RESILIENCE AND LIVABLE CITIES IN A WARMING WORLD

A FESTSCHRIFT IN HONOUR OF

TPL. DR. JOSHUA ADEWUMI ADEBISI FNITP, RTP

EDITED BY

ABIMBOLA SIMIAT OGUNSESAN
AYOBAMI ADEMOLA AKANMU, PhD
UMAR OBAFEMI SALISU, PhD

TPL. DR. JOSHUA ADEWUMI ADEBISI, FNITP, RTP

Chief Lecturer in Urban and Regional Planning at
The Polytechnic, Ibadan, Adjunct Lecturer at The University of Ibadan
Outstanding Administrator, Preacher of Faith, and a Renowned Consultant

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Editors:
A.S. Ogunsesan, A. A. Akanmu, PhD & U. O. Salisu, PhD

wumibisi2012@gmail.com
+2348052939962

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ABOUT THE EDITORS

Abimbola Simiat OGUNSESAN is a Senior Lecturer in the Department of Urban and Regional Planning, The Polytechnic, Ibadan, Nigeria. She obtained her foundational training in Urban and Regional Planning from The Polytechnic, Ibadan. She later earned a Master of Science degree in Housing Development and Management from the University of Ibadan. Driven by a strong interest in academic scholarship and global urban challenges, she further pursued a second Master of Science degree in Urban Management and Development at Erasmus University, Rotterdam, The Netherlands, and currently a doctoral candidate at Lead City University, Ibadan. Ogunsesan is a Registered Town Planner with the Town Planners Registration Council of Nigeria (TOPREC) and Corporate member of the Nigerian Institute of Town Planners (NITP). She has an extensive publication, and her research interests span urban governance, environmental management, housing studies, climate change adaptation, and sustainable urban development.

Dr. Ayobami Ademola AKANMU is a Chief Lecturer, researcher, and consultant specializing in transport, logistics, and spatial planning. He earned a PhD. in Transport Management Technology from the Federal University of Technology, Akure; serves as a pioneer Head of the Department of Transport Planning and Management and Director of Student's Industrial Works Experience Scheme (SIWES) at The Oke-Ogun Polytechnic, Saki. He is affiliated with several professional bodies, including the Association for European Transport, the Association for the Advancement of Automotive Medicine (AAAM), the Nigerian Institute of Town Planners (NITP); and is also a Chartered Fellow of the Chartered Institute of Logistics and Transport (CILT), Fellow of the Chartered Institute of Transport Administration of Nigeria (CIoTA), Chartered Transportant of Nigeria (CTN) with the Council for the Registrations of Transportants in Nigeria, and a Registered Town Planner with the Town Planners Registration Council of Nigeria.

Dr. Umar Obafemi SALISU is a Senior Lecturer in the Department of Transport Management, Olabisi Onabanjo University, Ago-Iwoye. He holds B.Sc. and M.Sc. degrees in Transport Studies from the same institution and a PhD. in Transport and Logistics from Lagos State University. He is a Chartered Fellow of the Chartered Institute of Logistics and Transport (CILT), Fellow of the Chartered Institute of Transport Administration of Nigeria (CIoTA), a member of Association of the Advancement of Automotive Medicine, and a Research Fellow of Earth System Governance (ESG) network. His research specializes in transport governance, transport safety, sustainable urban mobility, logistics and tourism transport. He has widely published and secured national and international research grants.

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CHAPTER 13

WATER QUALITY EVALUATION AND SANITARY SURVEYING IN SOUTHWEST NIGERIA

LASISI Kamil Oluranti, PhD
Department of Urban and Regional Planning,
The Polytechnic, Ibadan, Nigeria
Email Address: kamiloluranti@gmail.com | 2348064909000

Abstract
Sanitary surveying is an inspection technique that records visible problems that enable field workers to assess the likely quality of the water. Existing literature on water was more focused on management and access. Therefore, this study examined the use of sanitary surveying technique as an index for assessing water quality in South-Western Nigeria comprising of Ekiti, Lagos, Ogun, Ondo, Osun and Oyo States. 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. Concept of healthy city was used while mixed method design was adopted. Data for this research were obtained from both primary and secondary sources and they were both quantitative and qualitative in nature. Data from primary sources involved direct observation, questionnaire administration, in-depth interview and Focus Group Discussion (FGD). A total number of 2,500 pieces of questionnaires were administered to respondents while six sessions of FGDs were organized in the six states. Both descriptive and inferential statistics were used in analysing the collected data. Water quality was analyzed with the aid of UV-Vis Spectrophotometer. Near animal pens (23.8%), near laundry or washing slab (21.4%), close to private (domestic) dumping site (16.4%), near drainage (13.7%), near soak away/pit latrines (18.2%) and near large trees or trees with extensive root systems (6.5%) were the various locations of wells in the study area. The study reveals that Escherichia coli (33.3), Staphylococcus aures (22.2%), Salmonella typhi (11.11%), Proteus vulgaris (22.2%), Pseudomonas aeruginosa (5.6%) were the bacteria found in the sampled wells. The study recommends relocation of wells that are within 30m, 100m, 20m and 100m radius away from latrine, dumping site, animal pens and cemetery respectively. 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

1.0 Introduction

People use sources tainted with disease-vector pathogens or inappropriate levels of toxins and bacteria pathogens, and they lack access to drinkable water in many regions of the world (Bilal et al. 2020). In many nations, drinking or utilizing such water for food preparation results in acute and chronic illnesses that are common, leading to death and suffering (Michael, 2013). In many poor nations, the danger of waterborne illnesses and water quality are major public health problems (Strokal *et al,* 2019). Nearly a billion people, primarily in developing nations, lack access to sufficient and safe water, while unsafe drinking water, poor sanitation, and unsanitary behaviors are

responsible for approximately 94% of the world's diarrheal burden and 10% of all diseases (Salisu & Akanmu, 2018; WHO, 2011a). Therefore, access to sufficient and safe water promotes improved health and higher levels of production. It is also acknowledged that the potential for both economic and health advantages is significantly correlated with improvements in sanitation and water supply (WHO, 2011b).

Despite more than 60 years of independence and numerous attempts by different governments, as well as the involvement of the World Bank, African Development Bank, and UNICEF, there is still a lack of safe and portable water supplies in South Western Nigeria. As a result, residents, primarily women and children, have turned to hand-dug, unprotected wells for their water. As the subterranean water passes through the soil, it dissolves a lot of minerals, making the soil hard and vulnerable to organic pollutants. The water is most likely highly contaminated by the time it gets to its destination. Additionally, the majority of hand-dug wells are not situated correctly; they are typically shallow, close to a source of pollution, and have relatively poor quality.

With an estimated population of over 38%, the South West, one of Nigeria's six geographical zones, is made up of the states of Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo. Since the 1980s, there has been a severe lack of portable water supplies. The interior and central parts of the city are the worst. The study uses the sanitary surveying approach as an assessment tool to determine the possible risks or hazards associated with the water quality. There is a shortage of drinkable water in the area, particularly during the dry season, which frequently causes an increase in the prevalence of infections and illnesses linked to water (Ogunsesan, Akanmu & Oyejide, 2016). Since the majority of villages in southwest Nigeria have contaminated wells, it is anticipated that cholera, typhoid, and dysentery will rise if well water quality is not monitored. One of the key issues in the research area is the inadequate water supply, which frequently leads to poor environmental and personal cleanliness. Residents have no choice but to use wells, shallow streams, springs, and vended water because the tap water provided by the several States' Water Corporations, Agencies, and parastatals is woefully insufficient.

In areas with limited water supplies and those undergoing rapid development, an efficient water supply is essential to maintaining livable communities. Diarrhea, cholera, typhoid, and dysentery are just a few of the water-borne illnesses and infections that can contaminate hand-dug wells. The majority of hand-dug wells in the study region are not well-maintained and are ill-located. Within 2 meters of the wells, stagnant water is caused by poorly maintained drainage systems surrounding the wells. The wells are exposed to a variety of contamination sources, including waste sites and animal feces. The hand dug wells in the study area are also affected by the following issues: the wells are not fenced to keep animals and other undesired bodies away; the buckets and water-drawing ropes are placed on the floor, causing contamination; the parapet surrounding the wells is cracked, allowing pollutants easy access; the head wells (parapets) surrounding the wells are not far from the ground; and the walls of the well lining are not properly sealed.

The issues with hand-dug wells in the research area, which are a major source of water contamination, are all mentioned above. The wells are subject to a number of

sanitary hazards that may raise the likelihood of disease in the research region. However, these negatively impact people's social, physical, psychological, economic, and environmental well-being. Numerous studies on water have been conducted, but none have evaluated the hand-dug wells' water quality in South Western Nigeria to the researcher's satisfaction. In order to assess the quality of the water supply in the study region, this investigation took environmental health into account from the standpoint of sanitary surveys. Examining the application of sanitary surveying techniques as an index for evaluating water quality in South-Western Nigeria is the study's goal. Identifying the socioeconomic characteristics of the South-West Geopolitical zone's residents, evaluating the water quality in the area, assessing the current state of water supply and sanitation practices, looking into the diseases that are common in the study area due to the dirty environment and inadequate water supply, and offering suggestions on how to use sanitary surveying techniques to improve the study area's water supply and sanitation system are the goals being pursued.

2.0 Literature Review

2.1 Conceptual Review

2.1.1 Healthy City Concept

In 1842, the idea of "healthy cities" was first proposed. Following a "Health of Towns" meeting, the British government released the Chadwick report, which detailed the living circumstances of the underprivileged population. To take on the responsibility of enhancing living circumstances and tackling health issues in urban areas, the government established the Health of Towns Association. The concept of "Healthy Cities" was introduced at the "Beyond Health Care" conference in Toronto in 1984. Its strategies were founded on extensive intersectoral cooperation and community participation in order to address city-wide problems holistically. The World Health Organization (WHO) first introduced the Healthy Cities movement in 1986, and since then, more than 1200 cities in Europe and more than 7,500 cities worldwide have joined.

According to Trevor et al. (1986), a healthy city is one that continuously builds and enhances its social and physical surroundings while increasing its community resources to allow people to support one another in carrying out all of life's tasks and reaching their full potential. A healthy city is therefore a process rather than a final result. In other worlds, a "healthy city" refers to settings where people have a common goal and want to make improvements relating to their health, rather than just a city where people have reached a satisfactory level of health. The WHO believes that in order to create a clear indicator of whether a city is "healthy," a healthy city should have the following characteristics: a clean, safe, and high-quality living environment; basic necessities for residents; a stable and sustainable ecosystem; a strong and cohesive community; a community that actively participates in policies that affect welfare and living standards; residents in good health; a city with a future city plan and unique features; preservation of historical monuments and respect for local cultures; and diverse economic activities.

Therefore, the idea of a "healthy city" has been used to address the sanitation issues in several nations worldwide. This idea focuses on creating a sustainable

sanitation environment; if it is implemented in southwest Nigeria, it will enhance the people's quality of life, enhance the aesthetics of the surroundings, and eradicate sickness.

2.2 Empirical Review

2.2.1 Principle of Potable Water Supply

Potable water is defined as water that is sufficiently pure to be used or consumed with little chance of short-term or long-term harm (Damania *et al,* 2019). Although only a very tiny percentage of the water used in industry and households is actually consumed or used to prepare food, it is not of drinkable quality in the majority of modern nations. Water has long been a vital and life-sustaining beverage for people and is necessary for all living things to survive. About 70% of the mass of the human body is made up of water. It acts as a solvent for numerous body activities and is an essential part of metabolic processes. The average American adult consumes 2.0 liters per day, according to the US Environmental Protection Agency's risk assessment figures.

While the British Dietists Association suggests 1.8 liters of water per day per individual, some health authorities have recommended at least eight glasses (240 mL) every day (Harvard Health Medical School, 2023). There is no scientific evidence to support this widespread misunderstanding. There was no conclusive scientific evidence to support the 2008 evaluations of all the scientific literature on the subject that suggested consuming eight glasses of water daily (Prüss-Ustün, 2019). Including water from food, drinks, and drinking water, the Reference Daily Intake (RDI) for water in the United States is 3.7 liters (L/day) for male humans over the age of 18 and 2.7 L/day for female humans over the age of 18. (Damania & colleagues, 2019). Individual differences in water intake can be attributed to a variety of factors, including the subject's health, level of physical activity, and ambient humidity and temperature. Rather than a set amount, a person's thirst serves as a better indicator of how much water they need (Heege *et al,* 2019).

Between 1990 and 2015, the Millennium Development Goals of halving the number of people without access to safe drinking water were most likely not met. There have been some unfortunate attempts to increase the supply of safe drinking water. When the United Nations proclaimed the 1980s the "International Decade of Water," it was assumed that groundwater was necessarily safer than water from ponds, rivers, and canals. According to estimates, 60 million people were poisoned by well water that contained too much fluoride that dissolved from granite rocks (Flörke *et al,* 2019). Children's bone deformations are a clear example of the impacts. Numerous endemic diseases in the nation are typically linked to weak health education initiatives, inferior drinking water supplies, and unsanitary circumstances. Hepatitis, hook work, guinea worm, scabies, diarrhea, dysentery, gastroenteritis, and other parasitic illnesses are among them. Deficits in Nigeria's water supply have serious health consequences. The direct health effects of the situation, particularly on children, are sometimes underestimated because of the low percentage of the population that has access to potable water and the country's relatively dense population (Obaro *et al.,* 2017).

In sub-Saharan Africa, diarrheal illnesses claimed the lives of 769,000 children under five every year between 2014 and 2024. Consequently, almost 2000 children are

killed every day in the sub-Saharan region, where only 36% of the population has access to adequate sanitation (Ogunsesan et al, 2016). Between 2014 and 2024, diarrheal illness killed 683,000 children under five in South Asia annually. An estimated one billion people lacked access to safe drinking water in 2021, and waterborne illnesses were predicted to be the cause of 1.8 million fatalities annually (Stocks, 2024). It is obvious that an adequate supply of high-quality water is necessary for people in the developing countries. Notwithstanding the wealth of resources available to the most populous black country, water scarcity and inadequate sanitation continue to pose formidable obstacles for concerned citizens and development partners (Salisu & Akanmu, 2018). Since many working-class adults and children lose thousands of man-hours to communicable diseases, the nation's workforce is directly impacted by the country's poor health sanitation. Many families have anecdotes of the suffering caused by losing children, particularly those under five (Stocks, 2024).

The basic idea behind any water delivery system is to collect water at a place where customers can pick it up or carry it to a point of usage. Water is initially held in central storage tanks before being discharged into the distribution system in water supply systems that have a distribution network or be delivered straight to homes or to public standpipes with this system. Individual water points, like hand-dug wells and boreholes, allow users to draw water straight from the aquifer's point of extraction (Salisu & Akanmu, 2018). The wells' objective is to offer a dependable and secure way to draw water from the aquifer. Water in sufficient quantities must be found at a depth that permits safe excavation and economically viable exploitation of the water resource, contingent on a variety of specific local conditions, but at a depth that does not permit easy contamination of the aquifer's ground water in order for the construction of a hand-dug well to be feasible. The type of soil at the specific site will determine how much water a well can provide. It will also be impacted by the diameter of the hole dug to draw water and the depth of penetration into the water-bearing stratum. Certain requirements must be met before moving on with a trial borehole or actual construction, even if a specific location shows promising signs of the presence of shallow ground water. Two sets of criteria, one general and one pertaining to the proximity of other structures or facilities can be used to describe internationally recognized standards for the placement of a water point.

Table 1: Specific Minimum Distances between Hand-dug Wells and Communal Facilities in Metres

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

Source: World Water Quality Alliance, 2021

The suggested water point or source should, in general, be situated so that all users can access it without charge throughout the year. There must be a right of way to the wells; they should ideally be situated within the designated distance from the intended users; they should be above the flood level of any nearby lake, river, or other area susceptible to seasonal flooding; they shouldn't be situated beneath or close to any sources of pollution, such as pit latrines, slaughterhouses, dumping sites, stores selling fertilizer or pesticides, etc.; they shouldn't be situated in an area where a saltwater table influences the fluctuating fresh water table; be situated in an area that will allow spilled water to spread quickly; be in an area where the water table is consistently at least 2 meters below the surface; avoid areas where fertilizer or pesticides are applied to crops; and avoid areas that are susceptible to erosion. Nonetheless, Table 1 lists the precise minimum distances that the WHO has mandated be maintained between water points and different communal facilities.

2.2.2 Sanitary Surveying Technique

Sanitary surveying is an inspection method that documents such obvious issues, allowing field workers to evaluate the water's likely quality. It typically identifies any flaws, provides information on the watershed's general state, and offers suggestions for enhancing the water's quality. Designing site-specific monitoring programs and starting pollution source cleanup initiatives can be done using this information. A water body's current or possible pollutants can be found using sanitary surveying (USEPA, 2015). Pathogenic organisms that are known to cause a wide range of human diseases are often the contaminants of concern. Public health professionals, beach managers, shellfish regulators, and any other entity needing comprehensive information on possible sources of bacterial pollution to surface water can use sanitary surveys.

When large levels of pollution are suspected or present and the source of the contamination is unknown, sanitary surveys ought to be carried out. They ought to be carried out if there are plans for major alterations to the area's development, construction, or land usage. Sewage spills from pump stations and wastewater collection systems, malfunctioning septic systems, and non-point source contamination

from residential or commercial development are all potential sources of contamination that would necessitate a sanitary study. Sanitary surveying formally identifies potential contamination issues at the source, site of abstraction, treatment facilities, or distillation system that could endanger the quality of drinking water. It depends on an inspector or group of inspectors physically inspecting the installations. Sanitary surveying can be carried at any of the three points of water supply scheme namely:

i. At the source and intake (to determine whether the abstraction method is adequate and whether the raw water quality is in danger.
ii. At the treatment facility (to determine whether appropriate treatment methods are being
iii. employed and whether the right protocols are being observed.
. At the distribution system (to determine if the water's quality is endangered during distribution.

When doing a sanitary survey, an inspector finds possible threats to the water's quality, but he or she should also use the chance to offer constructive criticism that will result in improvements rather than harmful criticism. When developing new water sources, it is also advisable to do a hygienic survey. To evaluate the water's quality and determine whether any treatment is necessary. Three, comparing water sources for possible development, identifying contaminants when they are suspected, determining the likely cause in the event of an epidemic of a water-borne illness, interpreting the results of water quality analysis, determining how the water became contaminated, monitoring the sanitary condition as part of routine activities, or when there are significant changes (like heavy rain or construction activity) that could affect water sources.

2.2.3 Comparison of Water Quality Analysis and Sanitary Surveying

Water quality analysis (either in the field or in a lab) and sanitary surveys are complimentary tasks that are both significant and have drawbacks (see table 2).

Table 2: Water Quality Analysis and Sanitary Surveying

Water Quality Analysis	Sanitary Surveying
Water quality examination is costly, necessitates specialized equipment and skilled personnel, and is therefore not always simple to carry out on a regular basis.	Sanitary surveying is inexpensive, doesn't require specialized equipment or personnel, and may be done easily on a regular basis.
Only a record of the water quality at the moment of sampling is provided by water quality analysis.	Sanitary sampling can identify practices or circumstances that could lead to long-term pollution or isolated pollution incidents.
Analyses of water quality will show that a supply of water is contaminated, but they typically won't pinpoint the cause.	Sanitary surveying may not identify all ground water contamination sources, but it does identify the most evident ones.

Source: Researcher's compilation, 2024

2.2.3 Health Implications of Water Supply

The most prevalent illness afflicting Nigerians is malaria. Numerous other illnesses that are prevalent in the nation are typically linked to inadequate health

education initiatives, inferior drinking water supplies, and unsanitary circumstances. These include guinea worm, scabies, hook work, viral hepatitis, diarrhea, dysentery, and gastroenteritis, among other parasitic infections. Deficits in Nigeria's water supply have serious health consequences. The direct health effects of the situation, particularly on children, are sometimes underestimated because of the low percentage of the population that has access to safe water and the country's relatively dense population. A lot of industries use water as an input. Water is typically regarded as an infrastructural service, a final-consumption good or service designed to satisfy families' fundamental need. Public policy frequently ignores, undervalues, or fails to account for the cost of water supply problems.

3.0 Materials and Methods

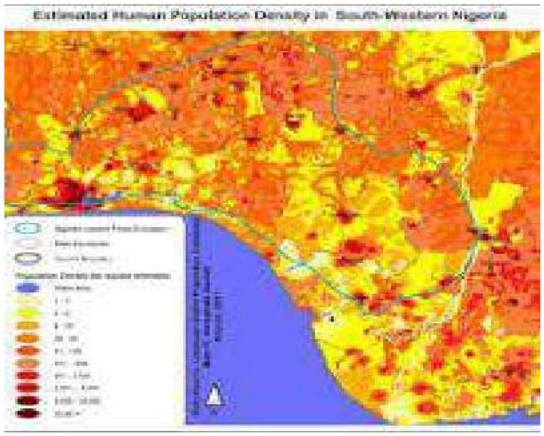
3.1 Study Area

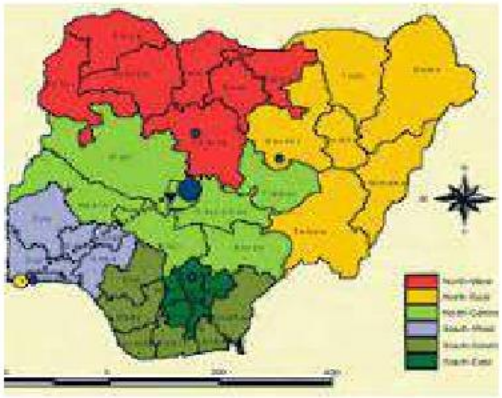
With a population of over 80 million, the region accounts for more than 28% of the nation's overall population. There are 137 Local Government Areas (LGAs) spread over six (6) states namely Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo States that make up Nigeria's South-West geopolitical zone. There are sixteen (16) LGAs in Ekiti State, twenty (20) in Lagos State, twenty (20) in Ogun State, eighteen (18) in Ondo State, thirty (30) in Osun State, and thirty-three (33) in Oyo. According to the 2006 population census, there are roughly twenty-eight (28) million people living in the entire region. However, the study estimates that there will be 50,795,637 people (see table 3).

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

State	Land size (Km^2)	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

3.2 Methodology

Both primary and secondary sources of data, both quantitative and qualitative in nature, were used in this study. A thorough evaluation of the literature is one of the secondary sources of data used in this investigation. For helpful secondary information, published sources including textbooks, journals, newspapers, and the publications of the many organizations addressing water, physical planning, and environmental-health issues were consulted. Where required, academic and consulting studies on water and sanitation from universities, polytechnics, monotechnics, and other research institutes as well as national and international agencies were consulted. While health-related data was gathered from the states' Health Management Boards, various health posts, and government-owned hospitals in the study area, information on water supply, solid waste management, safety, security, and land use was gathered from the various states' Ministries of Lands, Housing, and Urban Development.

Additionally, the National Population Commission, the appropriate state Planning Headquarters, and the Federal Ministry of Lands, Housing, and Urban Development provided data on the number of towns, wards, and homes in each of the six states that comprised the study region. The study area was also defined using maps of the different states in southwest Nigeria, a topographical map of the area, and a few pertinent publications about the region. Focus Group Discussions (FGD), in-depth interviews, questionnaire administration, and direct observation were all used to gather data from primary sources. To guarantee objectivity in the respondents' answers, the questionnaire design for this study was carefully examined using a pre-tested questionnaire. The research area's sampled residents were given the questionnaire. The major players in each of the six states participated in six FGD sessions. The survey method was the research approach used to gather primary data for this investigation. The veracity of the results it ensures and the fact that it is adaptable enough to offer access to a range of data are the reasons this approach was selected. It is also reasonably representative and accurate.

Respondents were given a structured questionnaire that was divided into four main sections: socioeconomic characteristics, housing features, neighborhood accessibility, and water availability. The respondents' socioeconomic status (SES) is highlighted in Section A. These consist of, among other things, sex, marital status, age, occupation, income, and level of education. Section B examines the dwelling units' housing qualities in relation to the building's condition, location, amenities, structural details, density, tenure, comfort, safety, and other factors as reported by the respondents. 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 planning issues, community pride and attachment. Section D of the questionnaire examined concerns relating to water supply, condition and location of the wells used. While many of the questions are open-ended, object-specific, or have multiple choice answers, many are on a five-point Likert scale, with the answers ranging from very good/strongly agree to very bad/strongly disagree.

A facilitator and a note-taker were enlisted to help with the FGD's conduct, with the researcher acting as an observer. Before each focus group meeting, the facilitator and note-taker received sufficient training to acquaint them with the theme and issues that the researcher is interested in exploring. Following each meeting, a debriefing was held in which the researcher, facilitators, and note-takers thoroughly analyzed the discussion's results. Each of the six state capitals that make up the research area was supposed to host one FGD. To ensure that no important information was lost during the analysis, the exercise was supplemented with an audio-visual recording of the conversations. Key figures from each of the six state capitals in the South-Western Nigerian metropolis such as Ibadan, Ikeja, Akure, Osogbo, Abeokuta, and Ado-Ekiti participated in six focus group discussions. A structured conversation guide was utilized to address topics such the settlements' dwelling characteristics, the land tenure system, environmental health and safety, and other water supply difficulties. An audio tape recorder was used to capture the interaction during the FGD session, and handwritten notes and jottings made throughout the sessions were also used. Later, all of the conversations were transcribed, and the resulting data was coded and examined using a computer program called Content Analysis. The primary goals of the focus group discussions (FGDs) were to provide additional information to the information gathered from the administration of the questionnaire and to shed more light on the contradictory concepts that were discussed during the questionnaire interview.

The Observation Method was used to supplement data from the questionnaire, Interview Guide, and Focus Group Discussions to make sure that no important information was overlooked. This approach recorded the infrastructure, neighborhood environment, and well locations that could be seen. An aerial survey of well availability and condition was carried out. Indicators that were linked to both the quantitative and qualitative water supply include these characteristics as essential components. When distributing the questionnaire, a multi-stage sampling technique was used. The initial step was identifying the six State Capitals (SC) that are part of the study area. The study

area was separated into Local Government Areas at the second stage. In the third stage, two Local Government Areas were chosen from each of the six State Capitals using the purposive sampling technique. Every street in the chosen Local Government Areas was listed in the fifth stage. One week before to the interview session, the listing procedures were completed. In the sixth and last step, the researcher methodically chose a suitable number of heads of households from each of the chosen streets. Neumann's (1991) claim that a modest sampling ratio (0.034 percent), or roughly 2,500, can be used to attain accuracy when sampling from very large populations (over 7 million), is the basis for determining sample size. The breakdown of responders by LGA is displayed in Table 4.

The gathered data was analyzed using both descriptive and inferential statistics. For pertinent analyses, the Statistical Package for Social Sciences (SPSS) was utilized. Tests of significance are additional steps in the data analysis process.

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).

4.0 Results and Discussions

4.1 Location of Sampled Hand-dugs Wells in the Study Area

According to Table 5, 23.8% of the respondents said that wells in the study area were close to animal pens, 21.4 percent said that they were close to laundry or washing slabs, 16.4% said that they were close to private (domestic) dumping sites, 13.7% said that they were close to drainage, 18.2% said that they were close to soakaway/pit latrines, and 6.5% said that they were close to large trees or trees with extensive root systems. This suggests that contaminants will have an impact on the study's well water. This supports the claim made by Heege et al. (2019) that household water storage, handling, and point-of-use treatment must be done in a sanitary and healthful manner. The well conditions in the research region are depicted in Figures 1, 2, 3, and 4.

Figure 1: A Typical Hand-dug Well

Figure 2: A Typical Hand-Dug Well

Source: Field Survey, 2024

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

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

Source: Field Survey, 2024

Table 5: Location of Sampled Hand-dugs Wells in the Study Area

Location	Frequency	Per cent
Near Soak-away/pit latrine	455	18.2
Private (domestic) dumping site	410	16.4
Near drainage	343	13.7
Near large trees or any tree with extensive root systems	162	6.5
Near animal pen	595	23.8
Near laundry or washing slab	535	21.4
Total	2,500	100.0

Source: Field Survey, 2024

4.2 Physio-chemical Characteristics of the Water Samples

Table 6 displays the findings of the physico-chemical characteristics of the water samples taken from the 12 wells that were chosen in South-Western Nigeria. The colorless and clear well water samples that were collected from the various sites that were chosen meet the World Health Organization's (WHO) requirements for colorless and clear water. The level of acidity or alkalinity of the well water sample taken from the 18 distinct locations is indicated by the PH value. The PH levels fall within the

WHO LIMIT OF 6.5-9.5.0 and vary from 4.93 at Ikere-Ekiti, 5.10 at Ibadan, and 4.36 at Epe.

According to the study, 33.3% of hand-dug wells in southwest Nigeria had Escherichia coli (E. coli). In the same area, 22.2% of hand-dug wells had Staphylococcus aureus. 11.11% of the hand-dug wells sampled had Salmonella typhi. Of the hand-dug wells sampled, 22.2% had Proteus vulgaris. 5.6% of the hand-dug wells that were sampled had Pseudomonas aeruginosa, and 5.6% of the wells that were sampled had 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.

Escherichia coli (E. coli), which can cause diarrhea, urinary tract infections, and other gastrointestinal disorders, and Staphylococcus aureus, which can cause skin infections, respiratory infections, and food poisoning, are two human bacterial pathogens found in hand-dug wells in South Western Nigeria. According to the study, Salmonella typhi can cause typhoid fever, a dangerous and occasionally fatal sickness. Proteus vulgaris is also capable of causing various illnesses, including urinary tract infections. Enterobacter aerogenes, which can cause urinary tract infections and other illnesses, and Pseudomonas aeruginosa, which can cause lung infections, especially in individuals with weakened immune systems. When people drink tainted water from these wells, these microorganisms can provide serious health hazards. To reduce these dangers, proper sanitation and water treatment procedures are crucial. This supports Tumwebaze et al.'s (2019) assertion that a systematic examination of microbial contamination across sources is necessary for home drinking water in developing nations.

Table 6: Microbiology Result of Water Samples

SN	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	2.2×10^3 CFU/100ml	Salmonella typhi
10	Owo	1.8×10^3 CFU/100ml	Proteus vulgaris
11	Oye	1.9×10^3 CFU/100ml	Proteus vulgaris
12	Ikere	1.6×10^3 CFU/100ml	Pseudomonas aeruginosa

Source: Field Survey, 2024

4.3 Human Bacteria Pathogens from the Sampled Wells Water

Zero tolerance (no detectable total coliforms) per 100 milliliters (mL) of water is required by the World Health Organization's (WHO) criteria for coliform levels in drinking water. Fecal coliforms should be fewer than 1 CFU (Colony-Forming Unit) per 100 mL of water, and there should be no detectable E. coli per 100 mL of water. These regulations are intended to reduce the danger of waterborne illnesses and guarantee that drinking water is safe for human consumption (Table 7). This supports the views of Ouedraogo et al. (2016) and Tumwebaze et al. (2019) regarding the necessity of applying pathogen knowledge to practice when making sanitation decisions.

Table 7: Some Human Bacteria Pathogens from the Sampled Wells Water

SN	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

4.4 Nature of the Sickness

The type of illness that respondents treated during the previous six months is displayed in Table 8. 9.8% of respondents said they had treated cholera, while 15.3% said they had treated typhoid. While 21.9%, 13.5%, and 12.7% reported skin infections, worm infections, and urinary tract infections, respectively, 26.8% reported diarrhea. This aligns with Schardt's (2000) perspective on water and illnesses.

Table 8: Nature of the sickness

Sickness	Frequency	Percent
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	100.0

Source: Field survey, 2024

5.0 Conclusion and Recommendations

This study on sanitary surveying and water quality evaluation has contributed to our knowledge of the relationship between illness prevalence and unsanitary conditions. Bacterial pathogens in the chosen areas and the associated illnesses were identified by this study. The research emphasizes the need to improve health by reducing the transmission of diseases, which is the primary objective of sanitation programs. Lack of infrastructure, crowded, small living spaces, inadequate water supply, and improper disposal of waste and wastewater from bathing, washing, and other activities are the main causes of poor sanitation. The urban poor opt to live on the cheapest land, which also requires the most expensive infrastructure. Unsafe water, inadequate sanitation, and poor hygiene habits can all lead to the spread of diseases like cholera and typhoid that can be prevented.

Therefore, the following study recommendations are based on the field observation that 70% of the wells in the study region were affected:

i. Wells within 30 meters of the latrine should be moved.
ii. Wells located less than 100 meters from the disposal site and 30 meters from the animal cage should be moved.
iii. All wells should have sufficient fencing to keep animals out because their waste may pollute the water.
iv. More wells should be built in order to prevent contamination from too many individuals drawing water from them.
v. To stop water from seeping in, all of the fractures surrounding the wells should be repaired. Drainage systems that are cracked or broken need to be fixed. The wells should be maintained generally, meaning that any that are rusted over should be replaced and those that are exposed should be covered.
vi. Water that is stagnant shouldn't be permitted within three meters of the wells.
vii. To prevent contamination, water should be drawn from a single drawer, avoiding the need for several buckets and being stored appropriately.
viii. To avoid contamination and undesired bodies, all wells should be completely covered while not in use.
ix. Youngsters should not be allowed to draw water from the wells.

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