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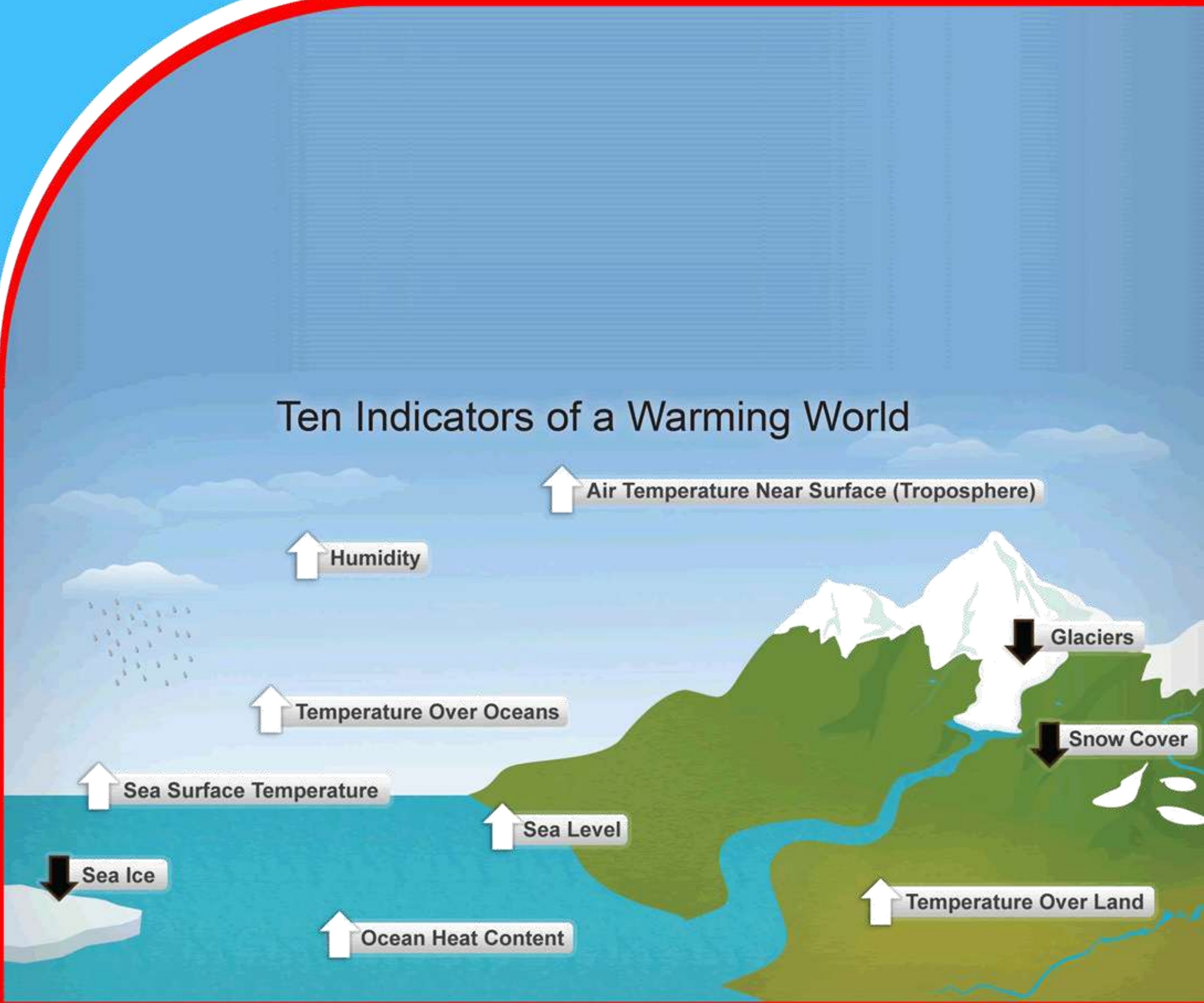

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ABSTRACT

Continuous release of leachates from the dumpsite into surface water might lead to environmental disturbance which could be considered as a threat to aquatic and human lives. **Purpose:** The aim of this study was to investigate the seasonal variation in the quality of surface water in Mpape dumpsite and its environs.

Methodology: This research adopted a comparative research design, where two seasons surface water quality were compared to if there was variation. A total of 15 water samples were analyzed for 27 parameters each during the dry and the rainy seasons in 2019. Five sampling points of surface water were identified and marked along the stream; two out of which are the upstream that were used as control. At each point three samples were collected for three months for both seasons (rainy and dry season), making a total of 30 samples for the study. Two mils of concentrated nitrate (HNO_3) was added to each sample in order to preserve the metals and also to avoid contamination. The data was also compared with the Values of World Health Organization.

Findings: The results of the analyses revealed a general low temporal variation within the samples and a high spatial variation between the samples. There was also seasonal variations in the level of contamination with higher values (55.6%) during the rainy season, 33.3% during the dry season. Results shows that there is deterioration in water quality with the following above WHO standard BOD (21.4±7.7), Mg (32.1±8.8), Mn (20.05±3.6), Cd (0.02±0.01), Hg (0.04±0.02), Cl^- (260.1±96), Br (0.3±0.5), Fe (0.61±0.9), and Pb (0.03±0.01). The results obtained revealed a general low variation. More so, increase of pollution load during rainy season indicated the increase in organic matter in the surface water during the season due to increase in anthropogenic interferences of the surrounding areas.

Recommendation: It is therefore recommended that there should be public health enlightenment and regular monitoring and treatment of the polluted water in order to obtain potable water.

Keywords: *Anthropogenic, pollution, leachates, parameters, and Waste.*

INTRODUCTION

Seasonal changes in surface water quality is an important aspect in the evaluation of temporal variations of river pollution due to natural and anthropogenic activities as it can provide a better understanding about the water pollution. Flow in rivers is a function of many factors which include intensity of precipitation, duration, and gradient among others. Seasonal variations of these factors have a strong effect on flow rates and hence the concentration of pollutants in the river water [1]. Due to spatial and temporal variations in water chemistry, surveys and monitoring program are necessary as this can provide a better knowledge about the river hydrochemistry and pollution [2]. This knowledge can be used in ensuring effective and efficient water management.

Mpape dumpsite did not meet the criteria for citing a landfill [3], 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. The water percolates through municipal solid waste it produce 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 plants and animals in an ecosystem [4,5].

Metal contaminants are very crucial due to their potential toxicity, bio-accumalative, and long persistence in the environment and living organism, especially human beings [6,7]. When heavy metals enter any water body, they are been transported as dissolved species or as integral part of suspended sediments in the water [8]. Some heavy metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes in plants and microorganisms, however; metals like Cd, Cr and Pb can be toxic even at very low concentration in the water [9]. For instance, the toxicity of Cd can cause kidney damage and bones pains in man [10], Pb causes renal failure and liver damage, and Cr cause nephritis, anuria and extensive lesions in the kidney [11].

Several studies have been conducted on the surface water due to the pollutions from different sources, such as; [12,13,14,15], while this study, used two streams within the dumpsite to assess the temporal and seasonal variation between the wet and dry seasons and also evaluate the status of the water quality with respect to drinking and irrigation agricultural purposes.

FIELD AND LABORATORY METHODS

Description of the study area

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 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. 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.

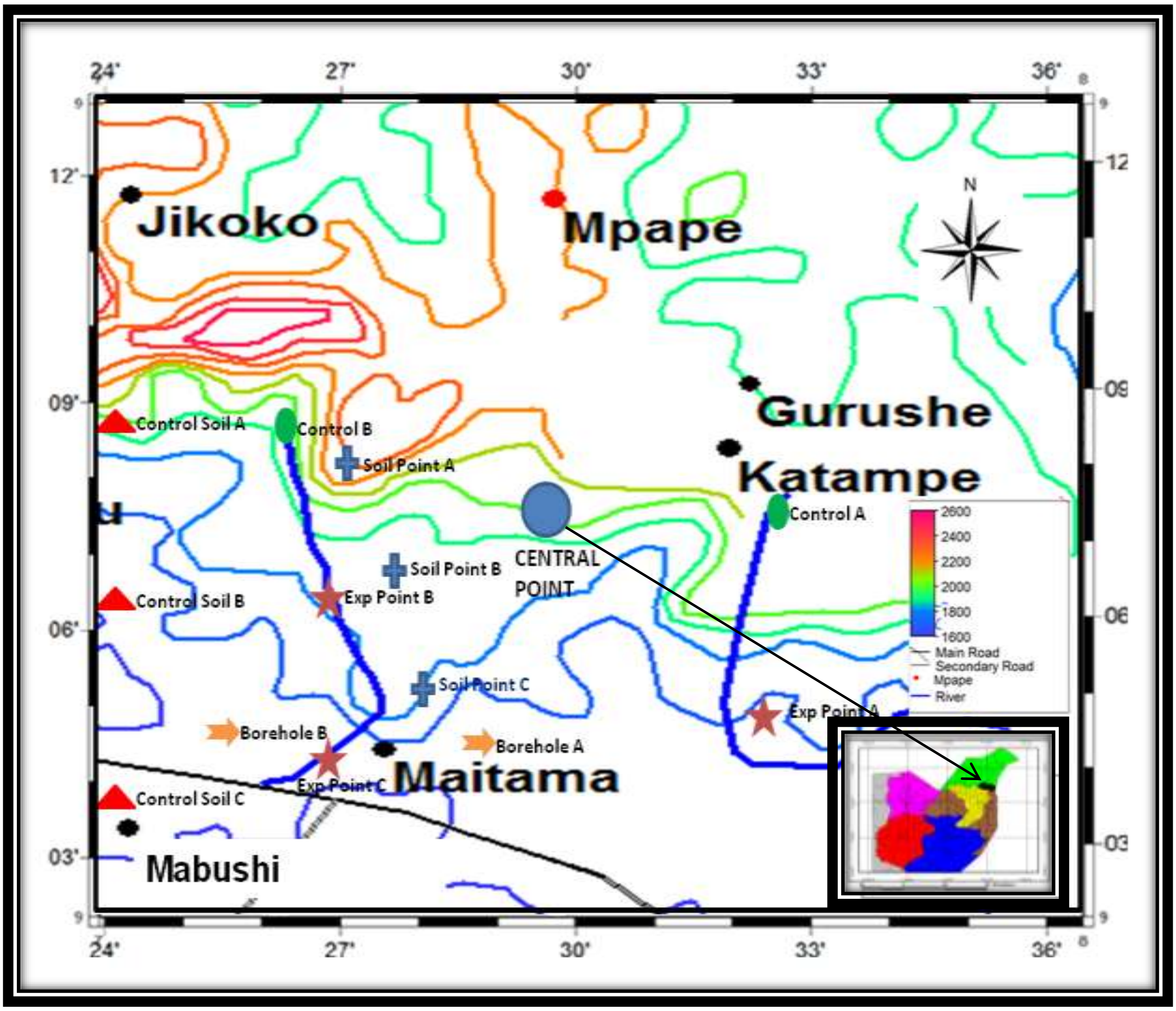

Figure 1: Location of Mape Dumpsite in the Federal Capital Territory, Abuja.

Source: Adapted and Modified from diverse sources by the Author, (2018)

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 [16]. 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°C in the Southwest to about 30°C in the Northeast. This also coincides with the period of high diurnal ranges of temperature which can drop to as low as 17°C, and by August, diurnal temperature rarely exceeds 7°C.

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.

Water Sampling and collection

Five sampling points of surface water were identified and marked along the stream; two out of which are the upstream that were used as control. At each point three samples were collected for three months for both seasons (rainy and dry season), making a total of 30 samples for the study. 2 mls of concentrated HNO3 was added to each sample in order to preserve the metals and also to avoid precipitation.

The determination of the concentration of the metals present in water can either be done 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 was adopted as described by [17,18].

RESULTS AND DISCUSSION

Descriptive Analysis of Surface Water for both Rainy and Dry season

The analysed results of 15 water samples collected for both rainy and dry seasons were subjected to descriptive statistics and the outcome is presented as follows:

Table 1: Temporal Analysis of Dry Season Results of the Surface Water

Parameter (mg/L except stated)	Experimental Sample 1		Experimental Sample 2		Experimental Sample 3		Control Sample 1		Control Sample 2	
	Values	COV	Values	COV	Values	COV	Values	COV	Values	COV
Temperature (^{0}C)	29.8±0.32	0.9	29.8±0.32	1.07	29.2±0.15	1.76	29.3±0.4	1.4	30.3±0.56	1.8
pH	6.9±0.2	4.8	7.0±0.2	2.9	7.1±3.78	2.14	6.5±0.1	0.9	6.7±0.26	3.9
Conductivity (ms/cm)	844.4±0.4	0.12	844.4±0.4	0.04	1435.9±2.1	0.26	166.2±0.1	0.1	629±1.05	0.17
TDS	127.3±1.2	0.45	127.3±1.2	0.90	143.3±0.3	1.45	121.7±0.6	0.5	128.3±1.5	1.2
DO	2.87±0.06	1.22	2.87±0.06	2.01	2.5±2.52	10.6	5.57±0.1	1.0	4.47±0.06	1.3
Total Hardness	166.7±1.2	0.36	166.7±1.2	0.69	172.7±0.1	1.46	154±0.0	0.0	165.7±0.6	0.4
BOD_5 at 20°C	18.7±0.26	3.15	18.7±0.26	1.41	20±1.0	0.5	9.67±0.6	5.97	18±0.0	0.0
COD	64.7±0.58	1.08	64.7±0.58	0.89	67.0±0.0	1.49	26.7±0.6	2.2	58±1.0	1.7
Nitrate (NO_3^-)	1.34±0.01	0.2	1.34±0.01	0.57	0.090±0	3.76	2.7±0.01	0.4	0.47±0.02	3.2
Nitrite	0.05±0.0	0. 13	0.05±0.0	0.0	0.07±0.0	2.14	0.41±0.0	0.2	0.05±0.00	4.4
Fluoride	0.01±0.0	0.0	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)	0.43±0.03	3.53	0.43±0.0	0.0	0.85±0.02	0.59	0.60±0.0	1.0	0.50±0.01	1.2
Magnesium (Mg)	34.5±0.0	0.0	34.5±0.03	0.07	33.7±0.03	0.06	40.7±0.01	0.0	17.1±0.02	0.1
Manganese (Mn)	0.30±0.2	1.02	0.30±0.02	7.02	0.7±0.1	4.05	0.9±0.01	1.1	0.19±0.01	5.3
Aluminium (Al)	8.3±0.43	0.58	8.3±0.44	5.25	9.0±5.3	1.11	1.3±0.01	0.4	0.8±0.02	2.5
Sulphate (SO_4^2)	62.7±1.15	1.51	62.7±1.15	1.84	124±0.0	4.27	53±0.0	0.0	96.7±1.53	1.6
Cadmium (Cd)	0.01±0.0	0.0	0.01±0.0	0.0	0.01±0.01	0.0	0.01±0.0	0.0	0.01±0.0	00
Mercury (Hg)	0.05±0.0	0.0	0.05±0.0	0.0	0.06±0.0	16.7	0.03±0.01	17.3	0.01±0.0	0.0
Silver (Ag)	0.01±0.0	0.0	0.01±0.0	0.0	0.02±5.8	0.0	0.01±0	0.0	0.01±0.0	0.0
Chloride (Cl^-)	135±1	0.68	135±1.0	0.74	221.7±0.0	0.0	53.3±0.6	1.1	123.7±1.2	0.9
Bromide (Br)	0.01±0	0.0	0.01±0.0	0.0	0.1±0.01	10	0.98±0.01	1.0	0.01±0.0	0.0
Copper (CU^+)	0.06±0.01	4.55	0.06±0.01	16.7	0.24±0.0	4.17	0.13±0.01	4.3	0.06±0.01	9.1
Ferric Iron (Fe)	0.02±0.01	0.29	0.02±0.0	0.0	0.02±0.96	0.0	2.01±0.01	0.5	0.96±0.01	1.2

Potassium (K)	8.07±0.21	0.0	8.1±0.21	2.6	19.1±1.4	5.02	10.7±0.6	5.4	10.8±0.11	1.1
Calcium (Ca)	50.2±0.76	0.02	50.2±0.76	1.51	125.7±0.0	1.07	13.2±0	0.3	62.8±0.05	0.1
Cyanide(CN^-)	0.01±0.0	6.7	0.01±0.0	0.0	0.01±0.0	5.61	0.01±0.0	6.2	0.01±0.0	0.0
Lead (Pb)	0.04±0.0	0.8	0.04±0.0	0.0	0.04±0.0	0.67	0.02±0.0	6.8	0.01±0.0	6.1
Salmonella	Present		Present		Present		Present		Present	
Shigella	Present		Present		Present		Present		Present	
E-coli	Present		Present		Present		Present		Present	

Source: Source: Field and Laboratory survey, 2018

Table 1 shows that all the three water samples collected at three different times in all the sample points exhibited low variation in their concentrations, except copper in sample 2 and mercury in sample 3 that varied moderately. The two upstream sample points used as the control points also showed similar trend except mercury in control sample 1 that varies moderately.

Biological analysis shows that all the water samples collected during the dry season for this study shows the presence of bacteria, such as Salmonella, Shigella, and E-coli.

This is could also be due to the anthropogenic activities and defecation that prevailed in the study area as it was observed in the upstream, where agricultural activities and animals grazing are going on with there. Generally, there is low temporal variation in the concentration of the analysed parameters from the five sample points, over the three months of the dry season study period.

Table 2: Temporal Analysis of Rainy Season 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 20ºC	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	125	0.02±0.0	2.84	0.01±0.0	5.6

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Salmonella	Present	Present	Present	Present	Present
Shigella	Present	Present	Present	Present	Present
E-coli	Present	Present	Present	Present	Present

Source: Source: Field and Laboratory survey, 2018

Table 2 presents the results of rainy season's water samples collected at the same sample points used during the dry season. Results show that all the three water samples collected at three different times also exhibited low variation in their concentrations, except Dissolved Oxygen (DO), copper and iron in sample 2 that moderately varied, while lead in sample 3 that shows a high variation this is probably because it wasn't detected in some samples. Two upstream used as the control points also showed similar trend. Result of the control Samples shows that except cadmium and mercury in control sample 1, and copper in control sample 2 that varied moderately, while cyanide in control sample 1 and cadmium in control sample 2 that highly varied, but all other analysed parameters have low variation.

Biological analysis shows that all the water samples collected during the rainy season also shows the presence of Salmonella, Shigella, and E-coli whose count was higher than the dry seaon results. This is could also be due to run-up water coupled with anthropogenic activities that take place in and around the area. Generally, there is low temporal variation in the concentration of the analysed parameters from the five sample points, over the three months study period.

Spatial analysis of the water pollution

The mean of the three samples collected at all the sampling points during the period of this study is presented in Table 3.

Table 3: The results of Dry Season 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)	29.8	29.8	29.2	29.3	30.3	29.7±0.44	1.5
pH	6.9	6.9	7.1	6.5	6.7	6.8±0.23	3.3
Conductivity(ms/cm)	844.4	844.4	1435.9	166.2	629.0	784.0±457.7	58.3
Total Dissolved Solid	127.3	127.3	143.3	121.7	128.3	129.6±8.1	6.3
Dissolved Oxygen	2.87	2.87	2.5	5.6	4.5	3.7±1.3	36.2
Total Hardness	166.7	166.7	172.7	54.0	165.7	145.2±51.0	35.2
BOD_5 at 20ºC	18.7	18.7	20	9.67	18	16.9±4.2	24.5
COD	64.7	64.7	67	26.7	58	56.2±16.8	30.0
Nitrate (NO_3^-)	1.34	1.34	0.09	2.7	0.47	1.19±1.0	84.7
Nitrite	0.05	0.05	0.07	0.4	0.05	0.12±0.2	124.6
Fluoride	0.01	0.01	0.01	0.01	0.01	0.01±0	0
Ammonia (NH_4)	0.43	0.43	0.85	0.6	0.50	0.56±0.18	31.2
Magnesium (Mg)	34.5	34.5	33.7	40.7	17.1	32.1±8.8	27.6
Manganese (Mn)	0.30	0.3	0.74	0.9	0.19	0.47±0.3	64.5
Aluminium (Al)	8.3	8.3	9	1.33	0.8	5.5±4.1	74.01
Sulphate (SO_4^{2})	62.7	62.7	124	53	96.7	79.8±29.8	37.3
Cadmium (Cd)	0.01	0.01	0.01	0.01	0.01	0.01±0.0	0
Mercury (Hg)	0.05	0.05	0.06	0.03	0.01	0.04±0.02	50
Silver (Ag)	0.01	0.01	0.02	0.01	0.01	0.012±0.0	37.3
Chloride (Cl^-)	135	135	221.7	53.3	123.7	133.7±59.8	44.7

Bromide (Br)	0.01	0.01	0.1	0.98	0.01	0.22±0.4	191.6
Copper (CU^+)	0.06	0.06	0.24	0.13	0.06	0.11±0.08	71.6
Ferric Iron (Fe)	0.02	0.02	0.02	2.01	0.96	0.606±0.9	145.9
Potassium (K)	8.07	8.07	19.1	10.7	10.8	11.3±4.5	40.0
Calcium (Ca)	50.2	50.2	125.7	13.2	62.8	60.4±40.9	67.7
Cyanide(CN^-)	0.01	0.01	0.01	0.01	0.01	0.01±0	0
Lead (Pb)	0.04	0.04	0.02	0.02	0.01	0.03±0.01	51.6

Source: Source: Derived from Table 1

The results of the analysis show that there is high variation in all the analysed parameters except BOD, Mg, that varied moderately and temperature, pH, TDS F, and Cn that exhibited low variation. The result was further subjected to Analysis of Variance (ANOVA) in order to verify if the variation is significant or not as presented in Table 4.

Table 4: Results of Analysis of Variance (ANOVA) for Dry season

Source of Variation	SS	MS	df	F	P-value	F crit
Between Groups	74304.0	18576.0	4	0.7565	0.5554	2.441
Within Groups	3192015	24554.0	130			
Total	3266319		134			

Source: Source: Derived from Table 3

The result in Table 4 shows that, F-cal.is 0.7565 and F-crit. 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 the 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.

Table 5: The results of spatial analysis of the water Pollution for Rainy season

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	28.9 ±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°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)	8.47	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	361.0	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

Source: Source: Derived from Table 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 showed low variation, while Dissolved Oxygen (DO) Carbon Oxygen Demand (COD) and Ca that varied moderately. This result was further subjected to Analysis of Variance (ANOVA) in order to verify the significance of the variation, and the result was presented in Table 6.

Table 6: 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				

Source: Source: Derived from Table 5

Result in Table 6 shows the results of Analysis of Variance (ANOVA). The F-cal. was 0.419 and F-crit. was 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 mean that variation does not exist, but simply mean that the variation was not statistically significant.

Seasonal variation in the level of pollution

The results of the analyses was compared between the dry season results with the rainy season results and the experimental results with WHO standard as presented in Table 7.

Table 7: Comparison of the Dry Season and rainy season Water quality

Parameter (mg/L except stated)	Dry season	Rainy season	Variation	Remark
Temperature (^{0}C)	29.7	28.9	0.8	Above
pH	6.8	7.00	-0.2	Below
Conductivity(ms/cm)	784.0	295.2	488.8	Above
Total Dissolved Solid	129.6	131.7	-2.1	Below
Dissolved Oxygen	3.7	4.0	-0.3	Below
Total Hardness	145.2	170.3	-25.13	Below
BOD_5 at 20^{o}C	17.0	11	6	Above
COD	56.2	38.9	17.3	Above
Nitrate (NO_3^-)	1.2	3.16	-1.96	Below
Nitrite	0.12	0.44	-0.32	Below
Fluoride	0.01	0.01	0	NV
Ammonia (NH_4)	0.6	0.8	-0.2	Below
Magnesium (Mg)	32.1	42.9	-10.8	Below
Manganese (Mn)	0.5	0.99	-0.49	Below
Aluminium (Al)	5.5	3.02	2.48	Above
Sulphate (SO_4^2)	79.8	45	34.8	Above
Cadmium (Cd)	0.01	0.03	-0.02	Below
Mercury (Hg)	0.04	0.02	0.02	Above
Silver (Ag)	0.01	0.01	0	NV
Chloride (Cl^-)	133.6	312	-178.4	Below
Bromide (Br)	0.22	1.11	-0.89	Below
Copper (CU^+)	0.11	0.16	-0.05	Below
Ferric Iron (Fe)	0.6	1.02	-0.42	Bellow
Potassium (K)	11.2	15	-3.8	Below
Calcium (Ca)	57.5	0.03	57.47	Above
Cyanide(CN^-)	0.01	0.01	0	NV
Lead (Pb)	0.03	0.02	0.01	Above

Note: NV - No Variation

Source: Derived from Table 5 & 6

Table 7 showed that there was seasonal variation in the level of the water pollution, except for F, Ag, and Cn that had no variation. About 55.6% of the analyzed parameters in the rainy season have higher values than those in the dry season, while 33.3% of the parameters in the rainy season are lower than those in the dry season and only 1.1% that do not varied. These differences might be due to leaching from the dump, and anthropogenic activities during the rainy season that influence the concentration level in the dumpsite. In order to verify if the variation is significant or not, the results was further subjected to students t-test

Table 8: Seasonal comparison of surface water

Variables	Mean diff	df	t	Sig. (2-tailed)	Remark
Dry vs Rainy season	14.36	26	1.3445	1.705618	Accept

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Table 8: presents the results of student t-test analysis verifying if the variation seasonal variation of surface water in the study area is significant or not. The results revealed that the calculated t-test was 1.445, which was less than the significance value of 0.705618 at α=0.05. This implies that there was no significance difference in the level of surface water pollution between the seasons. This does not mean that there is no difference but the difference was not significant.

DISCUSSION OF RESULTS

The temperature of water varies along the length of a river with latitude and elevation; it 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 mean surface temperatures were nearly uniform in both seasons with values of 29.3°C and 28.9°C for dry and rainy seasons, respectively. Lower mean values of temperature were recorded during the rainy season (28.9 ± 0.08°C) and higher values during dry season (29.3 ± 0.08°C), which are still within the WHO range **.** The temperatures of the water were believed to have been influenced by the intensity of sunlight during the dry season and lower during the rainy season other conditions being equal. Looking at the records, the variation in the surface water temperatures between the dry and rainy season was very low. This was also observed by the findings of [19] who observed a similar trend in Elechi Creek in Port Harcourt, Nigeria and [20] who also observed same in the surface water of River Mkomon in Kwande Local Government Area, of Benue state, Nigeria. 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. Many pathogenic bacteria thrive when the temperatures of some streams are slightly increased and when very high can be very harmful to fish.

The range of pH value for natural water is expected to be between 6 and 8 [21]. Aquatic organisms are affected by pH because most of their metabolic activities depend on pH. Optimal pH range for sustainable aquatic life is pH 6.5-8.2. One important indicator of water quality and extent of pollution in the watershed areas is pH of an aquatic system [22]. The pH values of surface water in the study area were 6.7±0.30 and 7.0±0.62 for dry and rainy seasons respectively. These values were within the permissible level set by WHO and SON that is 6.5 to 8.5. Lower pH in dry season might be due to slow leaching from the dumpsite, whereas higher pH values during rainy season revealed the aerobic conditions and lesser anthropogenic sources as compared to the dry season, or as a result of dilution effect. This finding was similar with those of [23] for Qua Iboe River, and [20], for Mkomon River in Benue state.

Results of conductivity test for dry season surface water was very high 644.5±534.5 (µScm-1) and a COV 82.9% and 842 ± 476 COV 56.5% for dry and rainy respectively. Results of the analysis indicated decrease in conductivity values during the dry season and increase during the rainy season. Reasons for the increase during rainy season could be due to increase in the concentration of salts, organic and inorganic materials in the in the surface water as a result of leaching from the waste dump and anthropogenic activities into the river during rainy season. The lower conductivity values during dry season may be due to the utilization of these organic and inorganic materials by phytoplankton and other aquatic organisms. High conductivity reflects the pollution load as well as tropic levels of aquatic body. Conductivity values below 50 (µScm-1) are regarded as low, while those between 50 -600 (µScm-1) are said to be medium and values above 600 (µScm-1) were considered to be high (Abida and Harikrishna, 2008).For the study the conductivity was high because the values for both dry and rainy seasons were above 600 µScm-1.

Total dissolved solids (TDS) in water are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese; as well as organic matter, salt and other particles [24]. The TDS of both dry and rainy seasons are 129.7mg/L and 131.7mg/L respectively. At high flows, the TDS values tend to be diluted by surface runoff and for most rivers there are an inverse correlation between discharge rate and TDS [25], 2006). The highest Total Dissolved Solids was observed during the rainy season (131.7mg/L) while in dry season (129.7mg/L) was observed. Higher level of TDS during rainy season it could be due to the influence of leachates from the dumpsite and some anthropogenic activities around the dumpsite. Waters with high TDS are unpalatable and potentially unhealthy.

Dissolved oxygen is one of the most important indicator surface water quality. Its deficiency directly affects the ecosystem of water bodies due to bioaccumulation and biomagnifications. The oxygen content in water samples depends on a number of physical, chemical, biological and microbiological processes. DO levels below 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for most of the fish population. The mean value of DO levels (6.5 mg/L) indicates the mean quality of river water [26]. In this study, the DO values are 4.04±1.3 and 3.2±1.3 for both dry and rainy season respectively. DO levels were higher in the dry season than in the rainy season. This finding is in contrast with those of [19,27].

The result of this study showed that the Total hardness is 144.0 mg/L and 170.3mg/L for dry and rainy seasons respectively, which was 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 [28].

Biochemical Oxygen Demand (BOD) is a measure of the oxygen in the water that is required by the aerobic organisms. The biodegradation of organic materials exerts oxygen tension in the water and increases the biochemical oxygen demand [29]. In the present study, the BOD was found to be 16.934±4.1, with COV 12.4% and 21.4±7.7 with COV 35.9, implying high level of pollution with high variation across the sampling point and seasons. This result is contrary with the findings of [19,30]. Water bodies with low BOD have low nutrient levels, therefore, much of the oxygen remain in the water. Unpolluted, natural waters will have a BOD of 5 mg/L or less. It directly affects the amount of dissolved oxygen in water, and the greater the BOD of water, the more rapidly oxygen is depleted in it. This means that less oxygen is available to higher forms of aquatic life.

The implication of high BOD is the same as low dissolved oxygen; aquatic Organisms become stressed, suffocate, and die. Open defecation nearby the river and discharging of leachates from the dumpsite during rainy season results to higher BOD.

The COD value was 54.02mg/L and 38.9mg/L for dry and rainy season respectively 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 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 are above the WHO guideline for drinking water, 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.

Chloride occurs naturally in all types of water with a very low concentration. Chlorides are important in detecting the contamination of water. In this study, the chloride ion concentration varies with seasons, 123.6mg/L and 312mg/L for dry and rainy season respectively. The mean value of chloride was higher during the rainy season (312 mg/L) than the dry season(123,6 mg/L).This may be as a result of water runoff during the rainy season from chloride sources (domestic sewage which contains a good amount of chloride.) into the river. The result of the study is within the WHO permissible limit of 200 and 250 mg/L. Higher concentration of chloride was associated with high domestic sewage disposal in the river which increased the level of pollution especially during the rainy season [31].

The values of the following metals (NH_4, Mg, Mn, Cd, Cl^-, Br, Cu^+, Fe, K, were found to be higher in the rainy season than those in the dry season, while Al, Hg, Ca, and Pb were lower in the dry seasons. This result is in agreement with the findings of [32, 33].

The results from water quality analysis clearly revealed that seasonal variations exist in the physicochemical and biological characteristics of the surface water quality around the dumpsite. The seasonal influence on the parameters indicated variations in the quality of water samples between the dry and the rainy season.

The observed bacteriological analyses revealed that the dry season 173.1MPN per 100mililitres while the rainy season water analysis recorded was 198.3MPN per 100milliliters of water samples. The high total coliform count during the rainy season was in lined with the results of [19,34] who observed that the bacteriological analysis found in rainy season was higher than that of the dry season, while contrary to [35], who work on River Osun and discovered higher total coliform count during the dry season.

CONCLUSION

The results from the water quality analysis clearly revealed that seasonal variations exist in the physicochemical and biological characteristics of the surface water quality around the dumpsite. The seasonal influence on the parameters indicated variations in the quality of water samples between the dry and the rainy season. Most of the studied variables showed higher values during the rainy season, an indication that the water from this stream is not safe for used especially during the rainy season. The possible sources of the contaminants in the area include leachates from the dumpsite, agricultural and other anthropogenic activities within the stream environment as well as runoff from the diverse land-uses. The bacterial counts detected were above the permissible limits for drinking water in all the sampled water.

RECOMMENDATIONS

In the light of this findings, the need for improvement in the water quality and availability will go a long way in aiding hygienic practices and barge in the transmission of enteric pathogens through contaminated water in the study area. There should also be public health enlightenment in order to improve personal hygiene, household and community hygiene.

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