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Sanitary Surveying and Water Quality Assessment in South-Western Nigeria

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Abstract

Sanitary risk factors are every unsanitary condition that could increase the risk of illness. The level of the risk may not be equal in magnitude as some may be higher than the other. However, inadequate water supply which often result to poor personal and environmental hygiene remains a major problem in the South-Western Nigeria. This study aims examining the use of sanitary surveying technique as an index for assessing water quality in South-Western Nigeria. In order to actualize the aim of the study, the objectives pursued are to: identify the purpose of sanitary surveying; undertake a comparism of samples taken using water quality analyzer and sanitary surveying; identify the major sanitary risk factors; explain the basic data required for sanitary surveying as well as highlight the relative significance of sanitary surveying to environmental planning and management as well as to elucidate how the sanitary surveying result can be used for planning purposes and policy formulation. The study focused on and limit its attention to the six (6) states that constitute the South-West Geopolitical zone of the country. These states are Ekiti, Lagos, Ogun, Ondo, Osun and Oyo. These States have very high population density that could be at the risk of water supply contamination if not properly addressed. Hand-dug wells were used as sample sources of water. The rationale behind the choice of hand-dug wells is that they form the major source of water supply in South Western States as over 2/3 of the buildings in the study area use well water as their main source of water or a viable alternative to tap water. It is therefore assured that if contamination from hand-dug well source of water supply can be curbed, then water borne diseases resulting from water pollution must have been adequately controlled.

Keywords: Pathology, Physico-chemical, hand-dug wells, water quality, and sanitary surveying

Introduction

Over large parts of the world humans have inadequate access to portable water and use sources contaminated with diseases vector pathogens or unacceptable levels of toxins and suspended solids. Drinking or using such water in food preparation leads to widespread acute and chronic illnesses causing death and misery in many countries (Michael, 2013). Water quality and the risk to waterborne diseases are critical public health concerns in many developing countries. Close to a billion people most living in the developing world do not have access to safe and adequate water (UN-Water, 2011). WHO & UNICEF (2006) estimate that around 94% of the global diarrheal burden and 10% of the total disease burden are due to unsafe drinking water, inadequate sanitation, and poor hygienic practices (WHO. 2011a). Thus, the provision of safe and adequate water contributes to better health and increased individual productivity. It is also recognized that there is significant relationship between water supply and sanitation improvements and the potential for health and economic benefits (WHO. 2011b).

Safe and portable water supplies in the South Western Nigeria are still inadequate in spite of over six decades of independence and several efforts by various governments, despite the intervention of the World Bank, African Development Bank and UNICEF, a gap still exist in the provision of safe water, hence the inhabitant mostly women and children have resorted in sourcing water from hand-dug wells which are unprotected. The underground water during its passage through the soil dissolves many minerals from the soil which makes it hard and is also liable to pollution by organic substances. By the time the water reaches its destination it is probably very impure. Also most of the hand dug wells are not properly located, most often the wells are shallow and located near source of pollution and the quality is rather poor.

The South West is the one of the six geopolitical zones of Nigeria comprising six states namely Ekiti, Lagos, Ogun, Ondo, Osun and Oyo with an estimated population of over thirty eight million started experiencing acute shortage of portable water supply since 1980s. The worst areas are the cores and inner areas of metropolis. In order to identify the potential risk or dangers that are related to the quality of water, sanitary surveying technique is used as an assessment tool for the study.

Statement of Research Problem

Water inventory of south western Nigeria shows that tapping from underground water sources is unregulated. The region experiences scarcity of portable water for domestic uses especially during dry season, which often lead to increase in the occurrence of water related diseases and infections. Most communities in South-western Nigeria have their wells polluted, hence cholera, typhoid and dysentery are predicted to increase if the quality of water from wells is not monitored. Inadequate water supply which often results to poor personal and environmental hygiene remains a major problem in the study area. Tap water supplied by the Water Corporations, Agencies and parastatals of the various States is grossly inadequate leaving residents with no option rather than the use of wells, shallow streams, springs and vended water. Effective water supply is crucial in sustaining liveable communities in places

experiencing rapid development and places where water supply is scarce. Hand dug wells are open to various types of water borne diseases and infections such as diarrhoea, typhoid, cholera and dysentery among others. Most of the hand dug wells are poorly sited within the study area and not wells maintained. The wells are located around drainages which are not in good condition which allow stagnant water within 2m of the wells. The wells are open to various sources of pollution such as animal excreta and refuse sites. Other problems affecting the hand dug wells in the study area are that the wells are not fenced to keep animals and other unwanted bodies away, the buckets and the ropes for drawing water are put on the floor which causes contamination, due to poor maintenance and over utilization, the parapet around the wells are cracked which allows easy access for pollutants, the height of the head wells (parapets) around the wells are not far from the ground and the walls of the wells lining are not well sealed.

All the above listed factors are the problems associated with hand dug wells in the study area which are major means of water contamination. The wells are exposed to various sanitary risks which could increase the chances of illness in the study area. These however have adverse effects on social, physical, psychological, economic and environmental well-being of the people. Many research works have been done on environmental health while none has assessed the quality of water of hand-dug wells within the environment of South-Western of Nigeria to the satisfaction of the researcher. This work therefore considered environmental health from the perspective of sanitary surveying to determine the quality of water supply in the study area. The aim of the study is to examine the use of sanitary surveying technique as an index for assessing water quality in South-Western Nigeria. The objectives pursued are to identify the socio-economic characteristics of the residents of the South-West Geopolitical zone; assess the quality of water in the South-West Geopolitical zone; assess the current state of water supply and sanitation practices in South-Western Nigeria; and investigate the diseases that are prevalent in the study area as a result of the filthy environment and insufficient water supply; and make recommendations on the use of sanitary surveying technique to improve water supply and sanitation system in the study area.

Conceptual Clarification and Review of Relevant Literature

Healthy City Concept

The concept of Healthy Cities originated in the year 1842. The British government held a "Health of Towns" conference and published a Chadwick report, revealing the living conditions of the under privileged populace. The government set up the Health of Towns Association to assume the task of improving people's living conditions and addressing health problems in the cities. In 1984, the idea of Healthy Cities was discussed in the "Beyond Health Care" conference in Toronto. Its tactics were based on wide community participation and broad intersectoral involvement, in order to resolve city-wide issues in a holistic manner. The Healthy Cities movement was officially launched by World Health Organization WHO in 1986 and the participation level spreads rapidly to cover more than 1200 cities in Europe and over 7500 cities worldwide.

According to Trevor *et al,* (1986) promulgated the definition of The Healthy Cities as one that is continually creating and improving those physical and social environments and expanding those community resources that enable people to mutually support each other in performing all the functions of life and in developing to their maximum potential. Therefore, a Healthy City is a process, not an outcome. In other worlds, a Healthy City refer to environments where the residents have a shared vision and would like to make health – related changes, not just a city where the residents have attained a satisfactory level of health. In order to establish a clear indicator to gauge whether a city is 'healthy' or not, the WHO believes that an ideal healthy city should provide a clean, safe and high quality living environment; provide residents with basic needs; possess a stable and sustainable ecosystem; possess a strong and a cohesive community; possess a community that is highly participation in policies affecting living standards and welfare; residents are in a good health conditions; provide residents with quality sanitation and health services; possess a prospective city plan and is a city with unique qualities; and preserve historical monuments and respect local cultures; economic activities that are diverse,

The healthy city concept is a concept that has been applied to the sanitation problem of different countries of the world. This concept focus on achieving a sustainable environment sanitation, in applying this concept to South-western Nigeria it will improve the quality of life of the people and the aesthetic quality of the environment, and make the area to be disease free.

Concept of Water Governance

Portable water is water pure enough to be consumed or used with low risk of immediate or long term harm (Hall *et al*, 2008). In most developed countries, the water supplied to households, and industry is not of drinkable standard, even though only a very small proportion is actually consumed or used in food preparation. Water has always been an important and life-sustaining drink to humans and is essential to the survival of all organisms. Water composes approximately 70% of the human body of mass. It is a crucial component of metabolic processes and serves as a solvent for many bodily functions. The United States Environmental Protection Agency in risk assessment calculations assumed that the average American adult ingests 2.0 litres per day.

Some health authorities have suggested at least eight glasses (240mL), of water per day (Harvard Health Medical School, 2023) while the British Dietists Association recommends 1.8 litres/day/person. This common misconception is not supported by scientific research. Various reviews of all the scientific literature on the topic performed in 2008 could not find any solid scientific evidence that recommended drinking eight glasses of water per day (Prüss-Ustün, 2019). In the US, the Reference Daily Intake (RDI) for water is 3.7 litres per day (L/day) for human males older than 18 years, and 2.7 L/day for human females older than 18 years including water contained in food, beverages, and drinking water. (Ann, 2004). The amount of water varies with the individual, as it depends on the condition of the subject, the

amount of physical exercise, and on the environmental temperature and humidity. An individual's thirst provides a better guide for how much water they require rather than a specific, fixed quantity (Ann, 2004)

The Millennium Development Goals of halving the proportion of people without access to safe drinking water between 1990 and 2015 shall probably be reached. Some efforts at increasing the availability of safe drinking water have been disastrous. When the 1980s was declared the "International Decade of Water" by the United Nations, the assumption was made that ground water is inherently safer than water from rivers, ponds, and canals. 60 million people are estimated to have been poisoned by wells water contaminated by excessive fluoride, which dissolved from granite rocks. The effects are particularly evident in the bone deformations of children. Many diseases that are endemic throughout the country are generally associated with unsatisfactory drinking water supply, poor sanitation conditions and inadequate health education programs. These include diarrhoea, dysentery, gastro enteritis, hepatitis, hook work, guinea worm, scabies and other parasitic infections. Health implications of water supply deficiencies in Nigeria are enormous. As the percentage of people with access to safe water in the country is low and the country is relatively densely populated, the direct health repercussion the situation imposes, especially on children, is often underestimated (Obaro, *et al*, 2017).

From 2014-2024, 769,000 children under five years old in sub-Saharan Africa died each year from diarrheal diseases. As a result of only thirty-six percent of the population in the sub-Saharan region have access to proper means of sanitation, more than 2000 children's lives are lost every day. In South Asia, 683,000 children under five years old died each year from diarrheal disease between 2014 and 2024. In 2021, waterborne diseases were estimated to cause 1.8 million deaths while about 1.1 million deaths each year while about one billion people lacked proper drinking water. It is clear that people in the developing world need to have access to good quality water in sufficient quantity. Water scarcity and poor sanitation have remained daunting challenges for concerned citizens and development partners, despite the endowed resources at the disposal of the most populated black nation. The ripples effects of the country's weak health sanitation also have direct impact on the nation's workforce as many people in the working class and children lose thousands of man -hours to communicable diseases. Many families have stories to tell about pains suffered from loss of children, especially less than five years (Stocks, 2024).

The fundamental principle of any water supply system is to gather water in a location from which it can either be collected by the consumers or transported to a point of use. In the case of water supply systems with a distribution network, water is first stored at central storage tanks before being released into the distribution system. This system may bring water directly to households or to public standpipes. With individual water points such as boreholes and hand-dug wells, water is collected by the consumers directly from the point of exploitation of the aquifer. The purpose of the wells is to provide a safe and reliable means of accessing the water in the aquifer. To make the construction of a hand-dug wells viable, water in sufficient quantities must be found at a depth which shall allow safe excavation and economically

feasible exploitation of the water resource (this shall depend, of course, on a range of specific local conditions), but at a depth which does not allow easy pollution of the ground water in the aquifer. The quantity of water made available by a well shall depend on the soil type at the particular location and shall also be influenced by the diameter of the hole made to extract the water and by the depth of penetration into the water-bearing stratum. Even if a particular site gives positive indications for the presence of shallow ground water, certain conditions must be fulfilled before continuing with a trial borehole or with actual construction. Internationally accepted guidelines for the location of a water point may be summarized under two sets of criteria, one general and one relating to the proximity of other structures or facilities.

Generally, the proposed water point or source should be in a location which allows the free access of all users all year round. A right of way must exist to the wells; ideally be located within the specified distance from the intend users; be above the flood level of any nearby river, lake or any other area liable to seasonal flooding; not be located below any source of pollution such as a pit latrine, abattoir, dumping site, fertilizer or pesticide store etc. In addition, the minimum distances, in any other direction, to such sources of pollution, are to be provided in the main body of the technical report; not be located in an area where the fluctuating fresh water table is influenced by a saltwater table; be located in an area which shall allow the rapid dispersal of spilt water; be in a location where the level of the water table is at a depth of at least 2m all year round; not be located in any area where pesticides or fertilizers are spread on crops; and not be located in an area liable to erosion. However, Table 1, summaries the specific minimum distances required from water point to various facilities.

Table 1: Specific Minimum Distances from Water Point in Metres

S/N	Facility Location	Minimum Distances(m)
1	Communal dumping site	100
2	Store for pesticides, fertilizers or fuels	100
3	Cemetery	50
4	Abattoir	50
5	Dwelling house	10
6	Pit latrine	30
7	Animal pen	30
8	Private (domestic) dumping site	30
9	Large trees or any tree with extensive root systems	20
10	Roads, airstrips, railway lines	20
11	River or lake	20
12	Laundry or washing slab	20

Source: World Health Organization, 2000

Review of Relevant Literature

Sanitary Surveying Technique

In the case where a dump, pit latrine or pesticide/fertilizer store is to be relocated to make way for a water point, sufficient time must be allowed for the existing pollutants to dissipate in the

ground, before beginning to use the water for human consumption. The water quality should be tested to ensure that all pollutants have been dispersed. In certain specific circumstances, the distance from a pit latrine may be reduced, but if there is any uncertainty about fulfilling these conditions, it is advisable to comply with the 30m criterion given above. Where pit latrines are in use, the bottom of the latrine pit should be normally no less than 1m above the top of the aquifer. In all cases, the local community must be fully involved in the decision about the location of water points.

Sanitary surveying is an inspection technique that records such visible problems, enabling field workers to assess the likely quality of the water; it is usually possible to spot any faults and information on the overall condition of the watershed and makes recommendations for improving water quality. This information can be used to design site specific monitoring programs and initiate pollution source remediation efforts.

Sanitary surveying is used to identify existing or potential contaminants to a water body. Normally the contaminants of concern are pathogenic organism known to cause a variety of human diseases. Sanitary surveys may be used by public health officials, beach managers, shell fishing regulators, and any organization requiring detailed information on potential bacterial pollution sources to surface water.

Application of Sanitary Surveying

Sanitary surveys should be conducted when high levels of contamination are present or suspected and the source contamination is unknown. They should also be conducted when significant changes in land use, construction or development of the area is proposed. Possible source of contamination that would warrant a sanitary survey are sewage spills from sewer collection systems and pump stations, faulty septic systems, and non-point source contamination from residents or commercial development. Sanitary surveying formally identifies possible pollution problems which may threaten drinking water quality at the source, point of abstraction, treatment works, or distillation system. It relies on the inspection of physical installations by an inspector or a team of inspectors.

Sanitary surveying can be carried at any of the three points of water supply scheme.

1. At the source and intake (to assess whether the quality of the raw water is at risk, and whether the abstraction method is satisfactory).
2. At the treatment works (to assess whether suitable treatment processes are being used and whether correct procedures are being followed.
3. At the distribution system (to assess whether the quality of the water is put at risk during distribution.

The Purpose of Sanitary Surveying

In carrying out sanitary survey, an inspector identifies potential risks to the quality of water but he or she should also take the opportunity to make constructive criticism, leading to positive improvements, it should not be an opportunity to indulge in destructive criticisms.

Undertaking a sanitary survey should also be considered when new water sources are being developed, to assess the water quality and any treatment needs, when comparing water sources for potential development, when contaminants is suspected to identify the likely cause as well as when there is an epidemic of a water-borne illness, to identify the likely cause, to interpret results from water quality analysis, to establish how water became contaminated and as a routine exercise, to monitor sanitary condition or when there are significant changes (such as heavy rain or construction activity) which could affect water sources.

Comparison of Water Quality Analysis and Sanitary Surveying

Sanitary surveying and water quality analysis (either in a laboratory or in the field) are complementary activities, they are both important and both have limitations. See table:

Table 2: Water Quality Analysis and Sanitary Surveying

Water quality analysis	Sanitary surveying
Water quality analysis is expensive, requires equipment and competent staff and, therefore is not always easy to perform regularly or routinely.	Sanitary surveying is cheap, requires neither equipment nor highly skilled staff, and may easily be performed regularly or routinely.
Water quality analysis provides only a snapshot-a record of the water quality at the time of sampling.	Sanitary sampling can reveal conditions or practice that may cause isolated pollution incident or longer term pollution.
Water quality analysis will indicate a water supply is contaminated, but usually will not identify the source of contamination.	Sanitary surveying reveals the most obvious possible sources of contamination, but may not reveal all sources of contamination of ground water.

Source: Zubair *et al*, 2009

Health Implications of Water Supply

Malaria is the predominant disease affecting the population of Nigeria. Many other diseases endemic throughout the country are generally associated with unsatisfactory drinking water supply, poor sanitation conditions and inadequate health education programs. These include diarrhea, dysentery, gastro-enteritis, infectious hepatitis, hook work, guinea worm, scabies and other parasitic infections. Health implications of water supply deficiencies in Nigeria are enormous. As the per cent of people with access to safe water in the country is low and the country is relatively densely populated, the direct health repercussion the situation imposes, especially on children, is often underestimated. Water supply is an input in many industries. As water is usually considered as an infrastructure service which is final consumption product/ service targeted to meet the basic needs of households. The cost of water supply deficiencies in public policy is often overlooked, underestimated, or totally unaccounted for.

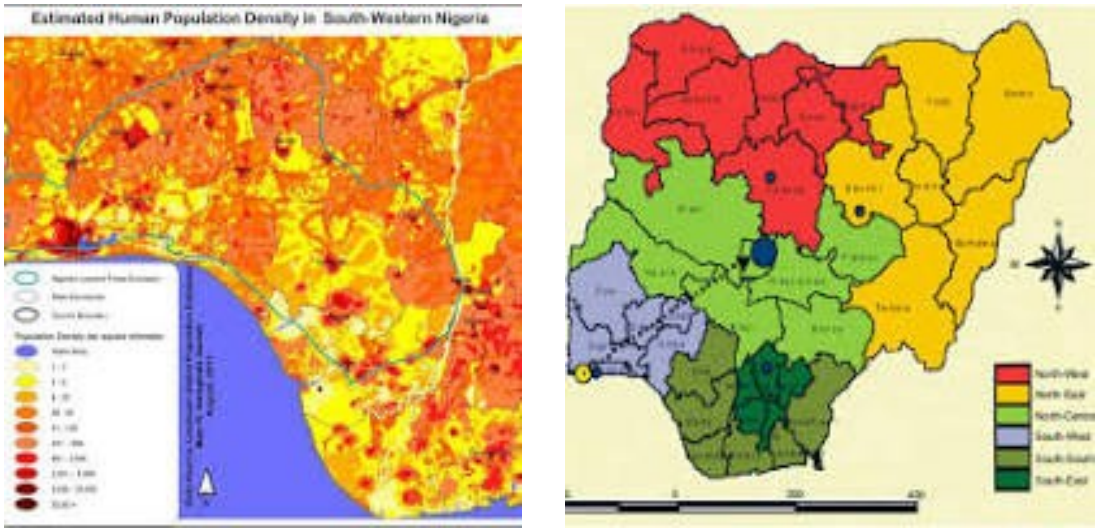
THE STUDY AREA

The region has a population of over 80 million people, more than 28% of the total population of the country. The South-West geopolitical zone of Nigeria is made up of six (6) states, namely, Ekiti, Lagos, Ogun, Ondo, Osun and Oyo States with one hundred and thirty seven (137) Local Government Areas (LGAs). Ekiti state with sixteen (16) LGAs, Lagos state with twenty (20) LGAs, Ogun state with twenty (20) LGAs, Ondo state has eighteen(18) LGAs, Osun state with thirty (30) LGAs and Oyo has thirty three (33) LGAs respectively. The population of the entire region according to the 2006 population census is about twenty eight (28) million people. However, the projected population according to the researcher is 50,795,637.

Table 3: Projected Population of South-Western Nigeria, 2024

State	Land size(Km2)	2006 Population			Projected Population, 2024		
		Male	Female	Both Sexes	Male	Female	Both Sexes
Ekiti	5,333	1,215,437	1,183,470	2,393,957	2257661	2198283	4455943
Lagos	3,496	4,719,125	4,394,480	9,113,605	8162699	8162699	16325398
Ogun	16,981	1,864,907	1,886,233	3,751,140	3464045	3503657	6967702
Ondo	15,195	1,745,057	1,715,820	3,460,877	3241425	3187117	6428542
Osun	8,700	1,734,149	1,682,810	3,146.959	3125801	3125801	6251602
Oyo	28,245	2,802,432	2,778,462	5,580,894	5205487	5160963	10366450
Total	78,505	14,081,157	13,641,275	27,722,432	25,457118	25,338520	50,795,637

Source: Fieldwork, 2024



Source: Google Map, 2024

MATERIALS AND METHODS

Data for this research were obtained from both primary and secondary sources and they were both quantitative and qualitative in nature. The secondary sources of data for this study include extensive review of literature. Published materials such as textbooks, journals, newspapers as well as the publications of the various organizations dealing with water, physical planning and

environmental-health issues were consulted for useful secondary information. Necessary academic and consultancy reports on water and sanitation from national and international agencies, universities, polytechnics, monotechnics and other institutions of research were used where necessary. Unpublished materials such as theses, dissertations, technical reports on water supply, environment and housing related agencies as well as academic and consultancy reports on housing, water supply, health and sanitation from national and international agencies, universities and other institutions of research were also consulted for additional secondary data. Information obtained from the various States Ministries of Lands, Housing and Urban Development include data on water supply, solid waste management, safety, security, and landuse while health were collected from the States' Health Management Boards and various health posts and government owned hospitals in the study area. Furthermore, information on the number of State Capitals, wards and houses in each of the six states that make up the study area were obtained from the National Population Commission, the relevant State Planning Headquarters and the Federal Ministry of Lands, Housing and Urban Development. Maps of various states, land Use and land Cover Classification Statistics for 1972 to 2022 in South-western Nigeria, topographical map of the region and some relevant publications on South Western Region of Nigeria were also used to delineate the study area.

Data from primary sources involved direct observation, questionnaire administration, in-depth interview and focus group discussion. The questionnaire design for this research were scrutinized through the use of pre-tested questionnaire in order to ensure objectivity in the responses from the respondents. The questionnaire was administered on the sampled residents in the study area. Six Focus Group Discussion sessions were conducted with the key figures in each of the six states. The research design adopted in collecting primary data for this study was survey method. This method is chosen because of the validity of the findings it guarantees, and the fact that it is versatile enough to provide access to a variety of data. It is also relatively accurate and representative.

Structured questionnaire administered on respondents were in three broad sections, namely; socio-economic characteristics, housing characteristics and neighbourhood characteristics (Appendix I). Section A highlights the socio-economic status (SES) of the respondents. These include; sex, marital status, age, educational attainment, occupation, income, among others. The housing characteristics of the dwelling units are considered in Section B, relative to respondents' condition of building, location, facilities, structural details, affordability, density, tenure, comfort, safety and others. The quantity and quality of neighbourhood facilities and serviceability are the focus of Section C with respect to neighbourhood accessibility, proximity to work, access to municipal facilities, proximity to pay areas (market, hospital, bank, filing station, post office etc), recreation and leisure opportunities, communal and social supports, social connection and interaction, opportunities to get involved in local panning issues, community pride and attachment and a host of others. Section D of the questionnaire addressed issues relating to water supply, condition and location of the wells used. Some of the questions are; object specific, multiple options or open-ended, while many are presented

in 5 point likert scale of responses ranging from very good/strongly agree to very bad/strongly disagree.

Furthermore, an Interview Guide was conducted on the Federal Ministry of Housing and Urban Development area. The six states capital in South-west Nigeria were visited. The interview elicited information on health issues, housing condition, age of building, materials used for building construction and housing facilities, the method adopted for waste collection, transportation and disposal in the study area, water sources and management strategies adopted and their challenges among other issues.

For the conduct of the Focus Group Discussion, the assistance of a facilitator and a note-taker was engaged while the researcher played an observer role. To familiarize the facilitator and the note-taker with the theme and issues that researcher is interested in probing, they were given adequate training prior to each focus group meeting. After each meeting, a debriefing was done during which the note-takers, the facilitators and the researcher discussed in detail the outcome of the discussion. It was intended that one Focus Group Discussion was held at each of the six state capitals that constitute the study area. The exercise was complemented by an audio-visual recording of the discussions to avoid any loss of vital information during the analysis.

Six Focus Group Discussion sessions were conducted with the key figures in each of the six state capitals in South-Western Nigeria metropolis, (Ibadan, Ikeja, Akure, Osogbo, Abeokuta, and Ado-Ekiti). A structured discussion guide addressing issues such as the housing characteristics of the settlements, land tenure system, environmental health and safety as well as other challenges of water supply were used. The interaction during the FGD session was recorded with an audio tape recorder which was complemented with handwritten notes/jottings taken during the sessions. Every aspect of the discussions was transcribed later and the transcribed data coded and analyzed using Content Analysis computer software package. The main intentions of the FGDs was to supplement the information that was obtained through the questionnaire administration and to arrive at clearer pictures about conflicting ideas encountered during questionnaire interview.

In order to ensure that no vital information is left uncaptured, Observation Method was applied to complement data from questionnaire, Interview Guide and Focus Group Discussions. This method captured observable location of wells in the study area. Therefore, observation checklist shall also be used to gather information that may not be asked directly from both the households and residents of the study areas.

Through direct observation, investigation was conducted to examine the state of the neighbourhood environment and the water infrastructure. A bird's eye-view survey was conducted on the availability and condition of housing facilities such as building condition, waste management system, water, electricity and others, as well as socio-economic amenities like public open spaces, markets/shopping outlets and others. These features are integral part of indicators that was ascribable to quantitative and qualitative water supply.

Time and resource limitations could not make a comprehensive survey of all buildings in South-Western Nigeria impracticable. Therefore, a multi-stage sampling strategy was adopted

for the purpose of administering the questionnaire. In the first stage, the six State Capitals (SC) that fall within the study area was identified. At the second stage, the study area was divided into Local Government Areas. At the third stage, purposive sampling technique was used to select two Local Government Areas from each of the six State Capitals. The selected Local Government Areas in each of the six State Capitals are expected to be true representatives of urban and peri-urban Local Government Areas respectively. In the fifth stage, all the streets in the selected Local Government Areas was listed. The listing operations was done one week before the interviewing period.

Finally, at the sixth stage, the researcher shall systematically select appropriate number of households' heads from each of the selected streets. Sample size is determined based on Neumann's (1991) assertion that to sample from very large populations (over 7 million), one can achieve accuracy using tiny sampling ratio (0.034 per cent) or about 2,500. Table 4 shows the breakdown of respondents for each LGA.

Table 4: Sample Size of Respondents According to Local Government Areas

State	LGA	Population (2006)	Projected Population (2024)	% of Projected Population	Sample Size
Lagos	Mushin	631,857	1,173,668	15.76	394
	Epe	181,734	337,569	4.52	113
Oyo	Ibadan North	308,117	918,586	12.36	309
	Ido	104,087	310,310	4.16	104
Ogun	Abeokuta South	250,295	746,196	10.04	251
	Odeda	109,522	326,515	4.40	110
Ondo	Owo	222,262	662,624	8.92	223
	Akure South	360,268	1,074,056	14.44	361
Osun	Osogbo	155,507	463,609	6.24	156
	Iwo	191,348	570,461	7.68	192
Ekiti	Ikere	148,558	442,893	5.96	149
	Oye	137,796	410,808	5.52	138
		Total	7,437,295	100.00	2,500

Sources: Federal Republic of Nigeria Official Gazette of 2009, Volume 96, No. 2; National Population Commission (2016) and Researcher's Estimates (2024).

Both descriptive and inferential statistics were used in analyzing the collected data. Data analysis shall involve an iterative process of preparing simple descriptive statistics such as frequencies and percentages. The Statistical Package for Social Sciences (SPSS) was used for relevant analyses. Additional procedures in the process of data analysis shall include tests of significance.

DISCUSSIONS

Table 5 reveals that 17.3% of the wells are located close to refuse dump, 13.7% are located near drainage, and 38.8% are located near soak away while 6.5% are located far from the drainage. This implies that the well water in the study are will be affected by contaminants.

This confirms the assertion of Nath, *et al*. (2006) on the imperative of hygienic and healthy condition for household water storage, handling and point-of-use treatment.

Table 5: Location of the wells

Location	Frequency	Per cent
Near Soak-away	119	38.8
Close to refuse dump	53	17.3
Near drainage	42	13.7
Far from the drainage.	20	6.5
All of the above	73	23.8
Total	**307**	**100.0**

Source: Field Survey, 2024



Figure 1: A Typical Hand-dug Well in Ado-Ekiti

Source: Field Survey, 2024



Figure 2: A Typical Hand-Dug Well in Ibadan

Source: Field Survey, 2024



Figure 3: A Dilapidated Hand-Dug Well in Iwo Town

Source: Field Survey, 2024



Figure 4: An Unprotected Hand-Dug Well in Ijebu Ode Town

Source: Field Survey, 2024

Results of the physico-chemical properties of the water samples from the 18 selected wells in South-Western Nigeria. The Eighteen sites selected are as shown in table 36. The wells water sample taken from the different selected locations are colourless and clear which is in accordance with the stipulated standard of the colourless and clear by the World Health Organization (WHO). The PH value represents the degree of acidity or alkalinity of the wells water sample collected from the eighteen different sites. The PH values range from 4.93 at Ikere-Ekiti, 5.10 at Ibadan to 4.36 at Epe which all fell within the WHO LIMIT OF 6.5-9.5.0. The study reveals that Escherichia coli (E. coli) were found in 33.3% of hand-dug wells in southwestern Nigeria. Staphylococcus aureus were found in 22.2% of hand-dug wells in the same region. Salmonella typhi were identified in 11.11% of hand-dug wells sampled. Proteus vulgaris were present in 22.2% of hand-dug wells sampled. Pseudomonas aeruginosa were found in 5.6% of hand-dug wells sampled while 5.6% of the sampled wells contain Enterobacter aerogenes.

These pathogens were found in various locations, including Ibadan North, Ido, Mushin, Epe, Epe, Abeokuta South, Odeda, Osogbo, Iwo, Akure South, Owo, Oye and Ikere. These pathogens can pose significant health risks to individuals consuming contaminated water from these wells. Proper water treatment and sanitation practices are essential to mitigate these risks.

Some human bacteria pathogen from hand dug wells in south western Nigeria and diseases associated include Escherichia coli (E. coli) which can cause urinary tract infections, diarrhea, and other gastrointestinal illnesses, Staphylococcus aureus which can cause skin infections, respiratory infections, and food poisoning. The study further reveals that Salmonella typhi can cause typhoid fever which is a serious and sometimes life-threatening illness. Proteus vulgaris which can also cause urinary tract infections and other infections. Pseudomonas aeruginosa that can cause respiratory infections, particularly in people with compromised immune systems and Enterobacter aerogenes which can cause urinary tract infections and other infections. These pathogens can pose significant health risks to individuals consuming contaminated water from these wells. Proper water treatment and sanitation practices are essential to mitigate these risks. This corroborates the position of Wright, *et al*, (2004) on household drinking water in developing countries requiring a systematic review of microbiological contamination between sources.

Table 6: Microbiology Result of Water Samples

S/N	Location	Mean Coliform Count (CFU/mL)	Major bacteria
1	Ibadan North	1.4×10^4 CFU/100ml.	E-coli pseudomonal
2	Ido	2.5×10^3 CFU/100ml	Enterobacter aerogenes
3	Mushin	9.6×10^3 CFU/100ml.	Staphylococcus aureus
4	Epe	9.6×10^3 CFU/100ml.	Staphylococcus aureus
5	Abeokuta South	1.6×10^4 CFU/100ml.	E-coli pseudomonal
6	Odeda	1.5×10^4 CFU/100ml.	E-coli pseudomonal
7	Osogbo	2.2×10^3 CFU/100ml	Salmonella typhi
8	Iwo	1.4×10^4 CFU/100ml.	E-coli pseudomonal

9	Akure South	2.2 x 10^3 CFU/100ml	Salmonella typhi
10	Owo	1.8 x 10^3 CFU/100ml	Proteus vulgaris
11	Oye	1.9 x 10^3 CFU/100ml	Proteus vulgaris
12	Ikere	1.6 x 10^3 CFU/100ml	Pseudomonas aeruginosa
WHO Limits		No detectable total coliforms per 100 milliliters (mL)	-

Source: Field Survey, 2024

The World Health Organization (WHO) guidelines for coliform counts in drinking water stipulates that there should be zero tolerance (no detectable total coliforms) per 100 milliliters (mL) of water. There should be no detectable E. coli per 100 mL of water and fecal Coliforms of less than 1 CFU (Colony-Forming Unit) per 100 mL of water. These guidelines are designed to ensure that drinking water is safe for human consumption and to minimize the risk of waterborne diseases. This affirms the position of Tumwebaze, *et al*. (2019) on the need to translate pathogen knowledge to practice for sanitation decision-making.

Table 7: Some Human bacteria Pathogens from Wells Water Sample

S/N	Location	Name	Dominant Diseases associated
1	Ibadan North	E-coli pseudomonal	Gastrointestinal illnesses
2	Ido	Enterobacter aerogenes	Skin infection, worm infection, external ear infection and urinary tract infection
3	Mushin	Staphylococcus aureus	skin infections, respiratory infections
4	Epe	Staphylococcus aureus	Skin infections, respiratory infections
5	Abeokuta South	E-coli pseudomonal	Urinary tract infections, diarrhea, and other gastrointestinal illnesses
6	Odeda	E-coli pseudomonal	Urinary tract infections
7	Osogbo	Salmonella typhi	Typhoid fever
8	Iwo	E-coli pseudomonal	Diarrhea, and other gastrointestinal illnesses
9	Akure South	Salmonella typhi	typhoid fever
10	Owo	Proteus vulgaris	Urinary tract infections and other infections
11	Oye	Proteus vulgaris	Urinary tract infections and other infections
12	Ikere	Pseudomonas aeruginosa	Respiratory infections
WHO Limits		No detectable	_ No detectable

Source: Field Survey, 2024

Table 8: Contracted water borne diseases in the last six month

Variable	Frequency	Per cent
Contracted	633	25.3
Not contracted	1,867	74.7
Total	2,500	100

Source: Field Survey, 2024

Table 8 reveals that 25.3% of respondents stated that they contracted water borne diseases in the last six month while 74.7% of respondents states no. This implies that majority of the respondents are not contracted in water borne diseases in the last six month.

Table 9: Nature of the sickness

Sickness	Frequency	Per cent
Typhoid	383	15.3
Cholera	245	9.8
Skin infection	548	21.9
Worm infection	337	13.5
Diarrhea	670	26.8
Urinary tract infection	317	12.7
Total	2,500	25.3

Source: Field survey, 2024

Table 9 shows the nature of the sickness treated by respondents in the last six months. 15.3% of respondents claimed to have treated typhoid, 9.8% of them claimed that they treated cholera. 26.8% claimed Diarrhea while 21.9%, 13.5% and 12.7% reported skin infections, worm infection and urinary tract infection respectively. This complies the view of Schardt, 2000 on water and diseases.

CONCLUSION

Summarizing totality of this study having found that the sources of potable water supply in South-western Nigeria and identified the challenges of the water and stakeholder action it is thereby concluded that the community take yield to the above recommendations and develop more for the standardization and sustainability of a good water hydro-environment for the South-western Nigeria. In conclusion, our research on the issue of water and environmental sanitation has aided our understanding of the nexus between unhygienic condition and disease prevalence. This study was able to identify some of the areas that lack water and sanitation facilities. The need to enhance health by limiting the spread of illnesses, which is the main goal of sanitation programs is highlighted by the research. Low levels of sanitation are the consequence of a lack of infrastructure, congested, cramped dwelling circumstances, insufficient water supply and unsafe disposal of excreta and wastewater from washing, bathing, and other activities. The cheapest land, which also needs the most costly infrastructure, is where the urban poor choose to reside. The poor hygiene practices, lack of adequate sanitation and unsafe water can contribute to the spread of preventable diseases such as cholera or typhoid.

RECOMMENDATIONS

Based on the field observation that 70% of the wells in the study area were infected the following recommendations are made for the study.

1. Relocation of wells that are within 30m radius of latrine, 20m away from road, 100m away from dumping site, 20m away from a large tree 30m away from animal pen and 10m away from dwelling unit.
2. All wells should be adequately fenced to keep away animals as their dung could constitute pollution.

3. There should be construction of more wells so as the eliminate contamination from too many people fetching from a wells.
4. All cracks around the wells should be mended to prevent the infiltration of water.
5. There should be general maintenance of the wells i.e all rusted over should be changed and those with without cover should be provided with cover.
6. Broken and crack drainages should be amended.
7. Stagnant water should not be allowed within 3m of the wells.
8. There should be one equipment used to draw water i.e the use of multiple bucket to be avoided and should be kept properly so as to eliminate exposure to contamination.
9. All wells should always be covered very wells when not in use to prevent contamination and unwanted bodies.
10. Children of under age should be prevented from fetching water from the wells.

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