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Assessment of Pollution Load in Surface and Borehole Water Obtained from Some Locations in Hong Local Government Area of Adamawa State, Nigeria

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Abstract

Water quality is very important to human, animals and plant's physiology and health. This work aimed at assessing the pollutant load in surface and borehole water obtained from some selected location in Hong Local Government Area of Adamawa State, Nigeria. The physicochemical properties of the water such as pH, Electrical conductivity (EC) Temperature (T), Dissolved Oxygen (DO), Hardness, Total Dissolved solid (TDS) and chlorine were analyzed. Heavy metals such as Fe, Ni, Zn, Cu, Mn, Cr and Pb were also analyzed using standard procedure. the results obtained were analyzed statistically using One-Way Analysis of variance (ANOVA) while Duncan Multiple Range Test was used for comparison between location. possibilities $P < 0.005$ were considered statically significant. The results obtained for heavy metal Cadmium and Zinc were found to be above the permissible limit of WHO physiochemical parameters were found to be within the permissible limit given by WHO (2006) which shows that the surface and borehole water of the areas studied need to be monitored to prevent it from total pollution..

Keywords: Pollution, Physicochemical, Heavy Metal, Surface Water and Borehole Water

Introduction

Water pollution has become a very critical area of study worldwide because of their direct implications on the aquatic life and the human beings (Ezemonye and Enuneku, 2005). The pollution of surface water by heavy metals is a serious environmental problem. They are non-degradable and can bio-accumulate through food chain. Though some metals like Fe, Cu and

Zn are essential micronutrients, they can be harmful to the physiology of the living organisms at higher concentrations (Kar *et al*., 2008, Nair *et al*., 2010).The security and effectiveness of domestic water supplies have become a significant concern as a result of rapid urbanization and climate change (Le Bot *et al*., 2016). Due to the increasing population from urban expansion, urban water security has been regarded as a major problem in megacities (Bichai and Smeets, 2013). The pollutants in the water environment have become more complex with the development of technology and the intensification of anthropogenic activities (Wang *et al*.,2022). Among the numerous pollutants, heavy metals have attracted global attention for decades due to their non-biodegradability and their high stability and persistence in either the environment or living organisms (Zhao *et al*.,2020). The concentration levels among common heavy metals in water vary greatly. In addition, the severity of the toxic effects of heavy metals is disproportionate to their concentrations. Toxic metals such as Cr, Cd and Pb, which have been listed as carcinogens by the World Health Organization (WHO), can induce adverse health consequences including gastrointestinal inflammation, blood cerebral diseases and cardiovascular diseases under long-term exposure at low-dose levels (Lu *et al*., 2015, Ranjbar *et al*., 2023).The presence of some toxic metals in rivers is a serious challenge to our society. For this reason, there is a need for careful assessment, monitoring, and control of their release into the environment. Through various socio-economic and industrial activities, man causes severe pollution in the water bodies that leads to serious environmental problems which result in diseases, sudden deaths, and disabilities Ranjbar *et al*.,2023. Polluted water related diseases such as dysentery, diarrhea, bilharzias, typhoid fever, cholera, guinea worm and so on are very common among communities that live close to polluted river sources. The retention of these heavy metal or pollutant depends on the physio-chemical properties of the water such as PH value, Electrical conductivity, Dissolve oxygen to mention but few.

Study Area

Hong LGA is located between latitudes 10° 00′ 00″ N and 10° 35′ 00″ N and longitudes 12° 35′ 00″ E and 13° 20′ 00″ E. It has a total land area 2,419.11 km^2 (Bashir and Raji, 1999). Hong is one of the 21 Local Government Areas of Adamawa State created in 1987 during the defunct Gongola State. It has it headquarters in Hong town being the largest settlement and is classified by Ilesanmi (1999) as a third order core urban settlement in Adamawa state. Hong Local Government Area consists of seven (7) districts which are Hong, Dugwaba, Pella, Kulinyi, Hildi, Gaya and Uba. The people leaving in the location are mostly farmers by occupation.

Sampling Location

Samples of Surface and Borehole water was collected from Hong, Garaha, Munga, Kala'a, Pella, Hildi and Uba in Hong Local Government Areas of Adamawa State.in each village, samples were collected in Seven location,

Water Sample Collection

Water Samples was collected. Sample collection was done manually using a 1liter bottle at 0.3m depth as described by Yohanna *et al*., (2015). Samples from the bottom of shallow water was collected by lowering a closed plastic bottle to the bottom, opening and closing it there by hand and taking it out. The water sample was collected at these different points across the surface water. The different samples collected was poured into a bigger container to form a composite sample. One liter of the composite was drawn and treated with 10mL HNO_3 to maintain the state of cations in solution and slow biological changes before reaching the laboratory for physiochemical tests as recommended by Maitera *et al*., (2011).

Water Analysis

Water samples collected was analyzed using standard methods for water and waste water (APHP 2005), International standard for drinking water (WHO, 1971) and according to Njosi (2010). Parameters like temperature, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), readings were taken on the site using a combined meter, Dissolved Oxygen meter was used for Dissolved Oxygen. Hardness of water and Chloride was determined using titrimetric method. Ni, Cr, Cd, Pb, Zn, Fe, Mn and Cu was analyzed by the use of Atomic Absorption Spectrophotometer (AAS).

Results

The results from Fig 4.1: show that Iron Fe was found to have the highest concentration in both surface and Borehole water in all the area studied. It was found to have the highest concertation of 2.00 mg/l in Borehole water obtained from Hong study area, the lowest Concentration was found to be 0.63 mg/l in Surface water obtained from Uba study area. Chromium was found in both the samples across all the studied the highest concentration was found to be 1.62 mg/l in surface water obtained from Hildi Study area. The lowest Concentration of Chromium was found to be 0.83mg/l in Borehole water obtained from Uba Study area. Chromium (Cr) is Carcinogen and widely distribute in earth Crust, it has the oxidation number of +3 and +6 it is usually present in a minute quantity. It is highly toxic at the oxidation state of +6. In this study, the highest Concentration of Chromium was found to be 1.62 mg/l which is above the Permissible limit of 0.003mg/L given, by WHO therefore both the surface and borehole water are Contaminated and not safe for Consumption

Cadmium Cd. was found to have the highest Concentration of 1.22 mg/l in borehole water from Kala'a study area, the Least Concentration was found in surface water from Uba study area with the concentration of 0.01mg/l it was found to be absence in Surface water from Hildi, Kala'a and Garaha. Copper. Cu, was found in all the sample, across all the areas Studied, it was found to have the highest concentration of 1.16 mg/l in borehole water obtained from Hong study area and the lowest Concentration was found to be 0.24 mg/l in Surface water from Munga. Copper (Cu) it is an essential Micronutrient but harmful at high dose concentration courses Severe Condition in human physiology It Cause gastrointestinal infection (WHO2006). The Concentration of Copper was found to be within the Permissible Limit of 2.00mg/L given by WHO. therefore, the water is not polluted by the metal copper. Manganese is an essential Component of those biochemical process the in-bone formation, Cartilage, brain and it supply energy but toxic at high concentration. The concertation of lead Pb varies from one location to another with the highest concentration of 0.92mg/l in borehole water from Hong, the Least Concentration was found to have concentration of 0.32 mg/l in borehole water from Munga study area. Lead Pb was not detected in surface water obtained from Garaha study are. Lead Pb is the most Toxic heavy metal, it is inorganic in nature and are absorbed through ingestion by food. Water and inhalation. Exposure to lead can result to wide range of biological effect such as gastrotestinal truck, kidneys and it affect the production of hemoglobin depending on levels of exposure and duration of exposure. The concertation of lead was found to be above the WHO permissible limit and therefore the water is polluted by the element

. Zinc (Zn) was detected across all the areas Studied with the highest concertation of 0.69 mg/l in borehole water from Hildi and least concentration was found to be 0.26 mg/l in surface water from Kala'a and Hong study area. Zin (Zn) is present in igneous rocks it is an essential micronutrient, the concentration of Zinc (Zn) was found to be within the permissible limit of 0.800mg/l given by WHO, therefore both the water is not polluted and are safe for consumption by both plant and animal. Nickle Ni was found across all the area studied with the highest concentration of 0.91mg/l in borehole water from Munga and least concentration was found to be 0.43mg/l in borehole water from Garaha borehole Nickel (Ni) The natural source of nickel in water are the ultramafic rock and the soil formed from these rocks it is Carcinogenic and harmful to the physiology of all Living Organism if present in high concentration the Concentration was found to be above the permissible Limit by WHO in borehole water but Within the permissible limit in Surface water. This mean that the borehole water is not polluted by the metal and safe for Consumption. Surface water of Pella and Uba were found to have the same concertation of manganese Mn with the concentration of 4.47mg/l in both samples, across all the areas studied the highest concertation was found to be 0.81mg/l in borehole water obtained from Garaha and the least concentration was found to be 0.39mg/l in borehole water obtained from Pella. The Concertation of these metal varies in the order Fe > Cr > Cd > Cu >Ni > Mn >Zn >Pb

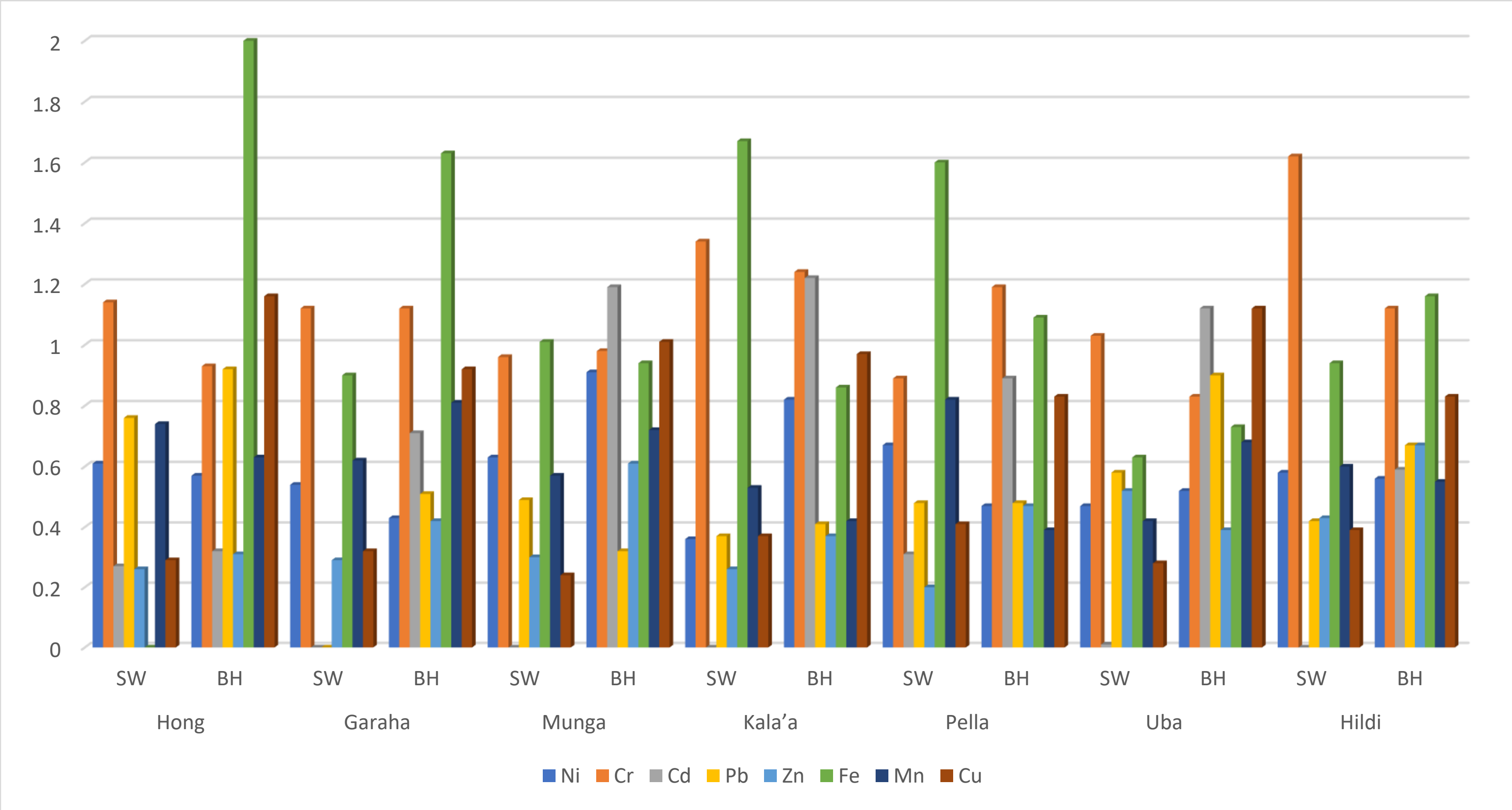

Fig 4.1 present the mean Concentration of some heavy metals in surface and Borehole water obtained from some part of Hong Local Government Areas.

Physicochemical Parameter of Water from Some Study Areas in Hong Local Government Areas

Temperature (O^C) of Water from the Study Areas

The temperature of the Surface water ranged from 21.11±0.19 ^oC in Kala'a to 25.45 ±0.54 ^oC in Hong study area. In borehole Water, the temperature ranged from 19.75±0.500 ^oC In Munga to 29.97±0.31 ^oC in both surface borehole water, the temperature were found to be within the recommended value of 25°C by WHO with the exception of borehole water from Hong Study area which was found to be high which have the value of 29.97±0.31^oC. Water is and indispensable Component in our lives, an essential substance to man, animals and all that surround them (Abba, 2013). The temperature of Water has Impact on the acceptability of some Inorganic Constituent and chemical contaminant which may affect the quality of water such as test (uyom *et al*., 2014). It also affects the Conductivity of water, the higher the temperature, the higher the Conductivity (Ibironke *et al*., 2018). The temperature been within the recommended Value, it shows that the temperature has less effect on the factors that affect the quality of water

Location	**Surface Water**	**Borehole Water**
Hong	25.45±0.54^c	29.97±0.31^c
Garaha	23.75±0.73^b	25.28±2.02^{ab}
Munga	24.14±0.16^{ab}	19.75±5.00^a
Kala'a	21.11±0.19^a	22.40±3.16^{ab}
Pella	22.96±1.42^b	23.65±1.68^{ab}
Uba	23.23±1.17^b	20.700.46^{ab}
Hildi	23.16±1.03^b	22.861.49^{ab}
Range	20.90-26.09	14.20-30.16
Grand Mean	23.40	23.51
Standard Deviation	1.44	3.83
C.V. (%)	6.15	16.29

Mean ± Standard Deviation within a column with different superscript letters are significantly different at $P < 0.05$ according to Duncan Multiple Range Test. CV = Co-efficient of Variation

pH of the Study Areas

The PH of surface water ranged from 6.04±0.1 in Hildi to 7.06±0.46 in Kala'a, the temperature of borehole water ranged from 6.24±0.93 in Hildi to 7.25±0.49 in munga, according to the finding, the PH of all the locations studied fall within the acceptable Limit of 6.8-8.5 by WHO. This means that the surface water can support aquatic lives and that of borehole is safe for consumption. High or low value of PH have been reported to influence aquatic life (Mnualefa and Torto 2007).

Location	**Surface Water**	**Borehole Water**
Hong	6.87±0.05^{b}	6.83±0.30^{ab}
Garaha	7.06±0.46^{b}	6.94±0.12^{ab}
Munga	6.85±0.14^{b}	7.25±0.49^{b}
Kala'a	7.00±0.07^{b}	7.15±0.36^{b}
Pella	6.75±0.13^{b}	7.03±0.11^{ab}
Uba	6.99±0.17^{b}	7.11±0.02^{b}
Hildi	6.04±0.11^{a}	6.24±0.93^{a}
Range	5.92-7.54	5.17-7.82
Grand Mean	6.79	6.93
Standard Deviation	0.37	0.48
C.V. (%)	5.44	6.93

Mean ± Standard Deviation within a column with different superscript letters are significantly different at $P < 0.05$ according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Dissolved Oxygen (μs/cm^3) of Water from the Study Areas in Hong Local Government Area

The Value of DO found in surface water from the study area ranged from 6.51± 0.26 μs/c ppm in Uba to 7.10±0-09 ppm in Hildi while in borehole water, the highest value of DO was found to be 6.23±0.10 μs/cm^3 in Hong and the least Value was found to be 4.59±0.42 ppm in Kala'a. in both the Sample across all the areas studies, the value of DO was found to be above the WHO acceptable limit of 5.0ppm with the exception of borehole water from Kala'a in which have the Value of 4.59±0.42ppm.

Location	Surface Water	Borehole Water
Hong	7.04±0.08^{c}	6.23±0.10^{a}
Garaha	6.94±0.19^{bc}	6.00±0.23^{cd}
Munga	7.21±0.02^{c}	5.99±0.44^{cd}
Kala'a	6.74±0.04^{ab}	4.59±0.42^{a}
Pella	7.01±0.21^{bc}	5.13±0.17^{ab}
Uba	6.51±0.26^{a}	5.50±0.43^{cd}
Hildi	7.10±0.09^{c}	6.02±0.30^{bc}
Range	6.30-7.24	4.28-6.51
Grand Mean	6.93	5.64
Standard Deviation	0.26	0.62
C.V. (%)	3.75	10.99

Mean ± Standard Deviation within a column with different superscript letters are significantly different at $P < 0.05$ according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Total Hardness (mg/L)

The results shows that, the hardness of surface ranged from 200.72± 64.40 mg/L in Hildi to 653.85±169.76 mg/L, while in borehole water the hardness ranged from 79-68±324.61 mg/L In Pella to 173.65±57.87 mg/L In Surface water, all the Values found is above the acceptable of 180 mg/L, while in borehole water all are found to be within the acceptable limit of 180mg/L by WHO. The hardness of water is the measure of polyvalent cations in Water, Water with high hardness value is regarded as hard Water (musa *et al*., 2018)

Location	Surface Water	Borehole Water
Hong	407.02±13.74^{b}	110.47±7.74^{ab}
Garaha	349.22±41.85^{ab}	106.47±12.97^{ab}
Munga	653.85±169.76^{c}	135.47±33.44^{ab}
Kala'a	576.47±98.94^{c}	173.65±57.87^{c}
Pella	270.97±83.49^{ab}	79.68±34.61^{a}
Uba	367.59±60.95^{ab}	156.00±43.26^{c}
Hildi	220.72±64.40^{a}	80.45±29.63^{a}
Range	178.19-801.11	42.81-218.03

Grand Mean	406.55	120.31
Standard Deviation	166.43	45.23
C.V. (%)	40.94	37.59

Mean ± Standard Deviation within a column with different superscript letters are significantly different at $P < 0.05$ according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Electrical Conductivity (ms/cm) of water from the Study Areas in Hong Local Government Area

The table present the electrical conductivity of water from the study area. In Surface water, the highest conductivity was found in Hildi with the value of 597.02±157.95 ms/cm and the least value was found to be 2.75±56.70 ms/cm in Munga. In Borehole water Pella was found to have the highest value of EC with the Value 495.49±17.16 ms/cm and the least Value was found to be 108.41±12.50 ms/cm in Garaha, in all the location studied, the EC was found to be within the a acceptable value of 1400ms/cm, the EC of Surface water was found to be higher than that of Borehole water which could be due to the fact that surface water is expose to all kind of substances around the Water. Electrical Conductivity is a useful indicator of Mineralization and Salinity. In Must Case high EC Indicate low water quality as EC of water to an indirect measurement of dissolved Chemical. EC is the Measure of the ability of water to pass electrical Current. It indicates the Presence of inorganic dissolved solids such as chloride, nitrile, Sulphate, ammonia, The EC of all the areas studied was found to be within the recommended value of 1400 ms/cm by WHO. This Show that both the Sources and borehole water are safe or consumption.

Location	Surface Water	Borehole Water
Hong	418.46 ± 77.17^{abc}	166.66 ± 54.76^{a}
Garaha	341.38 ± 158.35^{ab}	108.41 ± 12.50^{a}
Munga	275.56 ± 50.70^{a}	251.24 ± 56.17^{b}
Kala’a	296.11 ± 8.00^{a}	118.47 ± 8.26^{a}
Pella	540.22 ± 104.74^{c}	495.49 ± 17.16^{d}
Uba	508.19 ± 22.74^{bc}	340.45 ± 53.53^{c}
Hildi	597.02 ± 154.95^{c}	455.51 ± 37.46^{d}

Range	218.17-692.64	94.72-514.08
Grand Mean	425.28	276.60
Standard Deviation	145.88	153.61
C.V. (%)	34.03	55.54

Mean ± Standard Deviation within a column with different superscript letters are significantly different at P < 0.05 according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Total Dissolved Solid (μs/cm^3) water from the Study Areas

The Surface water was recorded the higher TDS with the value of 30.17±0.03 ppm in Uba and the Least Concentration was recorded in Hildi with a value of 117.13± 0.05 ppm in borehole water, the higher Value of TDS was found to be 214.66± 0.85 ppm in Kala'a and the least TDS was fond to be 105.55±0.59 ppm in Hong. In all the location studied the value of TDs was found to be within the acceptable Value of l000ppm of TDS recommend by WHO. High Value EC and TDS are good Indicators of possible water pollution in the site (WHO 1998). Base on the Value of TDS found. It indicates, that there is less risk of pollution on the bases of EC and TDS

Location	**Surface Water**	**Borehole Water**
Hong	6.73 ± 0.13^{ab}	5.51 ± 0.59^{abc}
Garaha	6.75 ± 0.42^{ab}	5.76 ± 0.56^{bc}
Munga	6.99 ± 0.94^{b}	4.66 ± 0.85^{a}
Kala'a	7.15 ± 0.04^{b}	5.10 ± 0.16^{abc}
Pella	6.40 ± 0.30^{ab}	5.52 ± 0.50^{abc}
Uba	6.17 ± 0.03^{b}	4.84 ± 0.06^{c}
Hildi	7.13 ± 0.05^{a}	5.88 ± 0.28^{ab}
Range	5.92-7.68	3.83-6.19
Grand Mean	6.76	5.32
Standard Deviation	0.49	0.60
C.V. (%)	7.25	11.28

Mean ± Standard Deviation within a column with different superscript letters are significantly different at P < 0.05 according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Chlorine (ppm) of water from the Study Areas in Hong Local Government Area

The Concentration of Chlorine ion in Surface water from all the location studied ranged from 332.45±33.55ppm In Hildi to 512.14±12.97 ppm in Hong, in borehole water, the ion ranged from 512.79±12.97 ppm in Hong.in borehole water ion in ranged from 104.18±12.47 in Uba to 197.34±16.35 in Hong. the value of chloride ion in Surface Water ware found to be above the WHO acceptable limit of 250ppm. While in borehole water, all the location studied were found to be within the acceptable limit of 250ppm by WHO. Higher chloride value in water indicate highly degree of pollution. Going by the results obtained, it Shows that Surface water contain more pollutant than the borehole water across all the location studied

Location	**Surface Water**	**Borehole Water**
Hong	512.14±12.97[b]	243.50±23.86[a]
Garaha	359.86±48.12[a]	197.34±165.35[a]
Munga	452.70±142.07[ab]	142.49±74.68[a]
Kala'a	416.96±24.67[ab]	110.77±20.27[a]
Pella	366.73±37.36[a]	117.12±18.66[a]
Uba	332.42±33.55[a]	104.18±12.47[a]
Hildi	359.00±56.17[a]	127.41±66.90[a]
Range	300.32-610.08	68.42-388.19
Grand Mean	399.97	148.97
Standard Deviation	81.15	79.54
C.V. (%)	20.29	53.39

Mean ± Standard Deviation within a column with different superscript letters are significantly different at $P < 0.05$ according to Duncan Multiple Range Test. CV = Co-efficient of Variation

Conclusion

The surface and borehole water of the areas studied were found to be polluted with some heavy metals and is snot afe for consumption by both plant and animals.

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