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ABSTRACT

In order to ensure availability and sustainable management of water and sanitation for all, as a set target for Sustainable Development Goals (SDG), there is every need to manage and monitor the sources and availability of water resources. One of those strategies is to investigate the level of water pollution and proffer management strategies.

Purpose: The aim of this study was to assess the water quality of surface water in Mpape dumpsite and its environs.

Methodology: A total of 15 water samples were analysed for 27 parameters during the rainy seasons in 2019. The data was then compared with the World Health Organization standard.

Findings: Temporal analyses revealed that all the water samples collected at three different times across the five different sampling points exhibited low variation in their quality, except Cd in sample 1, pH in sample 3, Cd and Cn in control sample 1 and 2 respectively have high variations, while DO and Fe in sample 2, Hg and Fe in control sample 1 and 2 respectively, varied moderately. Biological analysis shows that all the water samples used for the study have feacals, such as Salmonella, Shigella, and E-coli. Spatial analysis result showed that there was high variation between the sampling points though statistically the variation was not significant. Statistically, there was significance difference in pollution level between the dumpsite and the control samples at α=0.05. About 40% of the analysed parameters were above the WHO standard, and 46.7% is within the limit, while 13.3% their permissible limits were not mentioned.

Recommendation: It was therefore recommended that the water be treated before use and the public should be sensitized on the need to always purify their water before consumption. The authority concern should embark on regular monitoring and treatment of the polluted water in order to achieve goal 6 of the SDG.

Key words: *Rainy season, Water quality, SDG, WHO and Pollutants*

1.0 INTRODUCTION

Solid waste disposal is one of the major pollution problems in Nigeria. It has been observed that the generation rate of solid wastes increase per head per day and it varies from 0.5kg -1kg, and found that solid waste disposal is the greatest public health engineering hazard facing the urban centers [1]. The water environment is very often polluted by heavy metals due to various anthropogenic sources in the form of industrial waste water, urban surface water runoff, agricultural processes, etc. [2]. Heavy metal concentration within the water may be relatively low in some cases; however, the concentrations may increase in the sediment.

Landfill is one of the methods of solid waste disposal in the study area. Among the problems of landfills is leachate, a term given to the grossly polluted liquid that can emerge from a land filled waste mass if too much liquid is allowed into the waste. Leachate from fresh waste has high organic strength and Biological Oxygen Demand (BOD). This must not be allowed to discharge into the surface and groundwater or onto crops, because it will lower their quality [3].

Mpape dumpsite did not meet the criteria for citing a landfill [4], as such pollution is uncontrolled in the dumpsite. The dumpsite is situated in watershed area and two tributaries of River Usuma derived their sources from there. During the rainy season, as water percolates through municipal solid waste, it makes a leachate that consists of decomposing organic matter combines with iron, mercury, lead, and zinc, metals from rusting cans, discarded batteries and appliances. It may also contain paints, pesticides, cleaning fluids, newspaper inks, and other chemicals. These leachates find its ways and drained into the neighbouring water sources.as contaminants. Contaminated water can have a serious impact on all leaving creatures, including humans, in an ecosystem.

Heavy metal transfer in soil profiles is a major environmental concern because even slow transport through the soil may eventually lead to deterioration of groundwater quality. The risks of heavy metal pollution of groundwater are determined by the mobility and availability of elements [5]. The ability to predict the mobility of heavy *metals* in the soil and the potential contamination of groundwater supplies is a prerequisite in any program aimed at protecting ground water quality [6].

It is understood that all landfills will eventually release leachate to the surrounding environment and therefore all landfills will have some impact on the water quality of the local ecosystem. In small quantities, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (iron, copper, manganese, and zinc). These elements are commonly found naturally in foodstuffs, fruits, vegetables, and in commercially available multivitamin products. Heavy metals are also common in industrial applications such as in the manufacture of pesticides, batteries, alloys, electroplated metal part, textile dyes, steel, and forth [7]. Many of these products are in our homes and actually add to our quality of life when properly used. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, pharmaceutical, industrial, or residential setting.

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2.0 FIELD AND LABORATORY METHODS

The Mpape dumpsite was the major site used as landfill for the Federal Capital Territory before relocating to Gosa, around 2006 when the site was filled up. It is located at the Northeastern edge of the Gwagwa Plains, along Aso-Bwari Hills by the Kubwa expressway near the tipper garage of Mpape, within the watershed of the River Usuma Basin. The Federal Capital Territory (FCT) Abuja is located between latitudes 8º 25' and 9º 25' north of the equator and longitudes 6º45' and 7º45' east of Greenwich Meridian (Figure1). It occupies an area approximately 8,000km^2 and occupies about 0.87% of Nigeria. The territory is situated within the region generally referred to as the Middle Belt [8], and is bordered on all sides by four states namely Kogi, Niger, Kaduna, and Nassarawa. The Federal Capital consists of a number of distinct physiographic regions basically of two types, the hills and the plains. The elevations of these hills range from about 100m to about 300m in the more rugged areas.

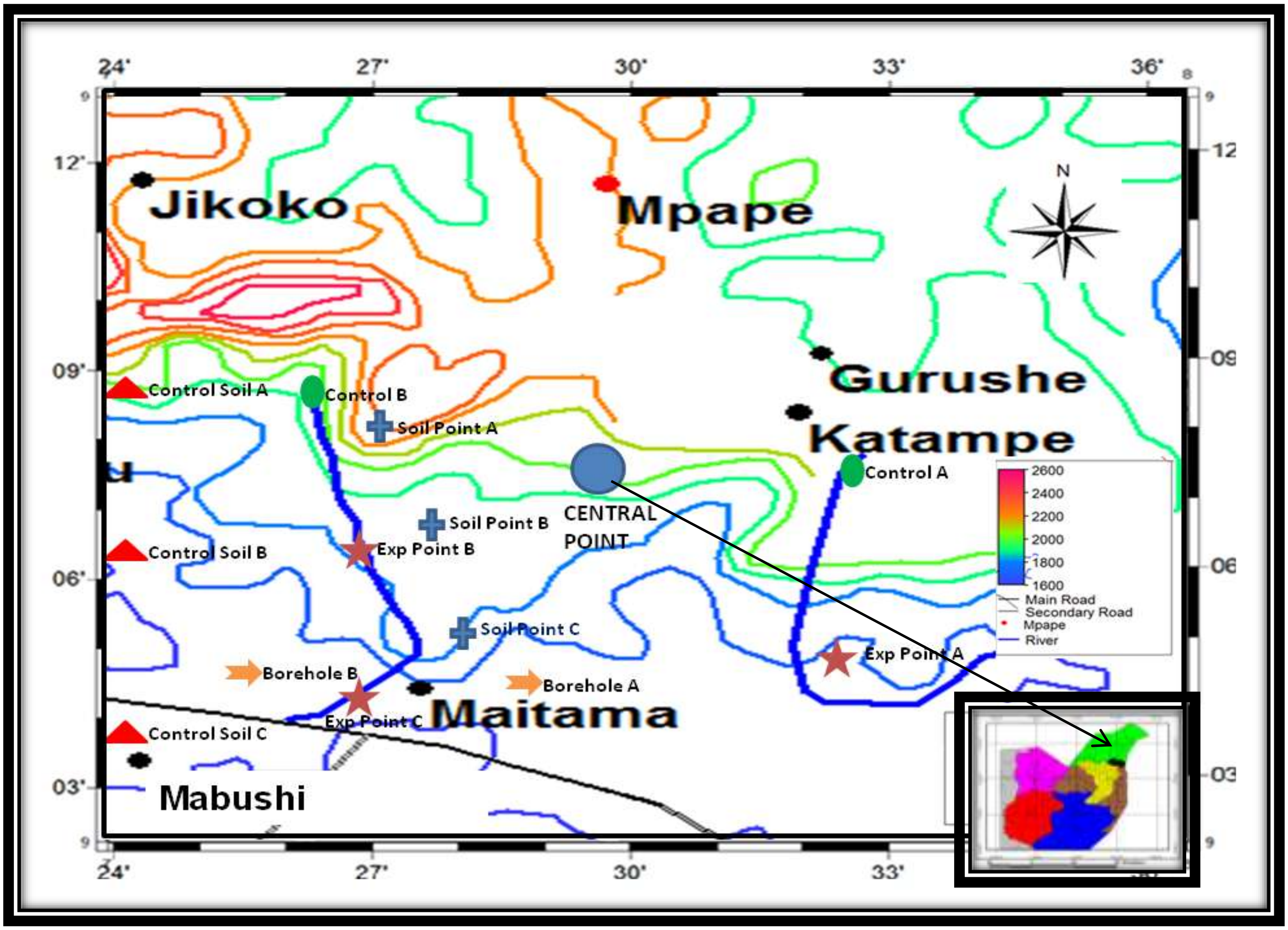

Figure 1: Location of Mape Dumpsite in the Federal Capital Territory, Abuja.
Source: Adapted and Modified from diverse sources by the Author, (2018)

The landfill is situated at the upper part of the plains. The influence of parent materials on the soil of FCT stem from the fact that two parent materials, namely, crystalline rocks of the basement complex and Nupe Sandstone are the surface from which they are formed. The soils of the FCT, for the purpose of easy identification is described along six major land systems, namely, the undulating Gwagwalada plains, the Abuja dissected plains, the Kau plains, the undulating Kuje plains, the Iku and the Robo plains [9]. The alluvial complexes of the territory are contained in all the stream channels which are made up of gleysols which are very fertile and occur dominantly in Abaji Area Council of the FCT. The soils of the plains are mostly sandy and sandy-loam.

The Federal Capital Territory records the highest temperature during the dry season months, which are generally cloudless. The maximum temperature occurs in the month of March with amounts varying from 37^{o}C in the Southwest to about 30^{o}C in the Northeast. This also coincides with the period of high diurnal ranges of temperature which can drop to as low as 17^{o}C, and by August, diurnal temperature rarely exceeds 7^{o}C.

2.1 Sources of data

The data for this research work was obtained from two sources, which are primary and secondary sources. The primary data which was the water samples was obtained directly from the surface water in the field, while the secondary data is the information from past study and those from the area Abuja Environmental Protection Board, Journals and other related materials from internet.

2.2 Water Sampling and collection

Five sampling points of surface water were identified and marked along the stream; two out of them were the upstream which were used as control. At each point three samples were collected for three months during the rainy season, making a total of 15 samples for the study.

The concentration of the metals present in any type of water may satisfactorily be determined by Atomic Absorption spectroscopy or colorimetric methods. These two methods are rapid and do not require extensive separation techniques. The methods and procedure for the analysis were adopted after [10, 11].

3.0 RESULTS AND DISCUSSION

3.1 Descriptive Analysis of Surface Water

The analyzed results of 15 water samples collected during the period of this study were subjected to descriptive statistics and the outcome is presented in Table 1.

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Table 1: Temporal analysis of the results of surface water

Parameter (mg/L except stated)	**Experimental Sample Point 1**		**Experimental Sample Point 2**		**Experimental Sample Point 3**		**Control Sample Point 1**		**Control Sample Point 2**	
	Values	**COV**	**Values**	**COV**	**Values**	**COV**	**Values**	**COV**	**Values**	**COV**
Temperature (^{0}C)	28.7±0.4	1.21	28.6±0.5	1.85	28.7±0.2	0.72	28.9±0.1	0.35	28.7±0.3	1.2
pH	6.87±0.1	0.84	7.23±0.2	2.88	7.8±0.10	1.28	6.1±0.05	0.86	6.9±0.06	0.8
Conductivity (ms/cm)	680±0.2	0.0	984.5±0.5	0.05	1574±0.2	0.0	295±0.1	0.02	680 ±0.2	0.0
Total Dissolved Solid	134±1.0	0.75	135.7±0.6	0.43	139.3±0.6	0.41	131±0.6	0.44	134±1.1	0.7
Dissolved Oxygen	3.2±0.10	3.13	3.03±0.06	19.0	2.43±0.1	4.75	4.07±0.1	1.42	3.2±0.1	3.1
Total Hardness	170.±1.0	0.59	175.0±0.0	0.0	180±0.0	0.0	170±0.6	0.34	170±1.0	0.5
BOD_5 at 20^{o}C	20.0±0.0	0.0	23.67±0.6	2.44	32.3±0.6	1.79	11± 0.0	0.0	20±0.0	0.0
COD	56.0±1.0	1.79	71.33±0.6	0.81	85.0±1.0	1.18	38.9±0.1	0.15	56±1.0	1.8
Nitrate (NO_3^-)	4.49±0.0	0.13	1.33±0.01	0.58	3.7±0.03	0.68	3.2± 0.01	0.32	4.5±0.0	0.1
Nitrite	0.01±0.0	0.0	0.05±0.01	10.8	0.06±0.0	0.96	0.4±0.0	0.13	0.05±0.0	1.2
Fluoride	0.55±0.0	0.18	0.01±0.0	0.0	0.01±0.0	0.0	0.01±0.0	0.0	0.01±0.0	0.0
Ammonia (NH_4)	17.1±0.0	0.06	0.54±0.0	0.18	1.0±0.0	0.06	0.80±0.0	0.07	0.55±0.0	0.2
Magnesium (Mg)	0.22±0.0	9.32	34.24±0.0	0.11	34.2±0.01	0.03	42.9±0.0	0.01	17.1±0.0	0.1
Manganese (Mn)	8.47±0.2	1.80	0.26±0.02	5.95	0.5±0.00	0.0	1.0±0.01	0.58	0.0±0.02	9.3
Aluminium (Al)	101±1.0	0.99	8.90±0.1	1.12	9.6±0.06	0.59	3.0±0.0	0.19	8.5±0.15	1.8
Sulphate (SO_4^2)	0.01±0.0	0.0	108±71	1.06	126.3±0.6	0.46	45±0.0	0.0	101±.01	1.0
Cadmium (Cd)	0.01±0.0	43.4	0.01±0.0	0.0	0.02±0.01	50	0.03±0.0	21.7	0.01±0.0	43.3
Mercury (Hg)	0.01±0.0	0.0	0.05±0.01	10.8	0.07±0.01	14.3	0.02±0.0	24.7	0.01±0.0	0.0
Silver (Ag)	0.01±0.0	0.0	0.01±0.0	0.0	0.06±0.01	10.2	0.01±0.0	0.0	0.01±0.0	0.0
Chloride (Cl^-)	214±1.2	0.54	361±0.6	0.16	361.0±1.0	0.28	151±0.58	0.38	213.7±1.2	0.5
Bromide (Br)	0.01±0.0	0.0	0.04±0.0	13.3	0.18±0.01	6.30	1.1±0.01	0.9	0.01±0.0	0.0
Copper (CU^+)	0.04±0.0	25	0.06±0.0	16.67	0.24±0.01	4.17	0.16±0.0	3.69	0.04±0.0	25
Ferric Iron (Fe)	1.02±0.0	0.56	0.02±0.0	24.8	0.02±0.0	0.0	1.03±0.0	0.56	1.02±0.0	0.6
Potassium (K)	14.8±0.1	0.78	13.2±0.1	0.08	13.0±0.1	0.44	15 ±0.0	0.0	14.8±0.1	0.8
Calcium (Ca)	36.7±0.6	1.57	38.0±0.0	0.0	38.3±0.6	1.51	17.1±0.0	0.03	36.7±0.6	1.7
Cyanide(CN^-)	0.01±0.0	1.44	0.01±0.0	0.58	0.01±0.0	0.0	0.01±0.0	42.4	0.01±0.0	1.5
Lead (Pb)	0.01±0.0	5.63	0.04±0.0	2.5	0.08±0.1	127.9	0.02±0.0	2.84	0.01±0.0	5.6
Salmonella	Present		Present		Present		Present		Present	
Shigella	Present		Present		Present		Present		Present	
E-coli	Present		Present		Present		Present		Present	

Source: Field survey, 2018

Table 1 Experimental Sample 1 shows that all the three water samples collected at three different times in same sample points exhibited low variation in their concentrations, except Cd that had high variation, this is probably because it was not detected in all the water samples collected. In Experimental Sample 2, it was observed that all the analyzed parameters have low variation too, except in DO and Fe that varied moderately, while in Experimental Sample 3, it was only Pb that highly varied, but all others have low variation.

Two upstream used as the control points also showed similar trend. In Control Sample 1, Results shows that Hg varied moderately, and CN varied highly; while in Control Sample 2, Cd showed high variation, while Fe varied moderately.

Biological analysis shows that all the water samples collected in all the sample points over the study periods shows the presence of feacals, such as Salmonella, Shigella, and E-coli. This could also be due to the anthropogenic activities that prevailed in the area as it was observed in the upstream, where agricultural activities were going on with animals grazing too. Generally, there was low temporal variation in the concentration of the analysed parameters from the five sample points, over the three months study periods.

3.2 Spatial analysis of the water pollution

The mean of the three samples collected at all the sampling points during the period of this study was presented in Table 2.

Table 2: The results of spatial analysis of the water pollution

Parameter (mg/L except stated)	Exp. Sample1	Exp. Sample2	Exp. Sample3	Control Sample1	Control Sample2	Mean±STD	COV
Temperature (^{0}C)	28.7	28.6	28.7	28.9	28.7	28.7±0.11	0.4
pH	6.87	7.23	7.8	6.1	6.9	7.0±0.62	8.9
Conductivity(ms/cm)	680	984.5	1574	295	680	842. ±476	56.5
Total Dissolved Solid	134	135.7	139.3	131	134	134.8±3.0	2.2
Dissolved Oxygen	3.2	3.03	2.43	4.07	3.2	3.2±0.59	18.4
Total Hardness	170	175.0	180	170	170	173±4.5	2.6
BOD_5 at 20^{o}C	20.0	23.7	32.3	11	20	21.4±7.7	35.9
COD	56.0	71.3	85.0	38.9	56	61.4±17.5	28.4
Nitrate (NO_3^-)	4.49	1.33	3.7	3.2	4.5	3.4±1.3	37.9
Nitrite	0.01	0.05	0.06	0.44	0.05	0.1±0.2	146.6
Fluoride	0.55	0.01	0.01	0.01	0.01	0.1±0.2	204.7
Ammonia (NH_4)	17.1	0.54	1.0	0.80	0.55	4.0±7.3	183.3
Magnesium (Mg)	0.22	34.2	34.2	42.9	17.1	25.7±17.1	66.3
Manganese (Mn)	8.5	0.26	0.5	1.0	0.02	2.05±3.6	176
Aluminium (Al)	101	8.90	9.6	3.02	8.5	26.2±41.9	159.9
Sulphate (SO_4^2)	0.01	108	126.3	45	101	76.1±52.2	68.7
Cadmium (Cd)	0.01	0.01	0.02	0.03	0.01	0.02±0.01	55.9
Mercury (Hg)	0.01	0.05	0.07	0.02	0.01	0.03±0.03	83.9
Silver (Ag)	0.01	0.01	0.06	0.01	0.01	0.02±0.02	111.1
Chloride (Cl^-)	214	361	361	151	213.7	260.1±96	36.7
Bromide (Br)	0.01	0.04	0.18	1.1	0.01	0.3±0.47	175.5
Copper (CU^+)	0.04	0.06	0.24	0.16	0.04	0.11±0.09	82.4
Ferric Iron (Fe)	1.02	0.02	0.02	1.03	1.02	0.6±0.55	88.4
Potassium (K)	14.8	13.2	13.0	15	14.8	14.2±0.93	6.88
Calcium (Ca)	36.7	38.0	38.3	17.1	36.7	33.4±9.12	27.3
Cyanide(CN^-)	0.01	0.01	0.01	0.01	0.01	0.01±0.0	0.0
Lead (Pb)	0.01	0.04	0.08	0.02	0.01	0.03±0.03	92.2

The results of the analysis showed that there was high variation in all the sampling points under study, except tempt, pH, Total hardness and Cn that shows low variation, while Dissolved Oxygen (DO) Carbon Oxygen Demand (COD) and Ca varied moderately. This result was further subjected to Analysis of Variance (ANOVA) in order to verify the significance of the variation, and the result is presented in Table 3.

Table 3: Results of Analysis of Variance (ANOVA)

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F- crit.*
Between Groups	58692.7	4	14673.2	0.419	0.795	2.441
Within Groups	4557489	130	35057.6			
Total	4616182	134				

Results in Table 3 shows the results of Analysis of Variance (ANOVA). The F-calculated is 0.419 and F-critical is 2.441. This means that the calculated F-ratio is less than the F-critical; therefore, the Null hypothesis is then accepted and then concluded that, there is no significant variation between and within the mean samples of water collected in and around Mpape Dumpsite. The fact that there is no significant variation does not refers that variation does not exist, but simply mean that the variation is not statistically significant.

3.3 Comparative analysis of the results

The results of the analyses was compared between the experimental results with the control results and the experimental results with WHO standard as presented in Figure 2 and Table 5 respectively.

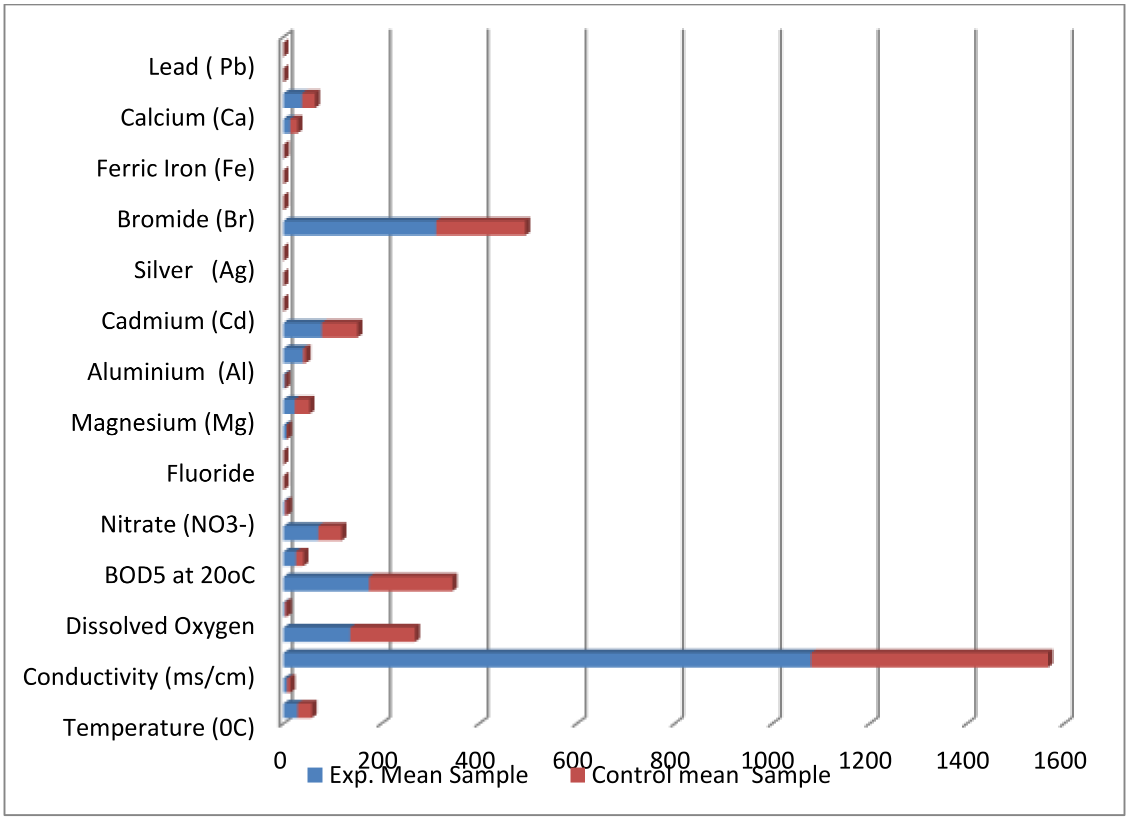

Figure 2: Comparison of the experimental and control results

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Comparing the concentration values of the water contaminated by the waste dump and the upstream water was made. The results was observed that temperature, DO, Nitrite, Mg, Ca, Br, Fe and K appeared slightly below the upstream values, otherwise, all the remaining parameters have values above the upstream values. To verify if these difference is significant or not, the result was further subjected to Student t-test analysis and the outcome is presented in Table 4.

Table 4: Results of student t-test analysis comparing the experimental and control surface water quality

Variables	Mean diff	df	Std. Dev.	T	Sig. (2-tailed)	Decision
Exp. vs Control water	30.1	26	115.2	1.356	0.187	Rejected

The statistical analysis between the concentration of the experimental and control surface water revealed that the calculated t-test (1.356) was greater than the significance value of 0.187 at α=0.05. This implies that there is significance difference between the concentration of experimental and control surface water. That is to say, the dumpsite has significantly polluted the water around the dumpsite. This water drains and joins River Usuma, which is the major river that drains FCT.

Table 5: Comparison of the Polluted Water and WHO standard.

Parameter (mg/L except stated)	Exp. Sample results	WHO	Remark
Temperature (^{0}C)	28.7	23.5	Within range
Ph	7.3	6.5-8	Within range
Conductivity (ms/cm)	1079.5	1000	Above limit
Total Dissolved Solid	136.3	1000	Within limit
Dissolved Oxygen	2.9	5	Within range
Total Hardness	175	500	Within range
BOD_5 at 20^{o}C	25.3	10	Above limit
COD	70.8	0.0	Above limit
Nitrate (NO_3^-)	3.2	10	Within range
Nitrite	0.04	1.5	Within range
Fluoride	0.19	1.5	Within range
Ammonia (NH_4)	6.2	NM	Not Mention
Magnesium (Mg)	22.9	0.3	Above limit
Manganese (Mn)	3.1	0.4	Above limit
Aluminium (Al)	39.8	NM	Not Mention
Sulphate (SO_4^2)	78.1	100	Within range
Cadmium (Cd)	0.01	0.003	Above limit
Mercury (Hg)	0.04	0.001	Above limit
Silver (Ag)	0.03	NM	Not Mention
Chloride (Cl^-)	312	250	Above limit
Bromide (Br)	0.08	0.1	Within range
Copper (CU^+)	0.11	1.0	Within range
Ferric Iron (Fe)	0.35	0.3	Within range
Potassium (K)	13.67	NM	Not Mention
Calcium (Ca)	37.7	200	Within range
Cyanide(CN^-)	0.01	0.01	Within range

Lead (Pb)	0.04	0.01	Above limit
Salmonella	Present		Above limit
Shigella	Present		Above limit
E-coli	Present		Above limit

NM- Not Mention
Source: WHO (2001): Guidelines for Drinking Water Quality [12]

Table 4 compares the results of the water quality of the study area and that of WHO standard. About 40% of the analysed parameters are above the WHO standard, and 46.7% is within the limit, while 13.3% their permissible limits were not mentioned.

4.0 DISCUSSION OF RESULTS

Water temperature varies along the length of a river with latitude and elevation, but can also vary between small sections only metres apart, depending on local conditions. For instance deep, shaded pool is cooler than a shallow, sunny area. The temperature of surface water is usually between 0ºC and 30ºC, although the temperature of hot springs may exceed 40ºC. In the study area, the mean temperature of the sample water collected was 28.7ºC which is still within the WHO range. A high temperature causes thermal pollution and adversely affects aquatic life. One of the effects of rising water temperature is that, it lowers the viscosity of the water and so causes faster settling of solid particles. An increase in temperature also causes a decrease in the solubility of oxygen, which is needed for oxidation of biodegradable waste. Many pathogenic bacteria thrive when the temperatures of some streams are slightly increased and when very high, can be very harmful to fish.

The pH value for this study was 7.0±0.62, which is within the WHO guideline. This results is in agreement with those obtained by [13, 14, and 15]. The pH may also be influenced by acid rain which might find its way into the sampled water sources leading to acidity [16]. When the water is acidic, it might cause stomach upset when consumed and as well corrosive to metallic plumbing materials which may serve as mechanism in exposing humans to harmful metals. The value of hard water is 173±4.5 which is within WHO limit. This results was higher than those obtained by [14,15]. Hard water is primarily due to the presence of calcium and magnesium ions in water, other metallic ions may also contribute to the hardness but mostly present in lower concentrations [17]. Hard water may results to both industrial and domestics wastage of resources it may also, have adverse effects on people with kidney and bladder stones [13].
The BOD is one of the most commonly used index in water quality management, it represent the amount of oxygen required for biological decomposition of organic matter under the aerobic condition at a standardized temperature 20^0c and time of incubation (usually five days). It is an expression of how much oxygen is needed for micros to oxidize a given quantity of organic matter. However, organic matter will undergo chemical oxidation even in the absence of the composers. The amount of oxygen needed to achieve this is called the chemical oxygen demand.

The BOD was 25.52, which is quite above the WHO guideline for drinking water. This was lower than 754.23±6.61mg/l in Mararaba well water as obtained by [15]. This implies that it is dangerous to discharge effluent directly into water without aeration, as this would deplete the water of dissolved oxygen that is needed by aquatic animals for respiration. This is because high BOD leads to dissolved oxygen, which is detrimental to aquatic live. The high BOD of course is due to the fact the leachate from the dump site discharges directly without any treatment. Poor self-purification of the receiving stream could also be a contributing factor. Comparing this value with WHO limit of 30mg/l^{-1} for water used for irrigation, the water quality around the dumpsite could be used for agriculture and not for drinking Purposes.

The COD value was 70.8mg/l which is within the FEPA standard of 80mg/l. High level of COD indicates the presence of chemical oxidants in the effluent and low COD indicates otherwise. The Dissolved Oxygen in the water sample was found to be 2.9mg/L, this satisfied the WHO guideline of 5mg/l for drinking water. Most game fish required at least 4-5mg/L level of DO to thrive [18]. It therefore implies that the discharge of these leachates into the stream will not discourage the breeding of fish in the stream water. Complete absence of DO results to anaerobic conditions, putrefaction and the development of foul odour. DO in liquids provides a source of oxygen needed for the oxidation of organic matter when the concentration is high and lack of it in acute cases might cause the water body to become dead or devoid of aquatic life.

The Total Dissolved Solids (TDS) of the sample was 136.3mg/l which is quite within the WHO guide line of 1000mg/l for drinking water. The result of this study shows that the Total hardness was 175mg/L which is also within the acceptable limit. Though it causes disadvantages in domestic uses by producing poor lathering with soap, deterioration of cloths, scale forming skin irritation, boiled meat and food becomes poor in quality [19].

The concentration of Mn, Mg, Cd, SO_4^2, Cd, Hg, Cl^- and Pb are above the WHO guidelines for drinking water. As noted earlier, Excess of calcium and magnesium contents in water will also give rise to poor lathering and deterioration of cloths. About 40% of the parameters analysed were above the WHO guideline for drinking water, these include conductivity, BOD, COD, Mg, Mn, Cd, Cl^-, Pb, and biological characteristics, while the rest are either within or not mention. The implication to water quality is that, it lowers the quality of water and renders it unhealthy for drinking and domestication.

5.0 CONCLUSION

The results of the Physicochemical and biological analysis of the surface water quality around Mpape dumpsite has provided germane insights into water quality in the study area. The results revealed that chlorides, sulphates, nitrates, temperature, alkalinity were within WHO permissible limits. About 40% of the analysed parameters are above the WHO standard, and 46.7% is within the limit, while 13.3% their permissible limits were not mentioned.

6.0 RECOMMENDATIONS

In the light of these findings, there is need for improvement in the quality and availability of water. This will go a long way in aiding hygienic practices and attaining goal No. 6 of SDG. There should also be public enlightenment programmes on the dangers of using such polluted water.

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