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Sustainable water management in Nigeria: Barriers to Water Access in Rural Communities

DOCTORAL THESIS

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DECLARATION

I hereby declare that I have elaborated the doctoral dissertation thesis titled "Sustainable water management in Nigeria: Barriers to Water Access in Rural Communities" independently, albeit the help of expert consultations, hence all texts in this thesis are original. In addition, all the sources have been quoted and acknowledged by means of complete references.

Prague, June 2022

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Ing. Jocelyn Ojochide Aikowe

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ABSTRACT

In the developing world, the rural population suffers from diverse water management challenges which have affected access to clean and safe water. To provide an extensive understanding of the existing challenges affecting these communities, this thesis evaluates communities' willingness to adopt sustainable water management practices and further identifies various barriers to adequate water access. We adopted the analyses of peer reviewed and grey literature, while utilizing specific search strategies and keywords. Key sustainable water management challenges such as distrust, level of community participation, type of existing water source, affordable cost of maintenance, culture and religious ties were identified as some of the most occurring themes. A survey with 404 randomly selected respondents was conducted in three local government areas in Kogi state alongside interviews with key participants (n = 12). The data collected were analysed using a Chi-square test to determine any significant relationship between water source choice and the predictor variables (age, education, occupation, religion, ethnic group, household size, income, and distance). Furthermore, multinomial logistic regression was adopted to investigate the relationship and effect between these variables. Findings indicated that the predictor factors such as age, level of education, ethnic group, and participants' occupation have a statistically significant relationship with using a particular water source. Ordinal logistic regression was utilised to investigate the influence of the aforementioned predictor factors on respondents' willingness to participate in sustainable water management. Finally, more in-sights for policymakers are provided to bridge the gap surrounding water access in developing countries while focusing on an adequate water source and its management.

LIST OF ABBREVIATIONS

ISWS – Improve safe water source

SWS – Safe water source

WMC – Water management challenges

SWM – Sustainable water management

WA – Water access

WM – Water management

WS – Water source

MLR – Multinomial logistic regression

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1 INTRODUCTION

In developing countries, national and regional governments, local and international NGOs and other concerned organizations invest large amount of money yearly for the implementation of rural water supply projects to address ongoing water access (WA) issues. However, these water construction projects does not help if they fail after a short time. To make the investment in water projects more effective, failure rates of these systems should be reduced. Sustainability of rural water system depends on factors controlled by the project such as training, technology, cost of the project and construction quality and “Sustainability” in this context best defined as the functionality of the water point over long period of time. Some other factors that are not controlled by the project for example, communities’ poverty level, access to technical assistances and spare parts. There are different factors affecting the sustainability of rural water systems. Looking at developing countries, Nigeria to be precise, some of the factors that affect the sustainability of rural water are, lack of community participation during the projects’ phases (selection of site and technology, implementation, operation and maintenance of the water source), leads to the lack of finances at the community level for operation and maintenance of water sources, use of complicated technology without proper capacity-building at community level and deep water table and poor quality of water. In the rural part of Nigeria where the water points not central and/or unavailable, especially during the harmattan season, households’ individual (mainly female and children) has to journey long distance to get water.

It is estimated that close to two (2) hours is lost per day per household collecting water by rural inhabitants who have no access to safe drinking water sources around their houses. Sometimes women prefer fetching water from unprotected well, river and other sources of it is closely in order to decrease the time spent to fetch water and from these sources they get water without worrying about the quality of water and its consequences.

Having adequate WA has been identified and deemed important everyone, therefore, it is necessary to identify the principal challenges faced in managing water resources and identify the barriers to water access (WA) in rural part of Nigeria.

The structure of this thesis as follows: **Chapter 1 -** the introduction chapter highlights the problem statement, research gaps in literature. This is followed by **Chapter 2**, which sheds light on literature by using an exhaustive systematic literature review to identify water management challenges, recommendation to these challenges and how these management affects water access. In addition, this chapter also identifies barriers to water access. **Chapter 3** shows the study objectives and goals. **Chapter 4** highlights the methodology adopted for this study. **Chapter 5** illustrates the results of the study. **Chapter 6** discusses the findings of the results, and **Chapter 7** summarises the thesis and offers recommendations for all relevant stakeholders and key policy makers.

2 LITERATURE REVIEW

This chapter comprises of 5 sub-chapters. **2.1** gives an overview of the systematic review method adopted. Discussing the various challenges and recommendations to water management affecting Nigeria and in the global context. **2.2** provides the various definition of WA and highlights the definition adopted for this study, in addition governing bodies and current WA status is discoursed in this section. **2.3** provides an insight on how WA has improved over time and provides more information on the water schemes in Nigeria. **2.4** highlights the various barriers to water access affecting Nigeria and similar developing countries. **2.5** discourses project schemes and formulation in Kogi state, Nigeria.

Water access (WA) is a fundamental human right as indicated in the article 25 of the Universal Declaration of Human Rights (UDHR) *"everyone has the right to adequate living standards"* (United Nations 1948). Moreover, inadequate WA directly challenges another right "right to education" (Article 26 of UDHR) for children in rural parts of developing countries, in particular (United Nations 2019). Adequate access to clean water is also reflected in the Sustainable Development Goal (SDG) 6 (Sustainable Development Goals Report 2019). Agenda 21 identified the importance of proper WA as it improves human development as well as a rural livelihood (United Nations Sustainable Development 1992). According to reports, only 73% of communities worldwide could meet part of the SDG 6 (Bain et al. 2014; WHO 2017; Miller et al. 2019). Evaluating the progress of the SDG 6 in the 2019 report, the United Nations Development Program (UNDP) identified that 785 million individuals still lack adequate water services, 2 billion health infrastructures lack basic WA, 3 billion people lack access to water for domestic use. Further, regions of Northern Africa, Central and Southern Asia were identified to experience water stress (United Nations 2019) as a result of the constantly growing population competing for limited water resources (Brown et al. 2014).

Statistics related to global water scarcity show that about 2.1 billion people (27% of the world's population) live in regions characterized by physical scarcity of water (current water resources do not meet current water demands (UN Water 2018) and another half a billion approaching the same situation (World Vision 2019). The problem of economic water shortage (the absence of necessary infrastructure to take water from sources, e.g. rivers, to the people) is faced by 25% of the worlds' population (UN Water 2018).

The term of water access is defined as *"the availability of water of at least 20 liters 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"* (WHO/UNICEF Joint Monitoring Programme 2010). Focusing on rural communities, and their livelihood dependent on income generated from agriculture (Forouzani et al. 2012), agricultural water (water for agricultural purposes) access would also be addressed. Almost 80% of extremely poor rural dwellers engage in and depend on agriculture (Forouzani et al. 2012; Castaneda et al. 2018). With limited WA for their agricultural practices, their livelihood would be consequently affected (United Nations Sustainable Development 1992).

Although some rural areas that have water resource available in its natural form still face WA challenges, e.g. in Nepalese rural areas Gurung et al. (2019) and in Iran, where irrespective of having Lake Urmia naturally available, there is reportedly WA challenge due to unsustainable agricultural practices leading to water wastage (Zenko and Menga 2019).

The Agenda 21 recognizes an adequate WA as a key for meeting primary health care needs. Contrary, an inadequate WA leads to life-threatening health issues causing millions of deaths annually in developing countries (Malik et al. 2012; Yang et al. 2012; WHO 2019). Together with the lack of adequate medical facility and poor infrastructure in rural areas, the severity of illness resulting from inadequate WA is increased (WHO/UNICEF 2019) impacting mainly women and children (Liew and Lepesteur 2006; Halvorson et al. 2011; Abdulkadir et al. 2017). Fonyuy (2014) indicates that water related diseases account for more deaths than terrorism, war and other global conflicts combined.

2.1 Systematic review

A systematic review of the WMCs in rural areas in developing parts of the world was conducted. Peer-reviewed articles and grey literature studies published in the past twenty years (2000 – Q1/2020) were reviewed. This review examined the following issues: WM influence on WA and key WMCs in the rural areas of developing countries.

The research design comes out from the assumption that WA is influenced by WM practices (Mogomotsi et al. 2018; Garcia et al. 2019; Malan et al. 2020).

The search results were restricted to keywords, abstracts, and title of papers. However, there was no restriction on the results based on the subject area because water management and water access are a multidisciplinary topic. For peer-reviewed articles ScienceDirect, Web of Knowledge, Google Scholar and PubMed databases were searched. For grey literature, the websites of the following organizations and respective programs were searched: United Nations Children's Fund (UNICEF), UN-Water, WHO/UNICEF Joint Monitoring Programme, World Health Organization, World Bank.

Due to a large number of search results, indicated in Table 1, the study selection involved screening of titles and abstracts of the peer-reviewed articles. Then, the full text was checked for relevance to the review.

Table 1: Original search results of articles as per respective journal database accessed during the periods of September 2019 - February 2020.

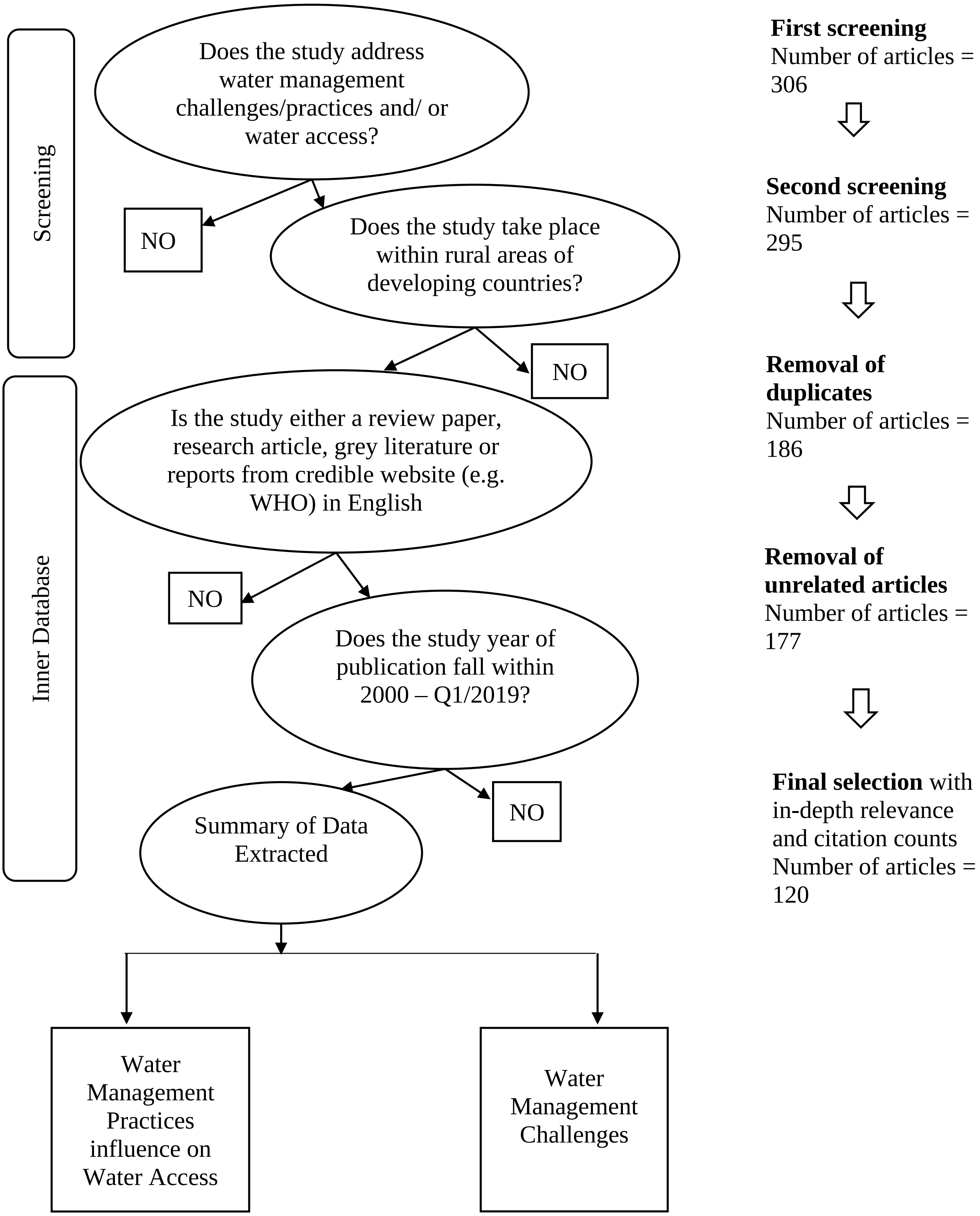
Search Operators	ScienceDirect	Web of Knowledge	PubMed
Water Management Problems AND Rural Areas	67,224	438	111
Water Management Problems AND Developing Countries	171,288	1,035	312
Water Access AND Water Management	224,563	4,998	1,461
Water Access AND Rural areas	66,837	979	381

Source: author

Clear criteria were developed to include only relevant sources as shown in Figure 1.The literature was included if (i) it addresses water management challenges/practices and /or water access; (ii) it takes place within rural areas of developing countries; (iii) it is either a review paper, research article, grey literature or reports from credible websites in English; and (iv) its publication year falls within the periods 2000 – Q1/2020. Literature earlier than the year 2000 and outside the scope of water management and access were excluded from this review.

Following the identification of articles and literature to be used in the study, the first screening was conducted, which resulted in the total number of articles being 306. Further in-depth screening was adopted which entailed files systematically arranged in a folder on personal computer, then going through the saved files and identifying similar file name, duplicates were then removed. Reducing the number of original articles to 186. Then more thorough scrutiny of articles was conducted. By reading the abstracts and glancing through article content, this highlighted a few articles not related to the study, i.e. articles not concerned with water and management or water access issues in rural areas as these articles focused more on technical aspect of water resources and management. This step brought the number of original articles to 177. Next, the pool of articles was further reduced to 120 based on more detailed scrutiny by reading article contents. Descriptive data such as the authors and year of publication alongside other characteristics relevant to the review such as the countries where the study was conducted, the location of the study, and the water challenges reported were extracted from the articles. The findings of the study and their consistency or inconsistency across the articles were also extracted. Summary of data extraction further explained in Figure 1

Figure 1: Decision tree summarizing the inclusion & exclusion strategy, inspired by Brown et al. (2013) and Miller et al. (2019).



2.1.1 Key water management challenges in rural areas of developing countries

WMCs in rural areas are manifested in diverse ways, such as challenges linked to water governance systems, high poverty levels, and inadequate capacity or skills at the municipality leaving the rural communities with little alternative but reliance on unsafe water sources for their water needs (Nkuna 2012). Studies have identified various issues which were classified into Socio-economic, Environmental and Technical clusters based on the nature of the challenge Table 2.

2.1.1.1 Socio – economic water management challenges

Underfunding remains the biggest challenge to WM in rural areas (World Bank Group 2018), especially Africa. Inadequate funding has been blamed for lack of access to proper sanitation affecting 2.5 billion people, open defecation, and lack of access to an improved drinking water supply (Paddock 2014). Underfunding has proved to be a major financial challenge in WM reported in studies to affect sub-Saharan Africa (Cecco 2012; Global Water Partnership 2015; Koehler 2015; Foster and Hope 2017; Etongo et al. 2018). It has also been described that most of the African countries face WMC related to the high cost of drilling boreholes (Lewis 2019). Poor financial support from the government in Namibia has been identified to influence WM (Ziervogel and Hegga 2018). Similarly, (Mulogo et al. 2018; International Finance Corporation World Bank Group 2019) identified low funding to influence how water is maintained in Uganda, which could be a result of the high user fees (Naiga et al. 2015). To solve these challenges, it is recommended that the local community, in collaboration with local government bodies, should seek funding from the central government and non-governmental organisations to establish robust water infrastructural system (Government of Uganda Ministry of Water and Environment 2018). Funding issues have also been indicated as a problematic factor in Tanzania (Herslund and Mguni 2019) and

Kenya (Kamiya and Chepyegon 2018). Problems with funding have equally been highlighted to affect rural India, Prabhu (2012) emphasised on the issue of improper pricing of water to be a contributing factor to WM in rural parts influencing water use and willingness to contribute to its management. Research findings from Vietnam showed high-water pricing preventing communities to use water systems, which resulted in low-income households having limited water supply and therefore inequality in WA (Carrard et al. 2019). Poor financial support has also been identified to affect non-Gulf Cooperation Council (GCC) countries, Elseoud and Matthews (2013) argue on that water projects' success are challenged by inadequate funding and other financial issues such as inability to pay for water usage.

In Kenya (Ndungu 2018), South Africa (Nkuna 2012) and Namibia (Ziervogel and Hegga 2018), high **poverty** level among residents is identified to influence their ability to afford water. Angoua et al. (2018) argue that even when there is an adequate supply of water to the rural areas, most of the residents cannot utilise it due to the cost and the poverty rate or low income alongside dispersed settlement in some parts of Cote d'Ivoire.

Politics in management and allocation of water resources come into play in WM (Musingafi and Chadamoyo 2013; Masocha et al. 2017; Kativhu et al. 2018) and water resource ownership (Hodgson 2006). If a water project is being initiated or developed by an opposition political party, there would be animosity towards who uses the resource and likely vandalism to that system. In addition, if the project is not completed before ruling party's tenure, the next ruling party (if different) always chooses to abandon such a project or cut off any existing management support the previous government was providing (Howard and Howard 2016; Du et al. 2019). Politics has been identified to influence how and who privatises the water sectors, this subsequently impacts how that water system would be managed in the future (Afroz et al. 2014). Majority of the privatised water projects in developing countries fail in meeting the demands and needs of the communities and thus are abandoned Herslund and Mguni (2019). Politics further identified to influence WM through the collaboration of communities and government in enforcement and regulation of water laws. In a similar context, Elseoud and Matthews (2013) argues that politics and war in Arab regions have been observed to impact WM, where water quality, water infrastructure and water availability is being threatened.

Global challenges in WM tackling water scarcity and shortage are mainly attributed to the fast **rise in population** (Geissen et al. 2015; Rasul 2016; Choi et al. 2017; Du et al. 2019). Accompanied with population growth is the issue of rapid urbanisation, and this subsequently affects the consumption rate of water (Herslund and Mguni 2019). Rapid increase in population growth not only affects the availability of water present by increase in demand, it also increases competition rate (Santos et al. 2017) and leads eventually to limited availability of water resources (Rakhecha 2018; Shah and Narain 2019) and water stress in developing countries (United Nations 2019). In addition, highly populated areas are mainly affected by poor water quality due to pollution of water resources by human activities (Liyanage and Yamada 2017; Santos et al. 2017). On the other hand, when a small population is scattered over a large area, the cost per capita of constructing water systems is increased (Nyarko et al. 2010; Naughton 2013). The rural parts of Nigeria experience high water demand, which surpasses the supply due to population growth (Ishaku et al. 2011; Ladan 2013; Chukwuma 2017). Similarly, in South Asia (Rasul 2016), Kenya Ndungu (2018) and Cote d'Ivoire (Angoua et al. 2018) the rapid growth in population causes WA issues in the form of shortage and limited availability. This scarcity forces children to travel distance in search for water (International Finance Corporation World Bank Group 2019). Similar reports have been made in Asian region, Lahiry (2017) and Ali and Dkhar (2018) identified a rapid population increase in India to be a contributing factor to the WMCs faced. The rural parts of Asia face similar challenges with adequate management of pollution. Some of the common challenges are lack of proper sanitation, water problems such as difficulties with availability and management of wastewater treatment facilities (Ali and Dkhar 2018) and decline in groundwater and quality problems associated with contaminated water sources (Udmale et al. 2016).

Ownership of water resources can determine various factors like; how and when the resources would be used, who can use the resource, if the resources can be used for free or at what cost, how resources are managed (Hodgson 2006). If water systems managed by the government are not managed to standards, then communities prefer not to utilise such water source. In Pakistan where communities viewed WA provision to be the responsibility of the government, the misuse of water sources and limited contribution to its maintenance were reported (Noga and Wolbring 2013). In other cases, landlords and tenants face issues with who manages the water source, where the tenants insist the responsibility is that of the landlord, leading to nonchalant use of available water supply system such as boreholes (Omarova et al. 2019). Without clarity on resource ownership and usage, communities where natural resources are naturally available, believe that the resources are their birth right. In such situations, communities use these resources without any consideration. If measures are out in place by the government to regulate usage, such involvement leads to **conflicts and clashes** with government and within communities (Naanen 2019) as reported in Nigeria and other developing countries. Conflicts and clashes report shows that when there is a pronounced shortage of water in the rural areas, it results in resource-based conflicts, especially in Kenya's poorest arid and semi-arid regions (KCIC n.d.). Some sustainable practices identified to pollute water resources such as sanitation and sustainable agricultural practices have been identified to be influenced by who owns the land, relationships with the landowners, the policy of land use and agreements (Niswonger et al. 2017; Meeks 2018).

Non-governmental bodies' involvement in some cases can be perceived as unappreciated when their project performance is evaluated. This has been identified to be a threat to WM in sub-Saharan Africa. In Namibia, the challenges of WM in the rural areas is aggravated by poor participation in decentralisation of management of water resources coupled with inadequate community involvement in planning decisions (Ziervogel and Hegga 2018). In Tanzania, **distrust** between communities and a water regulatory body influences their usage and support (Herslund and Mguni 2019).

Community participation and project acceptance was identified to be deterred in some rural areas in Zimbabwe (Murtinho 2016). The communities were not trained by the NGOs prior to the water projects instead just a few selected heads/community leaders were trained or informed about any water project(s), this minimised their participation, acceptance, and involvement in the WM (Murtinho 2016). This lack in community participation in WM is similarly reported in rural parts of Kenya and has been subsequently identified to influence WM (Kamiya and Chepyegon 2018). Additionally, social challenges in water development (especially low social acceptance of interventions and conflicts), and low stakeholder involvement in WM is a contributing factor to limited participation from communities.

Level of involvement of government is linked with the lack of coordination among the various authorities tasked with WM. This is primarily attributed to lack of a clear definition of roles and responsibilities, which may be resulting from the insufficient staffing in government offices reported (Murtinho 2016). Also, failure to harmonise laws and policies related to environmental management is a crucial challenge in water provision in Africa (United Nations Department of Economic and Social Affairs 2016). In Nigeria, poor coordination between the local, state, and federal government agencies in WM (Ladan 2013; Seedhouse et al. 2016; Slaughter and Odume 2017) has been identified by studies to influence WMCs.

Weak law enforcement and regulation of water resources are documented in developing countries despite the existence of several regulatory bodies and enforcement agencies. In the Western peninsular region of India, Maharashtra Water Resources Regulatory Agency (MWRRA) has been facing challenges due to the low involvement of communities and lack of transparency (Dubash 2008). This leads to low support in water laws and regulations by communities. This stems from the lack of trust of regulatory bodies by communities arising from the obscurity of existing regulatory bodies (Mumssen et al. 2018). Weak regulation and enforcement can be seen in cases where certain governing bodies are unaware of their duties and roles in ensuring the success of community-based management. For instance, in Zimbabwe, where the rural districts did not provide any form of support in regulation and funds to the community for the management of the water projects irrespective of the government allocated funds and attributed responsibility (Musingafi and Chadamoyo 2013; Behnke 2017). Without proper enforcement bodies and regulation on water use, water users would be less cautious on how they utilise water systems, disregarding conservative sustainable practices due to the fact that there would not be any penalty for their actions (Geissen et al. 2015; Naiga et al. 2015; Tantoh and Simatele 2018). The rural parts of the Botswana have been identified to experience issues with regulation and no coordination of water bodies within the country, thereby impacting on their WM practices (Mogomotsi et al. 2018). In Ghana, the rural population highlighted some challenges encountered during WM, of which was the failure of the government to translate water policy documents into concrete actions at the local level (UN Development Programme 2019). Policy changes aimed at ensuring that the rural population gets adequate funding for water infrastructure could help address these challenges. WMCs in rural parts of Nigeria have also been attributed to governance challenges, especially poor government policies and priorities (Edet et al. 2012; Abutu 2014), lack of community involvement in the drafting of such policies and failure of the government to utilise technology in WM (Hassan et al. 2019). This top-bottom approach is evident in these communities as proximity to the water points are reportedly identified as an issue in most of the rural communities, where they must walk several kilometres to get water (Emenike et al. 2017). Even though Nigeria has many water sources, it has been noted that the rural poor do not have access to clean and safe water because of regulation challenges, especially weak regulatory, legal and institutional frameworks which have resulted in pollution of its water sources (Slaughter and Odume 2017; Herslund and Mguni 2019). In the Kenyan rural areas, there is a bundle of problems and their respective combination related to lack of management capacity attributed to internal challenges of community groups, poor communication and accountability between community groups and water users, absence of legal status among the community-managed water groups, low literacy levels and inadequate technical skills needed to efficiently run the water resources, inadequate capacity building and follow-up by non-governmental organisations, and inadequate knowledge of regulatory framework by the communities themselves (Leclert et al. 2016). Indian communities face problems associated with low monitoring and evaluation systems, inadequate sustainable local government management models, and failure to decentralise management of water resources (Worldbank 2011). Furthermore, a lack of proper coordination between federal and state governments (Prabhu 2012) has equally been reported to affect WM practices in rural parts of India.

Corruption in the water regulatory body has been identified to influence WM. Through bribe, water projects are awarded to unqualified contractors (Smith 2012; Abutu 2014). Further, incompetent employees are employed based on their affiliation rather than their expertise (Abutu 2014) as seen in Nigeria (Nchuchuwe and Adejuwon 2012). The issue of illegal connection to water reservoirs and dams not only affects the management of the water system through shortages in finance, but illegal water tapping also affects the quality and supply of water to existing communities (Mothetha et al. 2013). Unlawful use of resources in Nigeria can also be attributed to areas where communities feel the resources are their birth right and do not agree with the current state of how the resources are managed (Naanen 2019). In Ethiopia, issues with WM result from vandalism of water systems and illegal connection from a water source to avoid payment (Herslund and Mguni 2019). Political influence and socio-cultural considerations in water provision (Mdoe 2011) is evident in Kenya and identified to influence WM.

2.1.1.2 Environmental water management challenges

Climate change resulting in drought and flooding of water resources led to challenges in managing reservoirs and limited availability of water during agricultural seasons. Studies have identified some communities in Arab (Elseoud and Matthews 2013) and Vietnam (Noi and Nitivattananon 2015) being vulnerable to various climate changes such as flood and drought, which consequently influences WM. The impact of the flood is high as it leads to loss of life and properties if not appropriately managed (Howard and Howard 2016). Flood occurrence in Nigeria is subject to both natural and human-made activities such as (poor drainage construction, illegal buildings on drainages, improper disposal of waste and many more. In a similar context, Fulazzaky (2014) reports on challenges faced when mitigating against consistent flooding in Indonesia. In the Caribbean, the challenges faced in securing an integrated water resource management system are as a result of limited rainfall (Cashman 2018). Other regions that face challenges with WM as a result of climatic conditions have been reported such as in Malaysia (Afroz et al. 2014) and Kazakhstan (Omarova et al. 2019). Also, in India Kumar et al. (2015) and Xenarios et al. (2017) indicated that seasonality and drought influence level of water availability and management. In addition, women and children have been identified to be more vulnerable to WMCs as a result of climatic conditions in India (Kher et al. 2015). Water scarcity resulting from climate change and seasonality is a factor affecting WM in Uganda (International Finance Corporation World Bank Group 2019). Increased flooding within rural communities in Ethiopia affects their WM (Herslund and Mguni 2019). UNESCO (2015) reports that in developing countries, especially in Africa, the typical water challenges include limited water resources which give rise to problems of infrastructure provision and scattered settlements primarily characterised by the agriculture-based economy. Mdoe (2011), in a similar context, finds Samburu County, Kenya, to be affected by water shortage due to anthropogenic climate change (Navarra Center for International Development 2016). In Botswana, the limited water access is due to climatic conditions causing scarcity, reduction in natural water resource such as rivers, lakes and pond (Mogomotsi et al. 2018). Drought leading to dams and other water sources drying up is an issue in Ghana (UN Development Programme 2019) and South Africa (Ngcobbo and Jewitt 2017). In rural Asia, the critical WMCs include land degradation and drought, water scarcity, desertification, and degradation of water quality (Food and Agriculture Organization of the United Nations 2014). In South Korea, river basins are recognised to be their primary water source. They are affected by climatic conditions influencing the quality (degradation) and distribution (reduced) of the water resource present in the region Choi et al. (2017). India has also faced challenges related to climate change resulting in shifting rainfall patterns, lack of a comprehensive national water framework law, excessive groundwater exploitation, increasing pressure of water-dependent industrialisation (Ali and Dkhar 2018). In a similar argument, Lahiry (2017) also reports on rural India tackling with wide variation in rainfall patterns across various regions of the country. Other challenges with WM in India are persistent drought, reduced levels of surface water bodies during dry seasons, and salinity of water during dry seasons (Udmale et al. 2016).

As developing countries are continually rising in population, water resources are being depleted due to competition growth, resulting from **pollution increase** (Aliyu and Botai 2018). There is a rise in the number of populations lacking access to clean water causing their increased vulnerability as seen in India (Afroz et al. 2014), Indonesia (Fulazzaky 2014) and Ethiopia (Tadesse et al. 2013). Pollution to water sources is not only an environmental hazard; it also leads to life-threatening illness if water treatment is inadequate (Odiyo and Makungo 2012). Sources of water pollution can come from poor management practices of the treatment infrastructures (Herslund and Mguni 2019). Also contributing water pollution are contamination from poor agricultural practices (e.g. fertilisers' leakage (Fulazzaky 2014)), soil erosion and poor drainage management and maintenance allowing contamination to water sources as identified in Jakarta, Indonesia (Fulazzaky 2014; Abubakar, 2018). Contamination from oil refinery have been reported in Egypt and Pakistan (Ritzema 2016) and in Ecuador (Maurice et al. 2019). Studies have also identified dumping of hazardous waste from various industries into water sources and unlawful disposal of household wastes (Afroz et al. 2014; Kher et al. 2015). This is a major issue in Nigeria, where the main source of water is groundwater supply being highly threatened and subjected to various forms of contamination from run-off from waste (Yusuf et al. 2019). Proper and more efficient water treatment alongside other methods are areas to investigate to address water pollution challenges in Nigeria as poor treatment of water is responsible for several health-related illnesses in rural communities (Odiyo and Makungo 2012). The problem of poor sanitation is not new as a challenge to Uganda's water system, as it has been reported by several authors (Gibson et al. 2018; Mulogo et al. 2018). Another contributing factor to water contamination could be the fact that the rural population also witnessed sanitation problems (especially open defecation), which has put pressure on water resources (Ndungu 2018).

2.1.1.3 Technical water management challenges

Water source distance is one of the challenges experienced in parts of Tanzania (Herslund and Mguni 2019), their study indicated that resident could travel up to 1 kilometre depending on where they lived in relative distance to the existing water source.

In Namibia high levels of illiteracy among community members tasked with management of water resources have been identified to affect WM in the region (Ziervogel and Hegga 2018). In Tanzania similar challenge related to **low-experienced staff** with poor education and training influencing WM is reported (Herslund and Mguni 2019). Most of the rural parts of Nigeria lacks the necessary engineering skills and knowledge required in the handling of even minor repairs of the water systems by the community users (Chukwuma 2017). Capacity challenges in WM has also been highlighted in various empirical and non-empirical studies (Uganda Bureau of Statistics 2012; Hirn 2013). Sève (2018) highlighted how poor capacity levels affects water supply and provision (International Finance Corporation World Bank Group 2019 in Uganda).

Rural residents of Uganda face some technical challenges threatening success of WM such as unreliability and unpredictability of **water supply** over time, and the scattered location of water sources. Inefficient water supply system has been reported also in Botswana (Mogomotsi et al. 2018). In Central Kazakhstan, water supply challenges are prevalent in rural areas. Omarova et al. (2019) noted that although villagers were supplied with tap water, most of them utilised alternative sources. The use of alternative sources was attributed to villagers' doubts about the quality of tap water, the availability of free or cheaper sources, and use of alternative sources out of habit.

Rural households are further faced with **non-functioning water infrastructure** systems and inexistent supply systems (Kome 2019). Additionally, lack of appropriate water provision technologies, challenges related to creating new infrastructure and maintaining it, and operation and maintenance challenges are among the factors identified by Naiga et al. (2015) to affect WM in Uganda. The unavailability of technical tools is also seen to prevent proper treatment of waste generated in Ethiopia, leading to an increase pollution rate (Herslund and Mguni 2019). Poor infrastructure and maintenance are reported in Tanzania (Herslund and Mguni 2019) and Kenya (Kamiya and Chepyegon 2018) where existing water pan structures are in decline, resulting from the poor management of water pans in affected regions (Mdoe, 2011), similar findings are also reported in Botswana (Mogomotsi et al. 2018). This questionable management of infrastructure is manifest in the frequent breakdown of hand-operated boreholes and wells reported in Nigeria (Nchuchuwe and Adejuwon et al. 2012). This breakdown of water infrastructure in the rural areas subsequently impacts on water supply in the rural residents. Some of the most common water supply infrastructural challenges in rural Nigeria include damage of sewage disposal and water supply infrastructures leading to contamination of water supply and waterborne diseases, breakdown of machines and equipment, and lack of operational inputs required to ensure the smooth operation of water infrastructure (Hassan et al. 2016). Studies further indicated that communities dwelling in rural parts of India do not have access to modern water infrastructure and frequently use traditional technologies (such as tanker truck water, vendor-provided water, surface water, unprotected spring, and unprotected dug well) to provide water to its population (Prasad and Indranil 2016). Ali & Dkhar (2018) agree that this insufficient infrastructure poses a threat to rural WM in India.

Table 2: Summary of water management challenges in the respective developing countries

Cluster	Water management challenges	Description	Country
Socio Economic	Lack of funding	Insufficient funding for water projects; High fee for users; Insufficient funds to maintain water systems.	Ethiopia India Namibia Nigeria South Africa Uganda Vietnam Zimbabwe Non-GCC countries
Socio Economic	Poverty	Poor and low- income households also show low ability to afford water, despite the appropriate source is available.	Ivory Coast Kenya Namibia South Africa
Socio Economic	Politics in management of water systems and projects	Politics influence communities that have access to water resources through projects implementations and employment of water resource managers	Kenya Zimbabwe Arab regions
Socio Economic	Increased population growth	Population increase causes shortage and reduction in water resources through competition and pollution increase	India Kenya Nigeria Pakistan South Asia
Socio Economic	Conflict between community members; conflict between community members and regulatory body	Disagreement between parties in the use and/or maintenance of water resource leads to lack of corporation in the management system	Kenya India Nigeria Tanzania

Socio Economic	Level of involvement and participation of rural communities; level of participation of governmental and non-governmental bodies	Reduced community participation in planning, initiation and maintenance of water resource affects WM, Poor approach such as top-bottom approach from non-governmental bodies, increases WMC rather than addressing it	Kenya Namibia Nigeria Uganda Zimbabwe
Socio Economic	Poor water law and regulation; Weak governance	Weak enforcement and implementation of existing water laws alongside inter- governmental differences makes WM challenging	Ghana Kenya Namibia Nigeria South Africa Zimbabwe India
Socio Economic	Ownership of water resources	Ownership to water resources influences how it is managed, maintained and used. Government recognition of ownership by communities' challenges WM.	Kazakhstan Nigeria Pakistan
Environmental	Climate change	Climate change (CC) resulting in floods, droughts, soil erosion causing degradation on naturally available water sources, losses of lives and property. CC constraining how communities manage and cope. CC makes efforts to introduce water systems/projects harder.	Botswana Caribbean Central Kazakhstan Ethiopia India Kenya Malaysia Nigeria South Korea Vietnam South Africa
Environmental	Pollution of water resources	Pollution impedes WM techniques by making it more difficult to manage water quality; leading to life-threatening issues	Ivory Coast Ethiopia India Kenya Nigeria South Africa Uganda Ecuador

Technical	Water source distance	Due to the low involvement of communities in planning, most water sources are situated within several kilometers from rural dwellers, making it difficult for access and contribution to the maintenance	Nigeria Tanzania Uganda
Technical	Water source distance is one of the challenges experienced in parts of Tanzania	Majority of water projects initiated in rural parts of developing countries failed through abandoning of the project, lack of cooperation with communities, corruption, misallocation of project funding	Ethiopia Kenya Nigeria Uganda
Technical	Lack of technical training to repair water/ experienced personnel	Without proper training facilities and involvement in the water provisions, rural communities are faced with abandoning water points after the breakdown	Ethiopia Kenya Namibia Nigeria Tanzania Uganda
Technical	Problems with water supply system	Failure of supply systems through infrastructural challenges, vandalism and theft of pipes, and lack of maintenance	Botswana Central Kazakhstan Kenya Nigeria South Africa Uganda Vietnam
Technical	Lack of adequate infrastructure	Unavailability of infrastructure, low-grade technology	Uganda Ethiopia Tanzania Kenya Nigeria Botswana India

Source: Chapter 2.1.1

2.1.2 Recommendations to alleviate water management challenges in rural areas across various regions

Findings and proposed recommendations from reviewed literature are structured according to the clusters and respective challenges Table 3.

2.1.2.1 Recommendation for socio – economic water management challenges

Assurance of finance through various channels: Many water projects fail due to no maintenance and abandonment resulting from lack of finance to support these projects. If financial support is created, and on standby for any maintenance work, the success rate of water projects would increase. Financial institutions such as cooperatives providing loans for maintenance of water systems and/or creation of water schemes are areas that can be further explored (Cooley et al. 2013).

In Nigeria, **privatization of the water sector** resulting from competition amongst stakeholders improves WM and access leading to tariffs that suit consumers need. Services and management are improved as consumers have choices of switching to another service provider (Oyebande, 2001). Privatization of water sector also has been identified to ensure steadier and more realistic income for maintenance (Sorenson et al. 2011).

The use of **water markets** in South Africa has been seen to improve water scarcity issues and financial challenges associated with WM (Matchaya et al. 2019). Successful water market practices are only possible through the availability of **water rights to communities** improving their feeling of ownership to water sources, and consequently impacting positively on the management and maintenance.

WMCs should be viewed on the local level rather than the global level, which would allow stakeholders to address challenges specific to the respective region (Tortajada & Biswas, 2019). **Equal community participation in a bottom-up decision-making process** is beneficial in ensuring sustainable water infrastructures (Tundisi, 2008; Poricha & Dasgupta, 2011). For successful participation, at first, the financial capacity of the communities needs to be identified, and then low-cost technology provided to communities (Tundisi, 2008). These also increase the communities' sense of ownership (Poricha & Dasgupta, 2011; Marks & Davis, 2012), making them more involved in the maintenance of water systems. Involving stakeholders in the decision-making process improves communities' knowledge transfer with regards to learning ways to maintain the water system. Participation of communities further enables government/regulatory bodies to identify how various water schemes conform to existing cultural settings. Shevah (2015) reflects on a success story in India, where community participation, which led to improved WM, was promoted by engaging more than 5000 farmers provided with training on sustainable farm practices that reduces water waste, promote conservation and other cropping schemes. Equal community participation by all members of the community, inclusive of women, is essential for success water access and management (Poricha & Dasgupta, 2011) as in case of Brazil (Alexio et al. 2019). Community-based management increases sustainable use and management of the water sources as evident from Zimbabwe (Kwangware, 2014), Kenya (Marks & Davis, 2012) and Kyrgyzstan (USAID, 2009). In the latest, rural communities formed a water user association responsible for controlling water usage during scarcity periods and managing irrigational water. The association improved their management system tackling environmental, socio-economic, and technical issues. Similar success story is recorded in South African region where bottom-up approach was used for most of the development programmes (Knuppe & Meissner, 2016). For example, West Cape integrated water resource management, whereby communities were encouraged to participate. The approach included the mediators ensuring gender inclusiveness, aligning all parties with plans, and in general listening to the voice of the community.

Encouraging communities to participate in water schemes further sensitises them on the regulation and laws concerning water issues. This makes stakeholders assume responsibility of ensuring water laws and policy they are adhered to. In the long run, it addresses the issue of corruption as everyone is a stakeholder (Cooley et al. 2013; Hoekstra et al. 2018).

The involvement of **cultural practices** and cultural values of respective communities in early decision-making stages of water-related issues can promote WM in rural communities. In rural parts of Uganda, where they adopt public shaming, local sanctions and caning of offenders or members of the community owing for water usage have been identified to improve communities' participation and contribution to WM. Although this approach might be viewed as extreme, Broeck & Brown (2015) argue that it improves the financial assistance of the affected communities, as most people would not want to experience shame, pain, and punishments. Further, the clan chief is appointed to be responsible for ensuring of maintenance of water sources which consequently leads to improved WM practices within the community due to the respect and value of his authority. Socio-cultural factors play an essential role in ensuring how water is accessed by communities. The study (Price et al. 2018) conducted in India, Sri-Lanka and Bangladesh identified cases in where religion, ethnicity, gender exclusion, social strata and political ties influence the communities' choice of water, conflict related to water use, domestic chores resulting in pollution to water source, distance travelled to get water and price and cost of water resources. Some cultural practices to tackle water scarcity such as monitoring number of baths per household, restrictions on toilet use and flushing times, adoption of different toilet facility that limits water usage were part of the strategies adopted by rural communities in Nigeria to improve WM practices (Grace et al. 2013).

2.1.2.2 Recommendations for environmental water management challenges

To train communities and government officials in the sustainable management of water resources within the context of adaptation to changing climatic conditions will help in minimising the negative impacts. In Turkey Cakmak et al. (2007) proposes that providing training to farmers on irrigation methods can minimise the level of wastewater generated and pollution as a result of excess water runoff. Jiang et al. (2013) recommended that communities and government officials should be trained on how to adapt to climate changes such as flood and drought to minimise the impact of the eventuality.

To tackle the WMC linked with the increasing pressure on water sources due to the population growth**,** it is recommended **to create awareness and educate communities on birth control methods to control population** along with creating subsidised birth control method for rural communities in developing countries (Bergstrom et al. 2013; Mora, 2014). This process aims to bridge the gap with any cultural barriers that prevent communities from participating in any form of birth control (Jenicek, 2010).

Implementation of regulation and policy to protect water source and usage: In China, policies governing the use, management and protection of water resources have been recommended in studies (Shen & Liu 2008; Deng et al. 2016). Shen & Liu (2008) identifies some laws that protect communities water use against climate change and pollution in China. For example, the 1997 flood control law monitors flooding and provides mitigation against waterlogging and flooding. Also, the 1984 water pollution prevention and control law were implemented to manage and protect water sources against pollution. Similarly, in Pakistan, (Anser et al. 2020) proposed the institutionalization of policies against climate issues can mitigate against future environmental issue threatening WM. In South Africa, communities identified water policies and regulation to be highly effective in improving WM techniques within the region (Knuppe & Meissner, 2016).

2.1.2.3 Recommendations for technical water management challenges

To address WMCs such as the issue of climate change and high cost of maintenance threatening Turkey (Cakmak et al. 2007) and Brazil (Tundisi, 2008), the creation of advanced technologies that would enable water sources unaffected by these changes. These technologies would assist in monitoring and management of water sources. Technologies such as treatment and water recycle machines should be considered in affected communities as described in Tundisi (2008) on the adoption of desalinisation technology. Jiang et al. (2013) highlight how innovative technologies used to identify flood, monitor and predict its risk are some of the practices adopted by China is addressing their WMCs. The use of simple technology such as mobile phones has been recommended by Cooley et al. (2013) to be a means of stakeholders, government and regulatory bodies, in general, to pass vital water information through. This method of information sharing can enable issue with water scheme easily identified and generally improve monitoring and management of water resources. Creation of more efficient dams to store water can improve WM in affected communities India (Shevah, 2015).

Similarly, in Singapore and Namibia (Hoekstra et al. 2018), and Nigeria (Grace et al. 2016) practices such as water harvesting, recycling and storage improve WA. The studies further highlighted the importance of technology in WA as in a case seen in Singapore where new innovative technology introduced to recycle water improved WA within its region. Similarly, Merz et al. (2003) identified how the use of roof water harvesting and fog collection could improve supply in Nepal. Gandure et al. (2013) identified the use of in-field rainwater harvesting techniques to be used in South Africa by farmers to adapt to water challenges faced.

To address water quality issues, various water purification technologies are recommended to improve WA in rural communities in Africa, Asia and Latin America, such as sustainable solar technological treatments (Pichel et al. 2018) or usage of cheap filters rather than expensive water boiling as a means of purification in Nepal (Merz et al. 2003). In Jamaica, to reduce pollution penetrating to groundwater some of the rural communities adopted the method of constructing dry pit latrine with the use of limestone rather than the conventional method based on plain soil without any reinforcement (USAID, 2009).

In India, rural communities adopted **environmentally friendly technologies to mitigate negative climate factors,** such drip irrigation reducing primarily water wastage, and subsequently erosion and flooding as a result of unsustainable agricultural practices that leads to water wastage (Kumari & Singh 2016); and "alternate wetting and dry irrigation" to conserve water (Xenarios et al. 2017).

In Uganda, Broeck & Brown (2015) identified how educating and informing communities on the technical aspect of water sources, makes them better equipped in maintaining these systems.

Table 3: Summary of recommendations to the identified water management challenges

Cluster	Water management challenges	Recommendation	Country
Socio-Economic	Insufficient funding for water projects; high fee for water users; insufficient funds to maintain water systems	• Assurance of finance through various channels, (for example, cooperatives) • Privatisation of water resources • Water markets and Water rights • Water policy; Use of locally affordable technology • Culture – adoption of cultural law enforcement, such as public shaming	Global India, Nigeria South Africa India Uganda
Socio-Economic	Politics in management of water systems and projects	• Gender inclusiveness in political roles	India
Socio-Economic	Increased population growth	• Education and awareness of birth control • Women empowerment programs • Affordable birth control means • Bridging cultural stigma on childbearing	Developing countries
Socio-Economic	Conflict between community members conflict between community members and regulatory body	• Cultural awareness – identifying the importance of local authority in communities • Identifying cultural barrier in water usage and management	Uganda Sri – Lanka, India, Bangladesh

Socio -Economic	Level of involvement and participation of rural communities level of involvement of governmental and non- governmental bodies	• Promoting community-based management in communities through either financial, technical, decision making and labour. • Equal gender representation in all aspects of water systems • Cooperation between governmental, non-governmental and communities	Kenya South Africa Brazil Kazakhstan
Socio-Economic	Poor law and regulation, Weak governance	• Cultural awareness – identifying the importance of local authority in communities • Implementation of regulation and policy to protect water source and usage	Uganda South Africa
Socio-Economic	Ownership of water resources	• Institution of water rights • Promoting community-based management in communities through either support in financial and technical issues, decision making and labour.	South Africa Kenya
Environmental	Climate change	• Laws, policy and regulation that protect against the consequences of climate change • Adoption of more sustainable techniques that mitigate climate change impact; control and monitoring of erosion and flooding such as drip technique for irrigation • Educating farmers on the use of more sustainable practices to reduce water wastage	China Pakistan Turkey Brazil China India Turkey India

Environmental	Pollution of water resources	• Allowing women to be key decision makers • Enforcing policy against pollution • Construction of proper toilet system • Protecting water catchments and adoption of cheaper water treatments method such as low-cost filters • Adoption of technology to purify water source	India China Jamaica Nepal Brazil Africa, Asia, Latin America
Technical	Water source distance	• Bottom-up approach in decision making to identify communities' capacity and needs with regards to management • Identifying cultural barriers preventing community member from utilising particular source and travelling distance to get water resulting from cultural clash and conflicts	Kazakhstan Sri-Lanka, India, Bangladesh
Technical	Water project failure, poor water project management and monitoring	• Bottom-up approach in decision making to identify communities' capacity and needs with regards to management • Community based management	Kazakhstan Kyrgyzstan Zimbabwe
Technical	Lack of technical training to repair water/experienced personnel	• Education /sensitization • Community based management	Brazil Kyrgyzstan Zimbabwe

Technical	Problems with water supply system	• Adequate support system in place for the maintenance • Implementation of local tariff system based on communities' capacity • Cooperation between governmental, non-governmental and communities • Identifying communities' water demand needs and choice of water source usage • Adoption of other means water harvesting such as roof water harvesting and fog collection • Identifying cultural barrier in water usage and management	Brazil Kazakhstan Nepal Nigeria Sri-Lanka, India, Bangladesh South Africa Nigeria Singapore Namibia

2.2 Potable water access definition

There have been several definitions of WA across many pieces of literatures. However, regardless of the variations in WA definition, factors such as distance, quantity, source, and time are commonalities found when defining WA (Aiga & Umenai 2003; Kulinkina et al. 2017). It is important to grasp the true meaning of WA, as unclear understanding and interpretation in WA definition was identified to be problematic in early years (Aiga & Umenai 2003). Misinterpretation of WA makes it difficult to address the underlying issue of inadequate WA in general (Aiga & Umenai 2003; Kulinkina et al. 2017). In defining WA, the World Bank (1997) describes WA as when individuals have access to a safe water source (SWS) of good quality, positioned not more than 200 m away from dwelling, further implying that a considerable amount of time should not be spent when collecting water. The World Health Organisation (WHO) describes adequate water access to be from an adequate source free from pollutants and chemicals, situated within a reasonable distance while being readily available when needed by individuals (World bank 2020). However, the World Health Organisation (2006) going further in their definition indicates that individuals are entitled to at least 20 litres of water per day and should not spend more than 30 min to and from their destination to get water. A factor such as ‘distance’ to and from the SWS can differ depending on locale (whether it is urban and rural) as it is discussed by several authors (World bank 1997; Geere et al. 2016; United Nations Water 2020) where they argue that urban residents are perceived to spend less time in collecting water compared to rural inhabitants.

Additionally, Ritchie and Roser (2021) emphasise the fact that the presence of SWS within a reasonable distance to an individual’s dwelling does not affirm adequate WA if the water quality is debatable. This study hereby adopts the WHO and UN-Water’s definition of WA encompassing distance, quality, source, waiting time, and availability as essential criteria in ensuring WA. Therefore, WA is defined in this study as readily available water meeting individual’s daily requirement of minimally 20 litres per day from an appropriate source, free from contaminants such as chemical, faecal, or other forms of waste situated. Furthermore, the WA should be within walking distances of less than a mile to individuals’ dwellings, where the time spent to collect/fetch would not exceed 30 min.

2.2.1 Water Access Infrastructure and Quality Issues in Nigeria

To address ongoing WA issues in Nigeria, several organisations (such as the World Bank, African Development Bank, French Development Bank, USAID, and partners), go on to fund Water, Sanitation and Hygiene projects (WASH) across the country in affected areas. These WASH projects are aimed at providing sustainable water access to 2.5 million affected Nigerians (Global water partnership 2020). It is important to note that most of Sub-Saharan Africa is dependent on ground water supply (Yusuf & Abiye 2016; Kulinkina et al. 2017). In Nigeria, groundwater availability is linked to geographical location, whereby some regions have it in abundance, and other regions do not (The Federal Republic of Nigeria, 2004). Furthermore, groundwater is threatened by pollution and contaminants. In areas where groundwater is naturally available, other factors such as uncontrolled exploitation and mismanagement threaten WA availability (The Federal Republic of Nigeria, 2014). To manage water-related matters, several governing bodies have been put in place Table 4.

Table 4: Overview of water governing bodies in Nigeria and their responsibilities.

Level of Government	Governing Body	Responsibilities
Federal • Regulatory act (NIWA Act, 1997; Water Resource Act, 1993; Minerals Act, 1917; River Basin Development Act (RBDA), 1979; The Environmental Impact Assessment, 1992)	Federal Ministry of Water Resources (FMWR)	• Controls and manages water resources in the country. • Investigates issues with water resources. • Promotes water resource training. • Creates regulations for preventing pollution to water source. • Regulates and manages water resources. • Plans river basin development. • Provides protection to the environment (land, water, air, and all layers of the atmosphere). • Coordinates water activities through SWA.
State	State Water Agencies (SWA)	• Provides FMWR with necessary information concerning ongoing water projects, proposed water projects, quality of water, and other water related matters. • Supplies potable water in urban, semi-urban and rural areas. • Provides technical support to local governments.
Local	Local Government Councils	• Provides potable rural water supply and sanitation facilities.
Community		• Participates in rural water supplies and sanitation.

Source: (The Federal Republic of Nigeria, 2014).

The water projects being implemented are mainly borehole types across sub-Saharan regions (Price et al. 2019). These types of water projects (borehole) can pose a challenge when it comes to maintenance, as many of the implemented schemes have been reported to fail and subsequently have been abandoned by rural communities (Scanlon et al. 2019).
Other water projects being initiated in Nigeria and sub-Sahara are usually centralised water systems, which make it more tasking to meet the needs of all community members, taking distance, time, quantity, and availability into consideration (Price et al. 2019). Affordability is another limitation that can arise. There are reported cases that have been identified in Thambonkulu community, South Africa, where the price of water increases as water demand also increases (Nkuna & Ngorima. 2011). Putting a high cost on the water can compel individuals to adopt alternate means of water regardless of whether the alternate source is considered safe or not (Price et al. 2019; 21]. Additionally, in a study conducted in Malawi and Zambia, Scanlon et al. (2019) argues that the high cost of water resources involuntarily forces individual(s) in communities to abandon a SWS, which can hinder the planned sustainability of the water scheme.

In addressing WA issues, another area to investigate would be water quality threatened by pollution (United nations environment programme 2016; World health organization 2017; Santos et al. 2017) resulting from either agricultural, industrial, or household contaminants (Fulazakky 2014; Giessen et al. 2015; Maurice et al. 2019). Livestock grazing has been identified to pollute surface water sources (Behera et al. 2020). This pollution occurs through the transportation of pathogens from faecal waste, fertilisation processes, and animal nutrients (nitrogen and phosphorous), which are harmful to the human body (Hubbard et al. 2004). As the population is rapidly increasing in developing countries (Lester & Rhiney 2018), more specifically in Nigeria (Yusuf & Abiye 2016), maintaining substantial sanitary and hygienic practices has been proven to be a challenge (Odiyo &

Makungo 2012; Aliyu & Botai 2018). The consequence of this is contaminated SWS, leading to life-threatening ailments more dominant in rural parts of the country (Alfaro 2010; Maurice et al. 2019).

In Nigeria, Galadima et al. (2011) identified water quality to be affected by both non-point source and point source pollution. Run-off from polluted areas is the primary source of non-point pollution in Nigeria, while point source pollution is mainly by industrial, sewage waste, and oil spills. Local communities in Nigeria were identified to be hugely affected by water pollution (World health organization 2013). Their study identified various cultural lifestyles to influence water pollution, such as the use of unconventional toilets, inappropriate waste disposals, nonchalant erection of structures that block drainage, and agricultural practices such as the improper use of fertilisers and pesticides.

2.3 Current Advancement in Water Access Issues in Nigeria

Irrespective of these shortcomings, we cannot fail to identify efforts by government, stakeholders, and non-governmental organisations in improving WA. Studies have reported some progress with the number of populations with improved SWS (ISWS) when the comparison is made with past years and more recent years (Figure 2). However, there is still room for more advancement (Santos et al. 2017; Aliyu & Botai 2018) especially as safe drinking water still shows a rise in inadequacy over time (Figure 2).

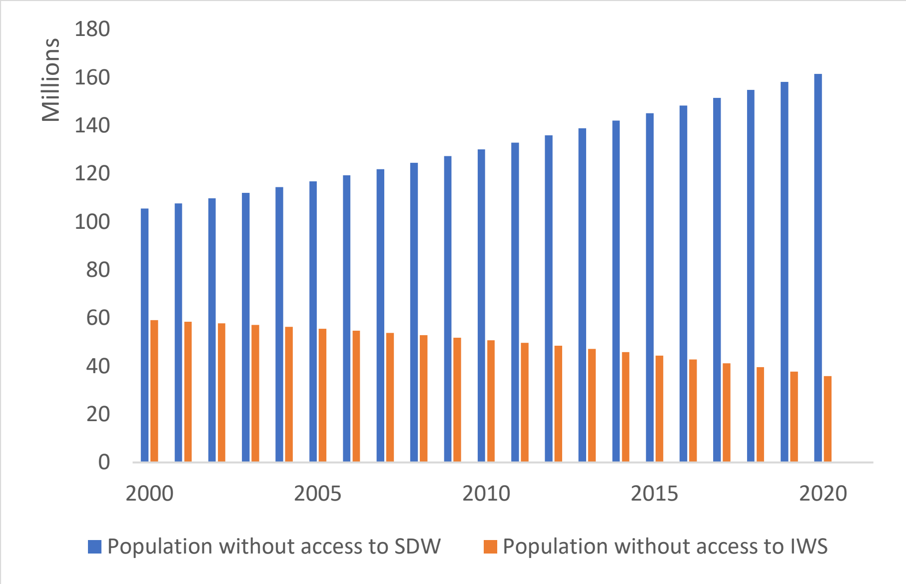


Figure 2: Overview of the population without access to safe drinking water (SDW) and ISWS in Nigeria from 2000 to 2020 (Obtained from (Ritchie & Roser 2021)).

As at 2020, from the 202 million population in Nigeria, 161 million do not have access to ISWS, while 35.8 million approximately are without access to safe drinking water (SDW) (Ritchie & Roser 2021). ISWS is defined as a "SWS which by nature of its construction, adequately protects the water from outside contamination" (World health organization 2013). However, having access to ISWS does not guarantee access to safe drinking water, which is when drinking water quality conforms with the WHO drinking-water quality guidelines on acceptable microbiological and chemical levels (World health organization 2013), which are also free from pollution and contaminant (Ritchie & Roser 2021).

Not only is water needed for our survival and considered our basic human right, but it is also believed that to improve sustainable development in rural areas, and adequate WA is considered an essential element in achieving this (Wasonga et al. 2016; Lester & Rhiney 2018; Herslund & Mguni 2019; Li et al. 2019).

2.4 Barriers to Water Access—The Role of Socio-Cultural Factors

Eichelberger (2017) highlighted the influence of socio-cultural factors on access to adequate water. Traditional beliefs, social norms, and various traditional practices determine what type of SWS is used by the rural communities in Alaska (Eichelberger 2017), where most individuals utilise poor SWS because of their cultural heritage and ties. This report conforms with studies by Smith & Ali (2006) where they investigated ethnic minorities in the United Kingdom, Kenya (Li et al. 2019), and Nepal (Behera et al. 2020), where cultural factors have been identified to influence water access. Maurice et al. (2019) further stressed that communities with strong cultural ties are seen to disregard the quality of an SWS due to inherited habits. In the context of Nigeria, where diversity in culture and ethnicity is evident across all states, Crow and Sultan (2002) attribute these disparities in culture to be an influencing factor in how water resource is accessed.

Another socio-cultural factor identified to influence adequate WA is gender inequality (Aliyu & Botai 2018). When it comes to deciding water access and ownership of water resources, women are often underrepresented (Crow and Sultan 2002), making it a male-dominated position. Gender disparity is apparent with regard to natural resource ownership in Nigeria (Oladokun et al. 2018). Most water projects carried out in Nigeria are mainly controlled by men in rural parts of the country (Oladokun et al. 2018). This practice can be relatively linked to the Hofstede cultural dimension of a high level of power distance within this community (Cheung & Chang 2011; Opeyemi & Bayode 2018), which then have limited chances of development and growth (Arends-Toth & van de Vijver 2008). In addition, equal gender representation in the use and decision making of natural resources can improve their management (Hrivikova 2016; Leisher et al. 2016).

Gender discrimination is predominant in remote areas of the world (Kinias & Kim 2012), and this is because of the strong cultural values being preserved within these communities. For instance, in rural parts of Benin, the average time spent by young female children in collecting water is estimated to be an hour in a day, compared to male children reported to spend less than 30 min (United nations water 2020). Asides from gender inequality, social inequality and exclusion have been identified to impact equal WA across communities (Aliyu & Botai 2018).

Key roles of social actors such as traditional rulers in ensuring WA in Sub-Saharan Africa have been identified (Sacnlon et al. 2016), further recognising that cultural factors such as religion in rural parts of Zambia have been established to influence WA.

Additionally, several practices such as farming, fishing, and other daily activities are also seen to influence water access in rural Nigeria. On top of climate change, the traditional farming practices contribute to the further worsening of water scarcity and increasing groundwater pollution (Yusuf & Abiye 2019; Gi Lee et al. 2019; World health organization 2021). This traditional method is accustomed to rural communities, and community members find it difficult to adopt more modern sustainable practices due to existing cultural ties and effort to preserve their cultural values (Choi et al. 2017).

2.5 Kogi State Water Project Formulation

Water projects have been introduced to rural communities in Nigeria, Kogi state to be precise in a bid to tackle ongoing WA issues. A major obstacle is the sustainability of these water schemes. WA issues in developing countries are central to the lack of adequate infrastructure and a proper SWS (Mathews-njoku & Nwaogwugwu 2014). To address WA issues, SWS has been identified to be an influencing factor in Nigeria (Atunes & Martins 2020)—with the presence of an adequate SWS, water access issues in affected communities would be tackled. Therefore, this study focuses on SWS choice and several predictors. According to prior studies, an adequate SWS is described as an ISWS, which can be either a borehole, piped scheme, and/or protected wells (World health organization 2013; Akoteyon

2019; Abubakar 2019). To further understand the influencing factors on SWS choice, studies carried out by Abubakar (2019) and Emenike et al. (2017) in Nigeria identified demographic factors such as distance to SWS, gender, household size, education, occupation, and income level to contribute to choosing a type of SWS being used by individuals in concerned rural communities. These findings are in line with other studies carried out in other regions such as Jamaica (Lester & Rhiney 2018), Ecuador (Maueice et al. 2019), and Nepal (Behera et al. 2020), where cultural factors such as gender inequality, beliefs, traditional practices, and religion (Scanlon et al. 2016) were also identified to influence decisions on SWS usage. This paper's hypothesis is that the predictor variables (age, water distance, gender, occupation, education, ethnic group, religion, income, household size) will influence the choice to use a particular water source.

Furthermore, with the provision of the appropriate SWS, the question of its sustainability arises. Therefore, this research seeks to investigate how the following predictor variables (age, water distance, gender, occupation, education, ethnic group, religion, income, household size, water source, cost of maintenance and trust of water source managers) would influence respondents' willingness to participate in sustainable water management (SWM).

In a bid to address the ongoing issues highlighted with water access under the SDG 6 framework, the federal government in Nigeria awarded several water projects to all thirty-six states in the country, targeting rural communities. The water projects were tendered and opened for bidding to private contractors who were awarded the contract to develop ISWS in specific locations selected by the Federal Ministry of Works and Housing (FMWH), under the Federal Republic of Nigeria. The Kogi project commenced in 2017, and the contractors selected are paid in stages and receive up to 90% of payment only after the completion of the project. Afterwards, the contractors are subject to a waiting period of 6 months to ensure any defects with the water scheme are addressed before they are paid the remaining 10%. The contractors must work with engineers appointed by the FMWH whose presence on site is essential in determining the water source location and type of water source that fits the location. The federal government engineers are the local expert that makes the decision onsite regarding what type of water source (borehole, handpump) is suitable for the rural community. Through collaboration with the community leaders, the site where the water scheme would be situated is selected (this is usually where tribal dominance takes hold, as the ethnic group with favoured political personnel or party will be at the forefront of the decision-making process which determines in which area the water source will be located). Some contractors implemented motorised or solar boreholes (as recommended by the onsite engineer). After the project completion and the 6-month defect period elapses, the responsibility of maintaining the ISWS is then transferred to the community leader who ensures long-term functionality of the ISWS in cooperation with the community residents.

The entire community has free access to the water source that has been provided and is now being managed locally by the appointed community members/leaders. They are expected to come up with ways to manage the schemes through maintenance fees and other minor contributions according to what is determined by the community and their leaders. However, in some areas where a solar borehole was proposed, long-term management issues of a technical nature discouraged the idea, which then led to a switch to a motorised borehole system. This preferred system will be cheaper to manage, and communal contribution for fuel and maintenance was agreed to be a better option for the beneficiaries.

3 STUDY OBJECTIVES AND GOALS

The previous chapter have concluded literature review. This chapter contains of the following parts: **3.1** Study aims and objectives. **3.2** highlights the Research questions and study objectives.

3.1 Study aims and objectives

This study aims to identify the factors that influences participants' willingness to participate in sustainable water management (SWM) that subsequently affects their WA, alongside the various challenges faced with SWM. Additionally, this study seeks to identify the influence of demographic factors (gender, education, income, occupation) and cultural factors such as religion and ethnic groups (Akoteyon 2019; Abubakar 2019) on water access in rural communities in Kogi state, Nigeria. Similar studies have been carried out in Nigeria in the northeastern and northwestern regions of the country (Abubakar 2019) as well as in the southwestern part of Nigeria (Emenike et al. 2017), where influencing factors such as age, ethnicity, gender, household size, state, and local government area (LGA) of residency, occupation, wealth, and level of education of the household head amongst other factors were investigated. However, this paper is conducted in a different region, the Middlebelt part of Nigeria, Kogi state, and it would go a step further to add to the uniqueness of the current research by investigating and identifying the level at which these factors influence SWS choice.

Furthermore, this study aims to proffer recommendations for future studies and policymakers in addressing issues surrounding WA. These will be achieved by identifying how the aforementioned factors influence the choice to use a particular SWS.

3.2 Study research Question

This study poses two main research questions, as follows:

1. Research Question 1 (RQ1): What factors contribute to individuals' willingness to participate in SWM amongst Nigeria rural communities?

2. Research Question 2 (RQ 2) – What are the factors that influence the decision on selecting a water source in rural Nigeria?

In the bid to answer the research questions formulated, three (3) study objectives are developed.

For RQ1, two objectives were formulated:

1. to Identify challenges in SWM for rural inhabitants of Kogi state,

2. To identify factors that affect individuals' willingness to participate in SWM;

for RQ2, one objective was formulated:

3. to evaluate Factors that influence selection of specific water source.

4 METHODOLOGY

This chapter highlights the study area and the various methodologies adopted for this study.

4.1 Study Area

Kogi state is among the states in the Federal Republic of Nigeria located in the middle belt region. Kogi has a total land area of approximately 30,230 km^2. The state is popularly known as the confluence state because of the meeting of two rivers (river Niger and river Benue). There are mainly two climate seasons: the wet/rainy season (April–October) and dry/harmattan season (November–April). As a result of this seasonal variation, alternate SWS is vital.

Based on the 2016 national census, the estimated population count is 4,473,544. The state is inhabited by diverse people from different cultural backgrounds. Kogi state is divided into three zones: Kogi East, Kogi West, and Kogi Central. This study was conducted in Kogi East, which is dominated by the Igala ethnic group. Kogi has more than ten different ethnicities and cultures (Kabiru et al. 2020; Babatimehin et al. 2020), which are richly flourished with natural resources ranging from water, land, and minerals. Within Kogi state, there are six main ethnic groups (Table 6). The state is mainly dominated by rural communities, amassing almost 70% of its population (Babatimehin et al. 2020). Occupations such as technical craft and trading are evident in the state, but the economy is mainly boosted by agricultural income, primarily through fishing and farming (Atedhor 2015; Babatimehin et al. 2020). Kogites (as inhabitants of the state are known to be called) have three main religious beliefs, which are Christianity, Islam, and traditional religion.

The characteristics of the participants in the study with relation to water collection are described as follows: 35.6% of participants travel on foot to the water source destination, usually less than 15 min or less than 1 mile, as described in more details in the Results section. Furthermore, participants use buckets and gallons as water collection instruments

(Figure 3, Figure 4). The average daily trip made to the water collection points is twice, in the morning and evening. A good portion (60%) of the individuals, as described in Table 10, utilise the water for domestic consumption within their households.

Figure 3: Resident collecting water from water point with a gallon

Figure 4: Resident collecting water from water point with a bucket

This study was conducted in the eastern part of the state in three LGA (Figure 6) namely, Dekina, Omala, and Ankpa, which in total have an area of 867.04 km² and are situated approximately 41 km apart from each other. These LGAs were randomly selected from the list of LGAs that were approved beneficiaries of government implemented water schemes within Kogi state (Kogi state government 2020). The selected LGAs are mainly dominated by rural communities, having most of the inhabitants specialising in agricultural practices, petty trading, and vocational jobs as a means of livelihood, with a few white-collar jobs in the region (Babatimehin et al. 2020). The LGAs are home to numerous tribes, with the majority group being Igalas; other tribes are Bassa, Agatu, Yoruba, and Idoma. Until recently, the residents of the study region depended on the water from rivers and streams and collected water for their daily needs. Still, some areas rely on these sources; however, the introduction of water projects to the region gives room for the residents to have options to choose from another range of SWS (e.g., motorised borehole systems and handpumps borehole systems) (Table 5; Figure 5). The rural communities studied were selected based on the number of approved water projects being implemented through the Federal Government of Nigeria.

Figure 5: Various water systems available in Kogi state, Nigeria

Table 5: The various water source with description of the level of adequacy.

Water Source	Level of Adequacy of the Water Source
Tap/Borehole	Adequate
Tap/Handpump	Adequate
Well	Average
Reservoir	Inadequate
Stream	Inadequate

Source: (World Health Organisation 2017)

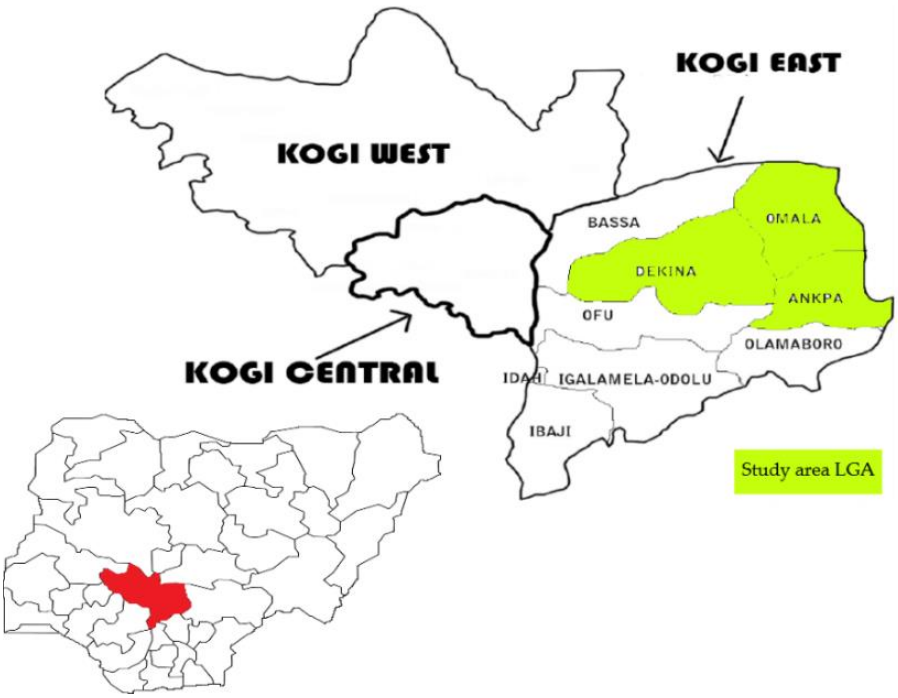


Figure 6: Selected Study local government area in Kogi state.

4.2 Data Collection and Analysis

This study used the viewpoint that water access is a basic human right, also emphasised in SDG 6, wherein every individual is entitled to potable water. Multistage sampling was adopted for this research. Based on the list of states that were beneficiaries of the water projects that have been implemented and ongoing, Kogi state was selected, after which the three LGAs within Kogi state were randomly selected (Kwangware et al. 2014). Participants were also randomly selected. The questionnaire survey was administered to 404 community members residing in any of the three selected LGAs described as follows: Dekina LGA (n = 140), Ankpa LGA (n = 132), and Omala LGA (n = 132) between June and July 2019. To build a good rapport with the community and assist with language barriers, a male local guide was present during the survey administration process.

The questionnaire was elaborated based on the adoption of the Joint Monitoring Programme (JMP) 2018 core questions intended for a water access household survey to monitor WASH and SDGs in affected communities. The questionnaire comprised of 19 questions, which were grouped to collect demographic and other relevant information used to measure the participants' access to water such as the SWS being used, their culture and ethnical background, along with their level of knowledge about and involvement in water management activities. The questions were designed as open-ended, multiple-choice, and a 5-point Likert-scale option. Water access is measured in this study using SWS (that is, the selected choice of SWS indicated by respondents). To identify the main water source in the study area, multiple-choice questions were used, including tap/borehole, tap/handpump, well, stream, and reservoir. Further insight on cultural factors of water access issues and effects of socio-cultural factors were identified through structured interviews with key players in the community (Mahama et al. 2014). A total of 12 participants including four community leaders, four farmers, two civil servants, and two private contractors were purposively selected from the three LGAs where the study was conducted (four participants from each LGA).

Qualitative data were analysed using the online application DEDOOSE for coding and analysis of transcribed data. For the quantitative data, STATA version 13 was utilised for the analysis. A Pearson Chi-square test of association was used to test for relationships between a dependent variable (SWS choice) and independent variables (demographic). Multinomial regression (Madiba & Ngwenya 2017) was used at a multivariate level to explain the relationships between dependent (water source choice) and independent variables (Mahama et al. 2014; Tuyet-Hanh et al. 2016) (age, gender, level of education, religion, occupation, household size, income, and ethnic groups). Ordinal logistic regression model was used to identify the influence of the predictor variables on the dependent variable (Willingness to participate in SWM). This choice of analysis has been used by prior research (Emenike et al. 2017; Abubakar 2019) in similar studies conducted in southern and western regions of Nigeria; hence, its adoption in the current study is being carried out in the middle belt region of Nigeria (Table 6).

Table 6: Characteristics of the main ethnic groups in Kogi state.

Ethnic Group	**Language**	**Main Occupation**	**District**
Igala	Igala	Farming	Kogi East
Ebira	Ebira	Farming, textile making	Kogi Central
Yoruba (Okun)	Yoruba	Farming, trading	Kogi West
Bassa	Bassa nge	Fishing, farming	Kogi Central
Nupe	Nupe	Fishing	Kogi Central

Source: Author

4.3 Multinomial Logistic Regression Model

The multinomial logistic regression assumes that the dependent variable should be nominal in nature; the independent variable(s) should not be multicollinear and should be more than one (either be nominal, ordinal, or continuous); the continuous independent variable and logit transformation of dependent variable should be linear in nature; the dependent variable should have exclusive categories; the model should not have high influential points and outliers (Rodrigues 2021).

To achieve the econometric specification of the dependent variable, which is SWS, the research adopts the use of the multinomial logistic regression model. SWS choice is accessed using the following predictor variables: (1) Age, (2) Gender, (3) Ethnic group, (4) Religion, (5) Household size, (6) Level of education, (7) Occupation, (8) Monthly income, and (9) Distance to a water source.

According to Rodriguez [65], the model estimates a set of coefficients, $\beta(1)$, $\beta(2)$, and $\beta(3)\ldots$, corresponding to each outcome

$$\Pr(y = 1) = \frac{e^{x\beta(1)}}{e^{x\beta(1)} + e^{x\beta(2)} + e^{x\beta(3)}} \quad (1)$$

$$\Pr(y = 2) = \frac{e^{x\beta(2)}}{e^{x\beta(1)} + e^{x\beta(2)} + e^{x\beta(3)}} \quad (2)$$

$$\Pr(y = 3) = \frac{e^{x\beta(3)}}{e^{x\beta(1)} + e^{x\beta(2)} + e^{x\beta(3)}} \quad (3)$$

In the model, there is more than one solution to $\beta(1)$, $\beta(2)$, and $\beta(3)$ that leads to the same probabilities for y = 1, y = 2, and y = 3; therefore, we set any one of the coefficients ($\beta(1)$, $\beta(2)$, and $\beta(3)$) to 0. In other words, if $\beta(1)$ is set =0, the other coefficients $\beta(2)$ and $\beta(3)$ will measure the change relative to the y = 1 group, and so on.

If $\beta(1) = 0$, then:

$$\Pr(y = 1) = \frac{1}{1 + e^{x\beta(2)} + e^{x\beta(3)}} \quad (4)$$

$$\Pr(y = 2) = \frac{1}{1 + e^{x\beta(2)} + e^{x\beta(3)}} \qquad (5)$$

$$\Pr(y = 2) = \frac{1}{1 + e^{x\beta(2)} + e^{x\beta(3)}} \qquad (6)$$

The SWS selected by the participants vary by distance to WS and other socio-demographic parameters. All obtained parameters must be interpreted relatively to this reference category, which is stream. SWS has M categories (Table 7); hence, we calculate M-1 equations for each of the categories relative to the reference category in the other to describe the relationship between the predictor variable and dependent variable. Given the probability (Pr = (Yi = j), to sum one over remaining choice, we then have this equation: $\left[\sum_{j=1}^{m} \Pr(Y_{i=j} = 1\right]$, allowing probability to be calculated independently. To solve the problem, we use normalisation to set the following β_{ik} = 0, k = 1, …, K. Considering this, normalisation Z_{i1} = 0, hence, the equation below:

$$\Pr(y_i = m) = \frac{\exp(Z_{ij})}{1 + \sum_{j=2}^{M} \exp(Z_{ij})} \qquad (7)$$

$$\Pr(y_i = 1) = \frac{1}{1 + \sum_{j=2}^{M} \exp(Z_{ij})} \qquad (8)$$

To calculate the log odds, the probability of outcome (j = m) to outcome (j = k) from the equations above ((7) and (8)), the equation below is derived. The log odds are the logarithm of the odds ratio, meaning the coefficient normalised by the standard error.

$$\text{Log}\left[\frac{\Pr(Y_{i=m})}{\Pr(Y_{i=k})}\right] = \alpha_m + \sum_{k=1}^{k} \beta_{mk} X_{ik} = Z_{mi} \qquad (9)$$

4.4 Ordinal Logistic Regression Model

Ordinal logistic regression was adopted in this research predict an ordinal dependent variable (willingness to participate in SWM), measured on a 3-point Likert scale (Unlikely, Neutral, and Likely) given one or more independent variables; (1) Age, (2) Gender, (3) Ethnic group, (4) Trust in person maintaining WS, (5) Household size, (6) Level of education, (7) Occupation, (8) Monthly income, and (9) Water source (10) Cost of maintenance.

In ordinal logistic regression, there are four (4) assumptions;

- The dependent variable is measured at ordinal level such as Likert scale, which is fulfilled in this study (see table 7).
- The second assumption is one or more independent variables that are continuous, ordinal, or categorical (including dichotomous variables). However, the ordinal independent variables must be treated as being either continuous or categorical.
- The third assumption is that there is no multicollinearity.
- The fourth assumption is the proportional odds. This assumption means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable.

In illustrating the model, we assume Y to be an ordinal outcome with J categories. Then (P($Y \leq j$) is the cumulative probability of Y less than or equal to a specific category j = 1, …, J-1. Note that (P($Y \leq j$) $= 1$. The odds of being less than or equal a particular category can be defined as

$$\frac{P(Y \leq j)}{P(Y > j)} \qquad (11)$$

For j = 1, …, J-1 since P($Y > j$) $= 0$ and dividing by zero is undefined. On the other hand, we can write P($Y > j$) $= 1 -$ P($Y > j$). The log odds is also known as the logit, therefore;

$$\log \frac{P(Y \leq j)}{P(Y > j)} = logit \ (P(Y \leq j)) \qquad (12)$$

Thus, the ordinal logistic regression model can be defined as

$$logit \ (P(Y \leq j)) = \beta_{j0} + \beta_{j1x1} + \ldots + \beta_{jpxp} \qquad (13)$$

For j = 1, …, J-1 and p predictors.

In Stata, the ordinal logistic regression model is parameterized as

$$logit\ (\mathrm{P}(Y \leq\ j)) = \beta_{j0-\eta1x1\ -\ ...\ -\ \eta\mathrm{p}x\mathrm{p}} \qquad (13)$$

As we want to identify whether the binary predictor "willingness to participate in SWM" predicts an ordinal outcome of rural participants in Kogi state, who are unlikely, neutral, and likely going to participate in SWM, the parallel lines assumption, irrespective of the five categories, the coefficient of "willingness to participate in SWM" stays the same across the two categories. The two equations for Willingness to participate in SWM = 1 and Willingness to participate in SWM = 0 are

$$logit\ (\mathrm{P}(Y \leq\ j|x_1 =\ 1)\ =\ \beta_{j0-\eta1} \qquad (14)$$

$$logit\ (\mathrm{P}(Y \leq\ j|x_1 =\ 0)\ =\ \beta_{j0} \qquad (15)$$

Then:

$$logit\ (\mathrm{P}(Y \leq\ j|x_1 =\ 1)\ -\ logit\ (\mathrm{P}(Y \leq\ j|x_1 =\ 0)\ =\ -\eta_1 \qquad (16)$$

This study interpreted the odds ratio, to interpret the odds ratio, the proportional odds assumption is not simply that the odds are the same but that the odds ratios are the same across categories. These odds ratios can be derived by exponentiating the coefficients (in the log-odds metric), but the interpretation is a bit unexpected. Recall that the coefficient –η1 represents a one-unit change in the log odds of respondents not willingly participating in SWM in rural part of Kogi state and those who are not. The exponent is the inverse function of the log, we can simply exponentiate both sides of this equation, and by using the property that; $\log(b) - \log(a) = \log\frac{b}{a}$ (17)

The odds ration therefore would be interpreted as;

$$\frac{(\mathrm{P}(Y\leq\ j|x_1 = 1)}{(\mathrm{P}(Y>\ j|x_1 = 1)} \Big/ \frac{(\mathrm{P}(Y\leq\ j|x_1 = 1)}{(\mathrm{P}(Y>\ j|x_1 = 1)} =\ exp(-\eta_1) \qquad (18)$$

Table 7: Descriptive statistics of key variables (N = 404).

Key Variables	Description	Min	Max	Mode	Mean	SD
Age (years)	Continuous variable	18	70	30	30.9	9.8
Sex	Female = 0 Male = 1	0	1	1	0.6	0.5
Ethnicity	Igala = 1 Ebira = 2 Yoruba = 3 Agatu = 4 Others = 5	1	5	1	2.3	1.6
Religion	Christianity = 1 Islam = 2 Traditional = 3 Others = 4 Atheist = 5	1	2	1	1.4	0.5
Household size	1–6 members = 1 7–12 members = 2 13–18 members = 3 19–24 members = 4 25–30 members = 5	1	5	3	2.6	0.7
Level of education	Primary = 1 Secondary = 2 Technical = 3 Higher education = 4	1	4	2	2.3	1
Occupation	Farmer = 1 Student = 2 Civil servant = 3 Business = 4 Blue collar = 5	1	5	4	2.8	1.4
Household's monthly income	More than N18,000 = 1 Less than N18,000 = 2 I will not say = 3 Does not apply/No monthly income = 4	1	4	4	2.2	1.1
Distance to water source	30 min = 1 15 min to 30 min = 2 15 min = 3 less than 15 min = 4	1	4	4	3.6	0.8

Dependent Variables						
Water source	Stream = 1 Tap/borehole = 2 Tap/handpump = 3 Well = 4 Reservoir = 5	1	5	2	2.6	1.2
Willingness to participate in SWM	Unlikely =1 Neutral = 2 Likely = 3	1	3	3	1.8	0.7

4.5 Socio-Demographic Characteristics of the Study

The descriptive characteristics of respondents are shown in Table 4. The survey evenly covered samples from three LGAs in Kogi state: 132 (32.7%) respondents from Ankpa, 140 (34.7%) from Dekina, and 132 (32.7%) from Omala. The majority of respondents (52.5%) belong to the Igala ethnic group (out of the five groups), the rest are distributed among Ebira (7.9%), Yoruba (Okun) (12.4%), Agatu (11.4%), and small tribes such as Hausa, Igbo, and Nupe (15.8%). The majority of the respondents proclaim association with Christianity (56.2%) and Islam (43.8%). Male respondents 241 (59.7%) prevailed over females 163 (40.3%) with an average age of about 30 years.

As regards the highest level of education achieved, 22.3% of the respondents have primary education, 42.6% have secondary education, 20.3% have higher education, and 14.9% have technical education. The respondents live in households comprising on average 2.6 members.

As for the occupation, the respondents reported themselves as small business owners (30.7%), farmers (24.8%), students (18.3%), civil servants (16.6%), and blue-collar workers (9.7%) including mechanics, welders, carpenters, brick layers (mason), and electricians. The income was measured using the minimum wage at the time of survey, which is 18,000 naira (43 USD). Only 11.9% of the respondents indicated that they earn less than 18,000 naira as monthly income, 40.1% earn more than 18,000 as household monthly income, while the majority (159 respondents) 39.4% refused to divulge information about their monthly income, while 35 (8.7%) of the respondents did not have a monthly income.

Distance to SWS was measured using the time it takes to walk to the SWS. The study estimated 30 min of walking to be approximately 2 miles (3.2 km) using a pace calculator; (with the average speed being 0.0667 per minute). Most (79%) of respondents indicated they walk less than 15 min (less than 1 mile) to a SWS, while only 4.0% respondents indicated that they walk more than 3.2 km to the SWS.

5 RESULTS

5.1 Challenges in SWM for rural inhabitants of Kogi state

In other to identify the challenges the participants face when it comes to SWM, the interview conducted was analysed using DEDOOSE. From the codes generated according to the research objectives, the main themes were identified according to gender and occupation of the participants in the study area. Table 8 shows a summary of the themes and how frequently they were recorded during the interview. Appendix A shows the comprehensive lists and the number of times they occurred during the interview with the respondents.

Table 8: Result of thematic analysis showing the summary of themes based on gender and occupation.

Themes according to gender/occupation	Maintenance cost	Distrust	Community Management	Involvement / Participation	Preferred water source	Satisfaction with WS	Culture and Religion	Government \ New systems provided	Conflict	Fear of Judgment
Female	0	7	4	5	11	3	10	4	5	4
Male	5	10	18	15	16	6	24	9	12	9
Female x Farmer	0	6	2	3	6	1	6	2	2	1
Female x Fisher	0	0	1	1	3	1	2	1	2	2
Female x Teacher	0	1	1	1	2	1	2	1	1	1
Male x Business	0	1	5	4	0	1	4	1	1	1
Male x Civil servant	2	3	3	3	5	2	6	3	2	2
Male x Contractor	1	0	5	1	4	0	4	2	3	3
Male x Farmer	1	1	0	2	2	1	3	1	2	1
Male x Teacher	1	3	2	2	2	1	3	1	1	0
Male x Vigilante	0	2	3	3	3	1	4	1	3	2

0 - 3	4 - 6	7 - 9	10 - 12	13 - 15	16 - 18	19 - 21	22 - 24

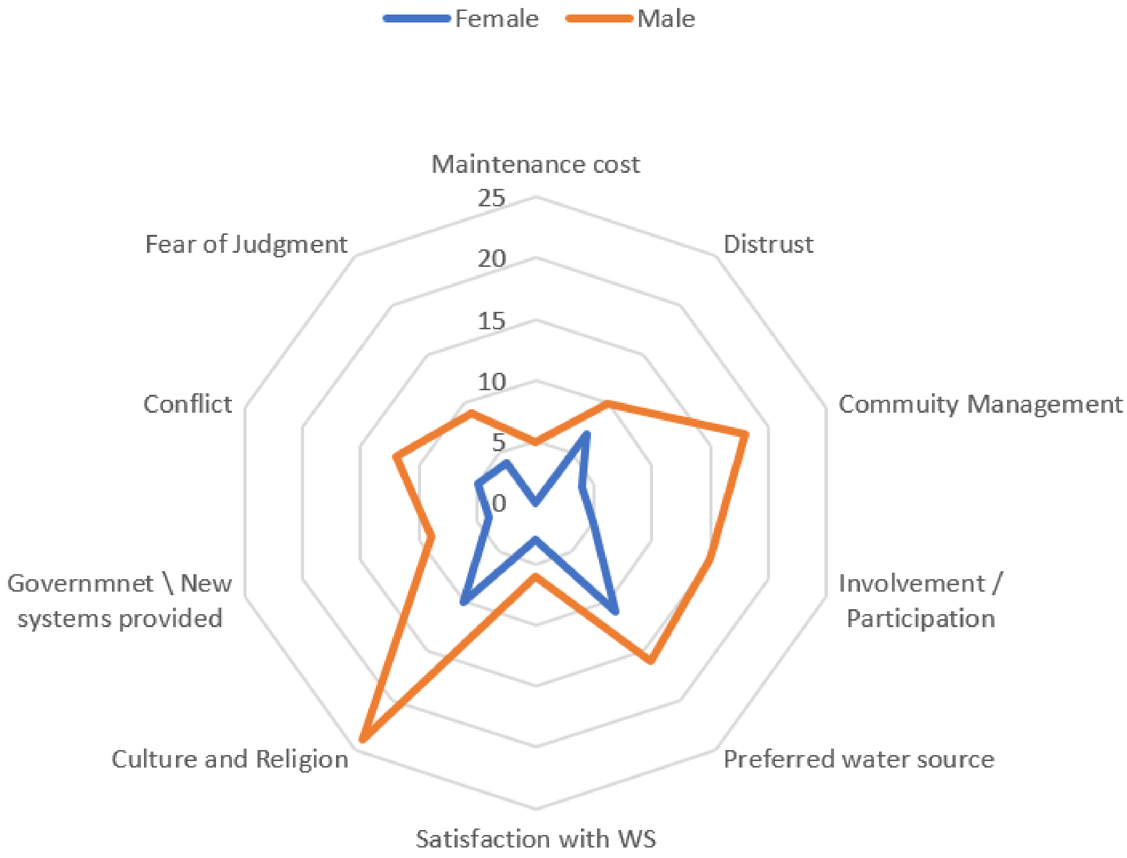


Figure 7: Spider chart showing occurrence of SWM challenge themes generated during the interview.

From the findings in the thematic analysis indicated that culture and religion theme were the most recurring from the other themes generated (figure 7). Looking at the respective gender, for female, the most recurring theme was distrust, preferred water source, culture and religion. However, for the male, Culture and religion, community management, preferred water source, involvement / participation, conflict, and distrust are the most recurring themes. Table 8 shows that the challenges (themes) identified to influence SWM varies according to gender, this can be related to the Hofstede cultural dimensions theory, masculinity versus femininity. According to Hofstede (1997), masculinity is associated with assertiveness, achievements through material things, competition while femininity is associated with naturing roles that is focused on the quality of life.

5.2 Association between a Water Source Choice and Predictor Variables

When testing for the relationship of the independent variables with the dependent variables, the study adopted the use of the Chi-square test (Emenike et al. 207). The test shows the association between respondents' characteristics and the SWS being used by the respondents. The results show a significant relationship between the level of education and type of SWS used ($p \leq 0.001$). Aside from respondents that indicated they had just a primary level of education, where it shows that their main water source was a "stream", the rest (secondary, technical, and higher education) had 16%, 5.4%, and 10.4% respectively, indicating "tap/borehole" source to be their main SWS. Additionally, there was a significant relationship between age and type of SWS used ($p = 0.055$, confidence interval =90%) (Table 9). From Table 9, most of the participants (4.5%) that fall within the age group 42 years and above utilise "stream" compared to the younger population, where the majority indicated that "tap/borehole" was their main source of water. Table 9 also indicates that more than 50% of the participants in each of the income level categories utilise ISWS (i.e., either tap/borehole or tap/handpump). The majority (56, 13.9%) of the respondents who earn more than N18,000 had access to "tap/borehole" water, 33 (8.2%) had access to "stream" water, and 23 (5.7%) of them had access to "well" water. Fifteen (3.7%) of the respondents who earn less than N18,000 had access to "tap/borehole" water, while 10 (2.5%) had access to "well" water, and 7 (1.7%) had access to "stream" water.

Table 9: Test of association between predictor variables and water source used (N = 404).

Water Source Used	Reservoir	Stream	Tap/ Borehole	Tap/ Handpump	Well	*p*-Value
	Number of respondents (%)					
Age (years)						
18–25	6 (1.5)	18 (4.5)	51 (12.6)	35 (8.7)	24 (5.9)	0.055 **
26–33	12 (3.0)	29 (7.2)	60 (14.9)	32 (7.9)	27 (6.7)	
34–41	3 (0.7)	10 (2.5)	24 (5.9)	11 (2.7)	10 (2.5)	
42 and above	5 (1.2)	18 (4.5)	15 (3.7)	3 (0.7)	11 (2.7)	
Level of Education						
Primary *	14 (3.5)	35 (8.7)	18 (4.5)	3 (0.7)	20 (5.0)	<0.001 ***
Secondary *	4 (1.0)	28 (6.9)	68 (16.8)	37 (9.2)	35 (8.7)	
Technical *	0 (0.0)	11 (2.7)	22 (5.4)	17 (4.2)	10 (2.5)	
Higher *	8 (2.0)	1 (0.2)	42 (10.4)	24 (5.9)	7 (1.7)	
Religion						
Christianity	9 (2.2)	37 (9.2)	86 (21.3)	54 (13.4)	41 (10.1)	
Islam	17 (4.2)	38 (9.4)	64 (15.8)	27 (6.7)	31 (7.7)	0.039 **
Ethnic group						
Igala *	9 (2.2)	37 (9.2)	87 (21.5)	53 (13.1)	26 (6.4)	
Ebira *	0 (0.0)	5 (1.2)	19 (4.7)	4 (1.0)	4 (1.0)	
Yoruba * (Okun)	1 (0.2)	14 (3.5)	17 (4.2)	9 (2.2)	9 (2.2)	
Agatu *	5 (1.2)	12 (3.0)	10 (2.5)	3 (0.7)	16 (4.0)	<0.001 ***
Others *	11 (2.7)	7 (1.7)	17 (4.2)	12 (3.0)	17 (4.2)	
Occupation						
Farmer *	6 (1.5)	44 (10.9)	23 (5.7)	9 (2.2)	18 (4.5)	<0.001 ***
Students	2 (0.5)	9 (2.2)	35 (8.7)	17 (4.2)	11 (2.7)	
Civil servant *	9 (2.2)	4 (1.0)	31 (7.7)	16 (4.0)	7 (1.7)	
Business *	9 (2.2)	11 (2.7)	46 (11.4)	32 (7.9)	26 (6.4)	
Blue collar	0 (0.0)	7 (1.7)	15 (3.7)	7 (1.7)	10 (2.5)	
Distance to water						
30 min *	0 (0)	14 (3.5)	1 (0.2)	0 (0)	1 (0.2)	<0.001 ***
15 to 30 min *	0 (0)	29 (7.2)	1 (0.2)	2 (0.5)	1 (0.2)	
15 min *	1 (0.2)	25 (6.2)	4 (1.0)	6 (1.5)	0 0 (0)	
Less than 15 min *	25 (6.2)	7 (18.6)	144 (35.6)	73 (18.1)	70 (17.3)	

N = 404 Confidence level = 95%, 90%, *** *p* value ≤ 0.001, ** *p* value ≤ 0.05, 0.1, * Significant group.

Table 10: Test of association of water practices with water source.

Type of Water Source	**Stream**	**Tap/ Borehole**	**Tap/ Handpump**	**Well**	**Reservoir**	**Total**	***p*-Value**
Number of respondents (%)							
Cost of maintenance of the water point is reasonable							
Strongly Disagree	5 (1.2)	6 (1.5)	1 (0.2)	1 (0.2)	0 (0.0)	13 (3.2)	
Disagree	16 (4.0)	15 (3.7)	13 (3.2)	4 (1.9)	0 (0.0)	48 (11.9)	
Neutral	23 (5.7)	40 (9.9)	26 (6.4)	17 (4.2)	6 (1.5)	112 (27.7)	0.014 **
Agree	31 (7.7)	87 (21.5)	41 (10.1)	50 (12.4)	20 (5.0)	229 (56.7)	
Strongly Agree	0 (0)	2 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.5)	
						404 (100)	
Women and children do the water fetching for domestic needs							
Strongly Disagree	0 (0)	3 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.7)	
Disagree	10 (2.5)	70 (2.4)	38 (9.4)	31 (7.6)	12 (2.9)	161 (39.8)	
Neutral	22 (5.4)	37 (5.4)	15 (3.7)	13 (3.2)	9 (2.2)	96 (23.7)	<0.0001 ***
Agree	41 (10.1)	37 (10.)	28 (6.9)	28 (6.9)	5 (1.2)	139 (34.4)	
Strongly Agree	2 (0.5)	3 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.2)	
						404 (100)	
The water available is better used for farming activities than domestic ones							
Strongly Disagree	0 (0)	18 (0))	3 (0.7)	0 (0.0)	0 (0.0)	21 (5.1)	
Disagree	3 (0.7)	123 (0.7)	62 (15.3)	21 (5.1)	13 (3.2)	222 (54.9)	
Neutral	11 (2.7)	8 (2.0)	13 (3.2)	33 (8.2)	12 (3.0)	77 (19.1)	<0.0001 ***
Agree	57 (14.1)	0 (0)	2 (0.5)	18 (4.5)	1 (0.2)	78 (19.3)	
Strongly Agree	4 (1.0)	1 (0.2)	1 (0.2)	0 (0.0)	0 (0.0)	6 (1.5)	
						404 (100)	
Daily trips to water points for households use							
3 times a day	34 (8.4)	61 (15.1)	51 (12.6)	43 (10.6)	16 (4.0)	205 (50.7)	
5 times a day	3 (0.7)	80 (19.8)	18 (4.5)	16 (4.0)	3 (0.7)	120 (29.7)	
More than 5 times a day	0 (0.0)	4 (1.0)	4 (1.0)	1 (0.2)	2 (0.5)	11 (2.7)	<0.0001 ***
Once a day	6 (1.5)	2 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	8 (2.0)	
Twice a day	32 (7.9)	3 (0.7)	8 (2.0)	12 (3.0)	5 (1.2)	60 (14.9)	
						404 (100)	
The water is used for cooking							
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.2)	0 (0.0)	5 (1.2)	
Neutral	39 (9.7)	1 (0.2)	0 (0.0)	11 (2.7)	2 (0.5)	53 (13.1)	<0.0001 ***
Agree	33 (8.2)	149 (36.9)	81 (20.0)	54 (13.4)	24 (5.9)	341 (84.4)	
Strongly Agree	3 (0.7)	0 (0.0)	0 (0.0)	2 (0.5)	0 (0.0)	5 (1.2)	
						404 (100)	

N = 404, Confidence level = 95%, 90%, *** p value ≤ 0.001, ** p value ≤ 0.05, 0.1.

Table 11: Multinomial logistic regression.

Water Source Used	Variables	Values	Coef.	Std. Err.	$p > z$
Stream	(Base outcome)				
Tap/Borehole					
	Age	years			
		26–33	0.6825705	0.959345	0.477
		34–41	1.54005	1.218627	0.206
		42 and above	−1.464128	1.144241	0.201
		18–25 [b]			
	Level of education				
		Secondary *	2.438755	0.9112686	0.007
		Technical *	2.509305	1.102314	0.023
		Higher *	5.617636	1.767656	0.001
		Primary [b]			
	Religion				
		Islam	−0.4578727	0.6720153	0.496
		Christian [b]			
	Tribe				
		Ebira	1.844106	1.223997	0.132
		Okun/Yoruba	−2.068542	0.885295	0.019
		Agatu	−0.443176	1.08457	0.683
		Others	0.5753387	0.921216	0.532
		Igala [b]			
	Occupation				
		Student*	0.153149	1.254742	0.009
		Civil servant	−0.1677164	1.134713	0.882
		Business *	1.349364	0.832663	0.001
		Blue collar	−1.948051	1.163646	0.094
		Farmer [b]			
	Distance to water source	30 min	−0.9191591	1.655886	0.579
		15 to 30 min *	1.340592	1.52721	0.000
		15 min *	7.634129	1.540821	0.000
		Less than 15 min [b]			
	cons		−5.767704	1.79348	0.001
Tap/Handpump					
	Age	years			
		26–33	0.243689	0.970339	0.802
		34–41	1.112352	1.244772	0.372
		42 years and above *	−2.820681	1.278305	0.027
		18–25 [b]			

	Level of education				
		Secondary *	3.495554	1.059181	0.001
		Technical *	4.027456	1.226449	0.001
		Higher *	6.987709	1.84979	0.000
		Primary [b]			
	Religion				
		Islam	−0.9805033	0.693886	0.158
		Christian [b]			
	Tribe				
		Ebira	0.8261669	1.2807	0.519
		Okun/Yoruba *	−2.168269	0.918882	0.018
		Agatu	−0.8467842	1.192332	0.478
		Others	1.25069	0.924189	0.176
		Igala [b]			
	Occupation				
		Student	−0.3053326	1.283788	0.812
		Civil servant	−0.2125548	1.177387	0.857
		Business	1.465985	0.851483	0.085
		Blue collar	−2.347968	1.235203	0.057
		Farmer [b]			
	Distance to water source	30 min	16.86397	6.144	0.997
		15 and 30 min *	18.71043	1.3941	0.000
		15 min *	24.16621	1.6122	0.000
		Less than 15 min [b]			
	_cons		−23.46168	1.5647	0.997
Well					
	Age	years 26–33	0.4342989	0.973115	0.655
		34–41 years	1.076971	1.23618	0.384
		42 years and above	−1.092513	1.147965	0.341
		18–25 [b]			
	Level of education				
		Secondary *	2.031327	0.9197395	0.027
		Technical	1.866753	1.13681	0.101
		Higher *	4.167881	1.812678	0.021
		Primary [b]			

	Religion			
		Islam	−0.825671	0.697828	0.237
		Christian [b]			
	Tribe				
		Ebira	1.165925	1.271032	0.359
		Okun/Yoruba	−1.558749	0.93303	0.095
		Agatu *	0.996792	1.066671	0.012
		Others *	1.631538	0.958386	0.003
		Igala [b]			
	Occupation				
		Student	−0.1563987	1.29754	0.904
		Civil servant	−0.0798009	1.19928	0.947
		Business *	1.458507	0.86799	0.002
		Blue collar	−1.657063	1.170383	0.157
		Farmer [b]			
	Distance to water source	30 min	1.41148	1.62373	0.385
		15 and 30 min *	−15.9897	2.487343	0.000
		15 min *	6.41447	1.46820	0.000
		Less than 15 min [b]			
	cons		−4.85758	1.68724	0.004
Reservoir					
	Age	years			
		26–33	0.2505239	1.151682	0.828
		34–41 years	0.0348633	1.46232	0.981
		42 years and above	−1.6978	1.340359	0.205
		18–25 [b]			
	Level of education				
		Secondary	−0.229556	1.121572	0.838
		Technical	−14.82726	769.544	0.992
		Higher	3.452957	1.914172	0.071
		Primary [b]			
	Religion				
		Islam	−0.0342996	0.8466606	0.968
		Christian [b]			
	Tribe				
		Ebira	−14.31414	767.0132	0.663
		Okun/Yoruba	−1.999022	1.409539	0.156
		Agatu *	1.536424	1.331755	0.050
		Others *	2.075243	1.065262	0.051
		Igala [b]			

Occupation				
	Student	0.729698	1.676664	0.663
	Civil servant *	2.494875	1.426156	0.008
	Business *	1.979099	1.088879	0.031
	Blue collar	−16.96119	793.0258	0.991
	Farmer [b]			
Distance to water source	30 min	0.120472	0.10284	0.998
	15 and 30 min	−17.59264	0.34839	0.997
	15 min *	0.228780	0.93420	0.000
	Less than 15 min [b]			
cons		−22.36752	0.9342	0.997

N= 404, * = significant at 0.05 level. Pseudo R-Square (McFadden = 0.1684). Model Fitting (Prob > Chi2 ≤ 0.001). Likelihood ratio Chi2 = 202.26. [b] = Redundant.

5.3 Influence of Predictor Factors on the Choice of Water Source Usage

The subsequent chapters highlight the results from the multinomial logistic regression showing the influence of the predictor factors (age, education, ethnic group, occupation, distance to WS) on the choice of water source usage.

5.3.1 Influence of Age on Water Source Choice

The multinomial logistic regression results (Table 11) show that the age of the respondents influences the choice of water source being used. While using “stream” as the reference category, only “tap/handpump” was statistically significant (p = 0.027), with the log odds for respondents within the age group 42 years and above choosing “tap/handpump” over “stream” to be -1.822 times less than respondents within the age group of 18–25 years. Even though the other water sources did not show any statistical significance, they all had negative coefficients, which implies that respondents that fall with the age groups (42 and above) when compared to the age group (18–25 years) are more likely going to choose “stream” over the other water sources investigated in this study. During the interview, an older respondent (54 years) expressed comfort and freedom as a reason for choosing to use "stream". In a similar finding, (Simelane et al. 2020) identified that households that are headed by people aged between 35 and 55 years were utilising an unimproved SWS compared to the households headed by younger people.

5.3.2 Influence of Education on the Water Source Choice

The relationship between water source choice and education was determined by placing the category primary education as redundant to identify the impact of the other levels of educations observed (secondary, technical, and higher education). With the reference category being "stream" while having all other factors constant, the multinomial logistic regression showed that the level of education has a positive effect on the choice to use a particular type of water scheme by participants. For "tap/borehole", education was significant (p = 0.007, 0.023, and 0.001, for secondary, technical, and higher education, respectively) and has a positive predictor. The log odds of participants that have secondary education choosing "tap/borehole" over "stream" is 2.439 times greater than participants that have primary education. For participants with technical education and higher education, log odds = 2.509 and 5.618, respectively. For "tap/handpump", the predictor was positive for all the education groups (secondary, technical, and higher): for secondary education (p = 0.001, log odds = 3.496), for technical education (p = 0.001, log odds = 4.027), and for higher education (p = <0.001, log odds = 6.988). Looking at "well", secondary and higher education showed statistical relationships (p = 0.027, log odds = 2.031) and (p = 0.021, log odds = 4.168) respectively, indicating that respondents with higher and secondary education are more likely going to choose a "well" over a "stream". In addition, there exists no statistical relationship between the level of education and "reservoir" for all educational levels. This relationship is not far-fetched from the fact that 10.4% of those with higher education had access to tap/borehole water, which is by convention known as the cleanest source of water.

5.3.3 Influence of Ethnic Groups on Water Source Choice

The tap/handpump category shows that only the "Okun/Yoruba" tribe are statistically significant (p = 0.018, log odds = −2.168), denoting that in comparison to Igala participants, Okun/Yoruba participants are less likely going to choose "tap/handpump" over "stream". For "well", the results (table 11) show it is statistically significant (p = 0.012, log odds = 0.997), for "Agatu" and (p = 0.003, log odds = 1.632) for "other" tribes. This implies that participants are more likely going to choose a "well" over a "stream" compared to respondents that identify as Igalas. Findings are similar with "reservoir", where "Agatu" (p = 0.050, log odds = 1.536) and "other" tribe (p = 0.05, log odds = 2.075) show a statistically significant relationship. The results indicate that the minor ethnic groups (Agatu and other tribes) in comparison to the dominant ethnic group (Igalas) are more likely going to utilise water of lesser quality. The MLR shows that "tap/borehole" and "tap/handpump" have no significant relationship with the tribe of the respondents.

5.3.4 Influence of Occupation on Water Source Choice

The results (Table 11) show a statistically positive coefficient for occupation and most of the choices with "stream" being the base outcome and "farmers" as the redundant. Looking at "tap/borehole", for "students", p = 0.009, log odds = 0.153; for respondents that engage in "business", p = 0.001, log odds = 1.349. For choosing "well", those that engage in business were the only statistically significant group (p = 0.002, log odds = 1459). "Reservoir" shows only respondents that work as "civil servants" (p = 0.008, log odds = 2.495) and engage in "business" (p = 0.031, log odds = 1.979) to be statistically significant. In Table 5, from the 24.8% of respondents that identify as farmers, 10.9% indicated that they use a "stream". Evidently, farmers in rural Kogi East that participated in the study prefer streams due to the ease as the majority of these farmers spend most of their day (leaving very early in the morning and returning late in the afternoon) on their farmland working. During the interview, a female farmer (41 years) indicated that it is more conducive to collect water when she is working, so she journeys to the farm with water containers. "… When we go to the farm, on our way back home we can carry water filled containers straight home, we would not have to branch somewhere to fetch water…".

In addition, due to the regulation of the water schemes (construction of tap/borehole, tap/handpump), there is miscommunication and discrimination as to when farmers come to the water point to fetch water. Respondents indicated that they strictly monitor farmers when they come to use a "tap/borehole" because they feel they waste it on their produce, as a community female member (teacher) 32 years responded within the interview: "… We have to strictly monitor to ensure that they (farmers) do not come and waste the water, emptying our tanks for their crops when we have not seen enough to use for ourselves…".

5.3.5 Influence of Distance to the water source on Water Source Choice

Looking at the results from the MLR (Table 11), the tap/borehole category shows that participants that walk between 15 and 30 min, alongside participants that walk approximately 15 min, are statistically significant (($p \leq 0.0001$, log odds = 1.341) and ($p \leq 0.0001$, log odds = 7.634)). Participants that fall within this group are more likely going to choose a tap/borehole compared to those that walk less than 15 min. Similar results are seen for tap/handpump. For "well", the result shows that respondents that walk between 15 and 30 min had a negative coefficient ($p \leq 0.0001$, log odds = −15.989). This implies that respondents that fall within this group are less likely going to choose a "well" compared to participants that must walk less than 15 min to the water schemes. For "reservoir", participants that walk approximately 15 min to water are more likely going to choose that over "stream" compared to participants that walk less than 15 min to the water source. Table 5 shows the majority (35.6%) of respondents that walk less than 15 min use a tap/borehole, and 3.5% of respondents that use a stream indicated that they walk more than 30 min.

5.4 Influence of predictor factors on Individual's willingness to participate in SWM

To identify the influence of the predicator variable on participants' willingness to participate in SWM, an ordinal logistic regression was adopted. Reporting on the marginal effect, Table 12 shows that only water source type, cost of maintenance, and level of trust of for who manages the WS were the only statistically significant variables.

Table 12: Ordinal Logistic regression

	Willingness to participate in SWM		
Variables	Unlikely	Neutral	Likely
Age	0.017 (0.016)	0.015 (0.014)	-0.033 (0.031)
Gender	0.013 (0.031)	0.011 (0.028)	-0.025 (0.06)
Household size	-0.016 (0.023)	-0.014(0.02)	0.031 (0.044)
Monthly income	-0.004 (0.015)	-0.003(0.013)	0.007 (0.028)
Occupation	0.011 (0.013)	0.01 (0.012)	-0.022 (0.025)
Education	0.031 (0.017)	0.027 (0.015)	-0.059 (0.032)
Ethnic group	-0.013 (0.011)	-0.012 (0.01)	0.026 (0.02)
Water source	-0.039 (0.015) **	-0.035 (0.015) **	0.076 (0.029) **
Maintenance cost	-0.221 (0.041) ***	-0.195 (0.042) ***	0.424 (0.064) ***
Trust	-0.201 (0.038) ***	-0.178 (0.042) ***	0.387 (0.065) ***

**P < 0.05, ***P < 0.01; N=404

6 DISCUSSION

In the association between a water source choice and predictor variables, the study finds no significant relationship between sex of the respondents and type of water source used within the communities. Similar findings are reported in the studies conducted in Eswatini (Simelane et al. 2020), Ghana (Mahama et al. 2014), and in Malawi (Price et al. 2021), where there exists no statistical relationship between gender and SWS choice. However, in an vast study on gender and WASH services provision in Nepal reveals some of the gender barriers that exists within the external groups. For instance, there are more men participating in the policy-making bodies; the number of male staff is much higher than the number of female staff; the personnel policies which is mostly formulated by men do not encourage women to join or to continue working in the group (Regmi and Fawcett 2001). Furthermore, their study (Regmi and Fawcett 2001) expressed that woman complained about their water collection increasing significantly (sometimes as much as four or five times) after the improved water services had been installed. This is in part because the borehole and well WS are located by the side of the road, where there is no privacy, making it difficult to bathe freely nor easily wash the clothes that they use during menstrual cycle, for fear of being seen by males. In a bid to avoid this, the women in Hile village in east Nepal carry water all the way to their homes several times each day, expending significant amounts of energy to do so. In some of the villages on the Tarai plain (Motipur, Magaragadhi, and Gajedi) in west Nepal, women reported waiting until dark to undertake these activities. They said that they had not had this problem when they had used more distant old-fashioned water sources, where there was no chance of men being around (Chandra Regmi & Fawcett, 2001).

Additionally, it was discovered that no significant relationship exists between household monthly income and type of water source. This is likely since the cost to use a SWS in the region is almost free of charge except for minor maintenance fees, as the water schemes being introduced are funded by the government. Thus, making water usage affordable within the communities. This could also be linked to the fact that there is no structured billing system in the study area responsible charging water users a fee to use existing water sources. Although Adamu & Ndi (2017) research highlighted that income was a determining factor of water source, their study reports on water access situation in urban parts Cameroon, where households with low-income lacked access to the piped water sources and were not able to afford expensive treatment options needed to improve the quality of water coming from handpumps WS and well WS. They (Adamu & Ndi 2017) also indicated that the cost of tanker-delivered water too expensive for households which was problematic, thereby swaying about 97% of households to use neighborhood other unsafe WS like reservoirs and rivers for drinking water (Adamu & Ndi 2017). Like (Adamu & Ndi 2017), In a study conducted in Nigeria, Grace et al. (2013) described that 80.5% of study households in Nigeria claimed vended water (water sold by private entities) to be unaffordable at certain times, leading them to seek out other alternatives such as bottled water and surface water. Similarly, Abubakar (2019) reports that income was stated to influence SWS. Likewise, Gondo et al. (2020) argues that a high level of income influences household access to SWS, whereby the findings in the research indicated that high income earners were able to utilise ISWS compared to low-income earners; however, this study shows no significant relationship between income and SWS choice.

Looking at the influence of age on water source choice, the findings reveal all negative coefficients, implying that older respondent are more likely going to choose a “stream” over the other sources investigated as earlier mentioned. An explanation for this outcome can be seen through modernism that is associated with younger generations, as they are more likely to use a “tap/borehole” (comparatively reviewed as new methods). Furthermore, another reason besides curiosity and exposure to modern tools is that most of the elderly members of the participants that were interviewed indicated that they would rather use a source that they are comfortable with. Further stressing on the difficulty in collecting water from the WS, as part of the newly implemented project design is the handpump, which requires a certain level of energy and force, and this makes it highly unsuitable for the older members of the population to utilise this WS. Additionally, in a research conducted in Eswatini, Simelane et al. 2020 also identified age to influence SWS choice, however their (Simelane et al. 2020) study argued that respondents below the age of 35 are seen to be from richer households compared to the older respondents; as a result, they were able to afford ISWS for their use.

Moving on to the influence of education on water source choice, as expected, individuals with a higher level of education are perceived to prefer using ISWS compared to those with only basic education because of their wider knowledge and exposure. One reason could be the fact that the educated population tend to understand the health risk (Emenike et al. 2017) and thus opt to use SWS. This finding is supported by (Armand & Fondo 2012), where level of education was seen to influence the choice of water usage. Their research which was conducted in Cameroon, points out that in households where the head are literate, their WS are from improved sources like boreholes because they know the health implications of utilising unimproved WS. This finding is in line with Akoteyon (2019), where the research identified that participants that are uneducated use poor SWS compared to educated participants. Similarly, using education as a socioeconomic factor, Iranti et al. (2016) argue that educated people are more likely going to use improved SWS compared to uneducated individuals.

For the influence of ethnic group on choice of water source, the results reveal that minor ethnic groups (Agatu and other tribes) in comparison to the dominant ethnic group (Igalas) are more likely going to utilise water from lesser quality. These findings corroborate with prior studies (Mulenga et al. 2017; Abubakar 2019) where the prevalent ethnic groups are seen to utilise water from adequate sources compared to lesser ethnic groups. In a study conducted in Nigeria, it was identified that distinct ethnic groups have a preference with regard to the type of water source being used (Abubakar 2019). The research also identified that a larger portion of the dominant ethnic group utilise ISWS in comparison to the subordinate ethnic groups (Abubakar 2019). A reason for this disparity could be associated with the political affiliation of dominant ethnic groups. In this study, the dominant ethnic group, which is defined by the population and ruling party, is “Igala”. This ethnic group can be more daring in requesting for developmental changes, which can be attributed to them having a sense of ownership. Subsequently, they become beneficiaries of new water schemes that also result from existing ties to the ruling party in the region. Additionally, the thematic analysis showed that the theme “culture and religion” was the most recurring theme amongst the participants during the interview. The communities are aware of the cultural inequality that exists and expressed how it influences not only their choice to use a particular water source, but also their willingness to participate in SWM. In a similar finding from a study conducted in Zambia, Mulenga et al. (2017) also identified inequalities in access to ISWS between various regions. The research argues that a particular province, which was identified to be the beneficiary to several water projects, was seen to have more access to SWS compared to other provinces that did not have these projects in their regions. Furthermore, in study carried out in Guinea Conakry (Olivier de Sardan & Diallo 2000) in rural areas revealed that certain groups refused to use the water from a borehole because they felt excluded from managing it and considered themselves discriminated against. This discrimination takes several forms; some women, despite arriving at the water point first, must wait for those who belong to the group in charge of the water installation to have finished collecting water before taking their own turn. For similar reasons of precedence, the children of certain families are not allowed to collect water on their own.

In explaining the influence of occupation on choice of water source, the findings suggest that farmers have the least favoured occupation when SWS availability is determined, as they are believed to overuse communal water sources. This argument is supported by Gomez et al. (2019), where agricultural practices in rural communities are seen to negatively impact access to SWS in middle- and low-income countries that were investigated. Usually, the demand for water usage would differ from farmers and other occupation that are not dependent on water as a means for generating income. In rural Kogi, the farmers start their day as early as 4am and spend most of the day at their farmland, as a result they are not willing to wait or compete with other members of the community that are collecting water from Tap/borehole and Tap/handpump WS. Thus, they utilise rivers and streams are situated close to their farm site and easily accessible to them; consequently farmer, and those that engage in fishery utilize these alternate WS instead of the borehole and other newly implemented WS provided. The study further argues that excessive water is consumed during agricultural practices in comparison to being used for the household (Gomez et al. 2019).

Furthermore, the walking distance to the water source shows that a participant chooses their water source according to ease. Distance to a water source is a factor known to influence water access and water source usage, as identified by several authors (World bank 1997; World health organization 2006; Geere et al. 2016; United nations water 2020; World bank 2020). This could be the reason why newly implemented water schemes (boreholes and handpumps) that are initiated by the government are to be centralised and within reasonable distance to households. During the research, respondents indicated that centralization of new WS was not taken into consideration as politics was evident in where WS projects would be situated. Some of the respondents further stressed that they were not aware of any upcoming projects and usually just see the ongoing water project(s) implementation which is usually situated in the dwelling of the town head or his allies. Resulting in the use of alternate WS as choice of locale for these water projects is still not ideal as they would have to walk far distance to collect water from the WS. In a similar context, Deal and Sabatini (2020) identified distance to influence SWS choice, the study indicated that respondents choose to use ISWS (handpumps) as it was situated in close distance to households. In addition, findings from an interview conducted in rural parts of Zambia, Kelly et al. (2018) reports that although the respondents primarily utilise borehole WS, they also chose to utilise hand dug wells as a substitute because the borehole was farther away.

The research highlights that the majority of the participants in the study area utlises water from improved sources stemming from government intervention through water schemes in the regions. However, the lessons learnt from this study implicate the inequalities in certain fractions whereby older, less educated individuals still depend on unimproved water sources, despite the availability of IWS, which is mainly due to the lack of awareness. Nonetheless, water access in Kogi rural communities have been improved in several local governments, including the study areas. Therefore, this study may be adapted in similar regions taking into consideration lessons learnt from the study.

Additionally, the study conducted has provided many insights into the problems associated with water access while investigating water sources in rural parts of Kogi state. It has also uncovered the rationale behind water source choice among rural communities in Nigeria. However, it is not without some limitations. The study was carried out during the rainy season, which means that water sources such as streams and reservoirs would be functional. Even though the government water projects implemented in these vicinities should serve especially during the dry and harmattan seasons, the investigation was only carried in the specified rainy season; hence, it is possible that in November up to April, the variation in seasonality may impact the choice of a water source. However, a prior study indicates that rainwater harvesting is hardly practiced in Nigeria (Madiba & Ngwenya 2017) and would contribute little to the current research goals.

With reference to the respondents participating willingly to SWM, the ordinal logistic regression model indicated only 3 factors from proposed ten (10) were statistically significant. The type of water source was identified by respondents to influence whether they would be willingly to sustainably manage their existing water scheme. The results shows that if the water source is of lower standards 3.9% of the respondents are unlikely going to willingly participate in SWM, whereas if the water source is of higher standards 7.6% would "likely" participate in SWM. From this result it is understandably clear that the respondents are aware of ISWS and its importance and would contribute to its benefit to ensure they have good use of it. Interestingly, the ordinal logistic regression also showed that with an increase in the cost of maintenance for the water schemes, 42.4% of the respondents are likely going to participate in SWM. This could like result from the fact that cost of maintenance of water system in the study area is affordable and as long a s respondents are benefitting from the ISWS, they would willing contribute to its maintenance. Trust is also identified to influence respondents' willingness to participate in SWM. As expected, with low level of trust for persons responsible for managing water schemes, there would be an equal low level of respondents willing to participate in SWM, however, if respondents trust the person(s) responsible for managing their water systems they are more "likely" going to willingly participate in SWM. This responses from these findings supports the dominant themes that were prevalent in during the interview. Some of the themes that were identified from the interviews when participants were asked about their water access issues, ongoing water management systems were; Land, Community Management, Culture and Religion, Fear of Judgment, Current water satisfaction, Distrust, Conflict, Preferred water source, Government

\ New systems provided, Lack of training, and Trust. It is crucial for policy makers to take these factors into consideration if WA issues is to be addressed through SWM.

7 CONCLUSION

This thesis aimed on identifying various SWM challenges affecting rural Kogi state, Nigeria. Various challenges affecting developing countries globally were identified and grouped to either of these clusters; socio-economic, environmental, or technical factors. Some of these WMCs are funding challenges, infrastructural challenges, policy challenges, and community involvement challenges. In other to address these lingering WMCs, recommendations and good practices based on success case studies, should be adopted by stakeholders, government, and non-governmental organizations.

African countries have been identified to be significantly affected by WMCs which influences their access to clean water. Some of the SWM challenges identified from the interview conducted with the respondents were cost of maintenance, distrust, community management, community involvement, preferred water source, culture and religion, and conflict. These findings are in accordance with several studies conducted in similar African regions. Future studies should explore other techniques to increase willingness to participate in SWM so that WA can be improved in the affected rural communities of developing countries, with focus on African regions. It is imperative that to address WA issues, identifying, investigating, and proffering solutions to current WMCs is a key.

In addition, the significance of providing public education in rural communities has been emphasised based on the findings of this study, as a lower level of education is associated with the use of unimproved water sources. Therefore, it is important for public awareness and basic education to be encouraged in rural communities of developing countries. Recalling the objectives of SDG 4 (quality education) and SDG 6 (clean water and sanitation), policymakers are responsible for providing an inclusive, quality primary free basic education especially in rural poor communities to avoid poor decisions that are detrimental to well-being. Furthermore, the study highlights the issues that persist amongst minority ethnic groups. Similarly, to the less educated, minority ethnic groups usually end up with poor water sources, and this inequality should be addressed in regions where dominant tribes are seen to have autonomy on the distribution of water projects or schemes and the usage of water provided under such schemes.

Alongside the minority ethnic groups, farmers are another group affected with discrimination when improved water sources are used such as tap/boreholes. Due to the nature of their occupation of which irrigation is heavily dependent, they are regarded as wasteful with water usage; therefore, alternatives such as providing famers with better options for irrigation should be incorporated into water project formulation so that these groups may have equal access to improved water source. Finally, the study suggests that the government, policymakers, and project implementers, in developing countries and rural communities, should investigate the issues identified (lack of awareness, education, and equal participation) to tackle inequality to water access and further the achievement of sustainable development goals in the process.

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Appendix A – Questionnaire items used

Water management practices survey

This survey is intended for the sole purpose of PhD research
Your identity would remain anonymous
There is no right and wrong answer
This survey is to investigate, water access, water source choice, water management practices and identify challenges faced
Thank you for your corporation.

1. Age

____

2. Sex

Mark only one oval.

- ⬭ Female
- ⬭ Male

3. Tribe

____

4. Number of Household

____

5. Level of education

Mark only one oval.

- ⬭ Primary
- ⬭ Secondary
- ⬭ Technical
- ⬭ Higher Education

6. Type of water source

Mark only one oval.

- ⬭ Stream
- ⬭ Tap / borehole
- ⬭ Tap / handpump
- ⬭ Well
- ⬭ Reservoir

7. Individual income/Monthly (in Naira)

Mark only one oval.

- ⬭ More than 18000
- ⬭ Less than 18000
- ⬭ I won't say
- ⬭ Do not apply / I don't have a monthly income

8. Occupation

____

9. Religion

Mark only one oval.

- ⬭ Christianity
- ⬭ Islam
- ⬭ Traditional
- ⬭ Other specify
- ⬭ atheist

10. I walk __________ to the water point (Distance to water point)

Mark only one oval.

- More than 30 minutes
- 30 minutes
- Between 15 minutes and 30 minutes
- Less than 15 minutes

11. 11. I wait in long queues before I get water access

Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

12. Daily trips to water points for households use

Mark only one oval.

- More than 5 times a day
- 5 times a day
- 3 times a day
- Twice a day
- Once a day

13. I am satisfied with my water availability

Mark only one oval.

	1	2	3	4	5	
strongly disagree						Strongly agree

14. The water at the point cost per trip is ______

Mark only one oval.

- >200 Naira
- >100 Naira
- >50 Naira
- <50 Naira
- Free

15. The water I use is ____ (Quality)

Mark only one oval.

- Very murky
- murky
- Average
- Clear
- Very clear

16. The water can be drunk immediately straight from the source

Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

17. The water is used for cooking

Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

18. The quality of the water meets my domestic needs

Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

19. The water available is better used for farming activities than domestic ones

Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree