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Assessment of Some Water Quality of Obuburu River, Okene, Kogi State, Nigeria

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ABSTRACT: The quality of water is very important and it determines the extent to which it can be used. The water for drinking should be potable and various parameter are always use for the assessment of water quality. The study was carried with the aim to assess the quality of Obubur river water, Okene town that serve as source of water to many inhabitants of the town. A total of 36 surface water samples were collected. The samples were analyzed for some physicochemical parameters and heavy metals such as pH, turbidity, total solids, total dissolved solids, suspended solids, alkalinity, total hardness, sulphate, phosphate and dissolved oxygen using standard chemical methods. Nitrate was determined by phenoldisulphonic acid method. Heavy metals (Cd, Co, Cu, Ni, Pb and Zn) were determined by atomic absorption spectrophotometry. The water is hard and with a high chloride concentration. Studied level of Cd and Pb in water samples exceeded the safe limits of drinking water. The average level of Zn is also of concern. The range of heavy metals observed were 0.011-0.023, 0.008-0.011, 0.001-0.014, 0.001-2.2, 2.80-7.20 for Cd, Co, Cu, Ni, Pb and Zn respectively. The results indicated that the water is probably not safe for drinking by human and other animals as well as for cooking.

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Water is regarded as a natural resource that is essentially needed by people for different purpose like for drinking, irrigation of food crops, and recreation activities among others (Emamgholizadeh, 2014). The use to which water is put to depends on the purpose and hence variation in quality of water needed. In whatever uses there must be acceptable water quality level. Acceptable water quality level for potable water is different from that for recreation or for fishing. However, in developing world many people are ignorance of this fact. As result of scarcity of potable water especially in rural area, any water they see provided it is clean is use for drinking, washing and recreation activities. Not knowing the exact quality of such water. There is great need more than ever before for surface water quality study because of increasing pollution load being release from residential, industrial and commercial activities into water bodies with its impact on health of human beings as well as aquatic ecosystems (Ranjeeta, 2011). In some areas washing of cars by the stream or river side is a common occurrence. This have impart on the quality of the water downstream. The contamination of surface water have been reported to cause transmission of waterborne and water-related diseases among individuals and communities that often use such water for recreation, drinking and other domestic purposes (Fong and Lipp 2005; Gersberg *et al*., 2006; World Health Organization 2008; Abdelzaher *et al*., 2010). Food crops irrigated with such water are often contaminated and it has a great consequence on the food chain (Shuval 1990; Mohanty *et al*., 2002; Gemmell and Schmidt 2012). Surface water contamination is majorly of nonpoint and point sources. A nonpoint source is of a wide range that includes animal defecation, domestic, unrepaired sewage and septic systems, storm water drainage and urban runoff (Kistemann *et al*., 2002; Chigor*et al*., 2012). Point sources is said to include municipal wastewater treatment plants (Shuval 1990; Okoh *et al*., 2007; Igbinosa and Okoh 2009; Lata *et al*., 2009: Chigor *et al*. 2010; Odjadjare *et al*., 2010), and runoff from where livestock are handled (Williams *et al*., 2012). Access to tap water is a basic need for man but its availability is of great concern to several communities. It has been reported in South Africa that in many rural areas, over 75 % of poor households have no access to treated tap water (DWAF 2004). Due to non-availability of treated tap water many households (approximately 74 % of all rural households) rely solely on untreated stream or river water (DWAF 2004; Obi *et al*., 2004; RHP 2004). Nigeria as a nation, the situation is even worst compare to South Africa. Okene town is not exception to this pathetic scenario. Obuburu river provides the people of Okene access to water for several purpose. Therefore the quality of the water need to be ascertains. There is dearth of information on the water quality of Obuburu river in terms of scope and duration for pollution studies. Going by the universal usage of the Obuburu water, it is expedient to ascertain the quality of the water and to let

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authority concern to know if the water quality is acceptable or there are inherent dangers to consumers that see the water as potable and for other purposes. This study is carried out to ascertain the quality of ObuburRiver, Okene town that serve as source of water to many inhabitants of the town.

MATERIALS AND METHODS

Description of study area: Okene runs along the highway in between Auchi-Lokoja highway. It had an area of 328 km² and with an estimated population of 320,260. Its geographical coordinates are 7° 33' 0" North, 6° 14' 0" East. The study was carried out on ObuburuRiver which runs through major part of Okene town, Kogi State. It takes its source from Okene-Eba passes through Okunchi to Ogaminana and joins Etegoza river at Orro river very close to the bridge along Ogaminana-Kabba road after New Zango Cattle Market adjacent to Usungwe. The area is rocky; the main physical upland that characterized the area is Okunchi Mountain. The river is perceived to receive wastes ranging from commercial, agricultural and domestic sources.

*Sampling collection and analysis***:** Six sampling stations were within an assigned coordinate of global positioning system (GPS) as in Table 1. Grab sample was collected at each of the points chosen along the river channel within Okene town as shown in Figure 1.A total number of 36 samples were collected in both seasons for physicochemical parameters. Same amount of samples were collection for heavy metals determination. Samples for dissolved oxygen (DO) were collected separately with DO sampling bottles.

DO samples were collected carefully to avoid bubbles. Measurements of the river dimensions and flow were not considered in this study. Samples were collected according to standard procedure describe by America Public Health Association (1998).

pH was determined at location, using field equipment, nitrate was determined by thephenoldisulphonic acid method while dissolved oxygen was fixed at sampling points as given by Winkler's method. All laboratory analyses were carried out using standard methods (APHA, 1998; Department of The Environment 1772) while appropriate quality assurance procedures for water analysis (USEPA,

Table 1: Location of sampling points

Sampling station (SW)	Latitude	Longitude
SW_1	N 7°33'23.982"	E6°13'45.72"
SW_2	N 7°34'5.466"	E 6°132'4.594"
SW_3	N 7°34'19.746"	E 6°132'0.904"
SW_4	N 7°34'40.836"	E 6°131'0.458"
SW_5	N 7°34'56.934"	E 6°21'253.37"
SW_6	N 7°35'34.692"	E 6°12'7.002"

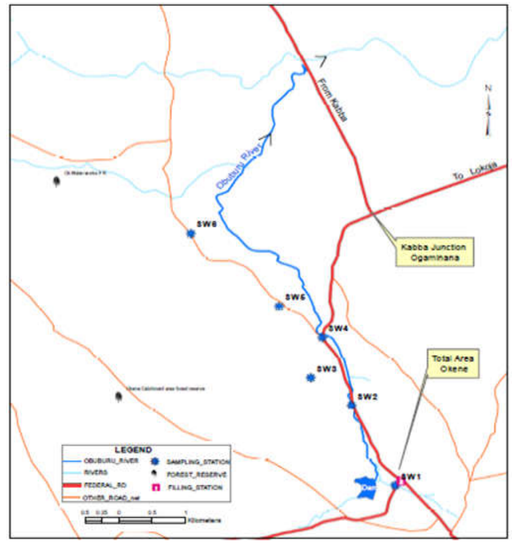

Fig 1: Map of Obuburu river in Okene Town showing sampling points1996) were observed. Metals (Cd, Co, Cu, Ni, Pb and Zn) were determined by atomic absorption spectrophotometry

*Quality assurance and statistical analysis***:** Samples were generally analysed in duplicates. All glasswares and sampling bottles used for sampling and analysis respectively was thoroughly washed with Teepol, soaked in 2 M nitric acid for 24 h and rinsed with de-ionised water. Stock standard solutions were prepared from Analar R grade salts. Dilute aliquots as working standards were made from the stock solutions. Freshly prepared reagents were standardized for actual strength. Analytical grade chemicals and reagent blanks were used in all analyses to check reagent impurities. A sample blank digestion was also prepared after every 10 samples. Recovery study for heavy metal was carried out to check the accuracy and precision of the entire experimental procedure. Average recoveries obtained were acceptable at 80 ± 17 to 106 ± 17%. Data obtained were subjected to analysis of variance using the general linear models.

RESULTS AND DISCUSSION

*Physicochemical properties of water:*The pH values of rainy and dry season ranged from 7.2 to 9.1 with a mean value of 7.90±0.48 (Table 2). The results for rainy season and dry season show no significant difference as results indicates alkalinity. Data obtained showed that downstream values were slightly higher in both season. The range of values of this study is within the range of 6.5 mg/L to 8.5 mg/L recommended by WHO (2011), and levels of the most of the samples were found within the permissible limit for drinking purposes and some other standard guideline (Table 3). Water pH greaterthan 8.5 is considered too alkaline and is not suitable for human consumption. Therefore the value of 9.1 recorded downstream makes water downstream unsuitable for drinking. The result shows that river water from all sampling stations were alkaline and this may be due to the presence of carbonate calcium and magnesium in water (Chandia *et al.,* 2012), which are naturally deliver into the river water due to the reaction between carbonate rocks and water. The present of carbonate rocks along the channels of the river flow is quite noticeable. Overall mean total alkalinity of the water was 290±120 mg/L. Values varied widely from 105 -565 mg/L. The differences observed in dry season upstream and downstream total alkalinity wassignificant ($p < 0.05$) as given in Table 1.

Table 2: Physicochemical properties of Obuburu river water

Parameters	Rainy season		Dry season		Overall	
	Upstream	Downstream	Upstream	Downstream	Range	Mean± SD
pH	7.50±0.26	7.73±0.21	8.04±0.30	8.33±0.67	7.2-9.1	7.90±0.48
Total alkalinity (mg CaCO3)	200±82	200±20	430±110	320±14	105 -565	290±120
Total hardness (mg CaCO3)	140±36	116.7±5.0	313.3±5.0	269±27	112 -318	210±89
Suspended solid (mg/L)	68±10	48±5.8	42±33	33±25	5 -80	48±23
Total solid(mg/l)	350±132	262±54	303±138	243±5.8	200 – 500	290±95
Chloride (mg/L)	231±64	161±42	105±25	54±18	35 -301	140±77
Nitrate (mg/ml)	0.006±0.002	0.007±0.003	0.005±0.001	0.11±0.18	0.001 – 0.3	0.03±0.09
Phosphate (µg/ml)	0.009±0.001	0.01±0.01	0.008±0.002	0.01±0.01	0.001 – 0.02	0.01±0.01
Sulphate(mg/L)	7.47±1.01	7.81±0.18	3.31±0.53	2.39±0.21	2.4 – 8.4	5.2±2.6
Turbidity (NTU)	38±11	33±15	18.3±6.8	12±9.6	10 – 51	25±15
Dissolved oxygen (mg/L)	2.64±0.27	5.31±4.11	3.92±1.36	3.73±1.1	0.91-9.04	3.9±2.2

Table 3: Comparing water quality data with regulatory standard bodies values.

Parameters	Rainy Season	Dry Season	This study	WHO(2011)	ICMR(1975)	FEPA(1999)	SON (2007)
	Mean± SD	Mean± SD	Overall Mean± SD				
pH	7.55±0.07	8.19±0.21	7.90±0.48	6.5 – 8.5	6.5 – 9.5	6.0 – 9.0	6.5 – 8.5
Total alkalinity(mg/L)	200±50	375±78	290±120	120	200		
Total hardness(mg/L)	128±17	291±31	210±89	200	300		
Suspended solid(mg/L)	58±14	38±26	48±23	500	-		
Total solid(mg/L)	305±92	270±73	290±95	500	-	2000	250
Chloride(mg/L)	196±49	80±36	140±77	250	250	250	250
Nitrate(mg/mL)	0.007±0.001	0.06±0.02	0.03±0.09	10	-	-	-
Phosphate(mg/L)	0.01±0.01	0.01±0.01	0.01±0.01	0.5	-	0.5	-
Sulphate(mg/L)	7.64±0.24	2.85±0.65	5.2±2.6	250	200	200 – 400	
Turbidity	36±14	15.2±4.5	25±15	50	-	10	15
Dissolved Oxygen(mg/L)	4.0±2.0	3.8±0.1	3.9±2.2	5	5	5	-

Although alkalinity value decreases downstream, values obtained during dry season exceeded recommended permissible limits (ICMR, 1975; WHO, 2011) as in Table 3. High alkalinity observed may be due to the rocky nature of the area and this implies high buffering capacity (Etim *et al.,* 2013). A measure of water's resistances to change in pH is termed total alkalinity. It is a reflection of alkali (bi-carbonates, carbonates and hydroxides) available in the water.Low alkalinity water can make the water to be corrosive and as well irritate the eyes. On the other hand if the water is of high alkalinity and has a taste of soda, when use for recreation, bathing or washing of hands, can dry out skin and can cause scaling on fixtures and throughout water distribution system (Farhad*et al*., 2017). The mean of the total hardness in water was 210±115 mg/L (as CaCO3) with value that ranged from 112mg/L to 318mg/L. The allowable permissible limit of total hardness for potable water is 500 mg/L but the desirable limit is 100 mg/L (WHO, 2011). The hardness of water understudy varies from moderately hard to hard following the general guidelines for classification of water (Briggs and Ficke, 1977). It therefore limits its use for some domestic purposes, such as laundry and washing. It can also lead to scaling in boilers and industrial equipment (Ndefo, *et al*., 2011). Similarly, it is also not good as drinking water. Hence hardness of water is of concern to many user of water. Fig 2 shows that the difference in mean total hardness value in dry season and rainy season mean value was significant ($p < 0.05$). A total solid is a measure of the inorganic salts and little level of the organic matter present in solution in water. Values of total solids in water samples ranged from 200 mg/L to 500 mg/L with a mean of 290±95 mg/L. With this range of values the water can be classified as good. However, it should be noted that the presence of total solids in water can actually affect the taste (WHO, 1996). Total solids upstream in both season were significantly different from downstream ($p<0.05$). The low clarity of water upstream may have resulted from the high concentration of total solids.Average value of rainy season (305±92 mg/L) was higher than dry season value of 207±73 mg/L. The range of data obtained in this study is significantly lower than 220 - 1460 mg/L reported for Ogunriver by Oketola*et al*. (2006) but similar to 292 mg/L to 541 mg/L reported for Ashopa river in Kogi State by Emurotu*et al*. (2014). The level of suspended solids ranged from 5.0 to 80 mg/L with an average of 48±23 mg/L. The mean value is within regulatory permissible limit as given (WHO, 2011).

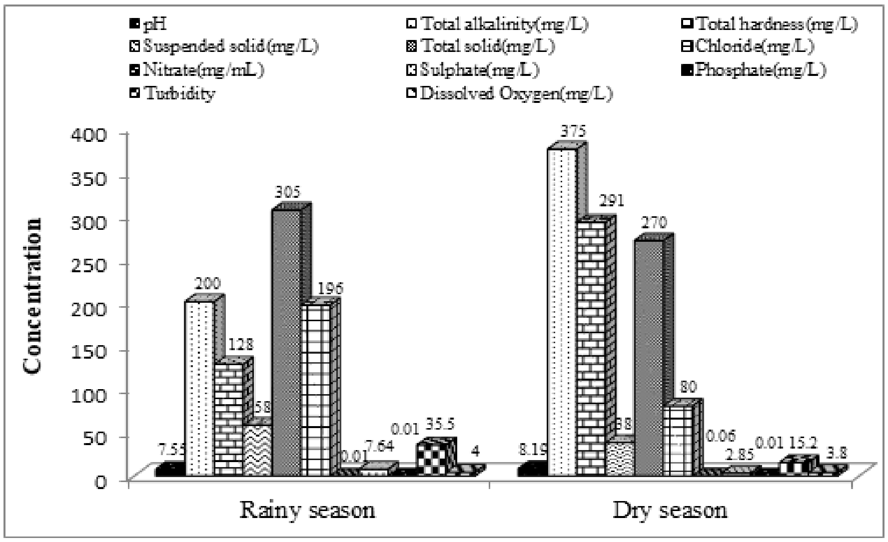

Fig: 2 Seasonal variations of physicochemical parameters

The mean level of chloride was 140±77 mg/L. Values varied widely from 35 mg/L to 301 mg/L. High value of 301 mg/L recorded upstream in rainy season is of concern. According to Chandia *et al*.(2012)high level of chloride content is a clear indication of pollution. High chloride concentration can cause damages to metallic pipes and structure, as well as harms growing plants (Yirdaw and Bamlaku, 2016). Hence WHO recommendation that chloride content in water should not be more than 250 mg/L (Table 3). Unlike total hardness and alkalinity, the chloride content was higher in rainy season compare to dry season and the difference is significant. However, these values are within permissible level. High nitrate level in water can cause disease. A particular disease due to high nitrate level in water is the blue baby syndrome in infants. Hence WHO recommends a permissible limit of 10 mg/L of nitrate as maximum allowable in water for drinking purpose? In this study the level of nitrate ranged from 0.001 mg/L – 0.3 mg/L with a mean of 0.03±0.09. These results indicated that the quantity of nitrate in ObuburuRiver is within allowable permissible limits.United State Public Health Service has recommended that for a sensitive fish such as salmon the concentration of nitrate in water should not be more than 0.06 mg/L (Behar, 1997). The level of phosphate in ObuburuRiver was very low. All values obtained are within permissible limit of drinking and surface water. There is no so much health risk associated with phosphates except when present in very high concentrations. However, the low level of water in dry season may make the phosphate level to react. It has been reported that small streams may react to levels of phosphate at levels of 0.01 mg/L or less (Behar, 1997). Like phosphate, sulphate has no major negative impact as far as human health is concern. However, a highest desirable limit of 250 mg/L of sulphate in drinking water is allowable (Table 3). Yirdaw and Bamlaku (2016) reported that sulphate mainly derived from the dissolution of salts of sulfuric acid and found in almost all water bodies. They also reported that high level of sulphate could be as a result of oxidation of pyrite and mine drainage etc. Turbidity has been reported to be a measure of how clarity of water is affected by the presence of suspended particles in water. Hence it is a good indicator of the level of suspended sediment and erosion. There is always an alteration to turbidity level during and after a rainfall because erosion causes sediment to be moved into the stream or river. When this occurs, it causes the level of turbidity to be high which lead to a rise in water temperature and lower dissolved oxygen. The Tyndall effect of possible high turbidity in water prevents light from reaching aquatic plants thereby affecting their ability to photosynthesize, and harm fish gills and eggs (Behar, 1997). The range of turbidity value of this study do not pose any threat to aquatic life since values obtained are within regulatory permissible unit by WHO except downstream in rainy season that had values of 51 NTU. Dissolved oxygen (DO) level ranged from 0.91 mg/L to 9.04 mg/L with a mean value of 3.9±2.2 mg/L. The high dissolved oxygen of 9.04 mg/L was recorded upstream and DO decreases downstream. The mean value of 3.9±2.2 mg/L recorded suggests that only a few fish and aquatic insects can survive. Behar (1997) has put a value of 2 to 4 mg/L as the range where only few fish and aquatic insects can survive. He gave factors such as addition of oxygen consuming organic wastes for example sewage, addition of nutrients, changing the flow of water, raising the water temperature, and the addition of chemicals as factors that affects DO due to activities of man.

The concentration of some heavy metals: Screened heavy metals in water sample were Cd, Co, Cu, Ni, Pb and Zn (Table 4). The concentration of cadmium ranged from 0.011 mg/L to 0.023 mg/L with a mean value of 0.02±0.01 mg/L. The mean value of Cd is higher than the allowed regulatory permissible limits of different regulatory bodies as given in Table 5. The WHO (2011) guideline value for cadmium concentration in water samples should be less than 0.01. Cadmium main target in human body is the kidney. Hence long term usage of water with high level of Cd is of concern. The effect if such water is used for irrigation for a long term is also of concern because it will accumulate in the crops and eventually finds its way into the food chain. Mean cobalt concentration was 0.010±0.002 mg/L. Co is considered as an essential element good for the body. Although the permissible limits have not been set by regulatory bodies, the level in water should not be too high. Copper concentration ranged from 0.002 mg/L to 0.007 mg/L with a mean of 0.005±0.003 mg/L. Copper is considered as an essential nutrient and a drinking-water contaminant (WHO, 2003). Therefore there is need to give attention to its concentration in surface water. The recorded concentration of copper in this study is within regulatory permissible limit. Nickel concentration in Obuburu river water varied from 0.001mg/L to 0.014 mg/L with a mean value of 0.007±0.004 mgL. WHO (2003) reported that food is the dominant source of nickel exposure particularly in the non-smoking, non-occupationally exposed population while referring to water as a minor contributor to the total daily oral intake. It is therefore no surprise to see the concentration of nickel within permissible limit. Other sources that could have contributed to high level of Ni are non-existence along this river channel.

Table 4: Seasonal concentration (mg/L) of some metals in Obuburu river

Metals	Rainy season		Dry season		Range	Overall mean
	Upstream	Downstream	Upstream	Downstream		
Cd	0.02±0.01	0.01±0.01	0.02±0.01	0.02±0.02	0.011-0.023	0.02±0.01
Co	0.010±0.001	0.007±0.001	0.001±0.003	0.012±0.001	0.008-0.011	0.01±0.002
Cu	0.007±0.005	0.004±0.003	0.005±0.002	0.003±0.002	0.002-0.007	0.005±0.003
Ni	0.005±0.004	0.004±0.003	0.008±0.006	0.011±0.003	0.001-0.014	0.007±0.004
Pb	0.7±1.2	0.02±0.02	0.47±0.73	0.093±0.003	0.001-2.2	0.33±0.68
Zn	4.97±2.01	5.2±1.9	5.4±2.3	5.6±1.0	2.8-7.2	5.3±1.6

Table 5: Comparison of metal concentration (mg/L) with regulatory standard limit

Metals	This study		WHO (1993)	FEPA (2003)	SON (2007)	EU (2014)	EQSSW) (1997)	CCME (2005)
	Mean	Range						
Cd	0.02±0.01	0.011-0.023	0.003	0.003	-	0.005	0.005	0.05
Co	0.010±0.002	0.008-0.011	-	-	-	-	-	-
Cu	0.005±.003	0.001-0.013	2	0.0-1.5	1	2	1	1
Ni	0.007±0.004	0.001-0.014	0.02	-	0.02	0.02	-	-
Pb	0.33±0.68	0.001-2.2	0.01	0.01-1.0	0.01	0.01	.0.01	0.01
Zn	5.3±1.6	2.80-7.20	3	5-15	-	-	-	5

The level of Pb in water ranged from 0.001mg/L to 2.20 mg/L with a mean value of 0.33±0.68 mg/L. The mean value (0.33±0.68 mg/L) of this study is higher than 0.02±0.0 mg/L reported by Oketola*et al*. (2013) for OgunRiver. The concentration of Pb in both seasons is above permissible limit as given by regulatory bodies (Table 5). Lead is a toxic metal and due to its toxicity it affects body mechanism to a large extent and in some cases death. The high value recorded may be due to automobile mechanic activities around the area which involve the use of fuel and automobile batteries which contain lead. Mastoi *et al.* (2014) reported that lead affects the safety of aquatic organisms at a concentration of 0.16 mg/L. In similar study, it was reported that lead poisoning causes acute brain problem or delayed brain development (Shi and Zhaoyu, 2008). The recorded concentration of zinc ranged from 2.8 to 7.2mg/L with average concentration of 5.3±1.6 mg/L. This value is within the range limit of 5 mg/L to 15 mg/L set by FEPA (2003) Nigeria standard and 5 mg/L as given by CCME (2005) Canada agency as shown in Table 5.

However, the level of zinc (5.3±1.6 mg/L) exceeded the WHO (2011) permissible level (3.0 mg/L) of zinc in water. The toxicity of zinc to some animals such as cattle, sheep, horses etc caused by excessive zinc intake has been reported (Elinder, 1986; Torrance, 1987). The average level of zinc may be of concern because of the antagonistic effects of zinc on the toxic effects of cadmium, lead, nickel and other metals. Zinc toxicosis has been documented in various mammalian species, including ferrets, sheep, cattle, pigs, horses, and dogs, mostly taking the form of copper deficiency caused by excessive zinc intake (Elinder, 1986; Torrance and Fulton, 1987). Research report has it that there are signs of toxicosis among a herd of 95 calves when exposed to a cumulative zinc intake of 42–70 g per calf (Graham *et al*., 1987). A high-zinc diet has been shown to induce hypocalcaemia and bone resorption in rats (Yamaguchi, 1983).The antagonistic effects of zinc on the toxic effects of other metals, including cadmium, lead, and nickel, have been described in several reports (Hietanen*et al*., 1982; Waalkes*et al*., 1985; Reddy *et al*., 1987). Water with high zinc concentration may pose great danger to human and animals.

*Conclusion***:** The result of physicochemical parameters showed that the pH level in dry season makes the water not fit for drinking. The water is hard and high level of chloride recorded indicates pollution. The level of DO is also of concern as only few aquatic organisms can survive in such body of water. The presence of toxic Pb and Cd above regulatory agencies limit is also of concern because of their effects on animals and human lives.

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