Assessment of Water Supply and Water Quality in the Rural Area of Obokun Local Government, Osun State, Nigeria

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Article

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Abstract: Rural areas are not only faced with the problems of rural depopulation but also with the problem of water supply and water quality which is a basic necessity of life. In light of this, this paper assesses the rural water supply situation and the bacteriological quality of different water sources in the Obokun Local Government Area of Osun State, Nigeria. The safety of the water sources for human consumption and possible occurrence of the water borne diseases in the study area were determined. The study employed descriptive and analytical methods of data analysis to achieve the objectives of the inquiry. Findings showed that the study area suffered from inadequate water supply and poor locations of the sources of water: The study also revealed that the microbiological quality of the water sources used was unsafe, poor and not acceptable for human consumption. In addition, many man- days-hours were wasted in search of water. It is therefore recommended that the government should make the rural water supply and the maintenance of water quality a priority in its policy formulation.

Keywords: assessment; bacteriology; water supply; water quality; rural area

Introduction

Apart from air, water is the next most important natural resource for the survival of both plants and animals. Man requires water for different uses such as drinking, cooking, general sanitation, and agricultural and manufacturing processes among others. Water is essential for day-to-day human activities and has a decisive influence on the population of any region (Adedotun et al, 2024). Ibrahim et al (2018) also mentioned in their study the importance of portable water in the right quality and quantity for the survival and continued well-being of human and animal lives. Water is also considered to be vital to life sustainability and plays a critical role in the socio-economic development of human beings and the existence of ecosystems (Akinde et al, 2019). It is universally expected that an adequate water supply is required for personal hygiene, public health and the general well-being of an environment.

Water is one of the most essential needs of man. It is a natural resource that is critically needed to human survival. It is not an over statement to say that life would be impossible without water. No wonder, the global slogan of "Water is life". In spite of such importance of water to life, access to clean and safe drinking water is very rare. Water supply and quality have been a major challenge since the beginning of modern society. The primary goal of water supply is the provision of portable water on a constant basis which addresses the security of supply across seasons and between wet and dry seasons and is also imperative of health and wider poverty mitigation benefits to be met and sustained [Paschaline et al 2022, Nwankwoala, 2011; Obeta, 2017].

In spite of the importance of water to the world economy, there has been a water supply crisis. Water supply has been a major problem in the developing world. Despite the fact that about 70% of the earth's surface is water, water has become a scarce commodity in many parts of the world. Boreitti

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and Rosa (2019) noted that clean water scarcity is a major issue in today's world of 7.7 billion people. Akinde et al (2019) in their study of water shortage and drinking quality in rural southwest Nigeria observed inadequate water supply systems and impaired drinking water quality in the rural area of the southwest, Nigeria. Obeta (2019) noted that in most rural areas of developing countries including Nigeria, water supplies are not commensurate with demand which results in a shortfall in water use which many people suffer from the scenario. In their study (Obeta et al 2015) identified the physical environment, inadequate water supply infrastructure, socioeconomic and geographical location, management and socio-cultural problem as factors responsible for water supply in their study region of Nigeria. Ishaku et al (2011) observed that over 70% of households in rural communities do not have access to improved water supply. They maintained that these people rely solely on self-water supplies such as rivers, perennial streams, water ponds and unprotected wells. Domínguez et al (2019) also noted that rural water supply systems in developing countries typically have deficiencies that threaten their sustainability. Olawale et al, 2020 reported that the provision of a sustainable water supply system in rural areas in developing countries has been a challenge for several years, which has resulted in the dependency of rural dwellers on polluted water from various sources. He (Olawale, 2020) also observed that the sustainability of rural water supply is an acute problem due to widespread water infrastructural decay and frequent system breakdowns which inadvertently lead to scarcity of safe water in the Sub-Saharan African region.

The world water supply is becoming relatively static in supply and deteriorating in quality as a result of pollution. In view of the importance of water and the acute short supply of potable water to rural areas, successive governments in Nigeria have been making tremendous efforts aimed at improving the water supply situation in the nation. Among these are

(i) The Water Resources Decree No. 101 of 1983

(ii) The National Borehole Programme of 1991.

(iii) The Osun state government mini water scheme project of 2004

It is a known fact that most Nigerians live in rural areas and these people do not have access to safe and reliable sources of water (Akinyoyenu 1990). Many developing regions suffer from either chronic shortages of freshwater or the pollution of readily accessible water resources (Lehloesa and Muyima, 2000). About 800 million people in Asia and Africa are living without access to safe drinking water. Consequently, this has caused many people to suffer from various diseases (Tanwir et al., 2003). The quality of drinking water is of vital concern to mankind since it is directly associated with human life. In spite of the problem of inadequate water supply and poor water quality in rural areas, few data exist on the bacterial quality of water supply in these settings, since most studies approach the problem by focusing on urban communities (Nevondo and Cloete, 1999). This study uses indicators of pollution (heterotrophic bacterial count, total coliform and fecal coliform) to determine the microbial quality of water sources of rural areas in the Obokun Local Government, Osun State and to compare these results with the Nigerian Standard for Drinking Water Quality (NIS 554:2007). This paper aims to address problems associated with inadequate water supply and low water quality in the study area.

Study Area

Obokun Local Government Area (LGA) is one of the 30 Local Government Areas in Osun State Nigeria (Figures 1 and 2). It is one of the LGAs in Osun State with a dominant rural settlement characterised by rural activities including farming, hunting, and fishing among others. It is located in South-Western Nigeria. It lies between Latitude 7°47' and 7°4' north of the Equator and between Longitude 4°46' and 4°48' east of the Greenwich Meridian, with a total land area of 527km^2. The LGA is dominantly occupied by the Ijesha land while the Headquarter is in Ibokun town, while other notable towns within the LGA include Ipetu-Ile, Otan Ile, Imesi-Ile, Ada-Owode, Esa-Oke, Ilase-Ijesha, Iponda, Ikiyinwa, Idominasi, Esa-Odo and Ora. The climate is a humid tropical type with a temperature of about 29^{o}C, while the mean annual rainfall is about 1700cm. The LGA is about 401m above sea level. The LGA is about 25km south-east of Osogbo LGA, 31km to Olorunda LGA, 23km

 doi:10.20944/preprints202404.1435.v1

south-west of Ifelodun LGA 21km north-east of Atakumosa West LGA and 20km north of Boluwaduro LGA.

Figure 1. Osun State within the Context of Nigeria. Source: URP GIS Laboratory, UNIOSUN, 2023.

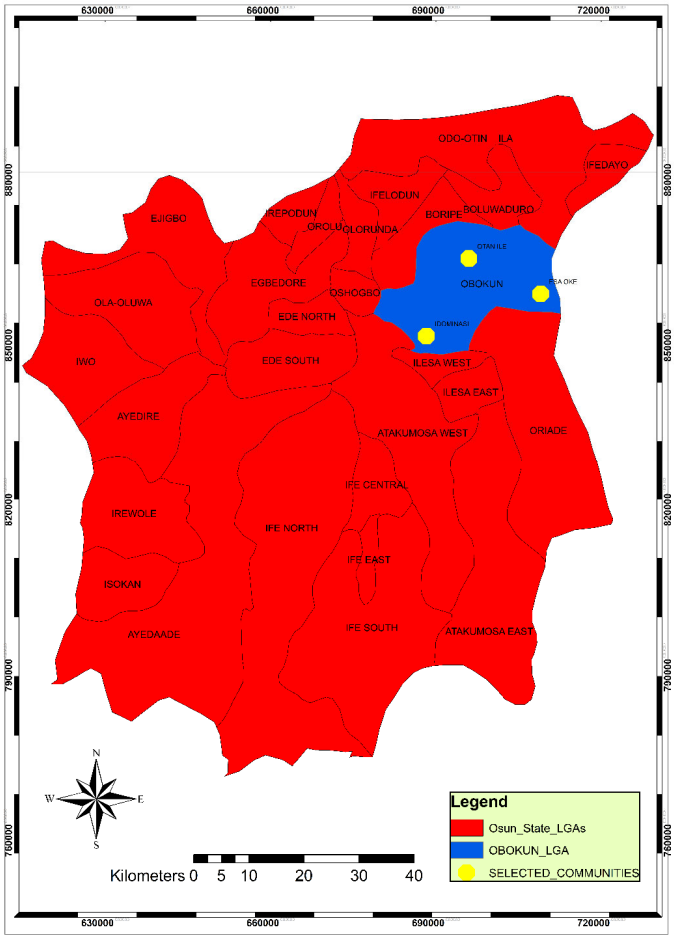

Figure 2. Esa-Oke, Otan -Ile and Idominasi in Obokun LGA within the context of Osun State. Source: URP GIS Laboratory, UNIOSUN, 2023.

 doi:10.20944/preprints202404.1435.v1

Methods

The methodology employed in this research work is essentially descriptive and analytical in nature and, therefore, depends on fieldwork that is complemented by laboratory analysis.

Types and Sources of Data

The main source of data for this work is from the primary source. This includes information gathered from the inhabitants of the study area through the administration of questionnaires. The questionnaire sought information on the socio-economic characteristics of respondents, their source of water, the time spent in search of water, the quality and quantity of water supplied, and the water-related diseases that are commonplace in the study area.

Sampling Technique and Sample Size

Obokun Local Government Area has been taken as the study area with a population of about 116,850 (Nwaerema, 2019). Due to the widespread population as well as the wide area coverage of the Obokun Local Government Area, three communities were randomly selected for investigation. They are Esa-Oke, Otan -Ile and Idominasi. Random sampling was used in selecting streets and houses to be sampled in each of the villages. Three hundred and sixteen (316) household units were sampled in the three communities selected, while data collected were presented descriptively using tables and percentages. The water samples were collected from streams, ponds, hand-dug wells and rainwater harvester used by residents in the study area. This was done monthly over a period of three months (April to June, 2022). Water samples were collected aseptically into sterile containers and transported in ice to the laboratory for microbiological analyses within 4 to 6 hours after collection.

Distribution of Questionnaires in the Study Area

For this study, the Table 1 shows the distribution of questionnaires across the villages studied. The distribution was based on the population and areal extents of the communities.

Table 1. Distribution of questionnaires in the study area.

Community	No of respondents	Percentage%
Esa Oke	156	49.33
Otan Ile	100	31.65
Idominasi	60	18.98
Total	**316**	**100**

Source: Authors' fieldwork,2022.

Results and Findings

This section discusses the socio-economic characteristics of the respondents in the study area, their sources of water, and the quality and quantity of water supplied.

Socio-Economic Characteristics of the Respondents

The socio-economic characteristics of the people considered here include gender, age, marital status, occupation and monthly income (Tables 2–4). Fifty five percent (55%) of the respondents were females while the remaining forty-five (45%) percent were males. The predominance of women is a result of women's involvement in the search for water. Respondents in all age groups were actively involved in the search for water for daily consumption.

Table 2. Age and gender structure of the respondents.

	Age groups				
Gender	<30yrs	30-39	40-49	50 above	Total

 doi:10.20944/preprints202404.1435.v1

Male	42	30	45	25	142
Female	48	20	45	61	174
Total	90	50	90	86	316

Source: - Author's fieldwork, 2022.

Table 3. Marital status and monthly income of respondents.

Marital Status	INCOME				Total
	< N30,000	N30,000 - 60,000	N60,001 - 90,000	> N90,000	
Single	42	21	15	08	86
Married	29	59	37	41	166
Divorced	01	06	04	05	16
Widowed	14	12	08	14	48
Total	86	98	64	68	316

Source: - Author's fieldwork, 2022.

Table 4. Education and occupation of the respondents.

	Education					
Occupation	No formal Education	Primary Education	Secondary Education	Post sec. Education	Total	
Farming	98	48	30	02	178	
Trading	21	10	09	30	70	21
Civil Servant	0	02	18	26	46	
Artisan	11	08	03	0	22	11
Total	130	68	- 60	58	316	

Source: - Author's fieldwork, 2022.

Most of the respondents are married which is 52.5% of the people interviewed, while 27.2% were single. Others were divorced or widowed. The study showed that 58.2% of the people interviewed earned less than thirty thousand Naira per month which is the minimum wage in Nigeria. It shows that most of the respondents are low-income earners which might have effects on their source, quality and quantity of water supply for daily consumption.

Furthermore, the study shows that most of the respondents (56%) are farmers who may equally account for their low incomes per month. About forty one percent (41%) of the respondents have no formal education. Only eighteen percent (18%) claimed to have a post-secondary school education. All these affect the quality of water supplied in the study area and also show the attributes of a typical rural area.

Table 6 shows that 44% of the respondents traveled less than one kilometer in search of water, while 49% traveled between one and two kilometers in search of water. This shows that most of the. Respondents do not have sources of water located within their vicinity; hence useful hours will be invested in search of water.

Furthermore, Table 7 shows that 66.4% of the respondents do not have adequate water supply. The study also showed that most of the wells and streams in the communities got dry during the dry season. Most (71%) of the people were of the opinion that the quality of their water is not good enough for human consumption. In addition, Table 8 shows water-borne diseases suffered by the people in the study area. Twenty eight percent (28%) of the respondents suffered from cholera as a result of contaminated or polluted water in the area. Twenty-nine (29%) percent from malaria while the remaining twenty percent (20%) suffered from other forms of water related diseases that were not specified in the data.

Table 9 shows the average time spent by the respondents in search of water in the study area. Fifty seven percent spent between one and two hours in search of water per day. Nineteen percent

 doi:10.20944/preprints202404.1435.v1

spent less than thirty minutes looking for water each day. The study shows that reasonable hours were spent in search of water in the study area, which, to a large extent, affects their productive hours.

Table 5. Sources of water supply in the study area.

	COMMUNITIES			
Sources of water	**Esa Oke**	**Otan-Ile**	**Idominasi**	**Total**
Well	82	78	38	198
Rain	26	04	04	34
Stream	40	10	18	68
Borehole	08	08	-	16
Tap water	-		-	-
Total	**156**	**100**	**60**	**316**

Source: -Author's fieldwork, 2022.

Table 6. Distance of source of water from residences.

	COMMUNITIES			
Distance(kms)	**Esa Oke**	**Otan-Ile**	**Idominasi**	**'Total**
<1km	56	56	26	138
1-2km	92	38	24	154-2
2 km and above	08	06	10	24
Total	**156**	**100**	**60**	**316**

Source: Author's fieldwork, 2022.

Table 7. Respondents assessment of water quality and quantity.

	QUANTITY		
Quality	**Inadequate**	**Adequate**	**Total**
Very good	20	18	38
Good	30	24	54
Fair	95	46	141
Bad	65	18	83
Total	**210**	**106**	**316**

Source: Author's fieldwork. 2022.

Table 8. Water related diseases suffered in the study area.

	COMMUNITIES				
Disease	**Esa Oke**	**Otan-Ile**	**Idominasi**	**Total**	**%**
Cholera	50	26	12	88	28
Typhoid	08	4	-	12	4
Dysentery	20	2	8	30	9
Diarrhea	14	10	06	30	9
Malaria	36	40	16	92	29
Others	28	18	18	64	20
Total	156	100	60	316	100

Source: Author's fieldwork, 2022.

Table 9. Hours spent in search of water per day.

	COMMUNITIES			
Hour	**Esa Oke**	**Otan-Ile**	**Idominasi**	**Total**
30 mins	20	15	25	60

 doi:10.20944/preprints202404.1435.v1

30-60 mins	36	25	15	76
60-90 mins	60	35	15	110
90-12 mins	40	25	05	70
Total	**156**	**100**	**60**	**316**

Source: Author's fieldwork, 2022.

Microbiological Analyses of Water in the Study Area

The heterotrophic bacterial count was determined using the spread plate method on nutrient agar and the plates were incubated aerobically at 37^0C for 48 hours. The total coliforms and fecal coliforms were enumerated on MacConkey agar using the spread plate method and aerobically incubated at 37^0C and 44.5^0C respectively for 24 hours. Selected colonies were purified using the streaking method. Pure colonies were characterized and identified using morphological and biochemical methods as described by Buccanhan Gibbon, 1974.

Table 10 shows the mean population of heterotrophic bacteria, the total coliform count and the fecal coliform count. The heterotrophic bacterial count ranged between 3.4×10^3 to 1.8×10^5 for stream water,$7.7 \times 10^4 to\ 3.5 \times 10^5$for pond water,$1.0 \times 10^2 to\ 6.7 \times 10^2$for well water and $1.9 \times 10^1 to\ 2.8 \times 10^2$ for rain water.The total coliform count ranged between $2.9 \times 10^2 to\ 3.4 \times 10^3$ for stream water,$3.5\times 10^2 to$ $3.7x10^3$ for pond water, 1.7×10^1 to 2.6×10^2 for well water and $1.2\times 10^1 to 2.2x\ 10^2$ for rain water. Similarly, faecal coliform count ranged from $2.0 \times 10^1 to\ 2.7 \times 10^2$for stream water, 3.2×10^1 to 3.5×10^2 for pond water, $0.9 \times 10^1 to\ 2.1 \times 10^2 for\ well$ water and $0.7 \times 10^1 to 1.9 \times 10^1$ for rain water.

Table 10. The mean population of heterotrophic bacteria, total coliform and faecal coliform counts.

Samples		Population of Bacteria		
		Heterotrophic Bacterial Count	Total Coliform Count	Faecal Coliform Count
Stream	S1	$1.5x10^4$	$2.3x10^3$	$1.5x10^2$
	S2	$3.4x10^3$	$3.4x10^3$	$2.0x10^1$
	S3	$1.8x10^5$	$2.9x10^2$	$2.7x10^2$
Pond	P1	$7.7x10^4$	$3.5x10^2$	$3.2x10^1$
	P2	$1.4x10^5$	$3.7x10^3$	$1.7x10^2$
	P3	$3.5x10^5$	$2.8x10^3$	$3.5x10^2$
Well	W1	$1.3x10^2$	$2.6x10^2$	$2.1x10^2$
	W2	$1.0x10^2$	$1.7x10^1$	$0.9x10^1$
	W3	$6.7x10^2$	$2.3x10^1$	$1.7x10^1$
Rain	R1	$2.8x10^2$	$2.2x10^2$	$1.9x10^1$
	R2	$1.9x10^1$	$1.2x10^1$	$0.7x10^1$
	R3	$1.1x10^2$	$1.9x10^1$	$1.2x10^1$

Key
S1: Stream water from Esa-Oke;
S2: Stream water from Otan-lle
S3: Stream water from Idominasi;
P1: Pond water from Esa-Oke
P2: Pond water from Otan-Ile;
P3: Pond water from Idominasi
W1: Well water from Esa-Oke;
W2: Well water from Otan-lle
W3: Well water from Idominasi;
R1: Rainwater from Esa-Oke
R2: Rainwater from Otan-Ile;

 doi:10.20944/preprints202404.1435.v1

R3: Rainwater from Idominasi

A total of six bacterial species: Escherichia coli, Bacillus subtilis, Pseudomonas aeruginosa, Salmonella sp, Enterobacter aerogenes and Shigella sp were isolated. Their distribution among the various sources is shown in Table 11. Escherichia coli was found in all the stream water samples, some pond water samples and only one well water sample, Shigella species was found in all the pond water samples and in some stream water samples while Salmonella sp, Enterobactia aerogenes and Shigella sp were not isolated from the well water and rainwater samples.

Table 11. Pathogenic bacteria isolated from water sources in the Obokun Local Government Arca of Osun State, Nigeria.

Bacteria isolates	Water samples											
	S1	**S2**	**S3**	**P1**	**P2**	**P3**	**W1**	**W2**	**W3**	**R1**	**R2**	**R3**
Escherichia coli	+	+	+	-	+	+	-	-	+	-	-	-
Bacillus subtilis	+	-	-	+	-	-	-	+	-	-	+	+
Pseudomonas aeruginosa	-	-	+	-	+	-	-	-	+	+	-	-
Salmonella sp	-	+	+	-	+	+	-	-	-	-	-	-
Enterobacter aerogenes	+	-	+	-	-	-	-	-	-	-	-	-
Shigelia sp	+	+	-	+	+	+	-	-	-	-	-	-

Key

S1: Stream water from Esa-Oke; S2: Stream water from Otan-Ile

S3: Stream water from Idominasi; P1: Pond water from Esa-Oke

P2: Pond water from Otan-Ile; P3: Pond water from Idominasi

W1: Well water from Esa-Oke; W2: Well water from Otan-lle

W3: Well water from Idominasi; R1:Rain water from Esa-Oke

R2: Rain water from Otan-Ile; R3: Rain water from Idominasi

+ Positive - Negative

The counts obtained for the heterotrophic bacteria, the total coliform as well as the fecal coliform exceeded the maximum permitted levels for no risk according to Nigerian Standard for Drinking Water (NIS 554: 2007). The maximum permitted level of 10cfu/ml is allowed for total coliform count while the maximum allowable limit for fecal coliform is 0 cfu/100ml. The high number of indicators detected revealed that the microbiological quality of the water sources used was unsafe, poor and not acceptable for human consumption (Obi et al, 2002). The presence of potential pathogenic enteric bacteria such as E. coli, Pseudomonas aeruginosa, Salmonella *sp.* and Shigella *sp*. portends serious health dangers as these enteric bacteria are reportedly causative agents of various diseases and their complications. the hemolytic uraemic syndrome caused by E. coli and dysentery caused mainly by water from the different water sources by rural residents in the Obokun Local Government area of Osun State in Nigeria must not be underestimated.

(Some words missing here) human and animal feces or the introduction of microorganisms by birds and insects fetching water which are often placed on the ground (Olowe et al., 2005) and the poor study. This study as well as similar studies on the quality of potable water in rural 2001 and Obi et al., 2002) showed the challenges for health and water resources in developing countries.

Summary and Conclusions

Water is one of the necessities of life. It is the foundation on which other necessities of life are based. Without a regular supply of fresh water, standards of life tend to decline. Although more than 70% of the earth's surface is water, water has become a scarce commodity in many parts of the world. The threat of world water crises is becoming increasingly real in the face of the increasing demand

 doi:10.20944/preprints202404.1435.v1

for this necessity of life because of its deteriorating quality due to pollution. It is against this background that this study concerned itself with the assessment of the quality of water supplied in the rural area of the Obokun Local Government and the implication it has on the rural dwellers.

The major findings in this study showed that a large number of people do not have access to safe and reliable sources of water. The area is characterized by unclean and seasonal water supplies. Hence, the inhabitants experience hardship in getting potable water, most especially during the dry season. The study also shows that water sources in the study area are mainly well water, streams and rainwater. There was no provision of public tap water in the area as mentioned earlier; water shortage is rampant during the dry season when many of the sources of water dry up. People are obliged to trek long distances in search of water. The study further shows that many respondents in the area suffered from various water-related diseases such as malaria, diarrhoea, dysentery and cholera.

According to these findings, most of the respondents have no formal education which constitutes one of the problems of the people because it affects their perceptions of water quality and general behaviour. The study also showed that the majority of the (N10,000.00). Hence, most of them cannot afford to sink or construct their wells or boreholes.

Recommendations

According to the results, it can also be concluded that the microbiological quality of the following recommendations are made: the government should make the rural water attention to the provision and maintenance of water in rural areas. The government and agencies responsible for rural water supply should ensure adequate provision of communal deep wells and boreholes which must be centrally, located for easy accessibility to the users.

Communities should be encouraged and assisted in providing potable water for themselves. People must be trained in the maintenance of boreholes and hand pump machines. Clubs and organisations in the rural area should also be encouraged to embark on the provision of potable water. The government should assist in treating sources of water with water treatment chemicals. Also, alternative sources of water like springs and streams should be protected. Rural dwellers should be educated on water treatment methods. Health educators should, however, supply chemicals to the villagers. Above all, communities should be involved in water project planning, construction, operation and maintenance. Integrated rural development should be embraced. The development of the rural area rests on a combination of the various sectors of the rural economy combined with the backward linkage from urban centers.

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