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ASSESSMENT OF WATER IN GURARA DAM AND ITS SUITABILITY FOR DOMESTIC USE IN FCT ABUJA, NIGERIA

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Abstract

The study assessment of water in Gurara dam and it's suitability for domestic use In FCT Abuja, Nigeria. The Gurara dam supply water from Gurara dam in Kaduna state to Lower Usuma dam in Federal Capital Territory (FCT) There is need for regular monitoring of water quality for various parameters of interest to ensure it meet the standard qualities required for intended use(s). Thus, the suitability of Gurara dam water for domestic use in FCT Abuja, Nigeria was assessed. The objectives were to assess the properties of Gurara dam water and ascertain its suitability for domestic purpose. A total of thirty (30) water samples were collected through direct fetching. Ten (10) samples each from upstream, downstream and midstream were collected. Precautions were taken to prevent sample contamination. Data collected from the result of laboratory test were analysis for physical, chemical and microbiological parameters, using standard analytical methods and compared with NSDWQ and WHO standard for domestic uses. Result shows ranges of parameters in the dry and rainy seasons respectively as follows: pH from 7.17-8.23 and from 7.12-8.23, Electrical conductivity (EC) from 222-354 µs/cm^3 and from 280-737 µs/cm3, TDs from 12.14-21.54 Mg/l and from 1.54-2.40 Mg/l, Total hardness from 13.58-39.72 Mg/l and from 13.18-32.67 Mg/l. The concentrations of EC and minerals (K, Na, Cl, Mg and Ca), in water in Gurara Dam were generally below their regulatory standard. It was concluded that water from Gurara dam are not safe for domestic purpose especially drinking. The users of Gurara dam water for domestic purpose should treat before direct consumption.

Keywords: Water, Water quality, Domestic water, Heavy metals, pollution, Water properties

Introduction

There is growing awareness on consequence of water pollution and available literature on quality of surface water indicated that streams, rivers and other sources are showing increasing trend of water pollution due to increasing population, industrialization and urbanization (Amadi*et al*., 2010; Oladele *et al*.,2011; Ordinioh, 2011; Jidauna *et al.*,2014). One of the internationally accepted practices used in preventing water pollution is by monitoring the water quality. This is usually done by carrying out tests and monitoring water physico-chemical properties, heavy metal and biological load in the water body (Riaz *et al,* 2018).

The increasing pollution of water bodies has been well attributed to anthropogenic factors (Akpoveta, *et al*., 2011; Agwu*et al*., 2015; Mbah and Muhammed; WHO, 2016). The consequences of consuming poor-quality water is also well documented (Yerima *et al*., 2008;

Akan *et al.*, 2010; Muazu *et al.*, 2012). The implication of water pollution is that such water will no longer be safe for some uses. According to Arshad and Shakoor (2017) "water quality influences its suitability for a particular use". In others, words, quality of water determines how well the water fulfills the requirement of the user". Similarly, Okoro, *et al* (2012) explained that "specific water may be suitable for irrigation but may not be suitable for drinking and industrial uses due to presence of some other ions at toxic level" Nwakonobi and Gwaza (2012). Thus, water quality is critical "in water resources planning and development for drinking, industrial and irrigation purposes" (Riaz *et al,* 2018).

Water can be applied for varieties of uses in human activities. Water uses can be broadly classified into agriculture/irrigation, domestic, industrial transportation and recreational, uses (Ujoh, *et al*., 2012). Each of these requires a particular characteristics or properties to give required services. Domestic uses include drinking, cooking, washing bathing and flushing toilets while for agricultural uses includes "cropping, flock watering, fish culturing and nursery of seedlings" (Okoro, *et al* 2012; Ahamefule, 2015).

The suitability of water for each these uses vary and many regulatory agencies have set standard for each use. Water samples can be collected and analyzed in laboratory for many physical, chemical and biological properties and compared with regulatory standard to determine its suitability for a specific use. "A number of scientific procedures and tools have been developed to assess the water contaminants" (Dissmeyer, 2000 as cited in Atiku *et al*., (2018). "These procedures include the analyses of different parameters such as pH, turbidity, temperature, dissolved oxygen, alkalinity amongst others. These parameters can affect the drinking water quality if their values are in higher concentrations than the safe limits set by the World Health Organization (WHO) and other regulatory bodies" (Atiku *et al*., 2018).

Yakubu, (2013) advised that the quality of water sources should be tested regularly for various parameters of interest to ensure it meet the standard qualities required for intended use(s). The quality of the available water must be tested to check its fitness prior to use. However, the safety for such dam like Gurara dam is not regularly monitored for their various uses such as domestic purposes. "River water quality monitoring is also necessary in present day society, especially for rivers affected by urban effluents" Amadi *et al* (2010).

Atiku *et al.,* (2018) assessed the drinking water quality of some selected drinking water sources in Abuja, Nigeria. "Samples of drinking waters were collected from river, sachet (packaged), borehole and well in Jabi, Abuja, Nigeria for physicochemical and bacteriological analyses. The result shows that "river water had the highest content of all the physicochemical parameters examined except pH". The physicochemical properties were generally within the World Health Organization (WHO) standards.

Aniebone (2014) investigated chemical and microbiological assessment of surface water samples from Enugu area, Southeastern, Nigeria. A total number of thirteen water samples were investigated in this study. The results showed that hardness ranges from 4.00 to 53.00 mgl-l, the pH range from 4.32 to 7.11 and these values fall within the acceptable limit of water for domestic use. Major ion concentrations were low and within the WHO guidelines for drinking water indicating chemical suitability of surface water. All the water samples tested positive to total bacterial count and E – coli and this is evidence of feacal contamination. It was suggested that water sourced from the water bodies sampled should be treated/disinfected before consumption.

Anyanwu and Okoli (2012) determined the bacteriological and physicochemical quality of various water samples from bore hole, dug well and spring, collected from ten different locations within Nsukka. The physicochemical parameters were analyzed using standard methods. The mean total bacteria count of the water samples ranged as follows: bore hole (0.92 × 104 to 1.41 × 104) cfu/ml, well water (1.80 × 104 to 2.40 × 104) cfu/ml and spring water (0.78 × 104 to 1.06 × 104) cfu/ml. The study reveal that the water supply sources have good physicochemical attributes for human consumption but the presence of *E. coli* and other potential enteric pathogens indicated feacal matter contamination of the water implying that they are not suitable for human consumption.

Okoro *et al.,* (2017) carried out a comparative analysis of three borehole water sources in Nsukka urban area, Enugu state, Nigeria. "Samples were collected from three locations within the area and analysed for some physico-chemical and microbial parameters, which were compared with the Nigerian Standard for Drinking Water Quality (NSDWQ) and the World Health Organization (WHO) standard. The physicochemical parameters include; pH, Hardness, Total Solids, Alkalinity, Turbidity, Sulphate, Phosphate, Silica, Cu, Pb, Fe, Residual Chlorine and Chloride with results ranging from 6.29-6.43, 15-483 mg/l, 41.4-227.2 mg/l, 0.00-0.00 mg/l, 0.2-0.5 NTU, 12.48-17.92 mg/l, 0.6-1.3 mg/l, 0.12-0.29 mg/l, 0.00-0.00 mg/l, 0.00-0.25 ppm, 0.1630-0.2853 ppm, 0.00-0.00 mg/l and 64.98-78.61 mg/l respectively. All the physicochemical parameters were within the standard limits recommended by WHO and NSDWQ, except for the following; pH, Hardness that were above the NSDWQ standard limit".

Behailu *et al.,* (2017) determined the level of common cations, anions, heavy metals and physical parameters in drinking water supply system in Konso and its surrounding area, Southwestern of Ethiopia. Water samples were collected from 23 different locations in the area where there is hand pump or motorized supply system that are used for drinking purpose. Collected samples were analyzed for physicochemical parameters including total alkalinity, Temperature, pH, Electrical Conductivity, Total dissolved solids, Turbidity, Alkalinity, Total hardness and Total suspended solid. Common cations (Li+, K+, Na+, Ca2+ and Mg2+), Common anions (NO3−, SO42−, PO42−, F− and Cl−) and Heavy metals (Pd, Ni, Mn, Pb, Co, Zn, Cu) were analyzed. The obtained results were compared with some national and international standards or guidelines for drinking water. Accordingly, the results obtained show that most of the physical and some common ions and heavy metals were within the accepted range of the guideline recommended by WHO.

Despite abundance of studies on suitability of water quality for domestic purposes, there is scares literature on water quality of Gurara dam. This is not withstanding that Gurara dam is major source of domestic water in Abuja. This study in bit to bridge this gap assessed the suitability of water from Gurara dam for domestic uses in FCT Abuja Nigeria. The study objectives were to assess the properties of Gurara dam in both rainy and dry seasons and determine the suitability of water properties for domestic purpose.

Materials and Methods

The area under study is Gurara Dam Project, the entire project area cuts across Kachia and Kagarko Local Government Areas (LGAs) in Kaduna State and Bwari Area Council of Nigeria's FCT, of approximately 150 km2 with the pipeline route inclusive (Figure 1).The Gurara dam fall within Latitude 090:32' N to 090:48' N and Longitude 070:29' E and 070:49' E (Environmental Impact Assessment (EIA) Report of the Gurara Multipurpose Dam Project).

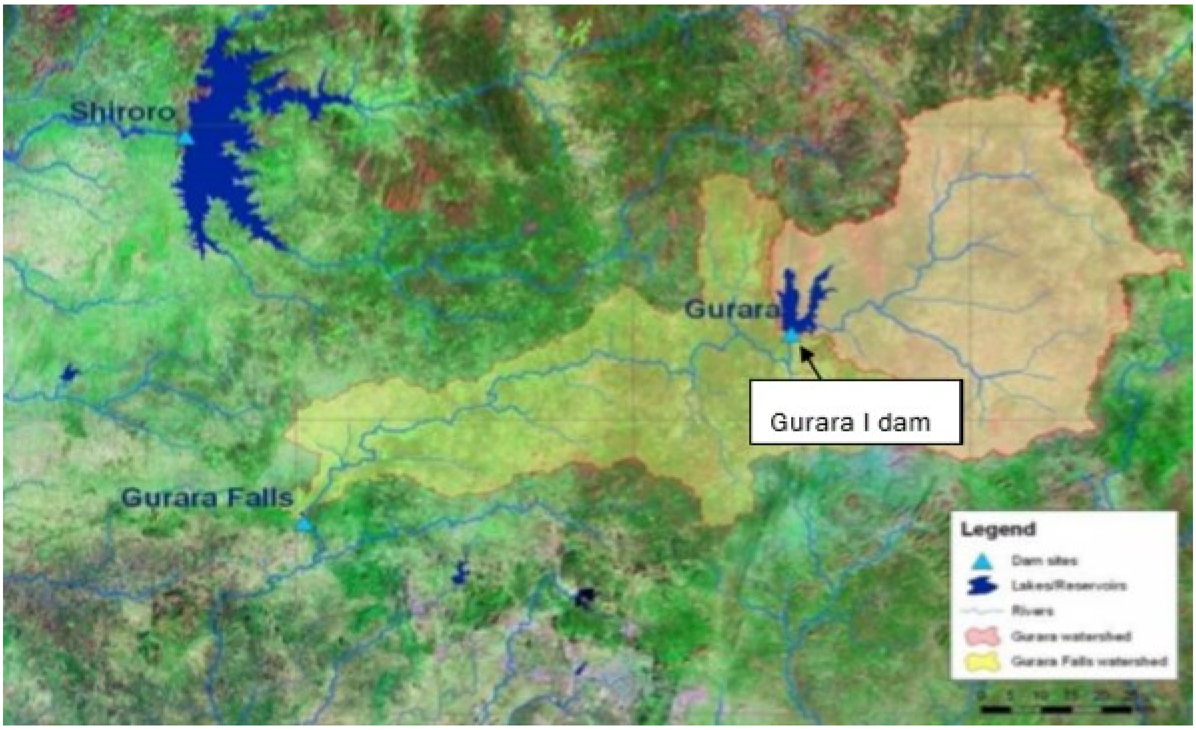

Figure 1: The Study Area
Source: Coordinate System (GCS WGS 88)

This study employed survey and sequential design for data collection and analysis. The data used for this study is mainly quantitative data on water quality parameter. Field survey was embarked on sequentially in dry and rainy seasons for collection of water samples from the study area. Sample was collected and analyzed in laboratory in dry season to get dry season data and also in rainy season to get rainy season data. Data on regulatory standard was also collected through desk top studies of relevant literature. After which data for both seasons were analyzed and compared with water quality.

Plate 1: Section of Structure of Gurara Dam
Source: Coordinate System (GCS WGS 88)

Methods employed for data collection is collection water samples from the Gurara dam. A total of thirty (30) water samples were collected in rainy and dry season each. Sampling was done for five consecutive weeks in each season from the upstream mid and downstream. The samplings were done at the peak of dry season (January-February, 2019) and rainy season (July-August, 2019) in order to capture the effect of seasonal variations. The water samples were fetched directly from the dam using a special water sampling grabber called water –

chestnut and fed into 1.5 litre plastic bottles which were thoroughly rinsed with the waters to be sampled, well labeled then wrapped in black polythene bags, before taken to laboratory in ice packed cooler on the same day the sampling was done for analysis of various parameters.

Plate 2: Outlet Structure of the Lower Usuma Dam
Source: Coordinate System (GCS WGS 88)

Data collected were analysed for physical, chemical and microbiological parameters, using standard analytical methods and compared with NSDWQ and WHO standard for domestic uses. The suitability of water samples for domestic purpose was ascertained by comparing the water properties with the Nigeria standard for drinking water quality (NSDWQ, 2007) and WHO (2010**)** standard for domestic purpose.

Result and Discussion

Table 1 present the properties of water from Gurara dam and regulatory standard for domestic purpose.

Table 1: Properties of Water in Gurara Dam and Regulatory Standard for Domestic Purpose

Parameters	**Range**		**Mean**		**NSDWQ, 2007**	**WHO, 2010**
	Dry	**Rainy**	**Dry**	**Rainy**		
Temp.(Oc)	26.59-30.73	25.59-28-89	28.04	27.56	<40	>20<40
pH	7.17-8.23	7.12-8.23	7.81	7.89	6.5-8.5	6.5-9.2
E.C(µs/cm3)	222-354	280-737	261.00	557.00	≥1000	≥1500(µs/cm3)
TDS(Mg/l)	12.14-21.54	1.54-2.40	14.56	1.94	500	500
TSS(Mg/l)	0.26-1.33	0.18-0.58	0.49	0.36	500	-
Turb.(NTU	0.29-0.93	0.27-0.93	0.46	0.56	≤10	≤5
T. Hardness (Mg/l)	13.58-39.72	13.18-32.67	23.87	19.79	500	200
K(Mg/l	3.05-5.09	6.05-8.18	4.10	6.71		100
Na(Mg/l	4.11-5.65	4.02-6.82	5.08	5.49	200	60
Cl-(Mg/l	4.29-8.93	3.34-8.93	6.62	6.74	250	5
Mg(Mg/l	2.03-17.86	4.32-17.04	9.53	11.55		30
Ca(Mg/l	8.04-21.86	8.04-48.43	14.34	15.38	75	75

Table 1 shows the range and mean concentrations of water properties and the NSDWQ and WHO standard for domestic purpose. It shows water properties regulatory standard as follows:

Temperature

The mean records of water temperature in dry and rainy seasons are 28.04 ^{0}C and 27.56 ^{0}C respectively. These values are below the maximum limit of <40 ^{0}C set by NSDWQ and also lies within the range 20 ^{0}C < 40 ^{0}C set by WHO.

pH

The concentration of pH ranged from 7.17-8.23 and from 7.12-8.23 in dry and rainy seasons respectively. These ranges are within the ranges of 6.5-8.5 NSDWQ and 6.5-9.2 standard set by WHO for domestic purpose. Thus, water from Gurara Dam is safe for domestic purpose in terms of temperature and pH in both dry and rainy seasons. The water is slight alkaline while Okoro *et al*., (2017) reported slight acidic (6.29-6.43) in borehole water.

Electrical Conductivity (E.Cμ^{s}/cm^{3})

The electrical conductivity of water in Gurara dam ranged from 222-354 µs/cm3 and from 280-737 µs/cm3 in the dry and rainy seasons respectively. With mean value of 261.00 µs/cm in dry season and 557.00µs/cm^{3} rainy season which are below ≥ 1000 µs/cm^{3} NSDWQ and ≥1500 µs/cm^{3}standard set by WHO for domestic purpose. Thus, the EC of water in Gurara Dam fall short of regulatory standard for domestic purpose. Therefore, water from Gurara Dam is not safe for domestic purpose in terms of EC in both dry and rainy seasons.

Total Dissolved Solids (TDS)

The concentrations of Total Dissolved Solids (TDS) in both dry and rainy seasons are within the regulatory standard for domestic purpose. The TDS ranged from 12.14-21.54 Mg/l and from 1.54-2.40 Mg/l in dry and rainy seasons respectively. Thus, all values are below 500 Mg/l limit set by WHO.

Turbidity

The mean concentrations of turbidity were 0.46 Mg/l and 0.56 Mg/l for dry and rainy seasons respectively. The values for both seasons surpassed the ranged 0.2-0.35 NTU recorded by Okoro *et al*., (2017). However, the turbidity of water in Gurara dam is within acceptable limit of ≤ 5 NTU set by WHO for domestic purpose and the ≤10 NTU NSDWQ.

Total Hardness

Total hardness of all samples in Gurara Dam in both seasons is within the NSDWQ and WHO standard for domestic purpose. Total hardness ranged from 13.58-39.72 Mg/l and from 13.18-32.67 Mg/l in dry and rainy seasons respectively. Though, Aniebone (2014) found a lower range of 4.00 to 53.00mgl-1 in surface water. These ranges of values are below the maximum limits of 200 Mg/l set by WHO for domestic purpose and the 500 Mg/l National Standard for Drinking Water Quality. Therefore, water in Gurara Dam is safe for domestic purpose in terms of total hardness.

Mineral Nutrients (K, Na, Cl, Mg and Ca)

The concentrations of these minerals K, Na, Cl, Mg and Ca, in water in Gurara Dam were generally below their regulatory standard. Potassium (K) ranged from 3.05-5.09 Mg/l and from 6.05-8.18 Mg/l in dry and rainy seasons respectively but WHO standard for domestic purpose is I00 Mg/l. Sodium (Na) ranged from 4.11-5.65 Mg/l and from 4.02-6.82 Mg/l in dry and rainy seasons respectively but WHO standard for domestic purpose is 60 Mg/l and national standard is 200 Mg/l. Chloride ranged from 4.29-8.93 Mg/l and from 3.34-8.93 Mg/l in dry and rainy seasons respectively but NSDWQ is 250 Mg/l. Magnesium (Mg) ranged from 2.03-17.86 Mg/l and from 4.32-17.04 Mg/l in dry and rainy seasons respectively but WHO standard for domestic purpose is 30 Mg/l. Calcium (Ca) ranged from 8.04-21.86 Mg/l and from 8.04 - 48.43 Mg/l in dry and rainy seasons respectively but WHO standard for domestic purpose is 75 Mg/l.

Conclusion and Recommendation

Data from the laboratory analysis of water properties show mild short fall of regulatory standard (NSDWQ and WHO) for domestic purpose. All parameter were within the acceptable limits in both rainy and dry seasons except for electrical conductivity and mineral such as (K, Na, Cl, Mg and Ca). Therefore, water is not suitable for domestic uses especially for drinking without treatment.

Thus, the following recommendations were made:

i. The users of water from Gurara dam should endeavor to treat properly by boiling, filtration, distillation before direct consumption.
ii. Residents should be caution of activities capable of polluting water within the area.
iii. Government should ensure that Gurara dam are properly treated before supplying to the public.
iv. Water from Gurara dam should be subjected to other uses unless if properly treated.

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