FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 3 No. 4, December, 2019, pp 40 - 45

QUALITY ASSESSMENT OF SHEREHILLS DAM WATER FOR DRINKING AND IRRIGATION PURPOSES IN JOS, NIGERIA

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ABSTRACT
This study was carried out to assess physiochemical parameters at different sections of the Sherehills dam reservoir situated in Jos North Area of Plateau State. Water samples were collected in three (3) different locations namely; upper, center and lower section, and analyzed at the Bauchi State Water Quality laboratory. The result of the analyzed parameters when compared with the standard water quality of NESREA (2011) and NSDWQ (2015) were within the permissible limits for irrigation purposes; for drinking, the turbidity and color were high. Turbidity and color do not have much effect on plant development and growth but with regards to consumption by humans, it must be treated with activated carbon filter and alum flocculation. There is need for periodic quality analysis of water for drinking and irrigation.

Keywords: Dam, Sherehills, parameters, physiochemical and Water quality

INTRODUCTION

The demand for water has been on the increase, its uses have become more diverse now, than in the past. The northern part of Nigeria is subject to arid conditions; hence, there has been a tremendous effort in irrigation development programs to avert the challenge of water scarcity (Ahmed and Tanko, 2000). Presently, the sources of water for usage in Nigeria are: rivers, streams, lakes, ponds, rainwater and boreholes among others (Asmal, 2009).

Water is essential for the survival of mankind and the future development of the world cities, industries and agriculture. As the world's population continue to grow so does the demand for water (ICOLD, 1999). Among other efficient ways to manage water resources for human needs is the construction of dams that create reservoirs for storage and future distribution of water. Construction of dams in Nigeria has been on the rise in the past decade, to curb the rising demand for water (ICOLD, 1999; Asmal, 2009).

Dams are structures built to retain water by forming a reservoir behind the structure. They are usually built across, or near naturally flowing water to manage the water for human use (BDS, 2015). Every dam causes temporary or permanent submergence and in some cases the displacement of person and property (ICID, 2011). Though, dams are supposed to bring about development in areas for water supply, irrigation for agricultural purpose and the generation of hydro-electric power, but it has also accounted for both told and untold misery by the dam community (Ogbeide *et al*., 2003, and Shettima, 2000).

Increase in population and urbanization contribute to water pollution (Coboum and Segale, 2003; Ali, 2008). The pollutants usually find their way into water bodies through direct pumping, deliberate channeling, overland flow and inflow, this may lead to health related challenges (Odjugo and Konyeme, 2008; Toufeek and Korium, 2009). The health impact of dams to human existence consist mainly of water related diseases; such as death, disability, illness and disorder are caused directly or indirectly by the conditions or change in the quality of any water (WHO, 2000).

Major uses of dam water can be summarized as thus: portable water supply, irrigation of agricultural lands, industrial and municipal water supplies, navigation fishing, recreation and aesthetic value (Adams and Peak, 2008). Properly planned, designed, constructed and maintained dams contribute significantly towards fulfilling the water supply requirement of crops, improves economy of farmers and boost food production (ICOLD, 1999, Shariff, 2009, Yakubu, 2009).

The Sherehills dam is located between the mountains of Sherehills, surrounded by Gwash village to the north, Shere village to west and Gwafan village by the east. The major use of the dam is basically for drinking and irrigation purpose, as well as fishing and church baptism. The dam serves as source of irrigation water and for domestic usage for the communities around the Sherehills dam; but till date there is no baseline data on the water quality of the dam. There has been an increasing concern about the environment in which the Sherehills dam is cited. Solid wastes, mount of rubbish, garbage and sewage are

being produced everyday by villagers residing around the dam. In an attempt to dispose these materials, residents have carelessly deposited sewage, municipal wastes into the dam, hence this may affect the physiochemical quality of water, making it unfit for use for drinking and irrigation, among others. The major challenge is that, the concentration levels of major elements of the Sherehills reservoir is yet to be assessed, to know if it is within the permissible level for drinking and irrigation, hence, the need for this research so that baseline data could be generated for the Sherehills dam. This research attempts to: investigate the suitability of the water in Shere hills dam for drinking and irrigation purposes; generate a baseline data; for farmers and other users within the study area.

MATERIALS AND METHODS

Description of the Study Area

The Sherehills are a range of undulating hills and rock formations on the Jos Plateau. It is an earthdam located between latitude 9º 56/ 35.99// N and longitude 9º 02/ 60.00// E, the length is approximately 261.6m.; situated about 10 kilometers to the East of Jos Metropolis, the capital of Plateau State in the middle belt of Nigeria (Dimlang, 2011).

Water Sampling

A side to side walk was taken throughout the surrounding area to observe the dam, the dam was divided into three zones namely the upper, center and the lower zone of the dam. Water samples were taken from these zones by sitting in canoe through these points. Collection of water samples was done in the morning between 7-9 am using Grab method as specified by World Bank (2008). Water samples were collected by lowering pre-cleaned plastic bottles to depth of 30 cm into clean bottles. A total of thirty (30) samples were collected, 10 samples from each of the three zones of the dam and the means were estimated as reported by Oiganji *et al.*, (2011); samples were quickly transported to the Bauchi State Water Board within 24 hours for analysis.

Chemical and Physical Analysis of Water Samples

Chemical analysis was carried out to determine some physical and chemical parameters, namely: salinity, sodicity, dissolve solid, pH, total harness, total dissolve salts, conductivity, turbidity and alkalinity. The water samples were analyzed for physical and chemical characteristics for drinking and irrigation purposes (Ayers and Westcot, 1985). Standards methods and procedures described by the National Environmental Standard and Regulation Enforcement Agency (NESREA, 2011) and National Standards for Drinking Water Quality (NSDWQ, 2015) was use to analyze the parameters as presented in Table 1.

Table 1: Parameters unit and Methods to be assessed

Parameters	Unit	Method used
pH	pH	pH meter
Electrical conductivity	µs/l	Conductivity meter
TH as ($CaCO_3$)	Mg/l	EDTA titrometrics
Magnesium $(Mg)^{2+}$	Mg/l	Gravimetric
Potassium (K^+)	Mg/l	Photometer
Sulphate (SO_4^{2-})	Mg/l	Sulfa ver 4
TDS	Mg/l	Conductivity meter
Sodium (Na^{2+})	Mg/l	Photometer
Calcium (Ca^{2+})	Mg/l	EDTA Titrometric
Chloride (Cl^-)	Mg/l	Agemtometric
Colour		Viewing/Observation
Odour	Degree (º)	Smelling

Statistical Analysis

Data obtained was analyzed using prism windows version 7.04 to compare the means of the physicochemical parameters. T-test was used to test for significant differences between means with respect to National Standards for Drinking Water Quality (NSDWQ, 2015) and National Environment Standards and Regulation Enforces Agency (NESREA, 2011) standards.

RESULTS AND DISCUSSION

Temperature and pH

The temperature of the water sample obtained throughout the period ranged from 22- 35.2º C. The highest temperature value of 35.2 º C was obtained in the month of November, while the lowest temperature value of 22.0ºC was obtained in the month of August as shown in Tables 2-4. Temperature is a measurement of the average thermal energy of a substance. Plants physiology is largely affected by temperature, while some aquatic plants tolerate cooler temperature; however, most prefer warmer temperatures. The temperature value of 35.2ºC obtained was not within the permissible limit of temperature for drinking and irrigation with respect to NESREA, (2011) and NSDWQ (2015) standards, which is good for efficient food conversion, best condition for aquatic lives, resistance to disease

and tolerance of toxins are enhanced as reported by Olubanjo and Alade, (2018).

The pH of the water samples obtained during the period of the study ranged from 2.66 in the month of November to 6.49 in the month of August. Results shows that the pH of the water samples collected in the month of November were acidic and are below the permissible limit for both NESREA (2011) and NSDWQ (2015) standard for irrigation and drinking water as shown in Table 2-4.However, at the sections of the Dam, the Temperature and pH were not significantly different from each other as presented in Table 2-4, which implies that at the upper, centre and lower section of the Sherehills Dam, Temperature and pH are same.

Table 2: Lower section of the Sherehills Dam

S/N	PARAMETERS	13/08/2018	13/11/2018	13/2/19	NESREA	NSDWQ	S.D
1	Temperature (°C)	22.0	34.1	24.2	2.7-28	Ambient	5.26
2	pH	6.49	2.32	6.08	6.5-8.5	6.8-8.5	1.88
3	EC (µs/cm)	94.0	88.1	80.3	1000	1000	5.61
4	TDS (mg/l)	47.0	44.0	40.2	500	100	2.78
5	Turbidity (mg/l)	8.50	1.88	4.52	5	5	2.72
6	Color Pt (mg/l)	65.0	0.00	10.0	15	15	28.58
7	Nitrate (mg/l)	1.26	12.00	1.89	10	50	4.92
8	Sulphate (mg/l)	14.0	4.00	22.0	500	100	7.36
9	Chloride (mg/l)	0.00	3.90	0.18	350	240	1.80
10	Copper (mg/l)	0.00	0.00	0.00	10	1.0	0.00
11	TH (mg/l)	37.0	18.0	18.0	150	150	8.96
12	Alkalinity (mg/l)	85.0	6.00	52.0	100	150	32.40
13	Nitrite (mg/l)	0.04	0.07	0.018	0.7	0.2	0.02

EC = Electrical Conductivity, TDS = Total Dissolve Solids, TH = Total Hardness,S.D = standard Deviation

Table 3: Center section of the Sherehills Dam

S/No.	PARAMETERS	13-08-18	13-11-18	13-02-19	NESREA	NSDWQ	S.D
1	Temperature (°C)	21.6	34.4	24.9	2.7-28	Ambient	5.43
2	pH	6.49	2.66	6.31	6.5-8.5	6.8-8.5	1.76
3	EC (µs/l)	83.3	72.6	84.6	1000	1000	5.38
4	TDS (mg/l)	41.5	36.6	42.2	500	100	2.49
5	Turbidity (mg/l)	7.25	2.76	6.03	5	5	1.90
6	Color Pt(mg/l)	120	0	55	15	15	49.05
7	Nitrate (mg/l)	1.64	13	2.12	10	50	5.25
8	Sulphate(mg/l)	11	0	16	500	100	6.68
9	Chloride (mg/l)	1.6	4.2	0.28	350	240	1.63
10	Copper (mg/l)	0	0	0	10	1	0.00
11	TH (mg/l)	36	20	20	150	150	7.54
12	Alkalinity (mg/l)	85	10	58	100	150	31.02
13	Nitrite(mg/l)	0.04	0.01	0.0210	0.7	0.2	0.02

EC = Electrical Conductivity, TDS = Total Dissolve Solids, TH = Total Hardness, S.D = standard Deviation

Table 4: Upper section of the Sherehills Dam

S/No.	PARAMETERS	13-08-18	13-11-18	13-02-19	NESREA	NSDWQ	S.D
1	Temperature (ºC)	23	35.2	24.9	2.7-28	Ambient	5.36
2	pH	6.69	2.17	6.4	6.5-8.5	6.8-8.5	2.07
3	EC(µs/cm)	82.1	87.2	91.3	1000	1000	3.76
4	TDS (mg/l)	40.9	42.9	45.9	500	100	2.05
5	Turbidity(mg/l)	8.42	3.31	3.93	5	5	2.28
6	Color Pt (mg/l)	60	0	30	15	15	24.49
7	Nitrate (mg/l)	1.84	15	2.38	10	50	6.08
8	Sulphate (mg/l)	16	8	10	500	100	3.4
9	Chloride (mg/l)	0.1	5.6	0.38	350	240	2.53
10	Copper (mg/l)	0	0	0	10	1	0
11	TH (mg/l)	20	25	35	150	150	6.24
12	Alkalinity(mg/l)	65	12	60	100	150	23.89
13	Nitrite (mg/l)	0.07	0.01	0.01	0.7	0.2	0.03

EC = Electrical Conductivity, TDS = Total Dissolve Solids, TH = Total Hardness, S.D = standard Deviation

Electrical conductivity and total dissolve solid (TDS)

Electrical conductivity (EC) is the ability of water to conduct electricity, the EC obtained ranged from 72.6-94µs/cm. The highest EC value of 94µs/cm as obtained in the month of August at the lower section of the dam, while the lowest EC value of 72.6µs/cm was obtained in the Month of November at the center of the dam. The EC values obtained were within the permissible limit for drinking and irrigation water with respect to NESREA (2011) and NSDWQ (2015) standard for drinking and irrigation water. An indication that the water were free from salinity problems as the electrical conductivity gives a good indication of the extent of the dissolved salts as reported by Olubanjo and Alade, (2018).

Furthermore, the total dissolve solid (TDS) obtained ranged from 36.6 – 45.9mg/l. The highest value 45,9mg/l was obtained in the month of November at the upper section of the dam , while the lowest value of 36.6mg/l was obtained in the month of November was obtained in the month of at the center of the at the lower Sherehills dam. The TDS values obtained in the three section of the dam were within the permissible limit for drinking and irrigation with respect to NESREA (2011) and NSDWQ (2015) can be considered to be 'fresh water' for irrigation use and will not affect the osmotic pressure of soil solution as reported by Voutsa *et al.,* (2001). The results obtained in this research is however, at par with what Oiganji (2018) reported for Lamingo Dam in Plateau state, Nigeria.

Turbidity and Colour

Turbidity in water is caused by suspended matter such as clay, fine particles of organic and inorganic matter and microscopic organism. It is critical to successful water treatment and disinfection to keep turbidity in water level low. Turbidity obtained ranged from 1.88 - 8.45 mg/l; the highest turbidity value of 8.45 mg/l was obtained in the month of August at the lower section, while the lowest turbidity value of 1.88 mg/l was obtained from the lower section of the Sherehills dam shown in Table 2-4.

Results shows that the turbidity level of the dam were within acceptable range during the month of November, while in the month of August and February values obtained were higher than the recommended ranged as specify by NESREA(2011) and NSDWQ (2015) standard for turbidity. High levels of turbidity are often associated with higher level of disease- causing organism such as viruses, parasites and some bacteria. Turbidity of water can be treated with activated carbon filter and particulate filter, moringa flocculation and alum flocculation.

The color obtained ranged from null to 120 mg/l. The highest colour value of 120mg/l was obtained at the center of the dam in the month of August, while a null value was obtained in the month of November. It can be observed that the colour of the dam water seems to be within the acceptable range only in the month of November, however, colour of the water samples at the three sections were not within the permissible limit with respect to NESREA and NSDWQ standard for drinking and irrigation water.

The means of Turbidity and Colour were considered at P-Value of 5% for the months and sections of the Sherehills dam results shows that the turbidity and Colour level in the month of August was significantly higher compared to the turbidity level in the month of November and February, however, a null colour value was obtained in the month of November, which implies that in the month of November, the water from dam could be used for domestic purposes.

The turbidity and Colour values with respect to the sections of the dam was considered, with respect to sections, the colour at

the upper and lower section were not significantly different from each other, but the turbidity level at the three sections were not significantly different for the sections considered. A number of factors can cause color water usually due to the presence of dissolved material or suspended solids. A brownish, tea like color can come from decaying plant and similar yellow organic, humus and plant. Portable or drinking water must be treated before consumption but with regards to irrigation, it does not have much effect on plant development and growth as reported by Getahun *et al.*, (2013).

Nitrate and Nitrite

Nitrogen is a critical plant nutrient, so nitrate in water can be beneficial for irrigation but should be accounted for in the overall fertilization program. Nitrate on water does represent broader concerns for both human consumption and surface waters. The nitrate value obtained ranged from 1.64- 15 mg/l. The lowest Nitrate value of 1.64 mg/l was obtained in the month of August at the center of the dam, while the highest Nitrate value of 15mg/l was obtained at the upper section of the dam in the month of November. Nitrate values obtained in the month of November for all the sections of the dam during the study period were above the permissive limit with respect to NESREA (2011) but within the recommended range with respect to NSDWQ (2015) standard. The low nitrate concentration in drinking water is not toxic and cannot cause blue baby disease (methaemoglobianemia) in children and gastric carcinomas as reported by Priyanka (2017).

The Nitrite of the water sample obtained ranged from 0.01 - 0.07mg/l, the highest nitrite value of 0.07mg/l was obtained in the month of August at the upper section and also in the month of November at the lower section of the dam. However, for all the sections of the dam with respect to the study period, nitrite values were within the acceptable range as shown with respect to NESREA (2011) and NSDWQ (2015) standard shown in Table 2-4 respectively. Nitrite values obtained were not significantly different from each other at 95% probability level with respect.

Total Hardness and Copper

Total hardness is a measure of the mineral content in a water sample, which is irreversible by boiling (Rao *et al.*, 2000). Hardness is determined by the calcium and magnesium content of water. The total hardness (TH) obtained in this research ranged from 18- 37mg/l. The highest TH value 37mg/l was obtained in the month of August at the lower section of the dam, while the lowest value of 18mg/l was obtained in the month of November and February at the lower section of the dam. The range of TH obtained was within the permissible limit with respect to NESREA (2011) and NSDWQ (2015) standard for drinking and irrigation water. Results shows that the total hardness values obtained were significantly different from each other at 95% probability level.

The sample of water collected during the period of this research shows that there was no trace of copper in all the samples that were examined. The null value of copper were within the permissible limit with respect to NESREA (2011), NSDWQ (2015) standard for drinking and irrigation water shown in Table 2-4, respectively.

Sulphate and Chloride

Sulfur is an essential plant nutrient; concentration is rarely a concern other than in cool mining region where externally high levels are occasionally observed. The Sulphate values obtained ranged from 0- 22 mg/l, the highest value of 22mg/l was obtained at the lower section of the dam in the month of February, while a null value was obtained in the month of November at the center of the dam. The Sulphate values for all samples were within the permissible limit of the dam with respect to NESREA (2011) and NSQWD (2015) standard for drinking and irrigation water as presented in Table 2-4.

The chloride of water sample obtained ranged from 0- 5.6 mg/l. The highest value of 5.6 mg/l was obtained in the month of November at the upper section of the dam, while a null value was obtained in the month of August at the lower section of the dam. Results shows that the chlorine values obtained within the period of study were within the permissible limit with respect to NESREA (2011) and NSDWQ (2015) standard for drinking and irrigation water. The chlorine can occur in water supplies naturally or from various activities. Chloride is difficult to remove from water so advance treatment using membrane (reverse osmosis) or distillation is necessary as reported by Chang *et al.*, (2001).

Alkalinity

The alkalinity of the samples obtained in this study ranged from 6- 85mg/l. The highest alkalinity value of 85mg/l was obtained in August at the lower and centre section of the dam, while the lowest alkalinity value 0f 6mg/l was recorded in the month of August. The alkalinity level of the Sherehills dam values were within the permissible limited with respect to NESREA and NSDWQ for irrigation and drinking water standard as presented in Table 2-4.The Alkalinity values obtained were not significantly different at 95% probability level with respect to the month, however, result obtained shows that the alkalinity level was higher in the month of August compared to the month of November and February.

CONCLUSION

Evaluation of quality of Sherehills dam water was carried out result showed that the physiochemical characteristics of the dam water; temperature, pH, EC, TDS, Total hardness, Sulphate, Chloride, Copper, Nitrate, Nitrite and Alkalinity were within the allowable range to the standard for irrigation water quality according to NESREA (2011) and NSDWQ (2015) standard for irrigation water. Nevertheless, in the research reported herein there was no trace of copper ion, whereas turbidity and color were above the maximum permissible limit in respect to the standard; hence, the water must be treated before consumption but it does not have much effect on plant development and growth.

Also, the leaders of the communities surrounding the dam should enforce strict rules and legislation on adequate evaluation of the quality of water for drinking and irrigation; ensure a proper acceptable standard for good and effective crop Production in the study area. Furthermore, assessment should be carried out in both wet and dry season to better understand the dynamic changes in water quality that may occur with time.

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