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Perception of Rural Dwellers on Water Quality and Accessibility in Odeda Local Government Area, Ogun State, Nigeria

MASTER'S THESIS

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Author: **Oyetunde Israel Ayokunumi**

Chief supervisor: Miroslava Bavorova

Second (specialist) supervisor: Mustapha Yakubu Madaki

Declaration

I hereby declare that I have done this thesis entitled Perception of Rural Dwellers on Water Quality and Accessibility in Odeda Local Government Area, Ogun State, Nigeria independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 2025

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Oyetunde Israel Ayokunumi

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Abstract

Nigeria's Government has shown commitment to international water security goals like SDG 6. The research investigates the perception of rural dwellers in Odeda Local Government Area (LGA), Ogun State, Nigeria on water accessibility and quality. Using a mixed-methods approach for data collection the data set includes household survey (n=152) and in situ water sample analysis (n=16). Descriptive statistics and two probit regression models were used to examine the determinants of water quality perception, focusing on two binary outcomes: i. the belief that storage containers affect water quality and ii. the perceived need for water treatment regardless of water clarity. The descriptive results show that despite the SDG 6 commitment, rural communities remain heavily dependent on unprotected water sources such as hand-dug wells (66% of respondents) and surface water (56.2%), which are prone to contamination from microbial pathogens and heavy metals. The probit model regarding water storage show that more educated and married respondents using extension services and social media, are more aware of water quality. The results of the second probit model on water treatment need awareness showed that socioeconomic factors, particularly education and income, and access to extension agent positively influenced perceptions on need of water treatment. The in-situ water quality analysis revealed large disparities between perceived and actual water quality. While 91.4% of respondents rated their water as "good" or "excellent," laboratory tests showed elevated turbidity (exceeding WHO limits), salinity, and microbial risks. In particular the turbidity results raise significant concerns, as they far exceed the WHO water quality standard of 5 NTU. Groundwater samples collected from the study area show turbidity levels ranging from 8 to 319 NTU, greatly surpassing the recommended limit and contradicting the respondents' claims about their water sources. Surface water exhibits even higher turbidity levels, ranging from 413 to 1120 NTU, clearly indicating that the water is unfit for consumption. Gender disparities regarding water collection were evident, with women bearing the primary burden, spending up to 1 hour daily fetching water. The study highlights the lack of water quality and safety awareness, and this underscores the need for community-based solutions, integrating local knowledge, education importance, continuous awareness, with infrastructural investments to improve water security.

Key words: Water quality, water access, information behaviour, water treatment, Ogun State, Nigeria

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List of the abbreviations used in the thesis

CBPR: Community Based Participatory Research

EC: Electric Conductivity

FGN: Federal Government of Nigeria

JICA: Japanese International Cooperation Agency

IEA: International Energy Agency

IFCEM: Improved Fuzzy Comprehensive Evaluation Model

1WMI: International Water Management Institute

IWRM: Integrated Water Resources Management

LGA: Local Government Area

LHNO: League of Nations Health Organization

MG/L: Miligram Per Liter

MENA: Middle East and North Africa

NHSA: Nigeria Hydrological Service Agency

NTU: Nephelometric Turbidity Unit

ORP: Oxidation Reduction Potential

pH: Hydrogen Potential

RBDA: River Basin Development Authorities

TDS: Total Dissolved Solid

UNDP: United Nations Development Programme

UNICEF: United Nations International Children Emergency Fund

WASH: Water Sanitation and Hygiene

WHO: World Health Organization

1. INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Natural resources around the world are scarce, of competing use and can affect social settings and the health status of the people dependent on such resources. Water, a finite natural resource, is considered of great importance due to its diverse use and human needs, and the well-hidden or protected nature of its potable version. As vital as water is, its quality: referring to the potability of the available water and accessibility: referring to its ease of reach as and when needed, remain precarious, particularly in rural regions where agriculture thrives and where the lives of farmers and rural dwellers are intricately tied to its availability. The shortage of water resources has reportedly led to transboundary water conflict between nations (Gleick & Shimabuku 2023), deteriorating health issues, and ultimately, the death of individuals.

Access to water, a basic human right as indicated in Article 25 of the Universal Declaration of Human Rights (UDHR) has become an elusive resource for many rural communities across the globe. As the World Health Organization (WHO) highlighted over 2 billion people lack access to safely managed drinking water (WHO 2023). Hence, the United Nations comfortably recognized ensuring water security as one of the seventeen sustainable development goals (SDGs) - Goal 6. Water scarcity issue is particularly concerning in sub-Saharan Africa, where limited infrastructure and environmental challenges often exacerbate water scarcity and quality concerns. This situation is mirrored in Nigeria, where a significant portion of the rural population does not have access to use portable water resources for domestic use.

Being a signatory to the Universal Declaration of Human Rights (UDHR) which is targeted at poverty alleviation, Nigeria as a country is prioritizing poverty alleviation through different schemes, however, one such route is through the availability and accessibility of potable water sanitation and hygiene to its citizens, particularly the rural dwellers. The large majority of water sources for domestic use in Nigeria are however through individual sources and efforts, as a result, rural dwellers are largely dependent on open and unprotected water sources such as rivers, streams, and hand-dug wells, that are susceptible to contamination and sometimes, at long distance to the point of need of such individuals.

As centralized approaches struggle to address the complexities and intricacies of local contexts, effective community engagement becomes an important tool necessary for ensuring sustainable rural water supply and management as it ensures solutions are tailored to the specific needs of the people. The importance of community-based solutions was further supported after the top-down paradigm for water resources management faltered in the twentieth century (Villamayor-Tomas & García-López, 2017 and Mandara et al. 2013). This shift reflects a profound recognition of the connection between water and community, where the solutions to water-related challenges are not imposed from the centralized government but instead organically from the collective information from the members of the rural communities who are affected. The bottom-up approach also ensures the adaptation of the local community to the adverse effects of local water scarcity through different practices (Fan et al. 2019).

Odeda local government area in Ogun state Nigeria is one such rural community with farming as a major economic activity, with the majority of the community members falling between middle to low-income earners who rely on shallow groundwater and surface water as the primary water source for domestic use (Dahunsi et al. 2014). The dependence of the community on groundwater and surface water is further strengthened as the region experiences acute water shortage as a result of the poor water supply coverage by the state agency (Ufuogbune et al. 2010). This study therefore aims to understand the perceptions of the communities within Odeda regarding water quality and accessibility, which is crucial for developing sustainable solutions in collaboration with the residents of the LGA.

1.2 Problem Statement

Despite the recognition of water as a fundamental human right and the efforts of international organizations and national governments to address water scarcity and quality issues, rural communities in Odeda Local Government Area, Ogun State, Nigeria continue to face significant challenges in accessing clean and safe water with microbial contaminants such as coliforms and high levels of BOD reportedly found in the groundwater of the region (Olatunde et al. 2021 and Shittu et al. 2010). consumption of such water could lead to the spread of waterborne illnesses including cholera, typhoid fever, and dysentery and harm people's health and productivity (Adamu et al. 2022). The groundwater sources have also been reported by Amori et al. (2013) to contain elevated concentrations of heavy metals such as Nickel (Ni), Cadmium (Cd), Chromium (Cr), Zinc (Zn), lead (Pb) and Arsenic (As).

The region’s geological and hydrogeological formation is described as being underlain by a basement complex (Adeleke et al. 2015) which separated the shallow aquifer from the deep aquifer.

The difficulty and cost of drilling through the basement complex within the region further exacerbate the problem of water accessibility within the region. This leads to the general adoption of shallow wells and streams as the primary sources of domestic water supply within the region. However, these wells do not supply water adequately, as they are found deficient during the dry season. Hence, the women and children of the community spend an average of one hour daily covering about one kilometer (1km) to fetch water from adequate sources (Coster & Otufale 2014), putting them at risk of gender-based violence among various other health impacts. Limited infrastructure, and inadequate government intervention as identified by Ufuogbune et al. (2010) also contribute to the reliance of community members on open and unprotected water sources, which are often contaminated and distant from their point of need.

The lack of access and poor water quality identified within the region has a disproportionately negative impact on the inhabitants of the communities, with farmers being among those who are mostly negatively impacted. These farmers thereby rely on rainfall to satisfy the water needs of their crops, which are heavily reliant on seasonal rainfall patterns (Adetomiwa et al. 2020), a pattern that has been seen to record fluctuations in recent times. The inaccessibility of water further cascades into poor economic and financial growth for these rural farmers affecting the farmers' incomes and livelihoods as well as the lives of rural residents by reducing crop yields, resulting in lower-quality output, and raising production costs.

Community perception is an integral part of smallholder farmers' responses to water scarcity as noted by Fan et al. (2019), however, despite the various reports on the quality and accessibility of the water within Odeda local government area, there have been little or no studies on the community's perception of the water crisis within the region. Therefore, the extensive problem addressed by this study is the perception of the farmers and rural dwellers on access to clean and safe water and the resulting adverse impacts on the health, livelihoods, and overall quality of life in the community.

1.3 LITERATURE REVIEW

1.3.1 Introduction

Livelihood in rural areas in Nigeria is predominantly limited to farming, processing and small-scale trading. important to these economic activities is the access to water resources, which supports the community health, farming activities and other economic activities. This chapter reviews opinions and conclusions from various sources and authors, starting with an overview of water quality and accessibility, global perspectives on water accessibility and quality, water challenges in sub-Saharan Africa, water quality and accessibility challenges in rural areas, water management policies and interventions in Nigeria, The role of human perception in water quality and accessibility management, Gender and water issues in rural areas and community-based approach to water management. The last section reviews water management and policies and interventions in Nigeria.

1.3.2 Water Quality and Accessibility Overview

Water quality includes measurable physical, chemical and bacteriological properties of water based on the desired water usage and concern (Mahbubul Syeed et al. 2023; Johnson et al.1997). The quality is determined by several factors such as organic pollutants, and heavy metals, among others, from different sources, especially the parent materials (Gamvruola et al. 2012; Mosley et al. 2012), while Water access according to the WHO/UNICEF Joint Monitoring Programme from 2010 refers to "The availability of water of at least 20 litres of drinking water per person per day within a distance of not more than 1 km of the dwelling, corresponding to a maximum water hauling round trip of 30 minutes or less, including queuing time".

The concerns of water accessibility can be traced back to the earliest known permanent settlement around 8000-7000 BC where settlements were located near different water sources to take advantage of the resources (Juuti et al. 2007). The proximity to water sources allowed early civilizations to thrive and flourish, enabling agricultural production and the development of complex societies and cultures and as such, accessibility was not seen as a challenge. In Mesopotamia, for example, the fertile lands of the Tigris and Euphrates rivers supported the growth of the world's first urban centres, such as Sumer and Babylon (Juuti et al. 2007). The settlements then developed into the construction of shallow wells and stone rainwater channels. During this era, the siting of these settlements was also a function of water quality as the quality of the water was examined by the senses: taste, smell, appearance and temperature and the health of the people and animals using the water source (Vitruvius 1934). These water quality determinations were also the earliest method of analysis of water resources for varying uses.

In the 19th century, Mediaeval cities, castles and monasteries had wells, fountains or cisterns used for water supply and were sited to ensure accessibility of the town inhabitants (Ward-Perkins 1984). Before the 1930s, agencies were set up in clusters of countries such as the colonial powers to monitor water quality. Of such agencies are the Pan American (originally International) Sanitary

Bureau (PASB) founded in Washington DC in 1902 (Norman 2007), the Office International d'Hygiène Publique (OIHP) followed in 1907 with headquarters in Paris (Neville 1971) and the Rockefeller Foundation and the League of Red Cross Societies developing important health programmes with an international outlook. After World War I, the League of Nations Health Organization LNHO (now WHO) found itself thrust into the position of international monitoring of drinking water and sanitation finding answers to global health problems (Iris 2009) and assuming worldwide responsibilities, carrying out water quality monitoring, publishing recommendations and collecting data on the quality of drinking water (Bartram et al. 2014).

According to Rijsberman (2006), water scarcity is of two types; physical and economic water scarcity. Physical water scarcity is defined by UNDP (2006) as the restriction of people's physical access to water resources present in the area. The condition is a result of demand exceeding the available resources within an area, while Dhanasekaran & Balakrishnan (2019) define economic water scarcity as the limitation of access to water resources as a result of political and ethnic contradiction. This condition occurs even with adequate water supply; however, the unavailability is a result of a lack of significant investment in water infrastructure and policy by the regulators or institution (Rijsberman 2006; IWMI 2000).

1.3.3 Global Perspectives on Water Scarcity and Quality

According to Gleick (1996), the total volume of water in the current earth system is estimated at 1,386 million cubic kilometres, However, its quality and accessibility are a global concern as only 3% of the available water is fresh for consumption with most of the available freshwater also in solid form; ice caps (Cassardo & Jones,2011). Despite the importance of clean water, challenges persist in ensuring its availability and safety, particularly in the face of increasing population, pollution and climate change (Foss 1994). The uneven geographical distribution and the amount required/demand of the resource by individuals further intensify the water crisis, meanwhile, its quality and accessibility have significant implications for public health and sustainable development (VishnuRadhan et al. 2012; Kruger 2011). Water scarcity, described as an "impending water crisis" by Lundqvist (2000) despite being a foregoing problem, will continue its dominance and importance in the recent century and future development, with the issue being exacerbated by climate change.

Publications by different authors have identified the extent of current and projected water scarcity across the world. A global prediction of areas of projected physical and economic water scarcity by 2025 was first produced by IWMI (2000). The prediction largely focuses on classifying the different regions of the world based on physical and economic water scarcity, with economic water scarcity being predicted as the major problem for Africa, South America and Australia, while Europe, North America, and Russia are predicted to have little or no water scarcity, and North Africa, Middle East, and Asia predicted to face physical water scarcity. These predictions, however, are more significant for national water and food security than individual or household water accessibility (Penning de Vries et al. 2002).

Globally, Alcamo et al. (2003) predicted that water use and withdrawal will stabilize or decrease in 41% of the world river basin as a result of the demographic, economic and technological trends up to 2025, with the developing countries bearing the brunt of severe water stress and scarcity. A prior study by Hinrichsen (1998) evaluated a decrease in the per capita availability of freshwater at a global scale by about 60% between 1960 and 1997, a period marked by post-war reconstruction and decolonization, and the dawn of the digital age and globalization, with profound implications for economies, societies, and cultures worldwide. These views are also in sync with the United Nations report that more than 40% of the current world population experiences water scarcity, with over 700 million people lacking access to clean drinking water, with the report also establishes the inequalities in access to water, sanitation and hygiene revealing more than half of the world does not have access to safe sanitation services (Shemer et al. 2023; UNICEF/WHO 2019).

Vorosmathy et al. (2000) argued that the prediction of global water resources is not a straightforward approach as a result of the dynamism of water availability and water demand. However, the research predicted current water stress globally affecting a larger portion of the world, with increasing water demands that will further lead to water scarcity by 2025. The water demand beyond domestic and commercial uses, for manufacturing and consumer markets to produce electricity, mining and processing according to IEA (2012) will increase to about 85% within the next 20 years.

The World Water Assessment Program (WWAP) (2015) also mentioned that the rate of groundwater abstraction is on the increase with over 20% of the current world's groundwater storage depleted from over-exploitation and an annual abstraction increase estimated at 1% to 2%. The depletion also adds up to the looming water scarcity around the world as a result of the pressure on freshwater storage. These pressures are often more prominent in extensive agricultural zones with over-exploitation of the groundwater resources for farming activities (Ingrao et al., 2023).

1.1.1. Water Challenges

1.3.3.1 Water Challenges in Sub-Saharan Africa

Like their counterparts in South America and Australia, countries in Sub-Saharan Africa face a range of water challenges, including urban water crises (Niasse & Varis 2020), water scarcity (Hitchcock 2011), and the need for sustainable water management (Ferreira et al. 2023). The argument was supported by (Dos Santos et al. 2017) who added that least developed countries in sub-Saharan Africa are most affected, with these countries having a greater population without access to clean water than other major regions. These challenges are exacerbated by factors such as population growth, water pollution, and the impact of climate change (Jones 2004). The water scenario in Sub-Saharan Africa is unique, such that the WHO/UNICEF referred to the crisis as one of a kind, with the number of people without access to water rapidly growing since the beginning of the 21st century (WHO/UNICEF 2021).

Hitchcock (2011) opined those countries in Southern Africa are facing tremendous challenges when it comes to water. The publication further revealed that half of the 15 Southern African Development Community states were considered to be facing serious water-related constraints, and some have been classified as water-scarce as far back as 2009. Donnenfeld et al. (2018) also mentioned that the water crisis forecasts for the country also predicted that water demand will increase in all sectors out to 2035 with population growth, urbanisation, rising incomes, irrigation expansion, non-renewable electricity generation and growing manufacturing sector being the major cause. Later study by the World bank in October 2022 described the current situation in the region as worsening and about 226 million people in Eastern and Southern Africa not having access to basic water services, with the situation more pronounced in the rural areas of these regions (Worldbank, 2024). Niasse & Varis (2020) suggested that acute seasonal and chronic water shortages are already beyond the rural areas and are now encountered in almost all major cities in sub-Saharan Africa. Du Plessis (2017) was also of a similar opinion suggesting that South Africa will find itself in a precarious position regarding its freshwater resources within the near future and potential conflicts between economic sectors over declining water resources.

The case in Northern Africa is no different, MENA (2007) recorded that the rivers in the region are among the most heavily dammed in the world, leading to individuals and households depending on groundwater for domestic use. The groundwater resources are then over-exploited to meet up with the demand. The scenario coupled with the vegetation and hydrological characteristics of the region, together with climate change prospects severely threatens the water availability in the region.

In the Western part of Africa, Kenfack et al. (2016) mentioned lower access rates to safe water within the region as compared to the rest of the world, with over 60% of countries in the region to experience water scarcity by 2025 while about 80% of the available surface water sources experiencing eutrophication, where algae blooms already cover the surface waters. Conducting the research in a local government in Nigeria, Western Africa, Emenike et al. (2017) also quantify the water access in the region. The study concludes that there are complications in the situation of water access within the area with water systems and the government's minimal efforts over the years failed to solve the challenges around water access. The author documents some of the inconveniences the residents face, including the lack of direct water connections in their households to access potable domestic water for everyday use.

Yomo et al. (2019) also examined water security in Togo, West Africa using the Improved Fuzzy Comprehensive Evaluation Model (IFCEM) and concluded with a prediction of an overall decrease in the water security level in the future (up to 6% in 2025) within the country. This indicates a further worsening scenario, despite the setback in achieving the Millennium Development Goals, now replaced with the SDG. The predicted downward trend and setback have been attributed to several factors such as political, technical, legal, institutional, environmental, sociocultural, hydrogeological, and demographic factors.

The Sudano-Sahelian zone of West Africa has also experienced a series of droughts in the past decades that has also put more pressure on the already water-stressed region affecting at least 13 of the 16 countries of the region (Oyebande & Odunuga 2010). The water access issues were further exacerbated by declining rainfall further affecting the water distribution in the hydrological water cycle of the region. The challenges were visible in decreasing river discharges, declining water volume of freshwater bodies and storage systems, depleting groundwater systems, and accelerating the desertification process.

While the water crisis is a common thread across Sub-Saharan Africa, it manifests differently in the various regions. The arid and semi-arid regions are more prone to droughts, while the humid regions struggle with flooding. Both scenarios are not advantageous to the access to water resources for the inhabitants of the region. Across the continent, the underlying causes of water challenges in the region despite the huge water potential of the continents include Population Growth and

Urbanization (Emenike et al. 2017) Governance and Infrastructure Limitations (Yomo et al. 2019) Climate Change Impact (Oyebande and Odunuga 2010).

1.3.3.2 Water Accessibility Challenges in Rural Areas

Rural areas around the world, particularly in developing regions, face significant challenges regarding water accessibility and quality. These challenges stem from a combination of infrastructural deficiencies, limited financial resources, and environmental factors that impede the availability of safe and reliable water sources. In many rural communities, water sources are often distant, unprotected, or contaminated, leading to increased risks of waterborne diseases and adverse health outcomes. Various studies across the world have quantified the extent of the scenario playing out in rural areas as it concerns water quality and accessibility.

Shaku (2011) revealed that over 70% of rural households in Nigeria lack access to improved water supply, leading to reliance on unsafe sources and vulnerability to waterborne diseases. The study further detailed women and children at the receiving end of the burden of travelling long distances to source water. A later study by the World Bank (2021) also mentioned that residents of many rural areas in Nigeria are forced to rely on tainted water sources like rivers, ponds, and open wells since these communities lack adequate water delivery systems. These open water sources are usually contaminated by animal and human waste which can readily infiltrate into water sources.

In India, Bandyopadhyay (2016) recorded that rural area suffered pathogenic contamination of surface water and shallow wells, which was addressed through tube wells in the 1990s, however, chemical contamination is the new order of the day in the deeper aquifer where these tube wells extract water from. The study further advises a decentralized solution and initiatives such as public-private partnerships and community-managed systems as potential solutions to the water problem.

Studying water and sanitation challenges in rural South African Municipality, Asoba et al. (2020) reported that residents faced challenges related to unprotected water sources, poor sanitation practices, water scarcity, and inaccessibility, with women bearing the brunt of these challenges, leading to vulnerability to waterborne diseases and superstitious beliefs. The study also mentions that violence among residents in water queues is one of the scenarios playing out in those regions. The findings of this literature are similar to Adeyeye et al. (2020) who discuss water marginality in rural and peri-urban communities in South Africa, highlighting challenges such as inadequate infrastructure, climate change, and governance issues, while emphasizing the need for policy solutions and improved knowledge capacity of stakeholders.

The majority of the dwellers of peri-urban areas in Tanzania utilize shallow wells as their main water source with low reliance on public water supply as detailed in Juma et al. (2018). The study revealed that less than 50% of the community members had access to clean and safe water with challenges like inadequate budget and water infrastructure as the main factors affecting accessibility.

In developed environments like the United States of America, rural dwellers of Appalachia also face similar issues to their counterparts in developing worlds. Arcipowski et al. (2017) recorded those thousands of residents in the area struggle with issues of water quality and accessibility, with vulnerabilities of poverty, isolation, and rough geographical terrain complicating life for the residents in dire need of access to adequate water supply and septic systems.

While various authors have linked water accessibility to poor infrastructural development, limited financial resources, and environmental factors such as terrain and distance, some researchers have also found socioeconomic reasons that affect water quality and accessibility in rural areas across the world.

Aikowe & Mazancová (2021) studied the barriers to water access in rural communities and found that age, level of education, ethnic group, and occupation significantly influence the choice of a water source in rural areas in Kogi state in Nigeria emphasizing the Okun/Yoruba tribe of the region is less likely to choose tap/handpump over the stream, while minor ethnic groups are more likely to use lower-quality water sources.

A 2019 study by Gomez et al. also analyzed the impact of specific socioeconomic factors on access to improved water sources in rural areas of developing countries and found socioeconomic variables such as gross national income, female primary completion rate, agriculture, growth of rural population, and governance indicators as the leading factors affecting water accessibility.

Laura et al. (2019), assessing the public awareness of water usage and water quality, found that there are significant differences in water quality perception observed across education levels, with more educated individuals showing increased awareness of both water usage and potential water quality threats. This finding suggests that higher education may contribute to a more nuanced understanding of complex water-related issues.

1.3.4 Human Perception in Water Quality and Accessibility

1.3.4.1 The Role of Human Perception in Water Quality and Accessibility Management

The ultimate goal of water accessibility and quality is meeting human or consumer needs without compromising their health and safety, as such, outside of laboratory analysis and GIS data analysis, human perception is an important phase in water quality and accessibility determination. The perception of water users on their water sources is affected by perceivable aspects of water quality such as colour, odour and taste (Bayeh & Bakele 2018), this was also the view of West et al. (2016) who mentioned visible attributes of water such as colour and clarity as the most important factor in shaping the human perception of water quality. This perception is influenced by a range of factors such as visibility of pollution, personal usage of water resources, trust in local officials (or vendors as the case may be) (Canter et al. 1992), cultural beliefs and personal experiences (West et al. 2016).

Different researchers have studied the importance of human perception in proffering adequate and effective solutions to water accessibility and quality. Francis et al. (2015) in the study on the perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India highlighted the need to effectively involve communities at important stages of implementation for the long-term success of water quality interventions. Engaging community members at various stages of the intervention, from planning to execution and evaluation, is crucial. This inclusive approach helps in understanding the specific needs, preferences, and concerns of the community, which can significantly impact the acceptance and effectiveness of the intervention.

Omarova et al. (2019) interviewed over 1300 rural Kazakhstan respondents to assess the villages' access and perceived water quality. Despite the availability of Tap water(treated), most of the villagers prefer alternative sources, citing situations such as residents' doubts regarding the tap water quality; use of other sources out of habit; and availability of cheaper or free sources as the reasons for their choices.

Hu (2011) concluded that individual-level variables such as age and gender are significantly and positively related to perceptions of groundwater quality. Women are often more perceptive to water quality issues due to their traditional roles in many cultures that involve managing household water for drinking, cooking, and cleaning. This close interaction with water use means women might be more attuned to changes in water quality and its impacts on health and household activities. In the same study, Hu (2011) mentioned that Education is significantly and positively related to better surface water quality perception. This relationship underscores the importance of educational attainment in influencing how people assess and respond to environmental issues, particularly water quality.

Brungnach & Ingram (2011) in a study on rethinking the role of humans in water management emphasize the need for inclusive and participatory decision-making models in water management to address the complex and diverse nature of water issues globally. The study suggests reforming water models to include human roles and their perception in model building for decision-making processes.

In the study, Bayeh & Bakele (2018) investigated the perception of water quality in rural agricultural areas and found that the educational status of the household head and chlorination of the water source affect the perception of water quality positively, enforcing trust in the water users. Educated household heads are more likely to understand the importance of clean water and the benefits of water treatment methods, such as chlorination, which also positively impacts perception by reassuring users of the water's safety. Bain et al. (2014) in their study reveals that rural communities mostly rely on groundwater or surface water, and their perceptions of water quality mostly do not align with actual contamination levels. Some respondents will absolutely rate their water as Good or Excellent despite the presence of potential microbial risks in their water or water sources. Variables such as income, poor trust in suppliers, and past health risks experienced by waterborne diseases negatively affect the household perception of water quality. Households with lower income may lack access to safe water sources and resources for adequate water treatment and may have developed adaptability skills for the unprotected sources they have, hence, leading to a diminished standard and expectation for water quality. Kumpel & Nelson (2016) argue in their study that situations where water sources appear really clean, intermittent supply and storage or handling methods can introduce contamination into the water, which then leads to quality deterioration.

Rojas & Megerie (2013) also identify sensory information such as taste, odour, colour and turbidity as a sort of “quality standard” and the main factors influencing peoples' water quality perception within the rural areas of Columbia. These sensory attributes serve as immediate and tangible indicators for residents to judge the safety and suitability of their water for consumption and daily use. This underscores the need for policymakers to acknowledge the role of sensory information to ensure water management practices can be better tailored to meet the needs and concerns of rural communities, thereby enhancing the overall perception of water quality and promoting healthier water consumption behaviours.

Human perception significantly influences water quality and accessibility management. Factors like sensory attributes, demographics, and socioeconomic status shape community interactions with water resources. Engaging communities and incorporating their perceptions into decision-making enhances the acceptance and sustainability of water interventions. Recognizing these aspects allows policymakers to tailor practices that promote safer water consumption and ensure long-term success and trust in water management efforts.

1.3.5 Gender and Water Issues in Rural Areas

Rural areas are often characterized by traditional beliefs and practices that differ significantly from the more modern, civil approaches seen in urban areas. These traditional beliefs can deeply influence various aspects of life, including water management and usage practices. Gender disparities in urban and rural areas significantly impact access to safe drinking water, with women often bearing the brunt of the burden (Buddhi & Akash 2021).

Asaba (2013) in rural Uganda mentioned that women and children face disproportionate burdens and risks in accessing water, including health problems, accidents, and safety issues. These women are less involved in water governance and have little influence on water management decisions due to patriarchal norms and stereotypes that undermine their voices and choices.

Varua et al. (2018) examine the role of gender in groundwater management and use in two Indian watersheds, finding that women play a substantial role in collecting and using groundwater and that improved access to water can reduce the burden on women and allow them to engage in more diverse livelihood activities, and bargaining power, but only a minority feel empowered to make a difference in key domains.

Awoniyi & Obafemi (2021) also examine the critical role of women's participation in rural water management in Nigeria and the impact of gender insensitivity on women's limited involvement in water management at the community level, while highlighting the contributions of women's indigenous practices to meeting their practical gender needs.

My (2015) on the assessment of water shortage and its implications on gender roles in semi-arid areas in Tanzania concluded that women are more vulnerable and stressed by water shortage problems which leads to women spending more time fetching water instead of engaging in other socioeconomic activities.

The highlighted studies all capture the gender disparity that not only affects the effectiveness of water management but also perpetuates broader social inequalities. Despite their central role in managing household water needs, women are often excluded from water governance and have minimal influence over water management decisions. This exclusion is rooted in entrenched patriarchal norms and stereotypes that marginalize women's voices and choices. In many rural communities, decision-making authority typically resides with men, leaving women's insights and needs unaddressed in water management policies and practices.

Gender differences in access to water and uses are also context dependent (Harris et al. 2017). The variation can be related to the different water usage such as domestic, or production use (such as agricultural water use). The daily water requirement varies by gender as there are different interests of men and women in the use of the resources. Women are often the primary water managers in the traditional households and workplaces, wielding considerable influence over water usage and conservation practices

1.3.6 Community-Based Approaches to Water Management

The importance of incorporating communities in the planning and operation of water facilities cannot be over-emphasized. The effectiveness of community-based approaches to water management has been documented in different literature and proven to be effective in various contexts. Tantoh & Simatele (2016) argued that the so called community-based natural resource management can look into the total involvement of local people in development issues and sustainable management of potable water resources in rural societies in sub-Saharan African countries. Beal et al. (2023) proved that community-based demand management strategies piloted in four remote Aboriginal and Torres Strait Island communities in Australia provided greater opportunities for long-term sustainable water management outcomes that support the building of social capital.

Damiba et al. (2013) also concluded that by incorporating the community into the water project, villagers monitored changing water availability, took collective action, and collaborated with local government authorities, enabling informed decision-making, to mitigate and manage the water resources of their region. Ogi et al. (2010) in the study on the participatory approach to community-based water systems also discussed the importance of community-based water supply systems in addressing water scarcity, emphasizing the role of social interaction within the community in managing the system effectively. Vadikar (2024) explores rural community-based best practices for water harvesting, emphasizing the benefits of community participation to include helping to solve water problems, while the cooperative strategies lead to cost efficiency and revenue benefits. Despite the strong campaign for a community-based approach the water management, Yu (2014) in his findings emphasises the critical role of community-based water governance, and highlights the limitations of relying solely on community-based governance. Aashiq et al. (2020) also supported the argument stating that Community management is crucial for rural water supply system sustainability but requires modifications and external support, including institutional assistance and active community participation.

Osei (2012) had earlier suggested strategies for improving community-based approaches to rural water management, including community sensitization programs, capacity building for committees in charge of the project, political commitment, mechanization of boreholes, and creating an enabling environment for private entities.

1.3.7 Water Management Policies and Interventions in Nigeria

Nigeria is a signatory to many water policy initiatives such as the Millennium Development Goals (MDGs) in 2000, the United Nations International Decade for Action, “Water for Life” 2005–2015, and the 2030 Agenda for Sustainable Development driving the new Sustainable Development Goals (SDGs), all with a singular goal of improving water access and reducing poverty through the eradication of physical and economic water scarcity. The first attempt at water resources management by the country was the creation of the Federal Ministry of Water Resources in 1976 after the severe 1960 drought (Gbadegesin & Olorunfemi 2009) with the mandate of management of nationwide water supply, irrigation, freshwater and aquaculture. To achieve the mandate, River Bain Development Authorities were created under the ministries to ensure the management of water resources is done at a basin level taking cognisance of the different basin peculiarities.

The country also has several national policies that affect water supply, accessibility and quality. The first and broad of the policy is the National Policy on Environment launched in 1989 (FEPA, 1989). Originally, the policy was not specific on water resources management (Gbadegesin & Olorunfemi 2009), but one of its objectives included conserving and using the environment and natural resources for the benefit of present and future generations. This sole objective served as the umbrella to accommodate water resources as one of the natural resources of the country. The implementation of the policy birthed the development of strategies that are useful for effective water resources management, which led to the development of a comprehensive national water resources master plan with the support of the Japanese Government through the Japan International Cooperation Agency (JICA) (FGN 1993, Gbadegesin & Olorunfemi 2009).

The masterplan coupled with the enactment of the Water Resources Decree 101 (Water Act 100 of the Federal Republic of Nigeria) of 1993, led to the development of Nigeria's first draft of the Water Resources Policy which was formulated in the year 2004 based on the philosophy and principles of Integrated Water Resource Management (IWRM) (FMWR 2016). The Water Resources Policies guiding principles address issues related to socioeconomics and water allocation, institutional frameworks for transboundary waters and water resources, water and environment protection and conservation, planning and development, and information, education, and communication about water resources.

Despite the clear strategies in the national water policy, the overarching, overlapping and conflicting roles and responsibilities of the different Federal Government agencies like the River Basin Development Authorities (RBDAs), Nigeria Hydrological Service Agency (NHSA), Federal Environmental Protection Agency, Ministry of Environment etc., has caused a number of setbacks to the implementation of the strategies. These institutions have functioned with friction over the years and have not been able to effectively implement the national water policy to ensure water supply and access to the Nigerian masses (Enyidi 2017). Other authors (such as Ngene et al. 2021; Merem et al. 2017) have also cited weak legal and institutional framework and Lack of continuity in policy implementation as a significant setback in the way water is managed in Nigeria. Chukwu (2015) focusing on water supply in the wetland area of the Niger Delta in Nigeria identifies challenges to water supply and access to include lack of compliance, fragmented responsibility, poor infrastructure, corruption, and low-cost recovery. Nwankwoala (2014) emphasizes the importance of a broader perspective in water resources development, with adequate consideration of financial, economic, social, legal, political, technological, and environmental factors through institutional reforms, policy review, and integrated approaches for sustainable water supply and increased access.

In the past decades, several interventions have been orchestrated by international bodies such as the World Bank Group, the African Development Bank and many other partners to improve water access and sanitation facilities in different rural areas. These initiatives are mostly under Water

Sanitation and Hygiene (WASH) projects (Aikowe & Mazancová, 2021) with groundwater sources being the main source of water for such projects (Price et al. 2019). These wells and boreholes offer a promising solution for providing clean drinking water in areas lacking established piped infrastructure, however, challenges such as inconsistent power supply limiting the water extraction, poor maintenance practices and abandonment by the community members have grounded such projects. These challenges lead to the reversion of the rural communities to their traditional water sources. Addressing these challenges and incorporating community perceptions can be crucial for ensuring the success of water management interventions in Nigeria.

1.3.8 In-Situ Water Quality Assessment

In-situ water quality monitoring is crucial for assessing and managing water resources as they give an onsite assessment of the water source and exhibit strong relationships with many of the other water quality parameters. Parameters commonly measured include pH, dissolved oxygen, temperature, turbidity, conductivity, and various chemical compounds (Silva et al. 2022). Literatures such as Agori et al. (2021) have confirmed the prediction of the concentration of other water quality such as anions and cations, based on independent parameters that are measured on site, suggesting that the measurement of the in-situ parameter alone can foretell the overall health of the water quality of the source. This assertion is also confirmed by Srivastava et al. (2018) that used in-situ parameters such as pH, temperature and TDS to derive other water quality material parameters including salinity, oxygen reduction potential using a mathematical model. Understanding these relationships can aid in rapid water quality assessment, pollution monitoring, and ecosystem management, potentially saving time and resources in water quality analysis.

1.4 Theoretical Framework

Water accessibility and water quality are part of public health indices, which are complex and require socially and politically driven. This study therefore will adopt a blend of the Community-Based Participatory Research (CBPR) Framework and the Human-Environment Interaction Theory.

The Community-Based Participatory Research (CBPR) Framework with history dating back to 1940 by Kurt Lewin (Collins et al. 2018), gives preference to community members, researchers and other important stakeholders in the research process, recognizing the unique strength of their perception in the research finding and conclusion. The theory helps bridge the gap between reality and abstract theory and provides potential for solving practical problems (St Denis 1992) such as water scarcity and accessibility issues in the study area.

The theory having its origin in psychology, sociology and critical thinking has become a common research approach in the fields of public health (Collins et al. 2018). The focus of the theory emphasizes the engagement of community members as important stakeholders in the research process, promotes two-way learning and benefit for the researcher and the community member, and focuses on practical solutions and actions to address community needs. While this research will not necessarily Involve the rural dwellers in Odeda in the planning, data collection and analysis phases of the research will largely be dependent on the information provided by the rural dwellers and key informants within the community.

The research objective of determining how some of the socioeconomic factors of the people affect their perception of the water quality within the area is backed by the Human-Environment Interaction Theory. The framework examines the reciprocal relationship between humans and their environment, emphasizing how human activities and environmental conditions influence each other (Moran & Brondizio , 2012). The building block of this theory emphasizes that Actions taken by humans affect the environment, which in turn influences human behavior and well-being. The influence on human behaviour can lead to adaptation measures which can also further negatively or positively impact the environment.

1.5 Summary of Research/Research Gap

While community-based approaches are highlighted as effective, there is a lack of longitudinal studies examining the long-term sustainability and scalability of these interventions. While several studies mention cultural factors, further investigation is needed into how various other socioeconomic factors, beyond those already identified, interact to influence water accessibility. This includes the roles of income inequality effects on water access and quality in rural areas. Although there has been extensive research on the possible roles of human perception on water accessibility and water quality in rural areas, significant gaps remain in understanding the nuanced dynamics of these perceptions across different demographic groups and cultural contexts. There is a lack of detailed studies exploring how perceptions of water quality and accessibility vary within communities, particularly across different age groups, genders, socio-economic statuses, and educational levels.

Particularly, Research on water resources availability and access in rural Odeda LGA of Abeokuta has been limited and largely focuses on water availability parameters such as groundwater recharges and potential (Adeleke et al. 2015; Badmus & Olatinsu, 2012; Aina et al. 2019), groundwater contamination (Amori et al. 2013; Amakom & Jibiri, 2010) and audit of water interventions (Mogaji et al. 2017). None of the studies has factored in the community's perception of the rural dwellers on water quality and accessibility.

2. AIM OF THE THESIS

2.1 Research Objectives

This study aims to assess the perception of rural dwellers on water quality and accessibility in Odeda LGA, Ogun state, Nigeria. While the specific objective are:

i. To describe the water sources, water quality perception and the water distance to the rural residents.

ii. To identify the challenges faced by the dwellers to access safe water.

iii. To analyze the socioeconomic factors and information sources that determines the perception of the rural dwellers on water quality.

2.2 Research Questions

The research objectives on the perception of water quality and accessibility of water by rural dwellers in Odeda Local Government Area, Ogun State, Nigeria include:

I. What are the water sources, quality and the distance of the sources to the rural?

II. What are the challenges faced by the dwellers to access safe water?

III. What are the the socioeconomic factors and information sources that determines the perception of the rural dwellers on water quality (regarding use of containers and water treatment) in the area?

Hypothesis

H1o - there is no significant relationship between information sources and awareness of storage effect on water quality

H2o - there is no significant relationship between information sources and awareness of need of water treatment

H3o - there is no difference between the respondent water quality perception and the measured actual water quality.

3. STUDY METHODOLOGY

3.1 Study Area Description

Ogun State is actually one of the known 36 states in Nigeria, located in the southwestern part of the country. The state is bordered to the south by Lagos state, to the East by Ondo state, and to the West by the Benin Republic, and to the North by Oyo and Osun states. The state lies within latitudes 7 N and 7 5' N and longitudes 3 3' E and 3 37' W.

Odeda Local Government Area (LGA) is one of the largest LGAs in Ogun State, lying between longitudes 3° 26′ 76″ and 3° 47′ 28″ and latitudes 7° 29′ 88″ and 7° 05° 54″. The LGA is connected to the North by Oyo State, also the West by Abeokuta North and Abeokuta South Local Governments, connecting to the East by Obafemi-Owode Local Government. Odeda is a town and the headquarters of the LGA. situated along the Abeokuta-Ibadan expressway.

3.2 Demography and Population

Ogun State has an estimated population of approximately 5.5 million people, with a fairly balanced gender distribution: 49.7% male and 50.3% female. The demographic structure is notably skewed towards the economically active population, with individuals aged 15-64 years constituting about 58% of the total population. This highlights a significant portion of the population that is potentially engaged in economic activities, contributing to the state's productivity and growth. Additionally, a considerable segment, 37.9%, falls within the younger age group of 0-14 years, indicating a substantial youth population that presents both opportunities and challenges in terms of education, healthcare, and future workforce development.

The population of Odeda, based on the 2006 population census data, was 109,449 while its projected population in 2024 is estimated at 206,300, with an estimated national annual projection of 2.3% (Worldometer, 2024). Odeda is largely a rural area, and a large faction of whom speaks the Yoruba Language. The economy of the town is largely based on agriculture, informal services, and small-scale (cottage) industries. The area predominantly comprises the Egba people who speak the Egba dialect. The main language spoken in the area is Yoruba, but some people also speak Fulani, Hausa, Igede, and Ito

Despite the evolution of modern governance structures, the authority and significance of traditional leaders persist. These leaders command deep respect and are central to many cultural and ceremonial practices. Their influence extends beyond cultural preservation, as they play crucial roles in community leadership, conflict resolution, and fostering social cohesion. The enduring relevance of traditional leaders in contemporary times reflects their ability to adapt and maintain their position as key figures within their communities, bridging the gap between historical customs and modern societal needs.

3.2.1 Weather

The climate in this region is characterized by two seasonal climate regimes: the wet and dry seasons. These climate regimes are dependent on two prevailing air masses blowing over Nigeria. The two air masses are the Tropical Maritime (Tm) and the Tropical Continental (Tc). The weather of the study area mimics that of Ogun state, as it experiences rainfall all year round. Although the rainfall pattern varies significantly from year to year, the wet season is overcast, the dry season is partly cloudy, and it is hot and oppressive year-round. The dry months are mostly dry (November to March). The onset of rains begins in April, while the retreat is usually around November.

3.2.2 Topography and Hydrogeology

The topography within 2 miles of Odeda contains only modest variations in elevation, with a maximum elevation change of 240 feet and an average elevation above sea level of 531 feet. Within 10 miles, there are only modest variations in elevation (607 feet). Within 50 miles, there are significant variations in elevation (1,440 feet) (Weather Spark n.d)

The Hydrogeology of Odeda, as described by Amori et al. (2013) is the Precambrian basement complex of igneous rock formation that is characterized by poor porosity. Over the years, there has been development of cracks and fissures in the formation, leading to percolation and infiltration of rainwater through the formation, thereby raising the water table and aquifer yield.

Most part of Odeda LGA falls within the Ogun Drainage Basin. The area is drained by several rivers and streams (Figure 1). These streams are used by the rural communities for the different domestic activities. Notable among these rivers are River Ogun, Opeki River and Ona all flowing south of the area.

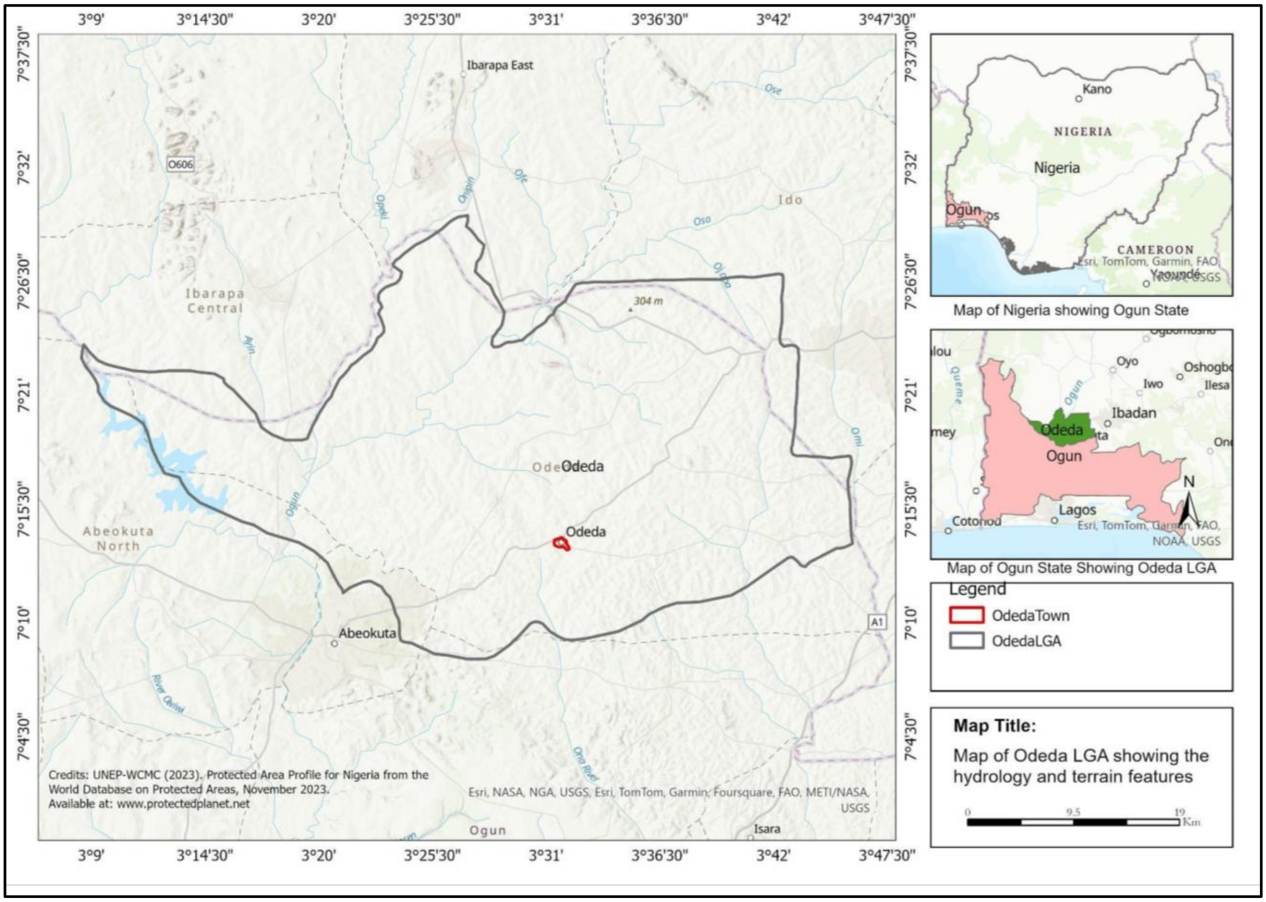

Figure 3. 1: Study area map

3.3 Sample and Sampling Procedures

3.3.1 Methods

The main study respondents in this thesis were rural dwellers within the Odeda community. The respondents were sampled using simple random, purpose-orientated and convenience sampling techniques to obtain effective data from the target population. Simple random sampling was effective in selecting rural households without any bias across Odeda community by ensuring that each household had an equal chance of representative. This helps in ensuring fairness and diversity in thoughts and perception. Purpose-Oriented sampling was implemented when engaging households with knowns or distinct experiences relating to their water source and quality (this was used to capture the depth and relevance of their understanding). In relation to access, time and source of water, Convenience sampling was used to get information about this from the respondents and also helps in bringing out households that can be reached in the community, with the fact that there is limited time, this was essential in creating a perfect target for the study. The study used a survey research method since it is based on households' survey as a unit of analysis. Therefore, a cross sectional survey research method was conducted to identify the household’s source of potable water, to assess factors affecting household perception of water quality.

3.4 Data Collection

3.4.1 Primary Data

Primary data collection is a widely utilized method in research, aimed at obtaining direct information from respondents. It can be achieved using different forms, one of which is a questionnaire. A questionnaire is a structured tool that includes a series of questions, which can be closed-ended or open-ended, designed to elicit specific data relevant to the research objectives. Closed-ended questions offer predefined answers, facilitating quantitative analysis, while open-ended questions provide qualitative insights by allowing respondents to express their thoughts in their own words. Ranganathan & Caduff (2023) mentioned the advantages of using questionnaires include cost-effectiveness, standardization of responses, opinions, attitudes, beliefs and the potential for anonymity, which can lead to more honest feedback.

3.4.2 Method of Data Collection

The study used a semi-structured questionnaire designed by gathering data from literature to obtain information from random rural dwellers within the community. The reliability of the instrument was tested with a pilot study with few of the rural dwellers to detect issues with clarity of questions, design flaws, or ambiguity. The feedback from the respondents and enumerators were used to adjust the variables within the instrument.

The data was collected in the month of October, 2025 which was during the raining season which influenced our accessibility and respondents’ participation son days. Total of 5 enumerators were engaged on the field and well briefed on the study objectives, good ethical considerations and also well informed on the tools that will be used for data collection. Prior to the main data collection process, pretest was actually conducted to be clear on the quality of the data instruments which was focused on evaluating grammatical correctness and also comprehension of the questions, which helps us to identify and review ambiguous questions in other to ensure the clarity and the understanding of the respondent.

The questionnaire (Appendix 1) was designed in a Word format and imputed into KoboCollect data collection app on mobile phones. Five (5) enumerators with the understanding of the indigenous language (Yoruba) were mobilized to the community to ensure the questions were well understood regardless of the level of farmer education and to ensure minimal time spent with each respondent.

In some situations, incentives were given to encourage participants. In total, 152 responses was received within the period of one (1) month.

The questionnaire guides were designed in a way that included close-ended questions to capture data on the socioeconomic data such as age, sex, size of household, marital status, education level, and income of the respondents. Variables such as sources of water, use of the water source, perception of the water quality from the source, challenges of water accessibility, perceived reasons for the challenges were also surveyed by the questionnaire. Each household surveyed were also asked for their water sources, and samples of the water were collected and analyzed on site. While the hydrocensus section of the questionnaire was used to record the in-situ data of surveyed households (where applicable). The data collection instrument was made up of three sections; A, B, and C. Section A contained questions about the socio-demographic profile of the respondents. Section B covers the identified water sources, uses, quantity and perceived quality while Section C focuses on the challenges in accessibility and the perceived reasons with solutions as perceived by the respondents.

Water samples were also collected from the different water sources identified within the study area, and in situ analysis including pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Oxidation and Reduction Potential (ORP), Salinity and Turbidity were carried out on the samples. The result of the analysis was then compared to the World Health organisation limit for domestic water use, and the samples were classified the water into good, fair or bad; where good means the result of the water sample analysis are all within the limits specified by the WHO in **Table 3,1**; Fair water means the samples exceed or were below the limit but with a margin not more than 25% of the limit. Samples that exceed the limit by more than 15% margin are classified as bad water sources. The location of the water sources is presented in **Figure 3.2.**

Table 3. 1: WHO 2024 physical water standard

S/N	Parameter	Unit	WHO limit	15% Margin
1	pH	-	6.5 to 9.2	6 and 9.5
2	Temperature	Celsius	28	32
3	TDS	mg/L	500	550
4	EC	mg/L	1000	1150
5	Turbidity	NTU	5	6.25
6	Salinity	mg/L	NA	NA
7	ORP	millivolts (mV	NA	NA

Source: WHO, 2024.

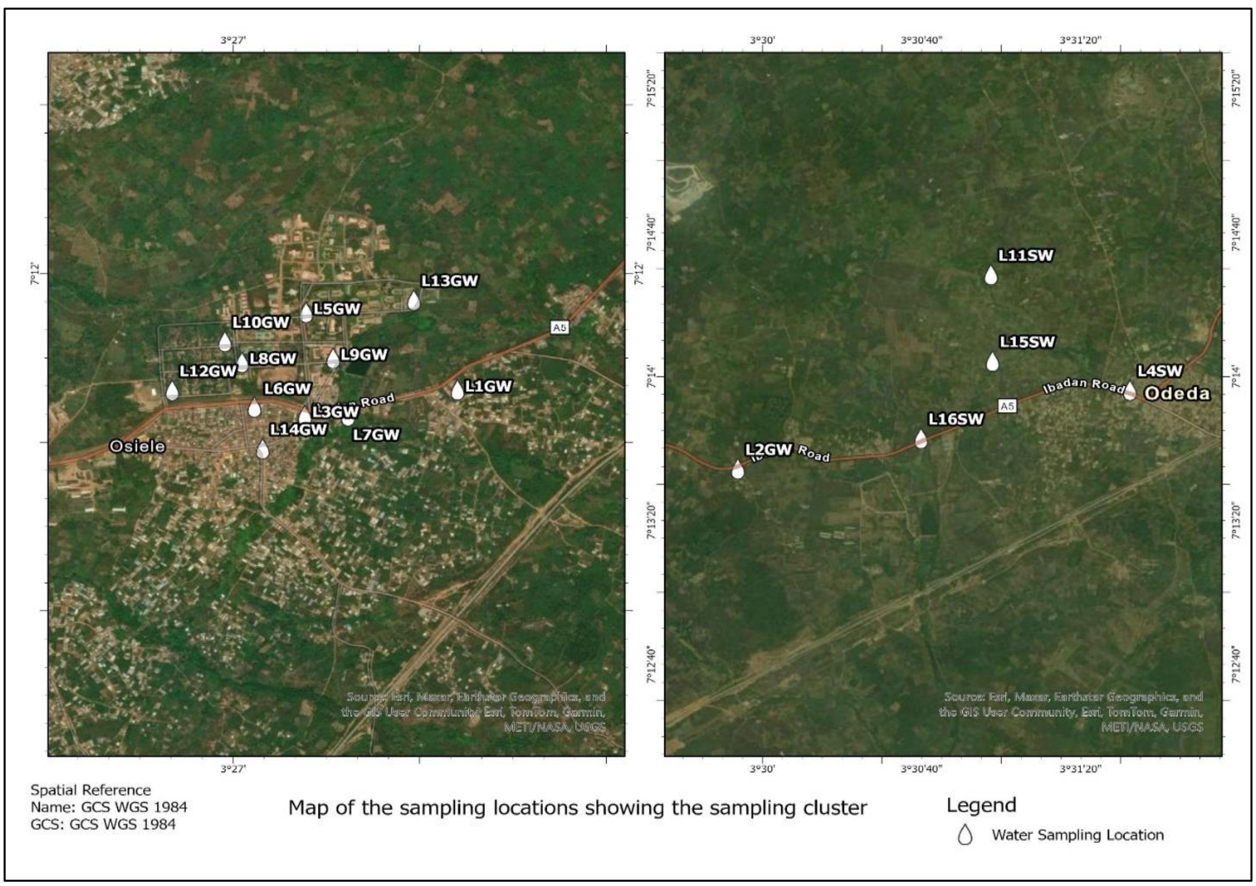

Figure 3. 2: Map of sampling locations

3.5 Data Analysis

The primary data that was collected from the selected respondents by the enumerators was cleaned up to remove errors and uncompleted sections. The responses that was retrieved from the tool were exported to Excel and further imported into SPSS (Statistical Package for Social Sciences) version 21. Each of the responses was assigned values (e.g., male = 1, female = 2, prefer not to say = 3) and analysed using a variety of approaches that include descriptive statistics, cross-tabulation, frequency and percentage tables, and inferential statistics, probit regression.

Research question one aims to explore the demographic characteristics of the respondents, utilizing questions that yield qualitative and nominal categorical data. These data types are assigned values that do not possess quantitative properties, rendering arithmetic operations like calculating the mean or standard deviation inappropriate (Jamieson 2004). Instead, descriptive statistics such as the mode, frequency, and percentage were employed to summarize the data effectively. Additionally, visual representations, including bar charts and pie charts, were used to present the data clearly and comprehensibly.

The third research question aims to establish the relationship between water accessibility, storage facilities, and perceived water quality. The perceived water quality is compared to the classified water quality using the WHO limit.

Research question four offers' answers to the challenges the rural dwellers face and their perceived solutions to the water challenges. Descriptive statistics were used to make sense of the responses provided by the respondents. The recording of quantitative data from key informant interviews was transcribed and analysed for keywords. The perceived challenges and suggested solutions are then presented.

3.5.1 Inferential Statistics

The third research question aims to explore the relationship between socioeconomic factors and water quality knowledge in the study area. In order to establish the associational effect of the socio-economic factors, such as gender, income, and education level, on the perceived quality knowledge by each of the sampled households.

The inferential statistical analysis conducted in the study utilized two probit regression models to examine the determinants of water quality perception among rural dwellers in Odeda Local Government Area, focusing on two binary outcomes: the belief that storage containers affect water quality and the perceived need for water treatment regardless of water clarity. The first probit model, assessing the impact of sociodemographic characteristics and sources of water information on storage perception, was statistically significant with a Pseudo R^2.

The model in its specific model is:

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_{11} X_{11} + \varepsilon \qquad \ldots \text{(Equ. 1)}$$

$$Y_2 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_{11} X_{11} + \varepsilon \qquad \ldots \text{(Equ. 2)}$$

Y_1 and Y_2 are the dependent (i. Effect of storage containers on water quality and ii. Need for water treatment) variable of the two probit models, both the variables are binary in nature, i.e if the household head is aware that water storage container affect the quality of the water denote 1, otherwise 0, same with the second dependent variable; if the household head aware that clear water need treatment denote 1, other 0.

β_0 = the regression constant

$\beta_1 - \beta_{11}$ = is the regression coefficients

$X_1 + X_{11}$ = is the independent variable/ predictors included in the model as shown in Table 3. 2 which remain the same in the two models

ε= is the regression residual

3.6 Effect of Sociodemographic Factor on Water Access and Water Quality Perception

3.6.1 Description of the model variables

The table presents the descriptive statistics of the dependent and independent variables used in the study, focusing on the effect of storage containers on water quality and the factors influencing household perceptions. The statistics description of the dependent variables has been discussed in the earlier sections of this chapter.

The dependent variable measures whether respondents believe that storage containers affect water quality, with a mean value of 0.283 and a standard deviation of 0.452, indicating that most respondents acknowledged the impact of storage conditions on water safety. The relatively low percentage of affirmative responses may indicate a lack of awareness about proper storage practices or limited access to improved storage options. This finding suggests the need for targeted education campaigns to improve household-level water management practices.

Table 3. 2: Description of the variable imported into the probit models

Variable	Description	Mean	Std. Dev.	Min	Max
Dependent Variable					
Effect of storage containers on water quality	Storage containers affect the quality of water: Yes = 1, No = 0	0.283	0.452	0	1
Need for water treatment	Clear water need treatment: Yes = 1, No = 0	0.296	0.458	0	1
Independent variables					
Household head characteristics					
Gender	Male=1, female=0	0.461	0.500	0	1
Age	In years	43.066	13.925	19	71
Education		0.079	0.271	0	1
Marital status	Married=1, single=0	0.697	0.461	0	1
Household size	Number of people in the house	1.830	0.770	1	4
Water Quality Information Source					
Radio	Yes=0, No=1	0.197	0.399	0	1
Internet (social media)	Yes=0, No=1	0.118	0.324	0	1
Family and friends	Yes=0, No=1	0.289	0.455	0	1
Health Clinic	Yes=0, No=1	0.211	0.409	0	1
Extension agents	Yes=0, No=1	0.118	0.324	0	1
NGOs	Yes=0, No=1	0.118	0.324	0	1

4. RESULTS AND DISCUSSION

4.1 Sociodemographic Characteristics of the Respondents

The sociodemographic characteristics (summarized in Tables 4.1 and 4.2) of the respondents highlight key factors that may influence their experiences and challenges with water accessibility and quality. A total of 152 respondents who were residents of the study at least in the last 6 months completed the questionnaire. The respondents consist of 83% female (n=83) and 72% male (n=72). As supported by the literature review (Buddhi & Akash 2021; Awoniyi & Obafemi, 2021), this gender distribution suggests that women may play a significant role in household water management and decision-making regarding water use. The age distribution of the respondents also shows an average age of 43 years, with a minimum age of 19 and a maximum age of 71 years, suggesting a youthful population within the study area.

Marital status is also an important demographic influencing household responsibilities, economic status, and decision-making regarding quantity and accessibility. Most of the respondents (69.7%) are married, while 19.1% are single. A smaller proportion of the participants are widowed (7.9%) or divorced (3.3%) **(Figure 4.1).** The predominance of married individuals provides insight into water use patterns, where water demand may be influenced by household size and composition. The average household size in the study area was also two (2), suggesting a dominance of married couples with no children. The minimum household size in the area is one (1), while the maximum household size is found to be four (4), which would account for married couples with children.

The literacy level in the study area was also assessed, as education level has been suggested to influence awareness of water quality and accessibility (Laura et al. 2019). The findings **(Figure 4.1)** reveal that most respondents (57.2%) have only attained a primary level of education, which is the basic level of education in the country, while 32.2% have completed secondary education. Only 7.9% of respondents have received tertiary education, and 2.6% have no formal education. This indicates that a large portion of the population may have limited formal education, which could impact their awareness of water-related health risks and best water purification and storage practices.

The considerable proportion of respondents (53.9%) are engaged in farming, self-employed individuals, including traders and small business owners, comprise 29.6% of the respondents. Artisans, such as craftsmen and skilled laborers, account for 12.5%, while civil/public servants and individuals in other unspecified occupations represent a minimal proportion (2.0% each).

With farming dominance, the income distribution among respondents shows that 36.8% earn below N30,000 per month, which is the country's minimum wage at the time of this study, while 46.1% earn between N31,000 and N60,000. A smaller percentage of respondents (14.5%) earn between N61,000 and N90,000, and only 2.6% earn above N91,000. These figures suggest that most of the respondents fall within low-income brackets, which could affect their ability to afford alternative water sources, water treatment methods, and improved sanitation facilities. Limited financial resources may also impact their ability to invest in water storage infrastructure or participate in community-led water projects.

Table 4. 1: Socioeconomic characteristics of the community (n=152)

Variable		**Frequency**	**Percentage (%)**
Gender	Female	83	54.2
	Male	72	45.8
Marital status	Single	29	19.1
	Married	106	69.7
	Divorced	5	3.3
	Widowed	12	7.9
Education	None	4	2.6
	Primary	87	57.2
	Secondary	49	32.2
	Tertiary	12	7.9
Monthly income	Below N30,000	56	36.8
	N31,000 – N60,000	70	46.1
	N61,000 – N90,000	22	14.5
	N91,000 – and above	4	2.6
Source of Livelihood	Farming	82	53.9
	Self-employed	45	29.6
	Artisan	19	12.5
	Civil/Public servant	3	2.0
	Others	3	2.0

Table 4. 2: Age and Household size of the Study area (n=152)

Variable	Minimum	Maximum	Mean	Std. Deviation
Age	19.00	71.00	43.06	13.92
Household size	1.00	4.00	1.83	0.77

4.2 Water Availability and Accessibility

4.2.1 Water Source in The Study Area

Figure 4.1 presents the distribution of water sources used by respondents in the study area. The most common source of water is the hand-dug wells, used by 66.0% of the population; streams and rivers are the second most utilized source, with 56.2% of respondents depending on them; rainfall harvesting is another identified water source, reported by 53.6% of respondents. 15.7% of the population relies on boreholes for daily water consumption, while the least common water source is water vendors, which supply only 3.9% of respondents.

The reliance on groundwater, which may vary in quality depending on depth, location, and maintenance, was also mentioned by Ufuogbune et al. (2010) and Olatunde et al. (2021), as 66% of the respondents use this water source to meet their daily water need. The use of streams and rivers by the respondents also indicates significant use of surface water, which could be vulnerable to contamination from agricultural runoff, human activities, and seasonal fluctuations. This reliance could also be linked to lack of other portable sources of water such as pipe borne and boreholes. Boreholes typically offer cleaner and more reliable water than surface sources, but the relatively low percentage suggests limited availability, possibly due to financial constraints or a lack of infrastructure, which was also the view of Ufuogbune et al. (2010)

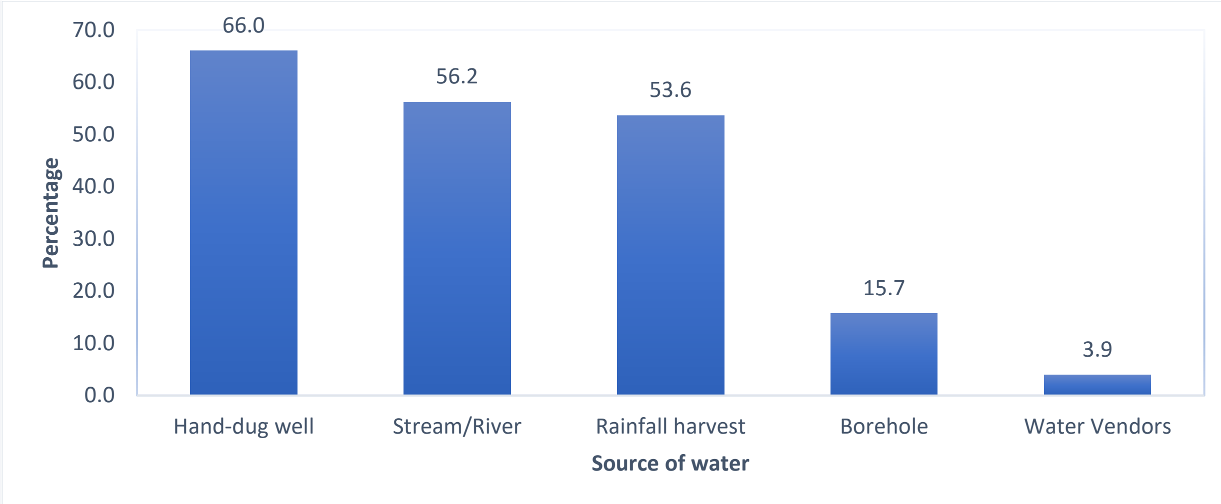

Figure 4. 1: Sources of domestic water of the sample

4.2.2 Location of Water Facility in the Study Area

Figure 4.2 shows the results of the location of water facilities used by the respondents. The result shows the distribution of the water sources used by the rural dwellers with the proximity to their households. Most (45.1%) of the respondents have their water source in their compound, which indicates the close proximity to water sources in their homes. This finding shows the reduced time and effort it takes to fetch water and reduces the burden of long-distance water collection. A slightly more than one-fourth (28.1%) of the respondents have their water source from the neighbourhood, indicating that they get their water from a few distances.

slightly more than one-third (24.8%) of the respondents identify as having water sources near their house; these people rely on the water from the hand-dug well from their friends and neighbours within walking distance away from their house. This shows that while some respondents do not have direct access to water in their compound, they can still fetch water close to their homes. A very small amount of the population has their water source from the community, which amounts to only 2.0% of the respondents.

Further analysis into water access among the respondents through distance to the water source and time taken to the water sources shows that the distance to water sources ranges from 10 meters to 300 meters, with an average distance of 80.82 meters (87.39 meters of standard deviation). These figures confirm the proximity to water sources provided in the paragraph above. The time required by the respondents to walk to the water source also varies between 1 and 25 minutes, with an average time of 6.52 minutes (6.66 minutes). This suggests that while some respondents have easy access, others may spend significant time fetching water, which can impact daily activities, particularly for women and children who are often responsible for water collection.

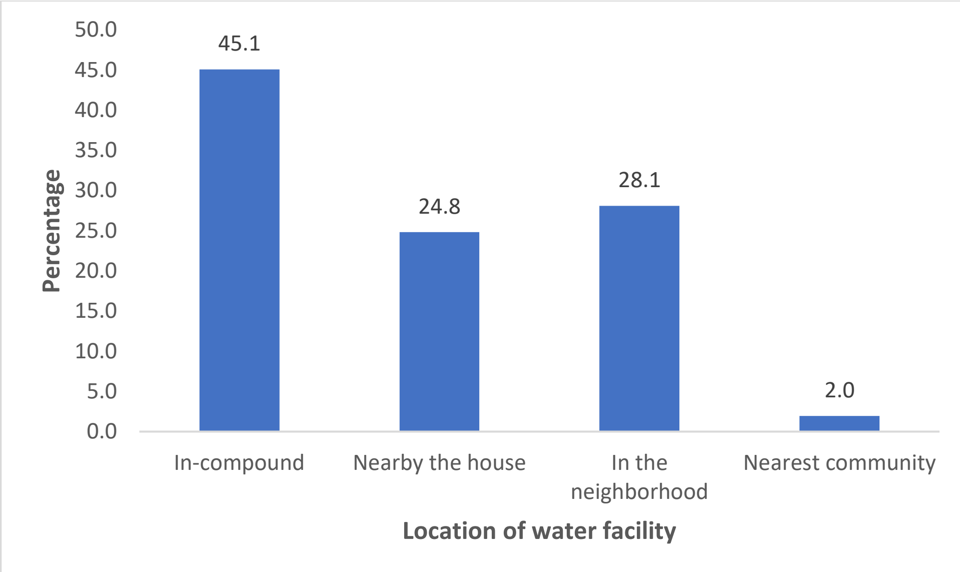

Figure 4. 2: Location of Water Facility in the Study Area

Table 4. 3: Estimated distance and time to water source along with daily water usage

Variable	N	Minimum	Maximum	Mean	Std. Deviation
What is the estimated distance to the water source (meters)?	152	10.00	300.00	80.8224	87.38937
How long does it take to walk to the water source (time in minutes)?	152	1.00	25.00	6.5197	6.66410
What is your estimated daily water demand/usage (liters)?	152	50.00	750.00	139.6382	103.13962

The estimated daily water demand per household ranges from 50 to 750 liters, with an average consumption of 139.64 liters with standard deviation of103.14 liters. The wide variation in water usage may be attributed to factors such as household size, access to alternative sources, storage capacity, and economic factors influencing water availability. With an average household size of two (2), **table 5.2** the per capita daily water usage in this region can be estimated range from 25 liters to 375 liters, having an average of 69.82 liters per person per day. According to the World Health Organization (WHO), the recommended daily water usage per person for basic health and hygiene ranges between 50–100 liters, while optimal access is 100–200 liters per person per day (WHO, 2003). This comparison suggests that while the average per capita water usage (69.82 liters) in this region meets the WHO's minimum standard, it falls short of the optimal threshold, which ensures greater comfort and improved hygiene.

4.2.3 Water Availability

The analysis of the frequency of water availability in the study area also revealed that a considerable majority of respondents (82%) receive daily water supply, indicating relative consistency in water access. The duration of availability among the respondents however varies; the majority of the respondents reported water availability lasting between 6-12 hours or even more than 12 hours from their water sources which could be hand-dug well or streams/rivers, suggesting that a considerable number enjoy relatively stable water access with the water being available during the days for most people. The limited hours of availability highlight potential issues related to water storage, rationing, and reliability, which could impact daily consumption patterns and overall water security in the region.

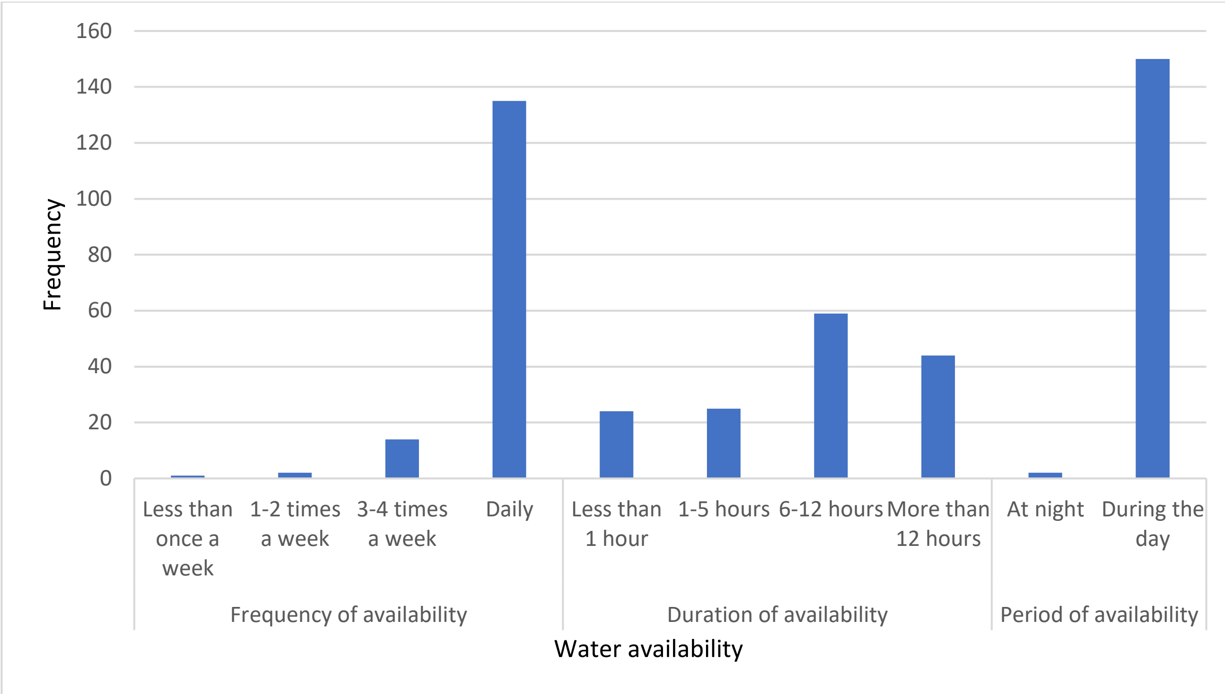

Figure 4. 3: Water availability for the respondents

4.2.4 Alternative Water Sources

The study was able to derive how the dwellers also get water when there are shortages. **Figure 4.4** shows the distribution of the alternative sources in the study area use when their primary source (hand-dug well, streams/rivers, rainfall harvesting, water vendors, and boreholes) of water is not available due to challenges that they might be facing during the water scarcity. From this study, the highest frequency of 81 respondents reported that they rely on nearby streams or rivers as an alternative water source during scarcity or shortages, which is considered unsafe for human consumption and usage as the water bodies are mostly exposed to contamination. This finding approves what Ishaku et al (2011) revealed that over 70% of rural households in Nigeria lack access to improved water supply, leading to reliance on unsafe sources. This finding shows that natural water bodies play a huge role in providing access to water when the community members cannot get water from their primary source. In this period of scarcity, the rural dwellers run to the stream to get water, and also, they are only able to get a small amount of water as a huge number of people depend on the water. Also, 34 respondents use water stored during this period of scarcity from any of their primary sources, which is only a temporary solution as stored water is limited and, if properly stored, can become contaminated with time. Some groups of respondents, amounting to

12.5% use the Well as an alternative water source, and in this case, the water level also drops if not properly maintained and monitored. A smaller proportion of the respondents, 10.5% reported buying water from the vendors as their alternative during the shortages, which mostly added huge financial stress to them financially, and 3 respondents had other means of water sources during the shortages.

A global prediction of areas of projected physical and economic water scarcity by 2025 was first produced by IWMI (2000). This study confirms that people in this community also experience water shortages, which mostly push them to use water that is not of good quality.

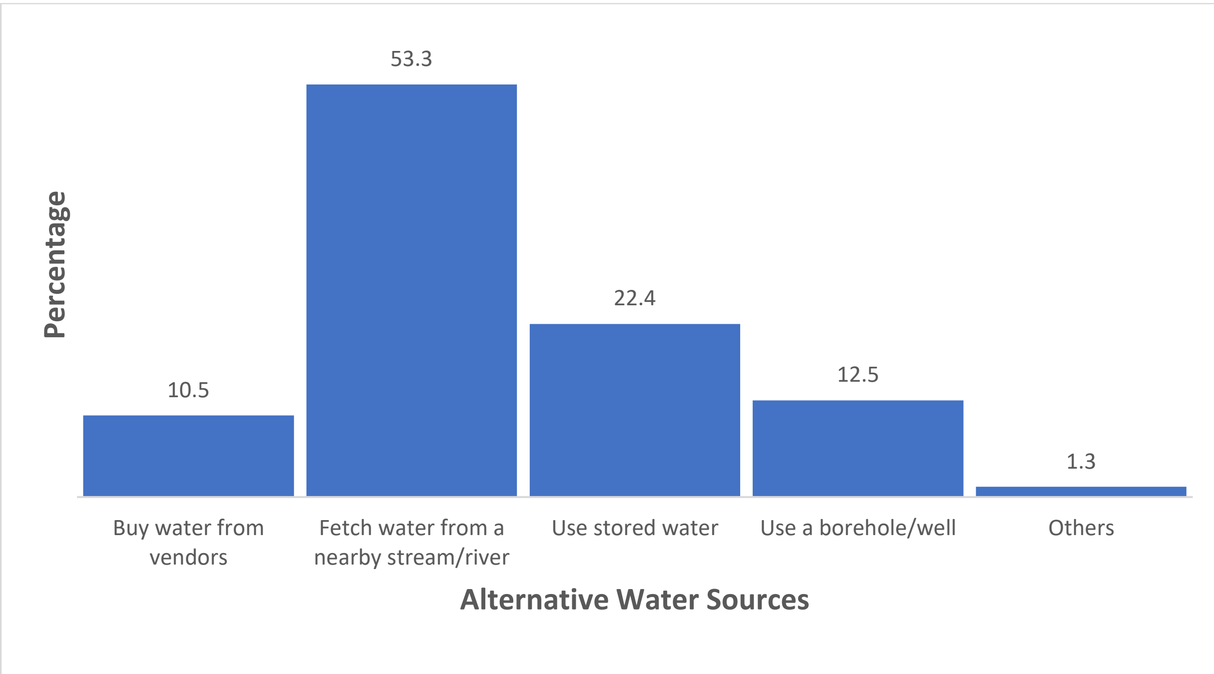

Figure 4. 4: Alternative water source during water scarcity and shortages

4.2.5 Distance of Alternative Water Source During Disruption

The analysis of the distance to alternative water sources, which includes buying water from vendors, streams/rivers, stored water, and hand-dug wells, indicates that most respondents have their backup water supply within 100 meters of their residence. This suggests that households within the study area can quickly access alternative sources without significant physical strain in cases of primary water shortages. However, some respondents rely on water sources 100 to 500 meters away, which may pose moderate challenges, especially for households without easy transportation. Fewer respondents access water from sources beyond 500 meters or more than 1 km, which could indicate either a lower dependency on distant sources or a limited availability of such alternatives. The proximity of alternative water sources is crucial for water security, as shorter distances reduce the burden of water collection, particularly in rural settings where water access may fluctuate due to seasonal changes or infrastructure limitations.

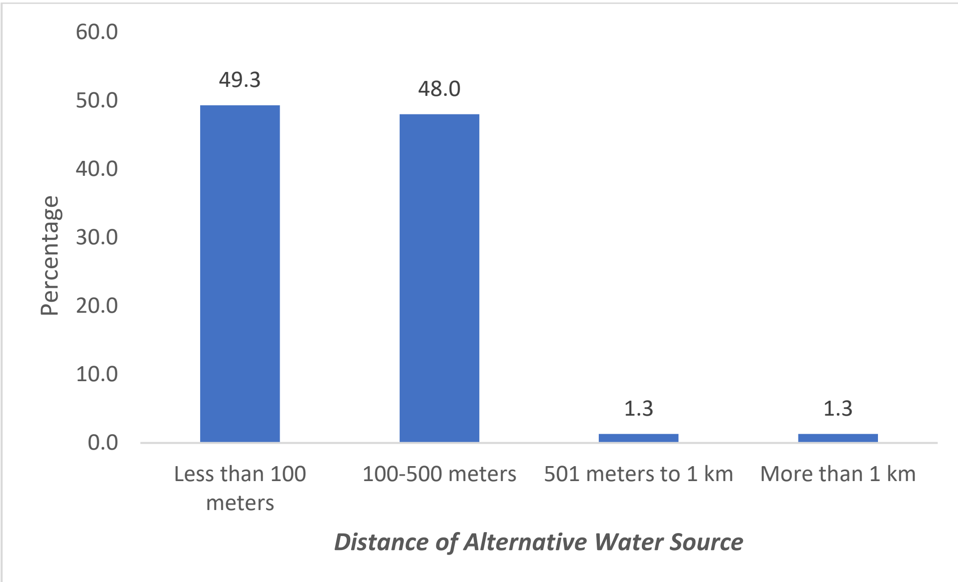

Figure 4. 5: Distance of Alternative Water Source during disruption

4.3 Water Quality

4.3.1 Knowledge of water quality

Water quality knowledge is very important for ensuring good health, most especially in rural areas where they are not taken into consideration. The results, which are presented in **Figure 4.6**, show the perception of the rural dwellers captured in the study. In this study, the majority of the respondents (88.2%) understand and agree that clean water should not have a taste, which aligns with the scientific studies that say that potable water should be tasteless. But 6.6% still believe that clean water should have a taste, and this shows a little gap in their understanding of what portable water is. The last set of people, which amounts to 5.3%, says that portable water should sometimes have a taste, which shows that they are still confused about their acceptance of water quality. However, with 11.9% of the population lacking behind in their knowledge, it shows that there is a need for further education to address their misconception, as Hu (2011) mentioned that Education is significantly and positively related to better surface water quality perception.

In terms of color, almost all the respondents, amounting to 98.7%, agreed that portable water (drinking water) should be clear and colorless, which perfectly aligns with the WHO standard water quality indicators. A very minimal number, amounting to 1.4%, demonstrates a lack of awareness of what the color of portable water should be. Cloudy water could indicate contamination, pollution, the presence of sediments, or microbial growth in the water. So, continuous awareness and education should be incorporated to support the knowledge of the rural dwellers so they can understand which water is safe or not. Laura et al. (2019) assessed the public awareness of water usage and water quality, finding significant differences in water quality perception observed across education levels, with more educated individuals showing increased awareness of both water usage and potential water quality threats. This finding suggests that higher education may contribute to a more nuanced understanding of complex water-related issues.

From the study, a huge population shows incorrect knowledge about how storage containers and handling can directly and indirectly influence the quality of the water. This study finds out that 60.5% of the respondents believe that the storage containers and handling process do not affect the quality of water, which is against the scientific evidence. 28.3% of the respondents agree that the storage can affect the quality of the water, while 11.2% remain unsure. This shows that there is a huge gap in their knowledge regarding storage hygiene, so there needs to be an educational campaign to further help them understand that storage can affect the quality of the water, as this gap poses a huge risk to their health.

Almost half of the community respondents 49.3% have a believe that clear water from their water sources does not require any further treatment again before drinking. But the fact that the water is clear does not indicate its quality, which is not known to them. 29.6% correctly agree that further treatment is needed, and 21.1% believe that the treatment is only sometimes needed. This level of gap in knowledge poses a serious health risk and concerns as many harmful pathogens, which includes bacteria and viruses cannot be seen with naked eyes, also as water percolates and infiltrates into the aquifers, some of them are contaminated and also intrusion occurs from contaminated or polluted dump sites and as well infringe with the water quality. Efforts need to be made to increase the awareness about waterborne diseases and the importance of water treatment.

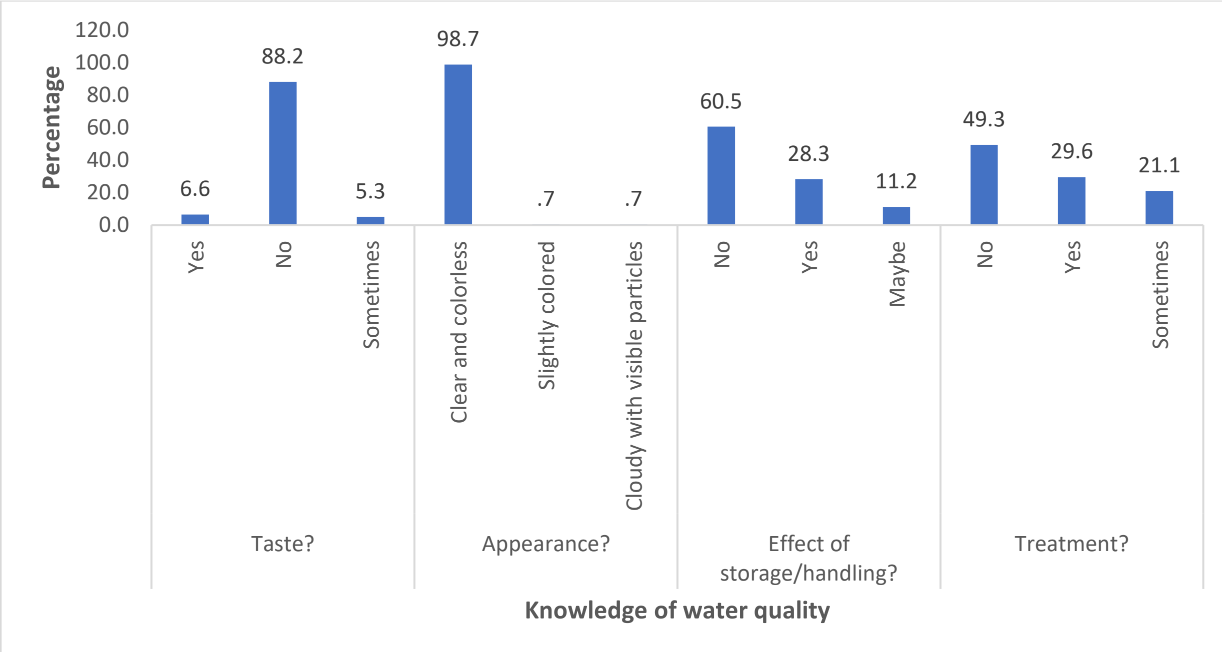

Figure 4. 6: Shows the Water quality Knowledge of the respondents (in percentage)

4.3.2 Treatment Method

The results from the data show that 41.4% of respondents are not practicing any form of water treatment, which means that a huge portion of these rural dwellers are at risk of consuming untreated and also potentially contaminated water. This is a major public health concern that should be taken into consideration, as untreated water can contain bacteria, viruses, and other harmful contaminants that cause diseases such as cholera, typhoid, and diarrhoea. Most practice treatment is boiling (53.3%), which is only an effective way to kill pathogens in the water and not probably the E. coli. However, boiling does not remove chemical contaminants such as heavy metals, pesticides, or nitrates, which may still have huge health risks.

A very small percentage of the respondents use chlorination (2.0%) as their form of treatment, and the remaining proportion uses filtration (3.3%), which suggests that modern water treatment practices are not adopted by the respondents in rural communities. Considering that 41.4% of the population does not practice any water treatment is alarming, and this calls for the urgent need for awareness and rural development programs.

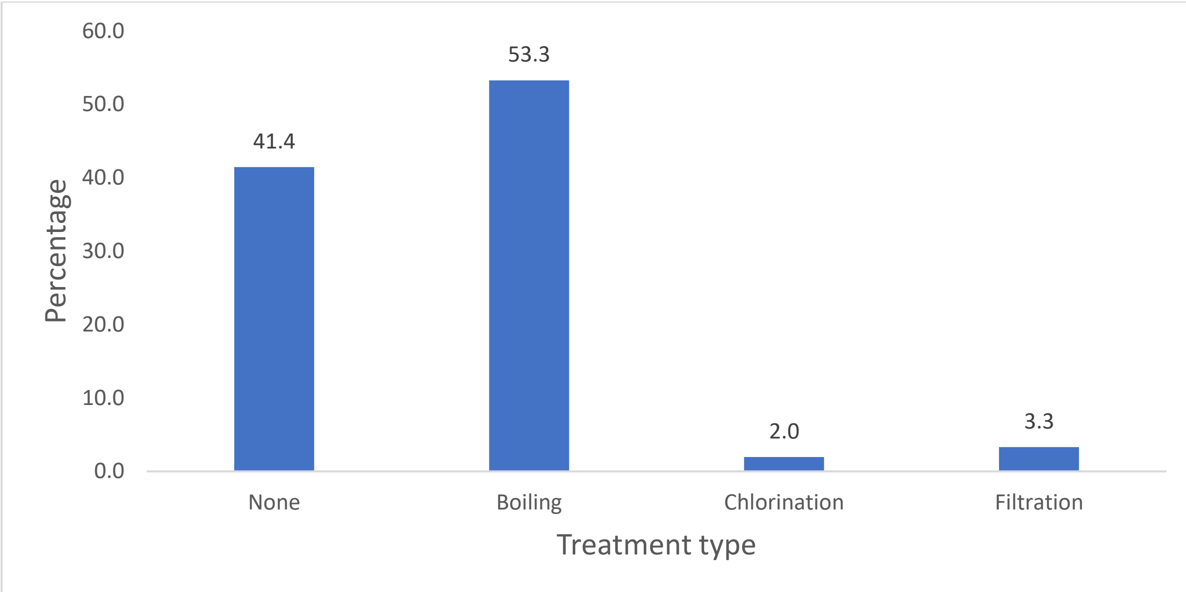

Figure 4. 7: Shows the water treatment practiced by the respondents

4.3.3 Water Quality Use

Figure 4.8 shows the distribution of responses from rural community members of Odeda Local Government presenting their perception on the quality of water they use in their household. In this study, the responses were categorized into four major levels: (a) Excellent (b) Good (c) Fair, and (d) Very Bad. A considerable portion of respondents (42.1%) rated the quality of the water they used to be Excellent. The majority of respondents (49.3%) responded that their water is Good. This response correlates with the findings of Bain et al. (2014), which reveals that rural communities mostly rely on groundwater or surface water, and their perceptions of water quality mostly does not align with actual contamination levels. Some respondents will absolutely rate their water as Good or Excellent despite the presence of potential microbial risks in their water or water sources. From the response received, small number of respondents 12 (7.9%) considered the quality of their water to be Fair, implying the presence of some notable quality concerns, such as taste issues, sensory issues, discoloration, or possible microbial content. From the study, very few (0.7%) respondents rated their water to be Very Bad, which poses a severe water quality concern to them. This aligns with Bain et al. (2014) in their study reveals that rural communities mostly rely on groundwater or surface water, and their perceptions of water quality mostly do not align with actual contamination levels. Some respondents will absolutely rate their water as Good or Excellent despite the presence of potential microbial risks in their water or water sources.

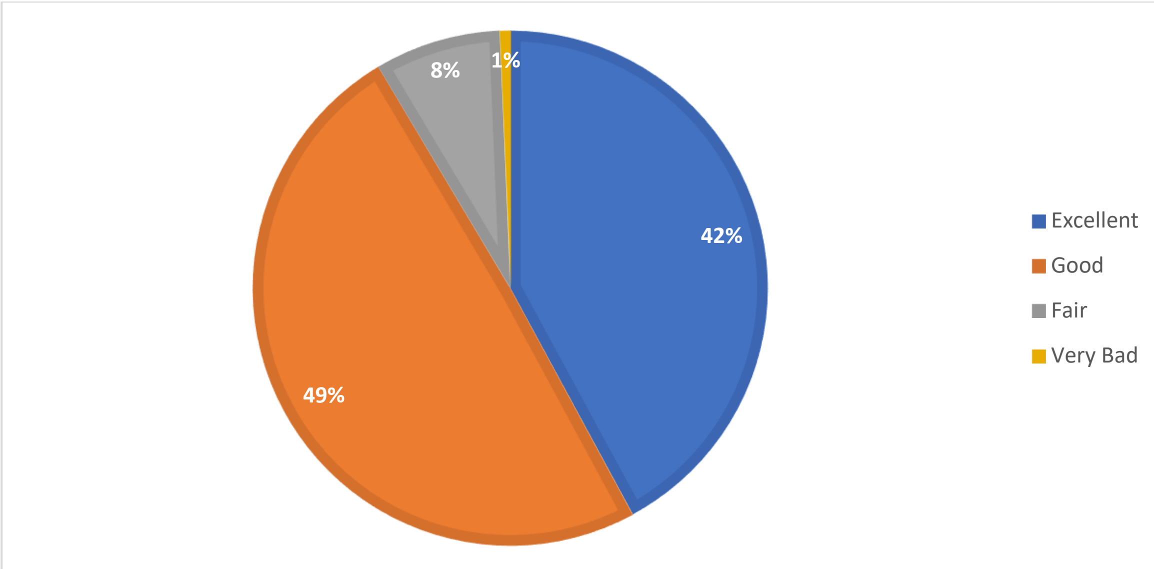

Figure 4. 8: Perception of the respondents on the quality of the water used

4.3.4 Water Quality Problem

The data presented in **Figure 5.9** shows insights into the frequency of water quality issues in terms of coloration, odour, and taste. From this study, 80.9% respondents reveal that they rarely experience coloration in their water. A very small proportion of 5.3% respondents encountered the issue once every two to three months, while 3.3% respondents experienced this problem twice a month. 4.6% of the population experience the coloration once every month. A proportion of 5.9% respondents reported that they experience water coloration issues very often. This finding presents that while water discoloration is not a regular challenge for most households, a very small fraction of the respondents does experience periodic contamination from the water, which could be due to sedimentation, seasonal runoff, storage, handling or aging infrastructure.

Further digging was done to understand what they perceive about the odour of their water in this study, and it found that 90.8% respondents rarely experience water odour problems, while 3.9% of the respondents said that they experience odour problems once every two to three months, while only 1.3% are faced with this problem twice a month. 2.6% of the respondents responded that they do experience an odour in their water once a month. The lowest frequency category, "very often," was reported by two. This finding shows that water odour is not a considerable issue in the community. However, occasional cases might be linked to situations (causes) like microbial contamination or organic matter decay, especially in hand-dug wells and streams.

The study also asked the respondents about taste-related problems in the water they use, and this study found that 135 respondents rarely experience taste-related problems. A relatively low amount 3.9% noticed unusual taste once every two to three months, while 1.3% encountered it twice a month, and 3.3% of the respondents faced this problem once a month. Only 2.6% reported taste problems occur very often.

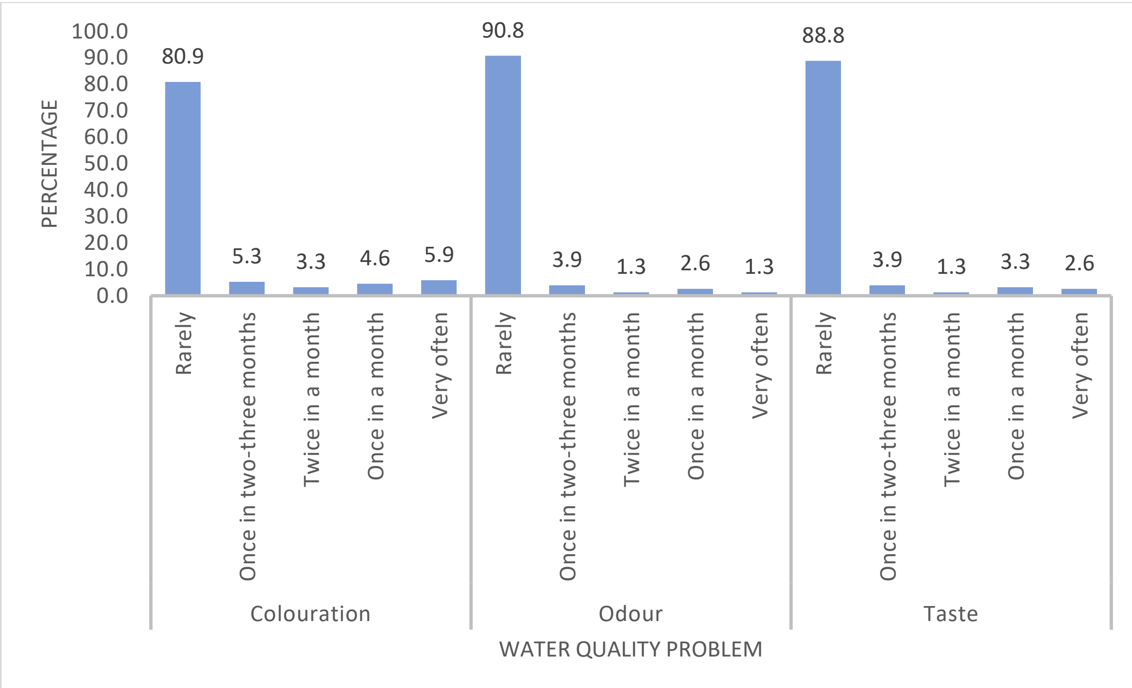

Figure 4. 9: Water quality problems experienced (in percentage)

4.3.5 Health Risk

The majority of the respondents mentioned not having any health risk related to water in the last six month. Listing out some common health risks associated with water, the analysis further revealed that most respondents had not experienced waterborne illnesses such as diarrhoea, dysentery, typhoid fever, or E. coli infections. The presence of few cases of these diseases among the respondents suggests that some of the households may be exposed to contaminated water sources, inadequate hygiene practices, or seasonal variations in water quality.

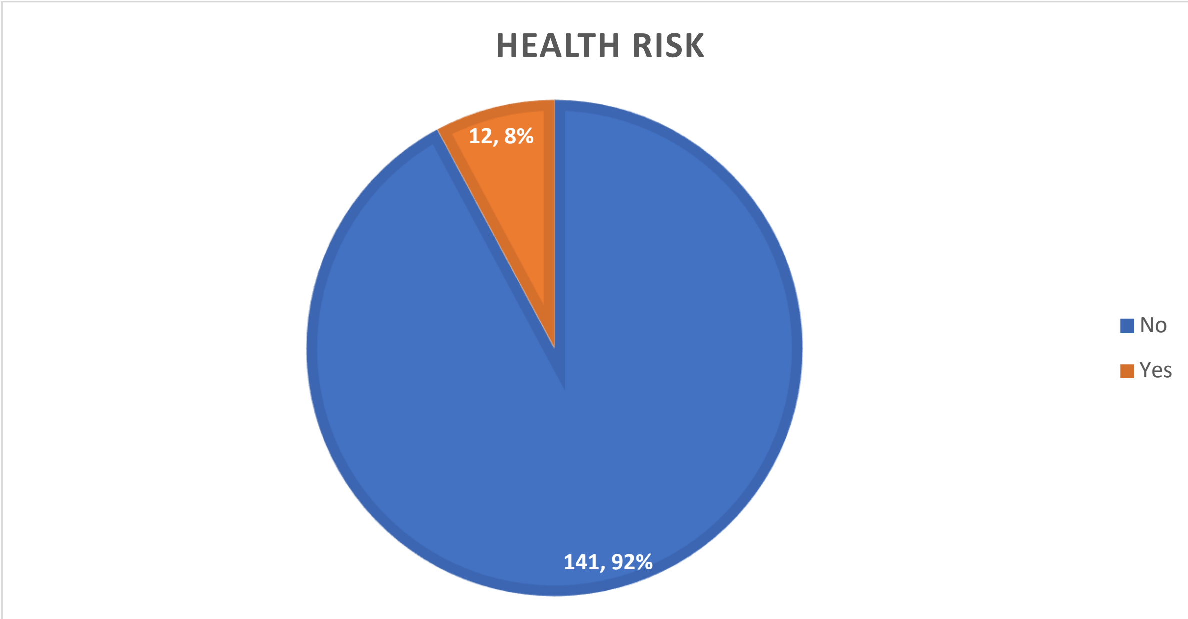

Figure 4. 10: Health risk experience

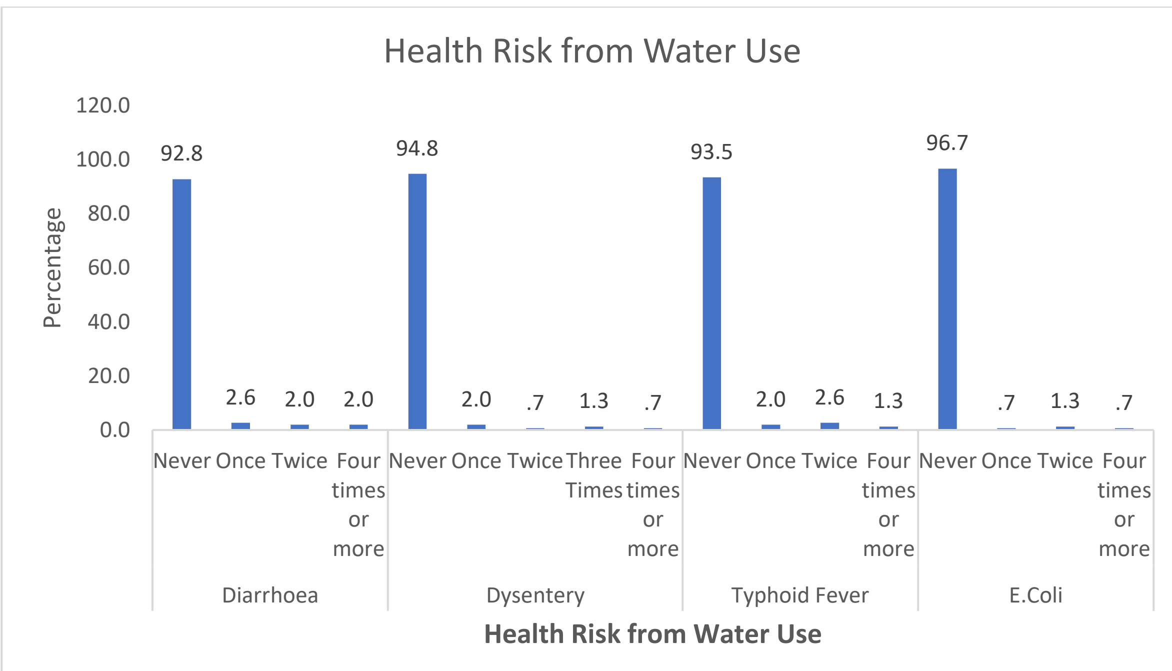

Figure 4. 11: Type of Health risk experienced

4.4 Water Quality Assessment

The samples collected from the study area was tested with **Hanna pocket multipurpose meter** to check for certain physical water parameters which includes measurements of pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), turbidity, salinity, oxidation-reduction potential (ORP), and total hardness (TH). Below is an analysis of the key parameters and findings:

The result in **Table 4.4** shows that the pH values for GW range from 7.0 to 7.77, while SW ranges from 7.39 to 7.84. All the values from the 16 water samples collected from different source fall within the WHO standard range of (6.5–9.2), indicating that their water sources are neither falling under highly acidic or highly alkaline but that does not certify the quality of the water.

Temperature: According to the in-situ analysis done to check the water quality from different sources, the Groundwater temperatures range between 27.2°C to 28.9°C, while surface water temperatures are slightly higher with a temperature of 28.8°C to 29.9°C. Though all values are below the WHO maximum limit of 32°C, but it is considered that higher temperatures in surface water may contribute to microbial growth in the water body. The result from the Groundwater samples shows that the EC values range from 134 to 872 mg/L, and surface water source shows a very high Electric conductivity value (1109 to 2781 mg/L) which is higher than the WHO standard. TDS levels in surface water also shows to be very high (546 to 1394 mg/L) compared to groundwater values of (57 to 433 mg/L). According to (WHO 2024) the limit for TDS (Total dissolved Solid) is 500 mg/L, this explains that surface water exceeds the limit, making it unsuitable for direct consumption as it is a possible indicator of some wastewater, organic waste, farmland waste.

The turbidity result brings in a huge and alarming concern as it really exceeds the WHO water quality standard which is 5 NTU, but groundwater results from the water samples collected from the study area have their turbidity ranging from 8 to 319 NTU which super exceeds the limit and also stands against the response gotten from the respondents regarding their water sources, and surface water is significantly higher at 413 to 1120 NTU, showing that the water is nowhere fit for consumption (WHO 2024). High turbidity rate in both water source suggests the contamination from runoff sediments, organic matter, and possibly microorganisms present in the water. Turbidity which is the measure of water clarity, influenced by suspended particles like silt, clay, organic matter, and microorganisms. It can also be considered that surface runoff carrying soil and organic matter, algal growth in stagnant surface water bodies, unprotected hand-dug wells from contamination from nearby waste or sewage, rainfall infiltration, can lead to high level of turbidity. Also, erosion and agricultural activities leads to the increase of sediment load (Chang 2007). Turbidity increases microbial contamination risks, leading to waterborne diseases like diarrhea, cholera, and typhoid (Hunter 2003; WHO 2013). Waterborne diseases have been attributed to several deaths annually and majorly among children under the age 5 (Vitousek et al. 2008). This clearly goes against the fact that the respondents are not well aware about the fact that the water they are using have been making them sick rather, they presumed that the sickness is due to other reasons.

The collected water samples from the surface water bodies have extremely high salinity which ranges between (273 to 697 mg/L) and this suggests the presence of significant mineral contamination which could possibly be from agricultural runoff or wastewater discharge from any source. Also, as considered in a study by (Ren et al. 2018) it is also considered that elevated TDS and EC presents high presence of dissolved solids, which in turn makes the water taste salty or metallic which has the potential causing long-term health effects from the water.

Table 4. 4: Water quality parameters from the water samples collected

S/N	Long. (N)	Lat. (E)	Ph	Temp oc	EC	TDS (ppm)	Turbidity (NTU)	Salinity(mg /l)	OR P	TH (Mg/L)
L1GW	7.19426	3.46003	7	28.4	134	66	13	33	288	200
L2GW	7.22622	3.49828	7.12	27.4	166	57	8	28.5	264	100
L3GW	7.19299	3.4532	7.09	27.2	140	69	16	34.5	281	50
L4SW	7.23228	3.52566	7.49	27.2	1109	546	413	273	197	156
L5GW	7.19252	3.45351	7.67	28	719	357	256	178.5	207	288
L6GW	7.19341	3.45095	7.39	28.3	681	337	239	168.5	201	94
L7GW	7.19193	3.45322	7.35	28.3	729	361	259	180.5	225	130
L8GW	7.19354	3.45091	7.63	28.7	627	311	218	155.5	193	134
L9GW	7.19332	3.45207	7.7	28.4	820	406	297	203	242	242
L10GW	7.19225	3.45342	7.77	28.6	540	262	177	131	244	132
L11SW	7.22989	3.50991	7.84	29.9	1927	965	763	482.5	182	278
L12GW	7.19217	3.45307	7.23	28.9	675	339	241	169.5	261	134
L13GW	7.19196	3.45324	7.59	28.6	872	433	319	216.5	183	408
L14GW	7.19135	3.45132	7.72	27.4	663	330	233	165	198	196
L15SW	7.22984	3.50988	7.39	28.8	2781	1394	1120	697	147	580
L16SW	7.22857	3.51107	7.72	28.4	1472	1032	823	516	162	538

4.5 Challenges With Water Usage and Access

4.5.1 Disruption in the Water Source Supply

Figure 4.12 presents the results from the study, which finds water disruption experienced by rural dwellers in Odeda Local Government over the month when this study was done. Most respondents (72.4%) reported that they had never experienced any form of water disruption in the last months from their primary water sources as discussed above. This shows that a large portion of the respondents have had a stable water supply in the last months. However, 16.4%respondents reported that they do experience water disruption once a month, while a proportion of 5.9% experienced disruptions in water supply several times a month from their water source. A very small portion of respondents 0.7% expressed the concern that they face disruptions several times a week. This study also shows that 4.6% respondents experiences water disruptions every day, which suggests that a few of the population are faced with severe water access issues.

These findings from this study show disparities in water accessibility among rural dwellers in Odeda Local Government. Meanwhile majority of the population really have a stable water supply. A segment of the population still faces challenges with frequent disruptions. There is a need for further research to be done to determine the underlying causes, which could be due to infrastructure problems, seasonal changes, or socio-economic factors.

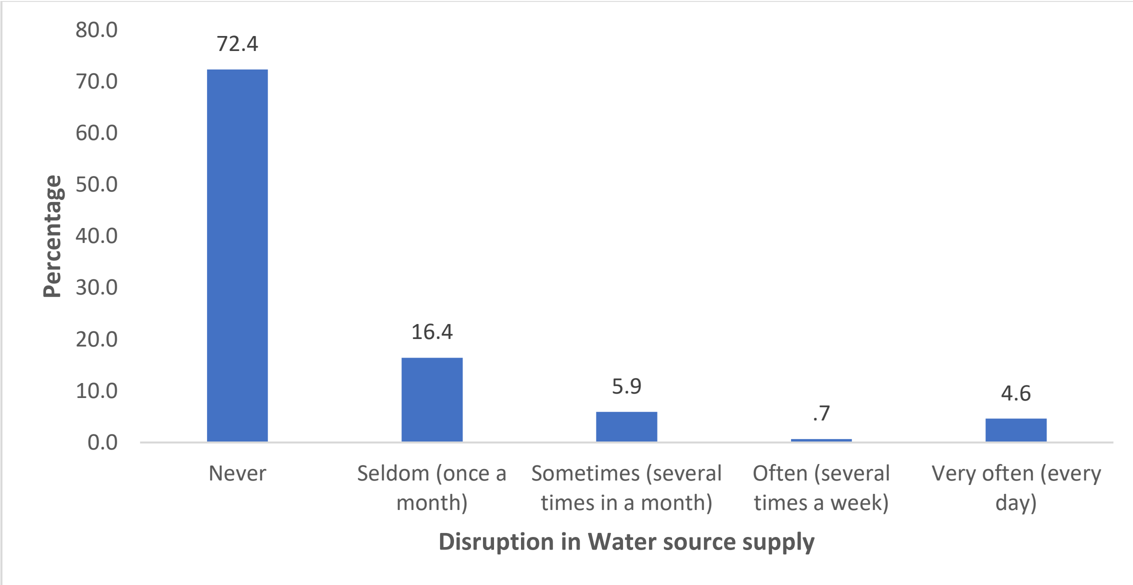

Figure 4. 12: Disruption in Water source supply

4.5.2 Contamination Challenges and Shortages

Figure 4.13 shows the result of the in-water shortages and contamination which is experienced by rural dwellers in Odeda Local Government across wet and dry seasons. A very large population of respondents 86.8% claimed that there were no water shortages during the wet season, with only 13.2% experiencing shortages during the wet season. This result suggests that rainfall provides sufficient water sources to either ass to the surface water availability or replenishes the aquifer to discharge water into their water sources and hereby reducing the risk of shortages. During the dry season, the respondents claimed to experience a drastic increase in shortages of their water sources, with 77.6% respondents reporting shortages compared to 22.4% who did not. This study shows that there is a heavy dependence on seasonal water, inadequate water storage and conservation practices in the households.

The study shows that there is a high contamination rate, with 53.3% respondents from the study claiming water contamination occurs during the wet season compared to 46.7% who did not experience the contamination. This can increase surface runoff, infiltration and percolation during rainfall, which carries pollutants into any water bodies, causing any form of microbial and chemical contamination. In this study, it was discovered that during the dry season the contamination levels dropped significantly, with just 15.1% respondents approving of the issue of contamination, while

84.9% did not experience contamination. This suggests that in the dry season, people may rely more on stored or groundwater sources, which are less prone to contamination during the dry season

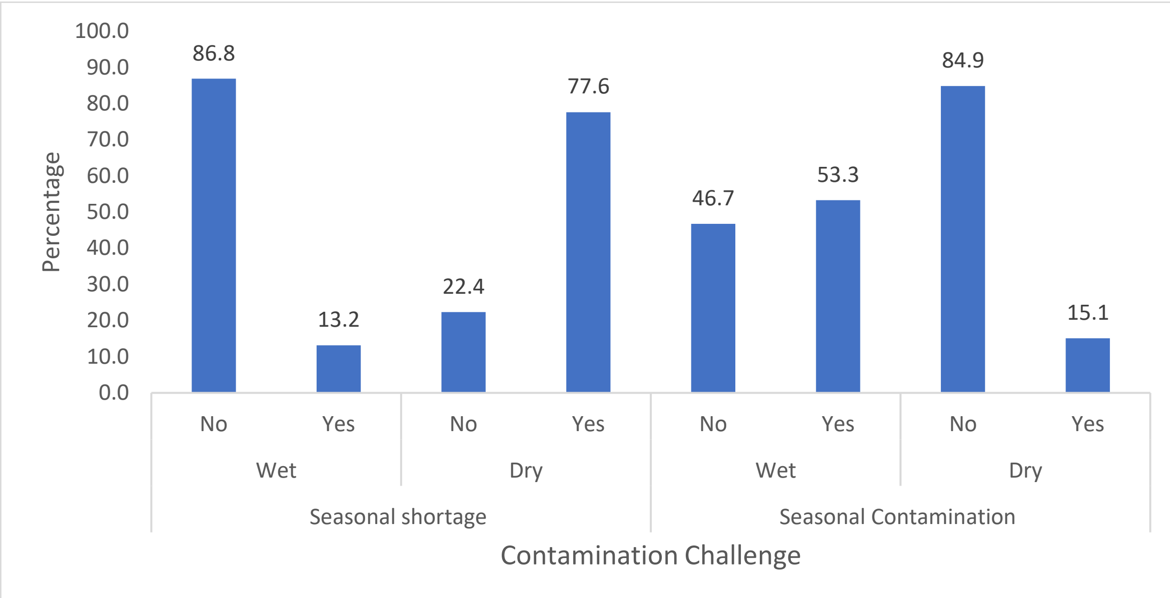

Figure 4. 13: Water Contamination Challenges and Shortages

4.5.3 Primary Sources of Water Information

The primary sources of water information within the study area are provided in **Figure 5.15.** Family and friends are the most influential sources of water information, suggesting that interpersonal networks play a role in disseminating water knowledge. Radio also emerged as a significant source, with a notable number of individuals indicating it as their primary information provider. Despite its prevalence in modern communication, social media shows a stark contrast, with far fewer relying on it for water-related information. The limited reliance on social media for water-related information aligns with the rural setting, where internet access and digital literacy may be lower. Health clinics and extension agents, presumably authoritative sources, are utilized by a smaller population. The relatively smaller role indicates potential gaps in structured public health communication regarding water safety. NGOs (Non-Governmental Organizations) appear to be a primary source for a substantial number of respondents, suggesting that external interventions play a crucial role in water education.

These findings suggest the need for a multi-channel approach to water information dissemination, integrating traditional and modern communication methods to ensure broader community engagement.

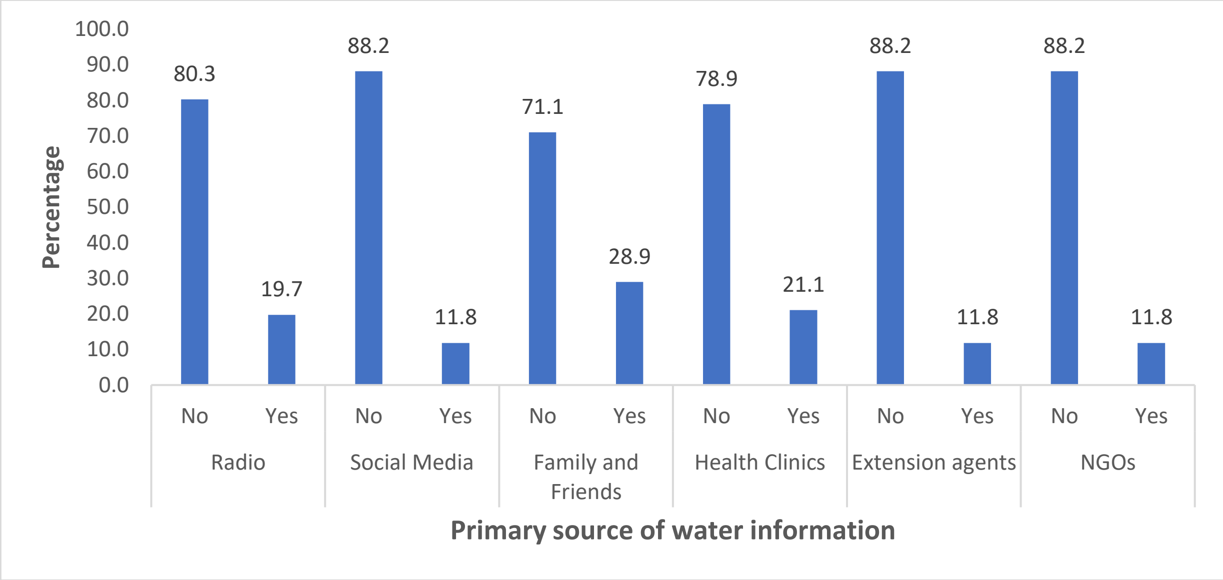

Figure 4. 14: Primary Sources of Water Information

4.6 Effect of Sociodemographic Factor on Water Access and Water Quality Perception

4.6.1 Probit result of the effect of sociodemographic and source of water information on water quality (storage)

Table 4.5 presents the probit regression results examining the effect of sociodemographic characteristics and sources of water information on water quality perception in relation to storage practices. The findings indicate that the model shows statistical significance at $P<0.01$, which means that the independent variable imported into the model are good enough to predict the water quality perception of the respondents. The model has Pseudo R^2 of 0.2912 which implies that the variable imported into the model explained 29% of the water quality perception of the respondents. The finding further shows that marital status is significant at the 10% level ($p = 0.096$), suggesting that married individuals are more likely to be aware that storage containers as influencing water quality compared to their single counterparts. However, other sociodemographic variables, such as gender, age, and household size, do not show statistically significant effects, indicating that these factors may not strongly determine perceptions of water storage's impact on water quality.

Among the sociodemographic characteristics tested, education emerges as a key driver, with a coefficient of 1.650 and a p-value of 0.012, indicating that higher education levels significantly increase the likelihood of recognizing the need for water treatment. This finding supports the finding of Adams et al. (2016), that found education level is a significant predictor of improved water quality access. This suggests that awareness and understanding, often enhanced by education, play a critical role in shaping attitudes toward water safety.

Table 4. 5. Probit result awareness of storage containers effect on water quality

Variable	Coefficient	Std. Err.	z	p-value
Sociodemographic characteristics				
Gender	0.407	0.281	1.45	0.148
Age	0.017	0.011	1.55	0.121
Education	1.650	0.959	2.51	**0.012****
Marital status	0.867	0,383	2.26	***0.024*****
Household size	-0.208	0.186	-1.12	0.263
Source of water information				
Radio	0.517	0.479	1.08	0.279
Internet (social media)	0.888	0.474	1.87	**0.061****
Family and friends	0.311	0.359	0.87	0.386
Health Clinic	-0.526	0.523	-1.01	0.314
Extension agents	1.037	0.423	2.45	**0.014*****
NGOs	0.385	0.452	0.85	0.394
Constant	-2.388	0.610	-3.91	0.000
Prob > chi^2	0.000			
Pseudo R^2	0.2912			

****significant at 0.01 **significant at 0.05 *significant at 0.1*

Marital status also shows a significant positive effect (coefficient: 0.867, p-value: 0.024), implying that married individuals may prioritize water treatment, perhaps due to family responsibilities this finding agrees with Zoungrana (2021), that found family composition also determine the choice of water sources. In contrast, variables like gender (p-value: 0.148), age (p-value: 0.121), and household size (p-value: 0.263) showed no statistically significant impact, though their coefficients hint at directional trends—positive for gender and age, negative for household size.

Information provided by the mass media and interpersonal sources influence on perceptions of quality (Miguel 2010), hence, sources of water information was also tested against the dependent variables. Information from extension agents stand out with a strong, significant effect (coefficient: 1.037, p-value: 0.014), underscoring their effectiveness in raising awareness, likely due to their direct engagement with communities. The internet, particularly social media, shows a marginally significant positive effect (coefficient: 0.888, p-value: 0.061), suggesting that digital platforms are increasingly influential, though not as definitively as extension agents.

Other information sources like radio, family and friends, health clinics, and NGOs yield non-significant results, with p-values well above 0.05, though the negative coefficient for health clinics (-0.526) raises questions about the messaging or context of their information.

4.6.2 Probit result of the effect of sociodemographic and water information sources on need for water treatment

Table 4.6 depict the influence of sociodemographic characteristics and how source of water information influence the need for water treatment. There is a strong positive effect (coefficient: 1.016) at p-value: (0.087), between education and need for water treatment. This indicate that the higher the level of education attained by the respondent the better their understanding of the need for water to be treated irrespective of water clarity. Educated people are more likely to realize that dangerous bacteria, viruses, and parasites that are invisible to the human sight can still be present in clear water (Bidaisee & Khalifa 2018). Since environmental education are integrated into school curricula at higher levels of education, this can significantly enhance students understanding of water quality management and help prepare student to engage with the issues effectively (Mostacedo-Marasovic et al. 2022). This corroborates the findings of Arif & Bashir (2024), which shows that critical thinking abilities are fostered by higher education, allowing people to challenge and evaluate information. This ability is essential to realizing that water is not always safe to drink, even if it appears clean. All things considered, education is a potent instrument for influencing public perceptions and actions regarding water treatment (Arif & Bashir 2024). This underscores the need for targeted water quality campaign among people with low level of education.

Table 4. 6: Probit result on need for water treatment

Variable	Coefficient	Std. Err.	z	p-value
Sociodemographic characteristics				
Gender	-0.157	0.251	-0.63	0.532
Age	-0.036	0.011	-3.38	**0.001*** **
Education	1.016	0.593	1.71	**0.087** **
Marital status	0.441	0.294	1.50	0.134
Household size	-0.034	0.177	-0.19	0.848
Source of water information				
Radio	0.167	0.404	0.41	0.680
Internet (social media)	-0.135	0.488	-0.28	0.781
Family and friends	0.047	0.342	0.14	0.892
Health Clinic	-0.232	0.428	-0.54	0.587
Extension agents	0.726	0.437	1.66	**0.097** **
NGOs	0.148	0.456	0.33	0.745
Constant	0.568	0.453	1.25	0.210
Prob > chi^2	0.0003			
Pseudo R^2	0.1852			

****significant at 0.01 **significant at 0.05 *significant at 0.1*

Information sources have an impact on how water treatment methods are viewed, accepted, and used. When advocating for the necessity of water treatment, credible and trustworthy sources are crucial (De França Doria 2009). Information from extension agents was significant with a p-value of 0.097 and coefficient value of 0.726. This can be explained by method of disseminating information used by extension agents, which involved direct communication with individuals within communities there by building trust and credibility (Alemu et al. 2023). According to Alemu et al. (2023), individuals are more likely to understand the significance of water treatment and take the required steps when they trust the source of the information. Extension agents also offer educational programs and disseminate research-based best practices that increase awareness about water treatment practices. These initiatives educate people on the value of water quality and how to preserve it (McKee et al. 2017).

Overall, extension agents are instrumental in bridging the gap between scientific research and practical application, thereby influencing the need for and adoption of water treatment practices.

4.7. Limitation of the Study

Due to the remoteness of the study site and the current security issues arising in Nigeria, only five enumerators were engaged, which limited the sample size that could be covered. Many of the respondents were also reluctant to interact with strangers for safety reasons, further constraining the scope of the study.

The study was conducted alone during the rainy season, when water is available in most of the earth storage system, potentially missing seasonal variations in water quality and accessibility among the respondents.

The study was unable to capture in the questionnaire if the respondents have been diagnosed with typhoid or cholera in the last six months.

5. CONCLUSION

This study on water quality and perceptions of rural dwellers in Odeda LGA, Ogun State, Nigeria, reveals insights into water quality and accessibility challenges, highlighting the interplay between respondent perception, socioeconomic factors, and environmental realities. Despite reliance on high-risk sources like shallow wells and rivers, most respondents believed their water was safe, reflecting limited awareness of invisible contaminants (e.g., coliforms, heavy metals) and the role of storage practices in water quality degradation. Also, given that the water quality perception of the community is contrary to the real water quality result from the laboratory result that was compared with the WHO water quality standard which put them in danger and prone to water borne diseases. With this finding, it shows that there is a massive gap between the perception of the rural dwellers on water quality compared to the actual quality of the water after it was compared with the water quality standard. To correct this, there is a need for: (i) encouraging water treatment practices, (ii) high level of awareness on water quality and contamination, (iii) provision of sustainable community portable water.

With regards to the first objective which focuses on the sources of water and distance to the rural dwellers, the findings indicated that the community rely predominantly on hand-dug well and surface water as their sources of water which not healthy because it is very prone to contamination from organic matter leading to several waterborne diseases, and the time travel to the water source is not appropriate during the water shortages that makes them to spend a lot of time in fetching water. The government and the water institution can rectify this by: (i) providing the community residents with adequate portable water sources within the community because bringing safe water sources closer to the households will drastically reduce the time of fetching water and as well reduce their own reliance on bad surface water or contaminated groundwater, (ii) Lunching public health education in school curriculum and outside schools as perception increases with education, (iii) engage the community leaders, religious heads, health workers, to serve as ambassadors to propagate the news about safe water practices. and (iv) Embrace community sensitization through all possible sources of information to educated the community dwellers on the health risk of using the unprotected and untreated water.

Regarding our second objective which focuses on challenges faced by dwellers on access to safe water, the study shows that the rural dwellers in Odeda Local Government Area are faced with several interrelated challenges with accessing portable water. The fact that they are solely dependent on hand-dug wells and surface water as their sources, which are actually unprotected and highly prone to contamination from organic wate and runoff from erosion. Their distance to alternative water sources during the scarcity also shows a significant challenge. Many of the households have to travel long distance to collect water during this period which exposes them to stress. They also perceived their water to be clean and safe based on their visual and taste which did not align with the scientific findings and disconnecting from their perceived quality and actual water quality. In addressing these challenges, there is need for both infrastructural development and behavioural change: (i) there is a need for provision of safe and more accessible water sources, (ii) There should be a continuous education on the importance of water quality and safe handling practices, (iii) Deploy Mobile water tankers to the community, most especially during the dry season to create a supplement for the dwellers during this period.

The findings from the third objective in this study shows that the there is a strong link of significance between the socioeconomic factors and information sources shape the perception of rural dwellers in Odeda Local Government as relating to water quality. The findings in this study shows that educational level, marital status, and also access to reliable information from social media and extensions agencies will improve the way they perceive water safety and quality. Those with higher education, married ones, those with access to social media and those who have access to water quality awareness from extension agencies have better chance to be more aware about how water should be stored and treated. In addressing these challenges, there is need: (i) investment in access to quality and reliable information which are to be made available in their local language, (ii) promote inclusive education campaigns to target all socioeconomic groups in the community, (iii) collaborate with community leaders, market leaders, religious groups on ensuring a smooth flow of information, (iv) strategically monitor the information channel to ascertain the quality of information that is been passed across.

Overall, there is a significant relationship between socioeconomic factors, source information and perception of rural dwellers on how water treatment need and the fact that water storage container can affect the quality of water. Therefore, there is need to push further in create more awareness through all possible means. Also, there is no relationship between the water quality perception of the dwellers and the actual water quality that was tested.

Probit analyses results underscore the critical role of digital and expert-based information sources in improving awareness of water quality management. The findings highlight education, marital status, and extension agents as the most robust predictors of awareness of need for water treatment, offering valuable guidance for targeting interventions and awareness campaigns. This also shows the possible channels of information that can be used for effective orientation and knowledge dissemination among the people within the study area to ensure accurate and reliable information reaches the target population and improves water quality practices

These findings advocate for participatory water management strategies that integrate local perceptions, improve infrastructure, and prioritize education to ensure sustainable water security. By addressing these challenges, policymakers can enhance health, livelihoods, and resilience in Odeda LGA and similar rural contexts across Nigeria.

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APPENDIX

Appendix 1: Questionnaire

PERCEPTION OF RURAL DWELLERS ON WATER QUALITY AND ACCESSIBILITY IN ODEDA LGA, OGUN STATE, NIGERIA

SECTION ONE: Socio-Economic Information

Gender	Male [ ] Female [ ]			
Age				
Marital Status	Single [ ] Married [[Divorced [ ] Widowed [ ]			
Education Level	Primary [ ]	Secondary [ ]	Tertiary [ ]	None [ ]
Monthly Income	Below N30,000	N31,000 – N60,000	N61,000 – N90,000	N91,000 – and above
Household Size (total individual count) Specify the number of dependents				
Means of Livelihood	Farming [ ]	Self-employed [ ]	Artisan [ ]	Civil/Public servant [ ]
	Others (Specify)			

SECTION TWO: Water Knowledge and Practices and Perception of Water Quality

A clean water should have odour?

Yes ( ) No ( ) Sometimes ( )

What should the appearance of clean drinking water be?

Clear and colorless ( ) Slightly colored ( ) Cloudy with visible particles ( )

A clean water should have a taste?

Yes ( ) No ( ) Sometimes ( )

Can storage containers or handling affect water quality?

Yes ( ) No ( ) Maybe ( )

Does clear water still need treatment before drinking?

Yes ( ) No ( ) Sometimes ( )

What form of water treatment do you practice in your household?

None ( ) Boiling ( ) Chlorination ( ) Filtration ( ) Others (Specify)

How often do you treat water in your household?

Everytime ( ) Sometimes ( ) Rarely ( )

How would you rate the water quality you use?

Excellent ( ) Good ( ) Fair ( ) Bad ( ) Very Bad ( )

How often do you experience problems with water colouration?

Very often ( ) Once in a month ( ) Twice in a month ( ) Once in two-three months ( ) Rarely ( )

How often do you experience problems with water odour?

Very often ( ) Once in a month ( ) Twice in a month ( ) Once in two-three months ( ) Rarely ( )

How often do you experience problems with water taste?

Very often ( ) Once in a month ( ) Twice in a month ( ) Once in two-three months ( ) Rarely ( )

Have you had any health risks from water consumption in the last six (6) months?

Yes ( ) No ( )

If YES, what water-related health concerns?

Diarrhoea: Once ( ) Twice ( ) Three Times ( ) Four times or more ( )

Dysentery: Once ( ) Twice ( ) Three Times ( ) Four times or more ( )

Typhoid Fever: Once ( ) Twice ( ) Three Times ( ) Four times or more ( )

E. Coli.: Once ( ) Twice ( ) Three Times ( ) Four times or more ( )

SECTION THREE: Perception of Water Accessibility

What are the sources for your domestic water use (more than one option is allowed)?

Hand-dug well ( ) Borehole ( ) Stream/River ( ) Rainfall harvest ( ) Water Vendors ( ) Others? Specify

Where is the location of the water facility?

In-compound ( ) Nearby the house ( ) In the neighborhood ( ) Nearest community ( )

What is the estimated distance to the water source? ______________________________________

How long does it take to walk to the water source (time)? _________________________________

What is your estimated daily water demand/usage (liters)? ________________________________

How much do you spend on domestic water supply daily? _________________________________

Free ( ) Less than N50 ( ) N50 to N100 ( ) More than N100 ( )

Water Access and Shortage

How often do you receive water from your primary water source weekly?

Daily ( ) 3-4 times a week ( ) 1-2 times a week ( ) Less than once a week ( )

On average, how long does the water supply last when it is available?

Less than 1 hour ( ) 1-5 hours ( ) 6-12 hours ( ) More than 12 hours( )

What time of the day is the water available?

During the day ( ) At night ( )

How often did you experience disruption to water access in the last month?

Very often (every day) ( ) Often (several times a week) ( ) Sometimes (several times in a month) ( ) Seldom (Less than once a month) ( ) Never ( )

Are water shortages more prominent in the wet season?

Yes ( ) No ( )

Do you have issues with water contamination during the wet season?

Yes ( ) No ( )

Are water shortages more prominent in the dry season?

Yes ( ) No ( )

Do you have issues with water contamination during the dry season?

Yes ( ) No ( )

During shortages, how do you access water?

Buy water from vendors ( ) Fetch water from a nearby stream/river ( ) Use stored water ( )

Use a borehole/well ( ) Others ( )

How far is it from your home if you use an alternative water source?

Less than 100 meters ( ) 100-500 meters ( ) 501 meters to 1 km ( ) More than 1 km ( )

SECTION FOUR:

Source of Water Information

The primary source of information on water information (Radio)?

Yes ( ) No ( )

The primary source of information on water information (Internet and Social Media)?

Yes ( ) No ( )

The primary source of information on water information (Family and friends)?

Yes ( ) No ( )

The primary source of information on water information (Health clinic)?

Yes ( ) No ( )

The primary source of information on water information (Extension agent/Government agencies)?

Yes ( ) No ( )

The primary source of information on water information (NGOs)?

Yes ( ) No ( )

What information about water quality have you learned in the last six months?

Challenges in accessibility

Do you agree that physical barriers, such as **broken pipes**, is a significant challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that physical barriers, such as **poor water quality**, is a significant challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that physical barriers, such as **lack of adequate water points**, is a significant challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that physical barriers, such as **distance to water sources**, is a significant challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that infrastructure issues, such as **inadequate water treatment facilities**, is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that infrastructure issues, such as **insufficient storage capacity,** is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that infrastructure issues, such as **poor maintenance**, is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that infrastructure issues such as **inadequate power supply** is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that institutional accessibility challenges, such as **government policies**, is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that institutional accessibility challenges, such as **inefficient resource management,** is an essential challenge in water accessibility?

Yes (   )   No (   ) Maybe (   )

Do you agree that institutional accessibility challenges, such as **artificial scarcity** is an essential challenges in water accessibility?

Yes ( ) No ( ) Maybe ( )

Do you agree that institutional accessibility challenges, such as **Insufficient investmen**t is an essential challenges in water accessibility?

Yes ( ) No ( ) Maybe ( )

Perceived Solutions					
Infrastructure-Based Solutions					
	Most important	Important	Somehow Important	Less Important	Not important at all
Additional community Water Points					
Improved Water Supply Systems					
Increased Water Storage Facilities					
Improved Water Treatment Facilities					
Community-Based Solutions					
Water Conservation					
Community Management					
Water Education					

Community-Led Initiatives					
Policy and Governance Solutions					
Inclusive Decision-Making					
Public-Private Partnerships					
Subsidies and Tariffs					
Increased Investment					
Other perceived Solution					

Hydrocensus

Water Source Type: ______________________________________

Location: Latitude: ______________________ Latitude__________________________________

S/N	Parameter	Unit	WHO limit	15% Margin	Concentration (on site)
1	**pH**	-	**6.5 to 9.2**	**6 and 9.5**	
2	**Temperature**	Celsius	**28**	**32**	
3	**TDS**	mg/L	**500**	**550**	
4	**EC**	mg/L	**1000**	**1150**	
5	**Turbidity**	NTU	**5**	**6.25**	
6	**Salinity**	mg/L	**NA**	**NA**	
7	**ORP**	millivolts (mV	**NA**	**NA**	

Appendix 2: Photo documentation











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RBM