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Determination of Faecal Contamination of Shallow Well Water Sources of Kofai Ward, Ardo Kola Local Government Area, Taraba State

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Abstract
Shallow well water is a very important source of water supply for most residents of Ardo Kola LGA and Kofai ward in particular especially during the dry season. Several studies have been carried out on water quality in Jalingo town and Ardo Kola LGA, but not much has been done on fecal contamination of shallow well waters in Kofai ward. This study therefore examines the fecal contamination of well water in Kofai ward, Ardo Kola LGA, Taraba State, Nigeria. The study used primary and secondary sources of data. The secondary sources include desk review of existing literature. The primary sources include field collection of sample water for laboratory analysis and use of questionnaires. Samples of water were collected from 5 different shallow wells in the study area and transported in cold chain to the laboratory. The water samples were tested separately for fecal *Escherichia coli* using a U.S. EPA-approved commercial culture kit IDEXX Colilert - 18 method according to the manufacturer's directions at the Taraba State Water and Sanitation Board laboratory in Jalingo town. Simple random sampling was used to administer 60 questionnaires to households where the sample water was collected in Kofai ward. The data collected was analyzed using descriptive statistics. The results of the findings reveal that all the well water samples analyzed are contaminated by fecal matters (angwan matta 1.4×10^2cfu/100 ml, angwan lapo I 1.2×10^2cfu/100 ml, angwan lapo II 1.7×10^2cfu/100 ml, angwan bakasi 4×10^2cfu/100 ml and angwan gate 2.4×10^2cfu/100 ml) and as such are not fit for human consumption. Findings of the study also reveals that 60% of the respondents use the well water for washing their clothes and household items and 53.3% use alum in treating the water, while 31.7% boil the water before use. Based on the findings, the study recommends that these shallow well water should not be used for drinking, laundry, bathing, or cooking purposes without treatment and the need for enlightenment campaign and awareness creation on safe water practices and risk of coliform and *E. coli* contamination in the study area by the concerned authority.

Keywords: ardo kola; fecal contamination; escherichia coli; kofai and shallow well

Introduction

Water is one of the most valuable resources in the world because of its scarcity. The World Health Organization (WHO, 2018) defines water scarcity as a situation in which there is a lack of potable water and individuals have difficulty acquiring the daily amounts necessary to support their socioeconomic activities. Natural disasters like droughts or manmade causes like pollution, population exposures, and ineffective distribution systems are what cause a water scarcity. The availability of portable water for the majority of households and businesses has been varying throughout time, which has led to a water crisis in practically all of the world's regions, particularly in Sub Saharan Africa (Nayebare, Owor, Robinah & Taylor, 2022).

According to the World Economic Forum, the number one global risk in terms of its impact on society is the water problem, which was noted in January 2015. Only 2.5 percent of the world's water is safe, and the rest is salty, according to Barlow and Clark (Barlow & Clark, 2017). There are 650 million individuals without access to portable water in the world (Boisson, Stevenson, & Shapiro, 2013). It has been highlighted that the leapfrogging population is constantly increasing its demand for fresh water. The dry season is when much of the world experiences the severe water shortages, particularly in Sub-Saharan Africa and several Asian nations (Nayebare, Owor, Robinah & Tsaylor, 2022).

Shallow groundwater systems, which remain a typical supply of water for home use in low-income nations due to reduced capital costs of construction, particularly when constructed by local artisans, are still a topic of debate over the optimal management practices (Van Steenbergen & Luutu, 2012). Chemical and fecal contamination of shallow groundwater systems is a problem (Lorentz et al. 2015; UNICEF 2019). The mobility of fecal and chemical contaminants to and within shallow groundwater systems can be facilitated by a number of factors representing pollutant pathways, such as the depth of the well, mode of construction, type of well, distance to the nearest on-site sanitation systems (OSS), geology, water-source ownership, and sanitary risk levels (Allevi *et al*, 2013; Tumwebaze *et al*, 2013; Sorensen *et al*, 2015; Abanyie *et al*, 2016; Lapworth *et al*, 2017; Back *et al*, 2018; Nayebare *et al*, 2020).

The most alluring concerns connected to drinking water, especially groundwater, are those posed by fecal contamination, and their management depends on the capacity to evaluate the risk from any source of water and implement the necessary treatment to eradicate it. It is advised to practice looking for organisms that show the presence of fecal contamination and, therefore, the possibility for the presence of germs, even if they are not harmful, rather than seeking to find bacteria when the consumer is in danger of infection. Escherichia coli (*E. coli*) is therefore frequently employed as an indicator organism to assess water treatment and as an index organism for faecal contamination. In cases where *E. coli* identification is not possible, a thermo-tolerant coliform count (fecal coliform) is acceptable (SON, 2007).

Particularly in small communities and underdeveloped nations, where groundwater is frequently the preferred supply of drinking water, the microbial pollution of groundwater has deep and severe repercussions for public health (Oruonye & Medjor, 2010). Although natural groundwater is often of high quality, due to inadequate source protection and ineffective resource management, this can change very quickly. When groundwater is contaminated, it can contribute to epidemics and high rates of morbidity and mortality from diarrheal diseases. For the preservation of groundwater quality and the protection of public health, excreta disposal through land-based systems is a critical concern. In peri-urban settings, using inefficient water supply and sanitation technology poses serious and ongoing threats to public health (Oruonye & Medjor, 2010).

The Human Right to Water and Sanitation, which guarantees everyone the right to "sufficient, safe, acceptable physically accessible and affordable water for personal and domestic uses" (CESCR, 2002), was reaffirmed by the United Nations General Assembly and Human Rights Council in 2010 (United Nations, 2010). This right encapsulates the significance of water to human health and wellbeing. Target 7c of the Millennium Development Goals (MDGs) states that the goal is to "... reduce by half the share of the population without sustainable access to safe drinking water... " a step towards achieving universal access (United Nations, 2013). The indicator "Use of an improved source" was chosen to track worldwide access to clean water, and its key data sources are national censuses and nationally representative household surveys.

Over the years, water which is the most precious resource is decreasing in quantity and quality. Individual who depends on different source have been faced with poor sanitation and health problems may be as a result of the doubtful sources from which they carry their water in this locality. Some water sources have been polluted with chemicals by farmers besides digging of toilets close to water sources. Water shortage has disrupted and dwarfed many domestic activities. This has inflicted pains on many women and children who now trek for a long distance in search of portable water. Because of the challenges triggered by potable water shortage in this area, a greater proportion of the households have been grappling with different adaptation measures to stem the situation but what bewilders them is that upon they plethora of individual and collective measure(s), the success yielded are usually temporal and limited with most of them being futile. Shallow wells are the major sources of domestic water for most rural and urban households especially the poor and marginalized group. This shallow well water is vulnerable to faecal contamination, especially in low-income urban areas where use of on-site sanitation facilities is high. This is the reason why it requires continuous monitoring by assessing the level of faecal contamination from time to time. *E. coli* has been described as best indicator available for pathogenic enterobacteria and a useful tool for water quality monitoring (Kitts, Shaffner, Samadpour & Reyburn, 2004).

Well water provide sources of household water needs for most residents of Jalingo town and Kofai ward in particular especially during the dry season. Several studies have been carried out on water quality in Jalingo town, but not much has been done on fecal contamination of shallow well waters in Kofai ward. This could be a source of concern because it is one of the densely populated areas with poor sanitation in the town. This study therefore examines the fecal contamination of well water in Kofai ward, Ardo Kola LGA, Taraba State, Nigeria.

Description of Study Area

Ardo Kola LGA is roughly located between latitude 8°35'N to 9°08'N and longitude 10°52'E to 11°35'E. It is bordered by Lau LGA to the North, Jalingo LGA to the Northeast, Karim Lamido LGA to the West, Gassol and Bali LGAs to the South and Yorro LGA to the South east (Fig 3). Ardo Kola LGA is one of the four LGAs created in 1996 in the state. Ardo Kola is made up of 10 political wards which include Alimgora, Iware, Jauro Yinu, Lamido Borno, Mayo Ranewo, Sunkani, Sarkin Dutse, Zongon Kombia, Kofai and Tau. It was carved out of Jalingo LGA. The LGA has a population of 86,921 people (44,020 male, 42,901 female) according to the 2006 national population census. Ardo Kola has a land mass area of 2,312km^2.

Kofai ward, is part of Jalingo town the capital of the state, but politically it is under Ardo Kola LGA. It is the most urbanized part of the LGA and forms a continuation of Jalingo metropolis. The study area houses important government institutions especially the Taraba State University main campus and Taraba State College of Agriculture. The study area falls under zone 4 of Jalingo urban water supply zone. Some part of it is connected to the urban water supply network. Because of the increasing population in the study area, they depend so much on boreholes and well waters for their day today needs. Oftentimes, the water from the boreholes and wells are inadequate to meet the demands, thereby forcing the residents and water vendors to resort to stream water (Oruonye & Ahmed, 2016).

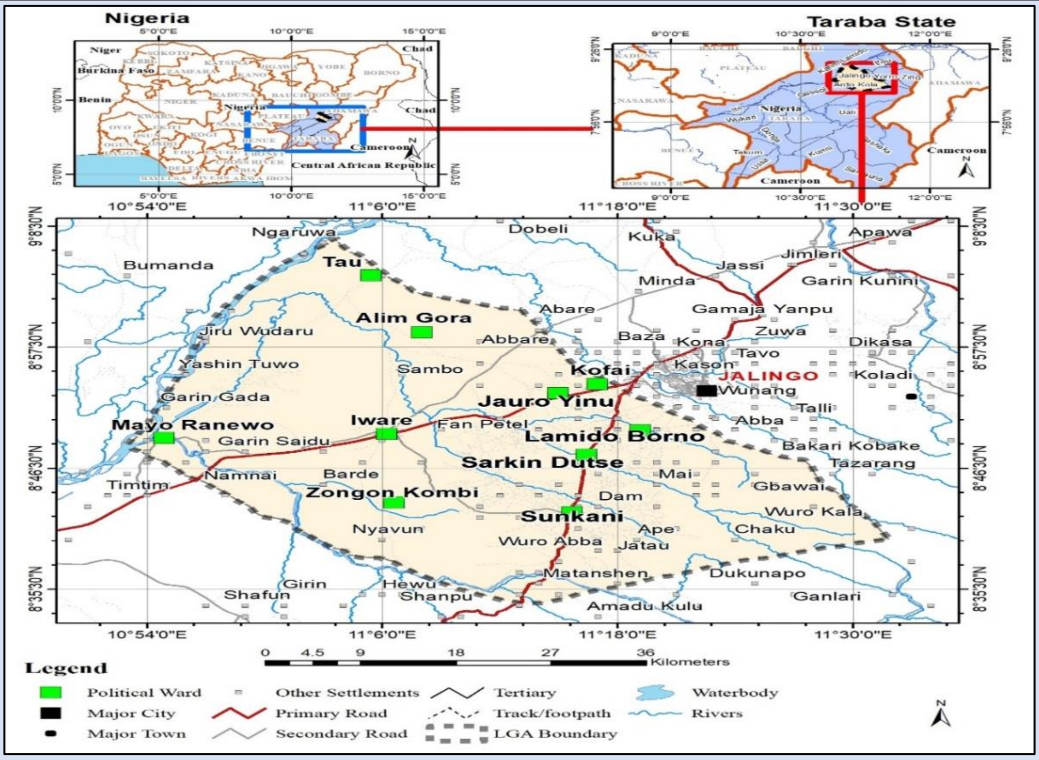

Figure 1: Map of Ardo Kola LGA.

Materials and Methods

Data used in this study were collected from primary and secondary sources. The secondary sources include a thorough review of available literature from online based libraries, internationally accessible academic journals and articles, relevant literatures among others. The purpose of the literature review was to identify gaps in the literature through an analysis of fecal contamination of shallow well water in the study area.

The primary sources include field collection of sample water for laboratory analysis. The targeted population for the study were residents living in the study area.

Samples of water were collected from 5 different shallow wells in the study area and transported in cold chain to the laboratory. Two of the 5 samples were collected from cemented well and 3 samples from non-cemented well. The water samples were collected on 18th May 2023 (at the beginning of rainy season). Appropriately labeled, pre-cleaned 75cl plastic bottle containers were first rinsed three times with the sample water, before formal collection. For each of the sample water, the container was allowed some time intervals during the process of sample collection. For the cemented and non- cemented shallow wells, the container was dipped well below the surface of the water and then allowed to overflow for some time before it was lifted up and covered. The water samples were tested separately for fecal *Escherichia coli* using a U.S. EPA-approved commercial culture kit IDEXX Colilert-18 method according to the manufacturer's directions at the Taraba State Water and Sanitation Board laboratory in Jalingo town. The frequency of occurrence of the bacteria was noted and their mean frequency was worked out separately from the samples collected from the different sampling points. Through the simple random sampling, 60 questionnaires were administered to households where the sample water was collected in Kofai ward. The data collected was analyzed using descriptive statistics.

Result of the Findings

The findings of the study revealed that the main source of domestic water for household use are the piped public water system, borehole, hand dug well and surface stream water. However, not all the houses are connected to the piped water system and the water supply from the piped water is intermittent as the water are pumped once in a week, two or a month as the case maybe. Most of the well-to-do households in the study area rely on boreholes while the poor and low-income households especially those living in rented houses rely on hand dug well, open stream or water from the vendors for their domestic water needs. Thus, the hand dug shallow well are predominantly used by people of low socio-economic status that could afford it while those that cannot afford it resort to stream water and purchase from water vendors.

Faecal Contamination of Well Water

The result of the faecal contamination of the water samples is presented in Table 1.

Table 1: Result Laboratory analysis

S/No	Location	E. coli (cfu)
1	Angwan Matta	1.4×10^2
2	Angwan Lapo 1	1.2×10^2
3	Angwan Lapo 2	1.7×10^2
4	Angwan Bakasi	4×10^2
5	Angwan Gate	2.4×10^2

Source: Laboratory analysis

The results of the findings in Table 1 reveals that the well water at Angwan Matta has 1.4×10^2cfu/100ml, Angwan Lapo 1 has 1.2×10^2cfu/100ml, Angwan Lapo 2 has 1.7×10^2cfu/100ml, Angwan Bakasi has 4×10^2cfu/100ml and Angwan Gate has 2.4×10^2cfu/100ml. The results above show that all the well water samples analysed are contaminated by faecal matters and as such area not fit for human consumption. Thus, they were unsafe to use as a drinking water source based on the World Health Organization standard of 0 colony–forming unit (cfu) *E. coli* per 100 ml. This is because of the high microbial contamination by *E. coli* as compared to the regulated standard of National Standard for Drinking Water Quality (NSDWQ) 0cfu/100ml. *E. coli* are a type of coliform bacteria found in the gut of mammals. When *E. coli* are present in water sample, it is considered to be contaminated by human or animal feces.

Sources of contamination of well water in the study area

Well water can become contaminated with bacteria if the well is not built properly, or if there are nearby source of animal or human waste. A water source can become contaminated with *E. coli* when animal waste makes its way into such water. The most common source of *E. coli* contamination in a well water is from septic system discharge. Most of the shallow wells in the study area are not covered (plates 1-4). Sometime a well is situated too close to a cracked septic tank bed. If the well casing is cracked some septic discharge, which is rich in *E. coli* will end up in the well water. Also, if the well is very porous, materials from septic discharge may percolate through the ground and enter the well through the water table. This most commonly occurs when the well head is below the level of the ground. Sometimes when a well is situated where refuse and other dirt including human feces are dumped, when rain fall, it tends to percolate this high dirt which are rich in *E. coli* into the well thereby making the well to be contaminated with the pathogenic micro-organism which can cause great health risk to humans when consumed. Faecal contaminants going into the water supply could lead to a serious form of water contamination leading to the transmission of enteric pathogens such as *Salmonella spp.*, *Shigella spp.*, *Vibrio cholerae,* and *E. coli* (Mahmud *et al*, 2019).

Findings of the study reveals that some of the wells were built in close proximity to pit toilets and suck away because of inadequate space in such compounds. Field observations reveals that all the households used bailer as mode of water collection from the well. Also, in some of the compounds, animals were kept such as local fowls, goats and sheep which move freely scavenging for feed within the compound. Physical observation during water sample collection and administration of questionnaire reveals poor waste handling practices such as open disposal of household waste, use of uncovered waste bin among others. This is further worsened by the fact that Kofai is a high population area where most students of Taraba State University living off campus resides. The houses are closely built to maximize space and many uses open pit latrines and septic soak away which are often located close to the wells in compounds. These poor sanitary practices certainly have the potential of exposing the shallow wells to fecal contamination. This finding of the study agrees with the claim of Wright, Gundry and Conroy (2004) that any potable water may be contaminated microbiologically due to insufficient sanitation and unhygienic practices.

Plate 1: Uncovered shallow well at Angwan matta.

Plate 2: Uncovered shallow well at Angwan Lapo I.

Plate 3: Cemented shallow well at Angwan gate.

Plate 4: Cemented shallow well at Angwan bakassi.

Plate 5: Uncovered shallow well at Angwan Lapo I.

Plate 6: A typical soak away at Angwan matta.

The findings of the study revealed that the main source of domestic water for household use are the piped public water system, borehole, hand dug well and surface stream water. However, not all the houses are connected to the piped water system and the water supply from the piped water is intermittent as the water are pumped once in a week, two or a month as the case maybe. Most well-to-do households in the study area rely on boreholes while the poor and low-income households especially those living in rented houses rely on hand dug well, open stream or water from the vendors for their domestic water needs. Thus, the hand dug shallow well are predominantly used by people of low socio-economic status that could afford it while those that cannot afford it resort to stream water and purchase from water vendors.

Uses of the well water

When the respondents were asked what they the water for, 60% claimed they use the well water for washing of clothes and plates only, 21.7% for cooking only and 18.3% claimed that they used it for all of the above uses. However, none of the respondents claimed that they used the well water for drinking only.

Table 2: Uses of the well water by households in the study area.

S/No	Uses of the well water	Frequency (n=60)	Percentage (100)
1	Drinking only	00	00
2	Cooking only	13	21.7
3	Washing of clothes and plates only	36	60
4	All of the above	11	18.3
5	Total	60	100

Source: Fieldwork, 2023.

When the respondents were asked if they have alternative sources of water for their domestic uses, 81.7% of them responded in affirmative while 18.3% claimed that the don't have. The respondents claim on their alternative sources of domestic water are presented in Table 3. The result shows that 75% of the respondents depends on the water truck (vendor) popularly known as *mai ruwa* for their alternative sources of domestic water, while 18.3% resort to stream water and only 1.7% of the respondents have piped water as their alternative source of domestic water in the study area.

Table 3: Alternative sources of water for households in the study area.

S/No	Alternative sources of water	Frequency (n=60)	Percentage (100)
1	Piped water system	01	1.7
2	Stream water	11	18.3
3	Commercial water tanker	00	00
4	Water truck (vendors)	45	75
5	Other methods not specified	03	5.0
6	Total	60	100

Source: Fieldwork, 2023.

This is not surprising as Oruonye and Ahmed (2016) had earlier reported 20,000 registered water vendors pushing water truck in Jalingo Metropolis who relied on water from private commercial boreholes, wells and streams. Oftentimes, the water from the boreholes is inadequate to meet the demands, thereby forcing the water vendors to resort to stream water. Oruonye and Ahmed also reported that at the moment, only 30% of the Jalingo town's water requirements are met.

Local water treatment practices

When the households were asked if they carry out any form of water treatment before using the well water, they responded as seen in Table 4. From the Table it can be seen that 53.3% of the respondents claimed that they use alum, 31.7% boil the water before use while 15% claimed that they use other methods but did not specify it. Also from the Table, it can be seen that none of the respondents claimed to use chlorine in treating their water before use. The respondents add alum and boil the water as a way of reducing or eliminating the potential harmful micro-organism in the water before using for their domestic uses.

Table 4: Type of water treatment practices by households in the study area

S/No	Type of Water Treatment	Frequency (n=60)	Percentage (100)
1	Use of alum	32	53.3
2	Boiling of water before use	19	31.7
3	Use of chlorine	00	00
4	Other methods not specified	09	15.0
5	Total	60	100

Source: Fieldwork, 2023.

Incidence of waterborne diseases in the area

When the respondents were asked if they have ever suffered from water borne diseases in the study area, 53.3% responded in the affirmative while 46.7% claimed that they have never experienced any waterborne diseases in the area. On the type of waterborne diseases that the respondents experienced, 43.3% claimed skin rashes, 5% claimed dysentery and diarrhea respectively, 23.3% claimed others but did not specify while 21.7% of the respondents did not respond to this question as shown in Table 5.

Table 5: Type of waterborne diseases experienced by households in the study area.

S/No	Type of waterborne diseases	Frequency (n=60)	Percentage (100)
1	Dysentery	03	5.0
2	Diarrhea	03	5.0
3	Cholera	01	1.7
4	Skin rashes	26	43.3
5	Others not specified	14	23.3
6	No response	13	21.7

Source: Fieldwork, 2023.

The high level of fecal *E. coli* in water samples indicate the possible presence of pathogenic (disease causing) organisms. The presence of this *E. coli* also indicates that the sanitary conditions of shallow well water in Kofai ward of Ardo Kola LGA is far from satisfactory. This was corroborated by the field observation report in this study

Conclusion

This study has examined the level of faecal contamination of shallow well water sources in Kofai ward, Ardo Kola Local Government Area, Taraba State, Nigeria. The results of the findings shows that all the well water samples analyzed are contaminated by fecal matters and as such are not fit for human consumption. None of the respondents admitted using the well water for drinking only. Findings of the study reveals that 60% of the respondents use the well water for washing their clothes and household items and 53.3% use alum in treating the water, while 31.7% boil the water before use. Despite the results of the study, there were obvious limitations of this study which include the small size of the water samples collected. The results of the test might have been slightly affected by the fact that the sampling size was small.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. These shallow well water should not be used for drinking, laundry, bathing, or cooking purposes without treatment. Using the water for laundry and cooking are possible if adequate precautions are taken. This precaution would include adequate use of chlorination for laundry and adequate boiling for cooking uses.
2. There is need for enlightenment campaign and awareness creation on safe water practices and risk of coliform and E. coli contamination spread through food preparation and laundering practices.
3. There is need for regular monitoring of the water sources in the area by the concerned authority.
4. Government needs to increase funding of the water supply project in the study area. This will help ensure regular treatment and supply of water to the residents in the area.
5. There is need for improvement and expansion of the piped water distribution network in the area to ensure that more houses are connected.

References

1. Allevi, R. P., Krometis, L. A. H., Hagedorn, C., Benham, B., Lawrence, A. H. et al. (2013). Quantitative analysis of microbial contamination in private drinking water supply systems. *Journal of Water and Health*, 11(2):244-255.
2. Back, J. O., Rivett, M. O., Hinz, L. B., Mackay, N., Wanangwa, G. J. et al. (2018) Risk assessment to groundwater of pit latrine rural sanitation policy in developing country settings. *Science of the Total Environment*, 613:592-610.
3. Barlow, M. & Clark, T. (2017). The battle against corporate. *Theft of the World's Water*.
4. Boisson, S., Stevenson, M. & Shapiro, L. (2013). Effect of household-based drinking water chlorination on diarrhea among children under five in Orissa, India: a double-blind randomized placebo-controlled trial. *PLoS Medicine*, 10:e1001497.
5. Committee on Economic Social and Community Rights (CESCR) (2002). General comment no.15,

The right to water. UN Doc. E/C.12/2010. *New York: United Nations*.
6. Kitts, C.; Shaffner, A.; Samadpour, M.; Reyburn, I. (2004). Feacal Contamination Source Tracking by Ribotype Fingerprints of Environmental E. coli from the Coachella Valley Stormwater Channel. Final Report; State Water Resources Control Board: Sacremento, CA, USA.
7. Lorentz, S. A., Wickham, B. & Still, D. (2015). Investigation into Pollution from On-Site Dry Sanitation Systems. Report (No. 2115/1, 15). *Report to the Water Research Commission, University of KwaZuIu-Natal, South Africa.*
8. Mahmud, Z.H., Islam, M.S., Imran, K.M., Hakim, S.A.I., Worth, M. et al. (2019). Occurrence of Escherichia coli and faecal coliforms in drinking water at source and household point-of-use in Rohingya camps, Bangladesh. *Gut Pathogens*, 11(52):2-11.
9. Nayebare, J.G., Owor, M.M., Robinah, K. & Taylor, R.G. (2022). Faecal Contamination Pathways of Shallow Groundwater in Low-income Urban areas: Implications for Water Resource Planning and Management. *Water Practice & Technology*, 17(1):285-296.
10. WASH conditions in a small town in Uganda: how safe are on-site facilities? Journal of Water Sanitation and Hygiene for Development 10(1), 96-110.
11. Oruonye, E.D. and Medjor, W.O. (2010). Microbial Analysis of Municipal Water Supply in Damaturu Metropolis, Yobe State, Nigeria. *Nigerian Journal of Microbiology*, 24(1):2106-2109.
12. Oruonye, E.D. and Ahmed, Y.M. (2016). Prospect of Urban Water Supply in Jalingo Metropolis, Taraba State Nigeria. *International Journal of World Policy and Development Studies*, 2(7):46-54.
13. Standard Organization of Nigeria (SON) (2007). Nigerian Standard for Drinking Water Quality. 15-16.
14. UNICEF (2019). Global Framework for Urban Water, Sanitation and Hygiene. UNICEF, New York.
15. Van Steenbergen, F. & Luutu, A. (2012). Managed Groundwater Development in Uganda.
16. United Nations (2010). Resolution on Human Right to Water and Sanitation. United Nations General Assembly. A/64/292. New York: United Nations.
17. United Nations (2013). UN Goal 7: Ensure Environmental Sustainability.
18. Van Steenbergen, F. & Luutu, A. (2012). Managed Groundwater Development in Uganda.
19. WHO (2018). Drinking-water. World Health Organization fact sheets.
20. Wright, J., Gundry, S. & Conroy, R. (2004). Household drinking water in developing countries a systematic review of microbiological contamination between source and point-of-use. *Trop Med Int Health*, 9:106-117.

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