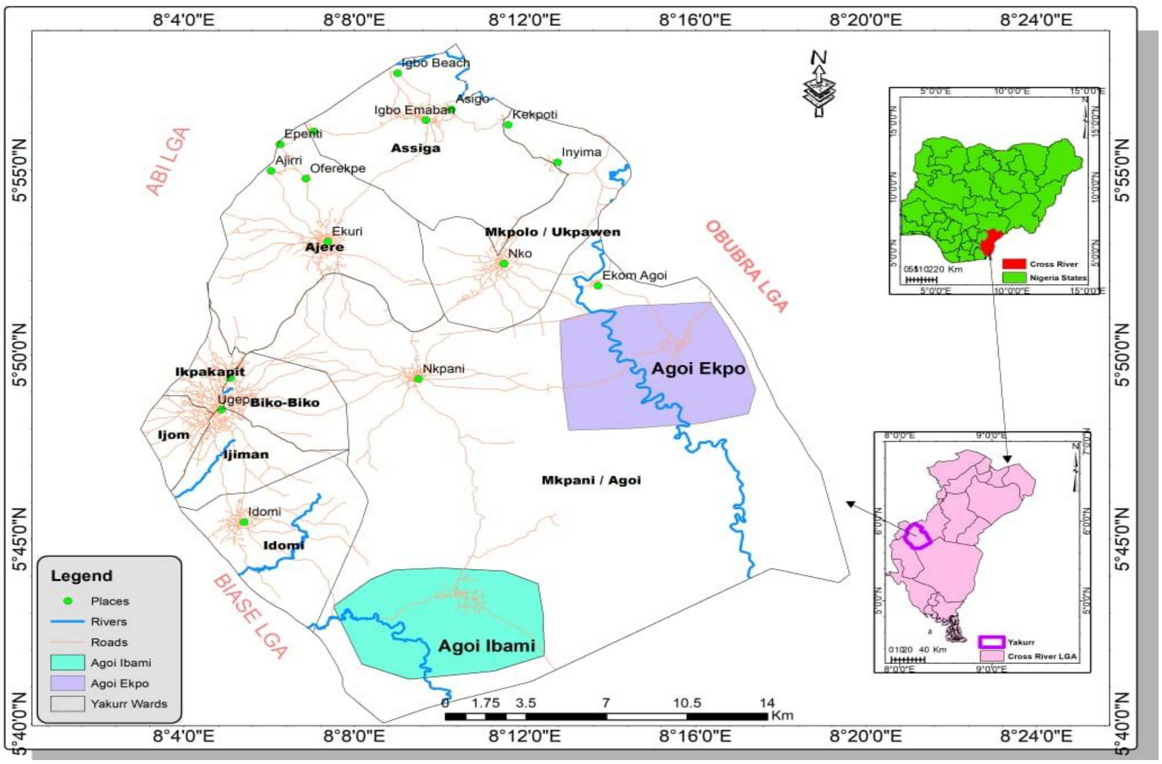

Figure 1: Yakurr showing study area
Source: Department of Geography and Environmental Science GIS Laboratory, University of Calabar.

3.2 Data Collection and Procedures

This study employed a mixed-method approach, combining simple random and stratified sampling techniques. Simple random sampling was used to administer copies of questionnaire to households in the study area, while stratified sampling was used to divide the villages into sub-WASH communities, aligning with the existing sub-WASH communities designated by the Yakurr LGA WASH department. Agoi-Ekpo has three sub-communities (Akarukpat, Asankpat, and Ijiman), and Agoi-Ibami has eight sub-communities (Ayoayoa, Ibinidin, Ikpari, Itu-Agoi, Nkalagu, Obanankpai, Ogu, and Okai) (Table 3.1).

Table 3.1: WASH Communities indicating the number of questionnaire that were administered

Sample Size	**Study Area**	**WASH Community**	**No. of Questionnaire**
396	Agoi-Ekpo	Akarukpat	60
		Asankpat	60
		Ijiman	60
	Agoi-Ibami	Ayoayoa	27
		Ibiniden	27
		Ikpari	27
		Itu-Agoi	27
		Nkalagu	27
		Obanankpai	27
		Ogu	27
		Okai	27
Total	**2**	**11**	**396**

Source: Researcher's fieldwork, 2023.

Physical assessments of WASH facilities were conducted in the various WASH communities. Water samples were collected from identified drinking water sources (boreholes, streams, lakes, and rainwater) using plastic bottles, which were washed, rinsed, and labeled (S_1-S_{11}). The location of each sample was recorded using GPS, and the samples were stored in a cool box and transported to the laboratory for analysis of physicochemical and bacteriological parameters. The laboratory analysis focused on nine parameters: conductivity, pH, turbidity, temperature, total hardness, sulphate, nitrate, dissolved solid, and chloride. These parameters were selected to reduce costs while still providing valuable insights into the water quality.

3.3 Pollution Index of Drinking Water

The pollution index of drinking water for the present study was estimated using the formula given by Milanovic, Milijasevic and Brankov (2011) as follows:

$$WPI = \sum_{i=1}^{n} \frac{Ci}{SFQS} \times \frac{1}{n} \quad \text{--------------------------} (1)$$

Where; Ci = the mean concentration of analyzed parameters obtained on the basis of data on the water quality; SFQS = represents World Health Organisation standards of water quality; n = indicates the number of analyzed parameters.

4.0 Results and Discussion

4.1 Drinking Water Sources of the Studied Communities

The study found six drinking water sources in Agoi-Ekpo, while five drinking water sources were found in Agoi-Ibami. The spatial distribution of these sources is presented in fig. 2. The map shows that the first six samples (S_1 to S_6) are located in Agoi-Ekpo, while the remaining five samples (S_6 to S_{11}) are located in Agoi-Ibami. The water sources include streams, lakes, handpump boreholes, motorized boreholes, and rainwater collection systems. Each source is labeled as S_1, S_2, S_3, ..., S_{11}, corresponding to samples 1 to 11 (Fig.2). The frequency distribution of drinking water sources in Agoi-Ekpo and Agoi-Ibami are presented in table 4.2. The results indicate that only 9.1% of the communities' residents use manual pumps and 9.1% use motorized boreholes for drinking and other purposes. This suggests that merely 18.2% of the groundwater is utilized for drinking by the entire study population. In contrast, previous studies have found that boreholes are the primary source of water in rural areas, with 46.1% of Yakurr settlements relying on boreholes for their water needs *(Oka et al*., 2019). However, this study reveals that the majority (63.6%) of the population relies on surface water for drinking, with lakes and streams being the main sources (45.4% and 18.2%, respectively). Additionally, some residents use rainwater for drinking. These findings are consistent with previous research, which showed that rural communities in Kwara State primarily use unprotected shallow wells and contaminated streams and rivers as their water sources (Adeoye *et al*., 2013).

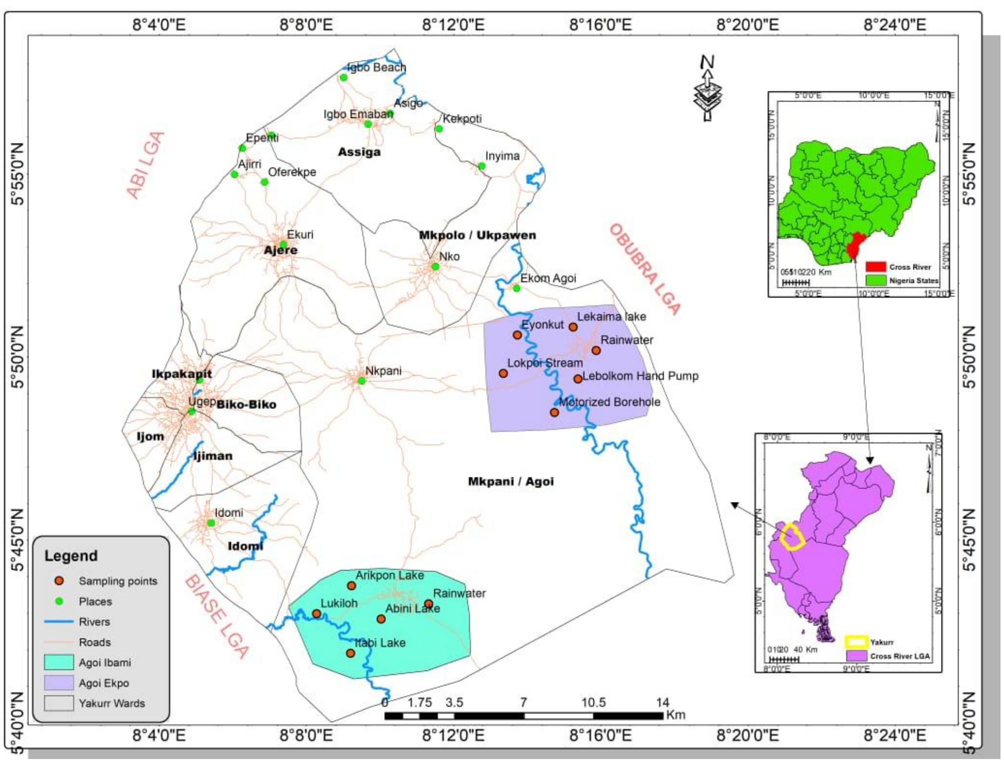

Fig 2: Yakurr, showing drinking water points in the study area.
Source: Department of Geography and Environmental Science GIS Laboratory, University of Calabar.

Table 4.1 Frequency distribution of drinking water sources

S/n	**Source**	**Name**	**Location**		**Community**	**Available number**	**Percentage**
			Latitude	**Longitude**			
1	Hand Dug Borehole	Lebolkom Borehole	N 5°50'18.29328"	E 8°15'38.88036"	Agoi-Ekpo	1	9.1
2	Motorized Borehole	Ijiman Borehole	N 5°50'11.51736"	E 8°15'35.33904"	Agoi-Ibami	1	9.1
3	Stream	Lokpoi Stream	N 5°49'51.69828"	E 8°14'30.55668"	Agoi-Ekpo		
		Likiloh Stream	N5°45'29.93112"	E 8°5'16.6434"	Agoi-Ibami	2	18.2
4	Lake	Eyonkut Lake	N 5°50'32.7786"	E 8°15'20.6316"	Agoi-Ekpo		
		Lekaima Lake	N 5°50'31.44876"	E 8°15'39.61296"	Agoi-Ekpo		
		Itabi Lake	N 5°43'38.68752"	E 8°10'33.91356"	Agoi-Ibami	5	45.4
		Abini Lake	N 5°43'38.442"	E 8°10'34.00212"	Agoi-Ibami		
		Arikpon Lake	N 5°43'43.5036"	E 8°10'12.387"	Agoi-Ibami		
5	Rainwater		N 5°50'22.21512"	E 8°15'38.37024"	Agoi-Ekpo		
			N 5°43'21.50256"	E 8°10'50.6082"	Agoi-Ibami	2	18.2
	Total					**11**	**100**

Source: Researcher's fieldwork, 2023

4.2.1 Physicochemical Characteristics of the Drinking Water Sources.

This part of the analysis examines and compares the physicochemical characteristics of the sampled drinking water sources in Agoi-Ekpo and Agoi-Ibami to WHO threshold. The physicochemical parameters of the selected drinking water samples in the two communities are presented in table 4.2. The level of temperature was comparatively the same with a slight increase of 29.6 °C in Agoi-Ibami compared to 29.3 °C in Agoi-Ekpo. The levels of temperature obtained in the present study are low and almost the same range with 27.9 to 28.6 °C reported in Yakurr LGA by Okori and Ekanem (2022). These levels are ideal for human lives and have negligible effects on acidity.

Table 4.2: Mean physicochemical parameters of drinking water samples in Agoi-Ekpo and Agoi-Ibami

Parameters	**Location**		
	Agoi-Ekpo	**Agoi-Ibami**	**WHO limit**
pH	6.8	6.5	6.5 - 8.5
Turbidity (NTU)	0.29	0.11	5.0
EC (us/cm)	247.0	71.6	1000
TDS (mg/L)	165.14	88.12	500
Tempt (^{0}C)	29.3	29.6	35
Hardness (mg/L)	31.4	18.4	100
CL (mg/L)	92.4	47.5	600
NO_3 (mg/L)	0.01	0.03	10
SO_4 (mg/L)	0.34	0.09	250

Source: Researcher's fieldwork, 2023; WHO, 2017

The range of temperature reported in the present study falls within the range of 29°C and 30°C comparative with 26.1°C to 28.10 °C reported by Awoyemi, Achudume and Okoya (2014) in Lagos State, Nigeria. The temperature values obtained for drinking water in the two communities are within WHO maximum permissible limit of 35 °C. This means that the drinking water sources in the two communities are cold and as such can hold more dissolved oxygen and contain enough dissolved oxygen for the survival of different species of aquatic life. Surface water that is too warm will not hold enough oxygen for aquatic organisms to survive (Opaluwa, Muhammad, Madaki, Usman and Mohammad, 2022).

The result showed that the pH level was comparatively high in Agoi-Ekpo and low in Agoi-Ibami with mean values of 6.8 and 6.5 respectively. These values fall within the range of 5.10 to 6.63 reported in Yakurr LGA by Okori and Ekanem (2022). It also falls within the range of 5.29 to 6.37 reported by Inah*et al*. (2022). The pH level in the two communities is alkaline. The pH level obtained for drinking water in the two communities may not impact on the hardness of the drinking water as well as its metal solubility. The pH values obtained across the drinking water are within WHO maximum acceptable level of 8.5. The non-acidic but alkaline nature of the surface water may be accredited to the low input of organic waste into the surface water.

Turbidity is the level of cloudiness in water caused by both dissolved and suspended solids. It also indicates the quantity of suspended and dissolved solids in water. It is the opposite of transparency, which measures the depth to which light can penetrate. The turbidity level was relatively high in Agoi-Ekpo and low in Agoi-Ibami with mean values of 0.29 and 0.11 NTU respectively. These values fall within the range of 0.32 to 18.5 reported in Yakurr LGA by Okori and Ekanem (2022). The turbidity values of the water sources in the two communities are low and within WHO recommended limit of 1NTU.

Conductivity shows the ability of water to conduct an electric current and is used to estimate the quantity of dissolved solids. Its level in water increases as the quantity of ions (dissolved mineral) increases (Afangideh *et al*., 2011). The mean content of electrical conductivity (EC) ranged from 71.6 to 247µs/c/m with a high value obtained in Agoi-Ekpo and a low value in Agoi-Ibami. The contents of electrical conductivity obtained in the present study are within the range of 45 to 1057µs/cm reported in Yakurr LGA by Okori and Ekanem (2022). The EC values obtained for water sources in the two communities are within WHO maximum permissible limit of 1000µs/cm. This means that the water sources are not polluted with effluents from landfill sites and organic waste within their catchments; this further suggests that the sampled surface water sources may not be harmful to aquatic live (Ewa, Zaneta and Jacet, 2011). Conductivity in water is used to show the quantities of dissolved solids in water (Saidu and Musa, 2012). The low conductivity values obtained in this study especially in Agoi-Ibami is attributed to the low discharge of effluents (organic wastes) into the available surface water. This result is expected as the surface water sources in Agoi-Ibami used for drinking are given full protection by the community. However, the low EC level obtained in Agoi-Ibami implies that surface water samples are purer and more uncontaminated than those obtained in Agoi-Ekpo. However, the general low level of electrical conductivity in the surface water samples in the two communities suggests the lack of impurities within its water sources. Normally, human activities that generate organic wastes tend to increase the quantity of dissolved solids that enter waters which can increase the level of conductivity. The generally low conductivity values show very little solute dissolution in the surface water (Oyem, Oyem and Ezeweali, 2014). The values obtained show that the surface water sources in the two communities are not polluted (with organic impurities) implying they are suitable for human consumption and cannot be harmful to aquatic survival (Ajani, Popoola, and Oyatola, 2021; Oyem*et al*., 2014; Ewa *et al*., 2011).

Furthermore, the content of total dissolved solids (TDS) was relatively high in Agoi-Ekpo and low in Agoi-Ibami with mean values of 165.14 and 88.12 mg/l respectively. These values fall within the range of 25.8 to 654.22mg/l reported in Yakurr LGA by Okori and Ekanem (2022). The values of total dissolved solids in the two communities are low and within WHO recommended limit of 600mg/l. The low TDS value in the water samples may be attributed to the control in the discharge of household waste and other organic wastes.

The content of total hardness was also relatively high in Agoi-Ekpo and low in Agoi-Ibami with mean values of 31.4 and 18.4mg/l respectively. These values fall within the range of 17.1 to 256.5mg/l reported in Yakurr LGA by Okori and Ekanem (2022). The total hardness level of 18.4 to 31.4mg/l fall within WHO maximum permissible limit of 100 mg/L. Values above this threshold are described as hard water. According to Singh, Bharose, Nemčić-Jurec, Rawat, and Singh (2021), total hardness at 100 mg/L offers good control over corrosion and is the generally acceptable limit. The study further stated that total hardness is usually classified as soft (0–60 mg/L), moderately hard (60–120 mg/L), hard (120–180 mg/L) and very hard (>180 mg/L). With this, it is apparent that the water sources in the two communities fall under the soft classification. The low values of total hardness implies that the water sources are soft in nature and have not been accumulating much dissolved calcium and magnesium ions that could not possibly cause hardness. The low hardness level will not adversely affect detergent performance; implying the water is soft and does not create any problem to people in the two communities who rely on the water sources for laundry purpose (Ajani *et al.*, 2021; Iwara*et al.*, 2012).

The mean content of chloride (Cl) ranged from 47.5 to 92.4mg/l with a high value obtained in Agoi-Ekpo and a low value in Agoi-Ibami(table 4.2). The contents of chloride obtained in the present study are above the range of 16.0 to 31.0mg/l reported in Yakurr LGA by Okori and Ekanem (2022). The chloride values obtained for sampled water in the two communities are within WHO maximum permissible limit of 250mg/l. This implies that Cl levels in the surface water sources are low which suggests low inputs from runoff, inorganic fertilizer use, landfill leachates, septic system effluents, industrial emissions, irrigation discharge, and animal feed wastes. In addition, the mean content of nitrate (NO_3) ranged from 0.01 to 0.03mg/l with a relatively high value obtained in Agoi-Ibami. The contents of NO_3 in the present study are low and within the range of 4.23 to 8.01mg/l reported in Yakurr LGA by Okori and Ekanem (2022). The NO_3 level in the two communities falls within WHO maximum permissible limit of 50mg/l. This implies that NO_3 levels in the surface water sources are low which is attributed to the absence of organic or effluents discharges into the water sources. The low NO_3 values also suggest the absence of discharge of effluents from household wastes and landfills. In water sources, high levels of nitrate in water arises due to runoff or leakage from wastewater, landfills, fertilized soil, animal feedlots, septic systems, or urban drainage (Husaini, Enriquez, Arzu, Miranda, Mossiah and Cardinez, 2020). The generally low level of NO_3 in the sampled water sources implies absence of leakage from organic wastes. Also, the mean content of sulphate (SO_4) ranged from 0.09 to 0.34mg/l with a high value obtained in Agoi-Ekpo. The contents of SO_4) in the present study are low and within the range of 1.10 to 3.46mg/l reported in Yakurr LGA by Okori and Ekanem (2022). The levels of sulphate are far below WHO permissible level of 250mg/L suggesting the absence of sulphate pollution.

Pollution Index of Drinking Water

This section of the analysis uses the measured physicochemical parameters of the two communities to determine the pollution index. The result obtained is presented in table 4.4. The pollution index of surface water denotes the summation of proportions between the observed physicochemical parameters and the prescribed standard values (in this study, the prescribed standard is WHO thresholds for the studied physicochemical parameters).

Table 4.3 shows that if $WPI<1$, the water source is marked as pure, if $WPI>2$, the water source is polluted, and if $GWPI>6$, the water source is heavily impure waters (Milanovic, Milijašević and Brankov, 2011). WPI combines physical and chemical index and makes it possible for water quality of different water bodies to be compared (Milanovic *et al.*, 2011). It is widely applied and used to determine the quality of surface water, groundwater, runoff, river as well as of drinking water (Kwon, Koh, Jung, Kim and Ha, 2020; Milanovic *et al.*, 2011;

Nikolaidis, Mandalos and Vantarakis, 2008). Based on the obtained WPI values, the pollution indexes are classified into different classes as shown in table 4.3.

Table 4.3 Water quality classification according to WPI

Class	**Characteristics**	**WPI**
I	Very pure	≤ 3
II	Pure	0.3 – 1.0
III	Moderately polluted	1.0 – 2.0
IV	Polluted	2.0 – 4.0
V	Impure	4.0 – 6.0
V1	Heavily impure	≥ 6

Source: Milanovic *et al.*, (2011: 271)

The result in table 4.4 revealed that the mean level of drinking water pollution index across the two communities ranged from 0.00 to 0.09. With reference to the rating given by Milanovic *et al*. (2011), the values of pollution index of the drinking water sources fall under the class of pure. It reveals that the drinking water sources in the two communities are not polluted in spite of the various anthropogenic activities being carried out in the communities.

Table 4.4: Drinking water pollution index in the study communities

Parameters (Unit)	**Location**	
	Agoi-Ekpo	**Agoi-Ibami**
Ph	0.01	0.01
Turbidity (NTU)	0.01	0.00
EC (us/cm)	0.03	0.01
TDS (mg/L)	0.04	0.02
Tempt (^{0}C)	0.09	0.09
Hardness (mg/L)	0.04	0.02
CL (mg/L)	0.02	0.01
NO_3 (mg/L)	0.00	0.00
SO_4 (mg/L)	0.00	0.00

Source: Researcher's Fieldwork, 2023.

This result is expected because the studied physicochemical parameters in the two communities are within WHO permissible thresholds as such; the drinking water sources are good for drinking and for other domestic uses.

4.2.2Bacteriological Analysis of Surface Water Samples in Agoi Communities

This aspect of the analysis assessed the bacteriological characteristics (the amount of fecal coliform counts) of drinking water samples (table 4.5). Coliforms are bacteria typically found in plants, soils, and animals. One can contact with these bacteria by eating or drinking. According to Ewa *et al.* (2011), total or fecal coliform bacteria can be found in water contaminated by organic wastes (human and animal wastes). Bodoczi(2010) cited in Abong and Atsu (2022) stated that the sanitary quality of water sources is determined bythe presence or absence of pathogenic microorganisms shown by presence of coliforms. In addition, the Environmental Fact Sheet (2008) cited in Iwara*et al*., (2012) reported that the non-appearance of coliforms in water shows there is a very low possibility or chance of the presence of disease organisms in the drinking water. The result in table 4.5shows the mean value of fecal coliform counts (FCC) ranged from 18.5 to 19.6 cfu/100, with high coliform counts found in the drinking water bodies in Agoi-Ibami. The FCC values obtained in the present study fall within the range of 48 to 51cfu/100 reported in Yakurr LGA by Okori and Ekanem (2022); the values are however above the range of 2 to 11cfu/100 reported in another study in Yakurr LGA by Inah*et al*., (2022). Also, the FCC in this study is within the range of 20 to 70cfu/100 reported in Calabar South by Abong and Atsu (2022). The result simply shows the presence of fecal coliform counts in the drinking water samples in the two communities which is an indication of human and animal pollution (Iwara*et al.*, 2012). The bacterial analysis therefore shows that the fecal coliform counts in the drinking water samples exceed WHO recommended standard of 0cfu/100 for FCC in drinking water. It therefore means that sampled surface water samples have traces of fecal coliform implying the water samples are receiving organic contaminants. This is also a proof of ongoing open defecation in the study area.

Table 4.5:Mean bacteriological analysis of surface water samples in Agoi-Ekpo and Agoi-Ibami

Parameters	**Location**		
	Agoi-Ekpo	**Agoi-Ibami**	**WHO limit**
FCC (CFU/100)	18.5	19.6	0

Source:Researcher's Fieldwork, 2023.

4.3 Household Toilet Facilities and Open Defecation

The result in table 4.6revealed that a larger percentage of the households have pit latrine; this is followed by households with wooden/block toilet, only 23.3% of the households have flush toilets. This goes to show that majority of the houses in the two communities have pit latrine and wooden/block toilets. This result is expected because pit latrine and wooden/block toilets are commonly used in rural areas primarily as a result of their cost-effectiveness in construction and maintenance. This result agrees with those of Mustapha, Okareh, Sridhar and Aliyu (2022) and Inah*et al.* (2020) where the cost-effectiveness in pit latrine erection and upkeep are also identified to be the reason for its high availability in the rural areas. In addition, the capital-intensive nature of the flush toilet considering the low economic base of the respondents maybe responsible for its low number among houses in the area. The present study reveals that all the sampled houses in the study communities have toilet facilities; the implication is that open defecation which degrades the environment and intensifies disease spread is not a serious problem in the communities. This is because households do not defecate in open fields or bushes. Despite that, the communities under study have not attained ODF status as certified by UNICEF, because about 38% still defecate on wooden/block toilets (table 4.6). The survey shows that across the individual communities, 31.1% of households in Agoi-Ekpo defecate on wooden/block toilets. While a good number of households (44.9%) in Agoi-Ibami defecates on wooden/block toilets. A field investigation also identified two different locations where wooden toilets are found openly in Agoi-Ekpo. This shows that only 62% of the sampled population has either flush toilet or pit latrine, which is against the UN threshold for Nigeria. This result deviates from those of Inah*et al*. (2020) who reported that households in Akpabuyo without toilet facilities defecate in open fields or bushes.

Table 4.6:Toilet facilities

Variables	**Categories**	**Locations Agoi-Ekpo (n =180)**	**Agoi-Ibami (n = 216)**	**Total % (n = 396)**
Type of toilet use	Flush toilet	37.8	8.8	23.3
	Pit latrine	31.1	46.3	38.7
	Wooden/block toilet	31.1	44.9	38.0
Available toilet at work place (farm, office & market)	Flush toilet	4.4	5.1	4.8
	Pit latrine	30	36.6	33.3
	Wooden/block toilet	65.6	58.3	61.9
	Farm toilet	0	0	0
Distance to toilet	<2min	60.0	69.0	64.5
	>2m	40.0	31.0	35.5
	<10mins	0	0	0
	>10mins	0	0	0

Source: Researcher's fieldwork, 2023.

In addition, information on the availability of toilet facilities at workplaces (farm, office and market) revealed that apart from the farm, toilet facilities were available in offices and markets implying that these land uses are free from open defecation. It also indicates that open defecation is a serious challenge among farmers who practice open defecation in open fields, fallow lands and on their farmlands. Since, not neither pit latrine nor wooden/block toilets are available in the farms, farmers answer the call of nature in open areas. This has immense implication as it can pollute nearly surface water bodies as well introduce bacteria into the soil. The result in table 4.6 also showed that majority (64.5%) of the households trek less than 2mins to make use of toilet facilities; which implies that the toilet facilities are within reach and are easily accessible by members of the households. The result also revealed that 35.5% of the households in the two communities trekked 2mins and above to access toilet facilities. This category of households has toilets located some metres away from their houses. That is, they are not living in self-contained apartments; as such, they have to move out of their houses to make use of the toilet. In all, the results in table 4.6 revealed that majority of the households in the two communities have pit latrine and wooden/block toilets; that apart from farmlands, toilet facilities are available in offices and markets and that a large proportion of households' trek less than 2mins to make use of toilet facilities.

4.3.1 Frequency of Toilet Hygiene

Table 4.7 revealed that 41.5% and 32.2% of the respondents washed their hands whenever they are dirty and after toilet respectively, while 13.2% washed their hands once per day. It goes to show that a good number of the respondents are aware of the need for and importance of maintaining good hygiene; this they portray by washing their hands every day after using the toilet and whenever they are dirty. It also suggests that 73.7% of the respondents try as much as possible to maintain good hygiene in the two communities, indication that a good number of the households are knowledgeable about the health benefits of handwashing. This result and assertion pay credence to the work of Inah*et al*., (2020) where they reported that a larger percentage of the respondents washed their hands regularly after eating, before eating and after handling children's faeces. It further revealed that 50.8% of the respondents used only water for handwashing and 34.2% used water and soap, while a negligible percentage used water and ash for a handwashing practice. This goes to show that the level of personal hygiene among the respondents is poor as only a few individuals used water and soap for hand washing after using the toilet and whenever they are dirty.

Table 4.7: Hand washing and toilet hygiene

Variables	**Categories**	**Locations**		**Total**
		Agoi-Ekpo (n =180)	**Agoi-Ibami (n = 216)**	**% (n = 396)**
No. of times hands are washed	One time per day	24.4	1.9	13.2
	Two times per day	20.0	1.9	10.9
	After toilet	8.9	55.5	32.2
	When hands are dirty	42.2	40.7	41.5
	Not at all	4.4	0.0	2.2
Means of handwashing	Water only	62.2	39.4	50.8
	Water and soap/detergent	28.9	39.4	34.2
	Sand	4.4	0.0	2.2
	Water and ash	4.4	21.2	12.8

Mode of cleaning faeces after toilet	Tissue paper	28.9	10.6	19.7
	Hard paper	6.7	37.5	22.1
	Leaves	15.6	33.8	24.7
	Water	48.9	18.1	33.5

Source**:** Researcher's fieldwork, 2023

The use of leaves and hard papers is completely unhygienic and unsanitary because the anus/buttocks will not be completely cleansed of faeces. This can result in the introduction of flies which is able to cause cholera among other ailments. The result in table 4.7 therefore reveals that good number of the respondents wash their hands every day after using the toilet and whenever they are dirty; despite this, the level of personal hygiene among the respondents is poor as only a few individuals used water and soap/detergent for hand washing and water and leaves are the main modes of cleaning faeces after using the toilet. These WASH behavioural practices are rated poor which are able to increase the incidences of WASH related health complications. This agrees with the submission of Eneji, Eneji, Asuquo and Ubom (2015) where they reported that negative or poor WASH behaviours/practices intensifies the frequencies of WASH related health complications, whereas positive WASH behaviours/practices decrease WASH related health problems.

4.4 *Effects of Socioeconomic Factors on Hand Washing Practice*

The study explored the socioeconomic factors that affect handwashing practices using logistic regression analysis. The finding revealed the relationship of;

$Y = -5.011 + 5.060X_1 + 5.359X_2$ - (2)

Where Y = Handwashing

X_1 = Marital Status

X_2 = Monthly Income

Table 4.8:Summary of logistic regression (forward stepwise approach) result showing effects of socioeconomic factors on hygiene practice

Predictors	**B**	**S.E.**	**Wald**	**Df**	**Sig.**	**Exp(B) (Odd ratio)**
Marital status	5.060	.996	25.819*	1	.000	157.627
Monthly income	5.359	.920	33.900	1	.000	212.580
Constant	-5.011	.939	28.479	1	.000	.007

Overall model estimation

	Chi-square	**Df**	**Sig.**
Step	37.643*	1	.000
Block	464.863*	2	.000
Model	464.863*	2	.000

Nagelkerke R Square = 0.952; Overall model classification = 98%
*Significant at 5% confidence level

The strength of logistic regression measured by the Nagelkerke R Square showed that 95.2% (0.952) of the variability in the dependent variable (hand washing practice) was explained by two independent variables (monthly income and marital status) used in the model. The result in the model shows that the monthly income and marital status are relevant and significant in the explanation of hand washing practice. Likewise, result of the total percentage accuracy value of 98% surpassed the threshold of 56.6% (Bayaga, 2010) which implied that the logistic regression model was very suitable in the explanation of WASH practice of handwashing. The Wald statistics results in table 4.8 shows the significance of each predictor variable in the equation and has a chi square distribution which is significant at $p<0.05$. Therefore, predictor variable(s) that has p-value less than 0.05 is significant. Looking at the individual variables, it was apparent that monthly income (= 33.900, $p<0.05$) and marital status (= 25.819, $p<0.05$) significantly predicted handwashing practice.

The study reveals that monthly income is 213 times more likely to predict handwashing practice than marital status, and 158 times more likely than monthly income. This suggests that monthly income has a greater influence on handwashing practice than marital status. Previous studies have also found that socioeconomic characteristics, such as household size, education level, wealth index, access to mass media, place of residence, and region, are significant predictors of open defecation practice in Haiti. These findings highlight the importance of understanding socioeconomic factors in promoting handwashing practices.

The study reveals that households with high income are more likely to have in-place hand washing facilities, as they don't have to buy detergents, soaps, and tissue papers. This aligns with previous research by Muramatsu-Noguchi et al. (2022), who found that poor households in rural areas were less likely to have soap in their facilities. Marital status also plays a significant role in hand washing practice, with couples having more in-place facilities due to wives ensuring cleanliness and instilling practices during meals. The study suggests that monthly income significantly influences house likeliness to hygienic-related goods like soap.

In conclusion, the study demonstrates that monthly income is the most potent factor that significantly influences house likeliness to hygienic-related goods like soap in households. This is particularly true for households with high income who may not feel the burden of buying detergents, soaps, and tissue papers each time they finish, and who have soaps/detergent in their hand washing facilities.

4.5 Effects of Socioeconomic Factors on Hygiene Practices

The likelihood of practicing good hygiene (handwashing) was predicted using socioeconomic variables such as age, sex, education, occupation, household size, monthly income, and marital status. The logistic regression model output (table 4.8) displays the outcome that was retained. The output shows that the monthly income and marital status were the two socioeconomic characteristics retained and were able to predict handwashing behaviour. The logistic regression was shown to be significant (= 464.863, $p<0.05$). This indicates that only monthly income and marital status were retained by the model and adequately predicted the habit of handwashing. According to the overall outcome, handwashing behavior was predicted by socioeconomic characteristics. Hence, the null hypothesis is rejected and the alternative hypothesis which states that socioeconomic factors have significant influence on hygiene practice among households in the study area is accepted.

Conclusion

This study investigates the practice of water and sanitation (WASH) in remote areas, focusing on the impact of surface water consumption and coliform bacteria presence. The research indicates that residents in these areas drink more surface water than groundwater, and open defecation persists. The study suggests that government and individuals should invest in water supply, boil water, construct protected pit latrines, and provide WASH facilities for their families and citizens. Income remains a crucial factor in WASH practices in remote areas.

REFERENCES

Abong, A. A. & Atsu, J. U. (2022). Evaluation of concentration of some groundwater parameters around a major refuse dumpsite in Cross River State, Southeastern Nigeria. *Journal of Applied Science and Environmental Management*, 26(3), 525-531.

Adeoye, P. A., Adeolu, A. R. & Hassana, H. M. (2013). Appraisal of Rural Water Supply: Case Study of Kwara State, North Central Nigeria. *International Journal of Basic and Applied Science,* 1(4), 816-826.

Afangideh, A.I., Njar, G. N., Ewa, E. E., Eli, H.D. &Iwara, A. I. (2011). Assessment of water quality status of borehole in Calabar South Local Government Area, Cross River State. *International Journal of Biosciences*, 1 (5): 71-76.

Ajani, G. E., Popoola, S. O., &Oyatola, O. O. (2021). Evaluation of the pollution status of Lagos coastal waters and sediments, using physicochemical characteristics, contamination factor, Nemerow pollution index, ecological risk and potential ecological risk index. *International Journal of Environment and Climate Change*, 11(3), 1-16.

Awoyemi, O. M., Achudume, A. C. & Okoya, A. A. (2014). The physicochemical quality of groundwater in relation to surface water pollution in Majidun area of Ikorodu, Lagos State, Nigeria. *American Journal of Water Resources*, 2(5), 126-133.

Bayaga, A. (2010). Statistics & probability education in South Africa: constraints of learning. *Problems of Education in the 21st Century,* 20, 25-35.

Benesova, I., Novotny, V. & Franke, D. (2008). A theoretical approach to the computation of functional accessibility. *Journal of Landscape Studies,* 1, 79 – 89.

Berihun, G., Adane, M., Walle, Z., Abebe, M., Alemnew, Y., Natnael, T, Andualem, A.,Ademe, S.,Tegegne, B., Teshome, D. &Berhanu, L. (2022) Access to and challenges in water, sanitation, and hygiene in healthcare facilities during the early phase of the COVID-19 pandemic in Ethiopia: A mixed-methods evaluation. *PLoS ONE,* 17(5), 1-15.

Bodoczi, A. (2010). The Seasonal Quantitative Distribution of Coliform Germs in the Arieş River (Romania) Water Affected By Pollution. *AnaleleUniversităţii din Oradea - FasciculaBiologie*, 5pgs.

Eja, M. E., Arikpo, G. E. &Akpan. P. A. (2006). An overview of the state of water supply and sanitation in Sub-Saharan Africa: The Nigerian situation. *Global Journal of Environmental Sciences* 5(1), 65-70.

Enang, S. B. (2009). The history of Yako people in Cross River State, Nigeria. Makurdi: Oracle Business Limited.

Eneji, C. V. O., Eneji, J. E. O., Asuquo, I., &Ubom, B. A. E. (2015). Water sanitation and hygiene (WASH) in community disease control in Cross River state Nigeria. *International Journal of Environmental Science and Toxicology. Research,* 3, 173-181.

Ewa, O., Zaneta, P. &Jacet. N. (2011). Analytics of surfactants in the environment: problems and challenges. *American Chemical Society*, 111(9), 5667-5700.

Husaini, D. C., Enriquez, A., Arzu, T., Miranda, K., Mossiah, D. &Cardinez, C. (2020). Nitrate levels in rural drinking water in Belize. *Journal of Health and Pollution,* 10(27), 1-8.

Inah, E. O., Obiefuna, J. N., Eteng, E. O.,Iwuanyanwu, I. & Bello, A. A. (2022). Physico-chemical and microbiological analysis of borehole water sources in E-One Estate Lemna, Calabar, Cross River State, Nigeria. *International Journal of Emerging Trends in Engineering Research,* 10(2), 85–90.

Inah, S. A., Eko, J. E., John, E. A., Ochei, K. C., Obot, N., Iniam, D. E. & Elemi, L. A. (2020). Assessment of water supply, sanitation and hygiene practices among households in Southern Nigeria. *International Journal Environmental Pollution Research*, 8, 42-53.

Iwara, A. I., Njar, G. N., Deekor, T. N. & Ita, A. E. (2012). Effect of Adiabo abattoir on the water quality status of Calabar River in Odukpani, Cross River State, Nigeria. *Continental Journal of Environmental Sciences*, 6(2).

Jordan, H., Roderick, P., Martin, D. & Barnett, S. (2004). Distance, rurality and the need for care: access to health services in South West England. *International Journal of Health Geographics Research*, 3 (21), 1-9.

Kwon, H. I., Koh, D. C., Jung, Y. Y., Kim, D. H. & Ha, K. (2020). Evaluating the impacts of intense seasonal groundwater pumping on stream–aquifer interactions in agricultural riparian zones using a multi-parameter approach. *Journal of Hydrology*, 584(12), 46-83.

McNeely, I. F. (2002). “Medicine on a Grand Scale"- Rudolf Virchow, liberalism, and the public health. Welcome Trust. 97pgs.

Milanović, A., Milijašević, D. &Brankov, J. (2011). Assessment of polluting effects and surface water quality using water pollution index: a case study of Hydro-system Danube-Tisa-Danube, Serbia. *Carpathian Journal of Earth and Environmental Sciences*,6(2), 269-277.

Muramatsu-Noguchi, Y., Nonaka, D., Kounnavong, S. & Kobayashi, J. (2022). Association between socio-economic status and the presence of soap at handwashing facilities in Lao People's Democratic Republic: A cross-sectional study. *Asia Pacific Journal of Public Health*, 34(4), 423-426.

Mustapha, M., Okareh, O. T., Sridhar, M. K. C. & Aliyu, M. M. (2022). Households' awareness and practices on Water, Sanitation and Hygiene (WASH) in an Arid Region of Northwestern Nigeria-Sokoto State. *West African Journal of Applied Ecology,* 30(2), 47-66.

Nikolaidis, C., Mandalos, P. &Vantarakis, A. (2008). Impact of intensive agricultural practices on drinking water quality in the EVROS Region (NE GREECE) by GIS analysis. *Environmental Monitoring and Assessment,* 143, 43-50.

Ohwo, O. (2019).Dimensions of inequality in urban and rural water, sanitation and hygiene services in sub-Saharan Africa.*European Scientific Journal*, 15(8), 144-162.

Oka, I. A., Peter, O. H. & Alain, I. S. (2019). Sources and accessibility of potable water in Yakurr Local Government Area, Cross River State, Nigeria. *International Research Journal of Public and Environmental Health*, 6(5), 82-88.

Okori, B. S. &Ekanem, A. N. (2022). Physicochemical, spectroscopic and bacteriological analyses of surface and ground water in Epenti-Ekori, Yakurr Local Government Area,Cross River State- Nigeria. *Journal of Environmental Treatment Techniques*, 10 (1), 67-75.

Opaluwa, O. D., Muhammad, A. I., Madaki, K. S., Usman, A. & Mohammad, I. A. (2022). Water Quality Assessment of River Adema, Nasarawa, Nasarawa State, *Nigeria. Journal of Applied Sciences and Environmental Management*, 26(8), 1433-1442.

Opara, A. A. (2006). Water supplies in some rural communities around Calabar, Cross River State, Nigeria 2. The impact on water-related diseases. *Tropical Freshwater Biology*, 12 (13), 93-98

Oyem, H. H, Oyem, I. M &Ezeweali, D. (2014). Temperature, pH, electrical conductivity, total dissolved solids and chemical oxygen demand of groundwater in Boji-BojiAgbor/Owa Area and immediate suburbs. *Research Journal of Environmental Sciences,* 8(8), 444-450.

Paul, B., Jean Simon, D., Kiragu, A., Généus, W. & Emmanuel, E. (2022). Socio-economic and demographic factors influencing open defecation in Haiti: a cross-sectional study. *BMC Public Health*, 22:(1), 1-16.

Saidu, M. & Musa, J. J. (2012). Impact of abattoir effluent on River Landau, Bida, Nigeria. *Journal of Chemical, Biological and Physical Sciences,* 2(1): 132-136.

Singh, S. K., Bharose, R., Nemčić-Jurec, J., Rawat, K. S. & Singh, D. (2021). Irrigation water quality appraisal using statistical methods and WATEQ4F geochemical model. *In Agricultural Water Management*. Academi Press, 101-138.

WHO (2022). World Health Organization water fact sheets. Retrieved 21, March, 2022.

WHO and UNICEF (2015) Progress on sanitation and drinking water-2015 update and mdg assessment. www.wssinfo.org/fileadmin/user …/JMP-Update-report2015_English.pdf (Accessed November 20, 2017).