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Quality Assessment of Groundwater around Opendumpsites in Kano Metropolis, North-Western Nigeria.

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Abstract: *The physiochemical and bacteriological quality assessment of groundwater samples from three areas located nearrefuse dumpsitesin Kano cityof Nigeria was carryout to investigate the effect of pollutants to the quality of boreholes and wells waters located within 50m, 100m and 150m from the pollution source. The water quality indicating parameters were determined using standard procedures. SPSS was used to analyze the descriptive and correlation analysis of Alkalinity,*Ca^{+2} Cl^{-} *EC,* Mg^{+2}*,pH, TDS and Temperaturerespectively. The bacteriological analyzed were total coliforms and E-coli. All the results were compared with NSDWQ and WHO standards.It showed thatthe sample waters from Sites at sorandinkireceived the highest mean values of the physiochemical parameters and the total coliforms, which could be attributed to the presence of larger volume of open dumps at site then those from sites at Bola and court road respectively.The correlation between the alkalinity, TDS, pH and* Cl^{-} *is an indication of depositions of wastes of acidic nature at the dumpsites.The absence of E.coli in all sample waters rendered it useful for human consumptions when treated. Uncontrolled dumping of wastes should be evaluated to enhance the frequent evacuation of the refuse dumps and to avoid threats to water borne diseases from groundwater contaminations.*
Keywords*: bacteriological,groundwater, opendumpsite, physiochemical, quality*

I. Introduction

Water is life, the importance of providing portable drinking water to the society cannot be over emphasized, most resident within Kano metropolis depend on groundwater as a source of drinking water [11].Groundwater is the form of water found in the voids within the geologic stratum [9]. High population growth, industrialization and increased exploitation of groundwater resources are among the major threats to the groundwater quality. The main concern for the groundwater quality assessment is to achievegroundwater sustainability.

Nowadays, the provision of potable water in adequate quality andquantity for human consumptionshas been amajor concern of different policy makers in Nigeria. In the last five decades, changes in life styles, exponential population growth and industrialization have caused rapid exploitation of different types of natural resources thereby generating higher quantities of municipal solid wastes (MSW) worldwide and the higher the population growth the more the amount of MSW to be generated [16].

Moreover, the disposal of MSW in the open dumpsites is a common practice in many developingnations. In Nigeria, cities have in recent times becomes areas with high concentration of MSW emanating from social, economic activities of the rapidly growing urban population, these waste are largely of papers, glasses, ceramics, plastics, lathers, rubbers. In Kano state, it was estimated that, 66.25% of the household throws their refuse in many available open spaces; only 3.7% of the households disposes improper space depots provided by the states agencies responsible for solid waste management [11]. This practice is differentin developed nations where there are goodnumbers of municipaland sanitary landfills.

Therefore, thedisposal of MSW by transporting and discharging in to open dumpsites from residencein Kano cityis environmentallyunsafe. This is because the leachate to be generated by rain infiltrating through the waste dumpswould be a potential source of groundwater contamination and could pose threat to groundwater quality of agiven area [6].Some pathogens such asrotavirus, Campylobacter Sheila spp. and Vibriocholerae O1,possible enter pathogenic E.coli, and Aeromonas spp. Could find their way to the ground waters [4]. Hence, when an aquifer becomes polluted, its contamination is difficult to remediate because of its enormous storage, considerable retention time,and physical un-accessible (Wang et al., 2012)[21].

The impact of surface pollutants on groundwater quality from landfills and open dumps has gained the interest of many researchersworldwideJamshidzdeh and mirbaghri.,(2011)[9]evaluated the quality of groundwater in KashenBasin in the central Iran. The results of their study indicated that the sample waters are not potable when compared with the WHO standard and concluded that the presence of high salinity of samples was due to salt water intrusion.

More so, Longe et al.,[10]examined the level of groundwater contamination near municipal landfills in Lagos, Nigeria.It showed that there was insignificant impact of the landfills operation on groundwater resources of the study area. Aturamu et al., [5] assessed the physical, chemical and biological quality of groundwater inIkere in thesouthwestern, Nigeria. It showed that the chemical concentration of waters exited in a state that was not unhealthy for consumption and that the presence of bacteria from the biological analysis has made it unhealthy when consumed without prior treatment. Adekunle et al., [3] assessed the effect of seasonal variation and proximity to pollutant source on groundwater quality of atypical rural settlementin the southwestern, Nigeria. With the pollutants detected up 200m from the pollution sources. It showed anincreased in pollution potential in the rainy season than during the dry season and recommended the use of modern waste disposal systems inthe study areas.Ikem et al., [7]studied the groundwater water quality around two wastesites in Lagos and Ibadan, Nigeria. He found that the significantvariations between the wells in Lagos and Ibadan were due to impact of leachates in the two areas.

However, Nigeria's, Federal ministry of health hasrecorded 37,289 cholera cases and 1434 death cases between January and until 25 October 2010[13]. Another 22,797 cases and 728 deaths were reported from January until 18 November 2011[12]. This could be attributed to the fact that most of the citizens drink unhealthy drinking water with groundwater been the major source.Despite the high quality of ground water compared to the surface water, but without the quality evaluation, the best quality for drinking cannot be always guaranteed. Many researchers have carried out studies on groundwater quality in different areas of Kano metropolis around landfills, one of such is the study on the assessment of groundwater quality in some selected landfills in Kano metropolis by Adamu.,[2] which revealed that, the sample's pH ranges are (6.80-7.75) and that BOD and COD values show active method ofmethogenis in the study areasand recommended that the water samples in the study areas needed some prior treatments.Since almost all of the past studiesavailable in literatures were on the assessment of groundwater qualityaroundlandfills. Therefore, this study is aimed at evaluating theeffect of the open dumpsites onthe groundwater qualityinKano city of Nigeria. As itcould be useful when implemented for some policy statements to the government for the management of open dumpsites, especially on issues relating to environmental quality.

II. Materials And Methods

2.1 study Areas

Kano metropolis is lies between latitude 12^0 25N and 12^0 40, and longitude 8.035°Eand 80.00 45ºE to the green-which meridian. It occupies an area of about 683km^2, with an aerial distance of 19km from east to west and about 15km from north to south. Kano metropolis is underlain by basement complex rock of Precambrian origin, which consists of undifferentiated ingenious and metamorphic rock. The soil is the tropical ferruginous type, rich in iron. The natural vegetation is that of the Sudan Savannah. The climate of the area is the tropical wet and dry type with wet season lasting for 4.5 months between May and SeptemberOlofin and Tanko [15].

2.1.1DescriptionOf The Refuse Dumpsites

The study areas were three open dumpsitesin the Kano city. The siteBola was an open dumpsite at KofarNasarawa inBola in Kano municipal Local Government area. The sitecourt road was an open dumpsite beside Bayero University Kano Staff Quarters in Tarauni local Government area. The site Sorandinki was an open dumpsiteoppositeHasiyaBayero Islamiyya School, Kano municipal Local Government area. TheB1, B2, and B3 were samples from sitesat Bola, K was a sample from siteatcourtroad, and theS1, S2, and S3were samples from sites at Sorandinki respectively.

2.1.2Sample Collection And Laboratory Analysis

Water samples were collected three times fromthree individual wells and borehole locatedwithin 50m, 100m, and 150m from the refuse dumpsites respectively, after rainy season in November, 2010.The details of the samples are presented in table1.The containers of 1litre capacity were used during the collection and were re-washed three times with the water sample water before sampling was carriedout. The temperatureof the samples were immediately measured and recorded after collection. Each sample was leveled and transported to the public health engineering laboratory in department of Civil Engineering, Bayero University, Kano for the analysis of, Alkalinity chloride Electrical conductivity , pH, Magnesium, Calcium, TDS, total coliform and E-Coli, and was done in accordance with the standard method by [14]

III. Results And Discussions

3.1 Physiochemical Analysis Of Groundwater Quality Parameters.

3.1.1Simple Descriptive Statistics.

The results of descriptive statistics of the quality parameters were comparedwith the Nigerian standard for Drinking Water Quality (NSDWQ) and world Health organization (WHO) standards. For the three sites are represented in Tables 2, 3 and 4 respectively. At site Bola, the mean values of Alkalinity, EC and TDS of the water samples of site B are well above the NSDWQ and WHO threshold levels while Ca^{2+}, Cl^{-}, Mg^{+2}, pH and temperatures of the samples are within the recommended limits of NSDWQ and WHO. Similarly, for water samples of site court road , their mean values of Alkalinity, EC and TDS are greater than the NSDWQ and WHO threshold levels while that Cl^{-}, $Ca^{2+}Mg^{2+}$, pH and temperature of the samples are within NSDWQ and WHO safe recommended limits.

More so, the mean values of Alkalinity,Ca^{2+}, EC and TDS of sample waters of site Sorandinki are higher than the recommended mean samples of NSDWQ and WHO. Only $Mg2^{+}$, pH, and Temperature of the sample waters are in the safe recommended threshold limits of [18][14].

4.1.2 Correlation Analysis Of Quality Parameters.

The results of statistical correlation analysis of the physiochemical quality parameters of water samples at site Bola arepresented in Table 6. It showed that there is a strong positive correlation between alkalinity with Cl^{-}, pH and TDS respectively, and weak negative correlation with Mg^{2+}. Ca^{2+} has appositive correlation with Mg^{2+},Cl^{-} and pH respectively. EC has strong positive correlation with TDSand pH. The pH has strong positive correlation TDS. There is no any correlation between temperatures with any of the physiochemical quality parameters.

However, the result of correlation analysis of water samples of court road is presented in table 7 above. It revealed that there is no strong positive and negative correlation between all the physiochemical quality parameters. Similarly, there is no any correlation between temperatures with any physiochemical quality parameters.

Furthermore, the results of correlation analysis of the quality parameters of samples from sites atSorandinki has shown a strong positive correlation between alkalinity with EC, Ca^{2+}, Cl^{-}, Mg^{2+} and TDS. Similarly, there is a strong positive correlation between Ca^{2+} withCl^{-}, EC, $Mg^{2+}$and TDS. $Cl^{-}$is strong positively correlated with TDS. There is a strong positive correlation between EC with Mg^{2+}. Temperatures of the samples has no correlation with any other physiochemical quality parameters in all the study areas.

4.2 Biological Quality Assessment.

The biological analysis revealed the presence of the total coliform in all the sample waters. The furtheranalysis of the samples showed that the Eschechia coli (E. coli) was absent in all the samples. The presence of coliforms is an evidence of some enteric microbiological organism from human or animal's wastes. Samples at sites in Sorandinki, showed an increasedin numbers of the total coliforms in the samples close to the dumpsites. However, the absence of E. coli is an indication of no possible presence of other more harmful microbes, such as Cryptosporidium, Giardia, Shigella, and norovirus.

A comparison is made on the number of coliforms in the sample waters within the three dumpsites, it showed that the pollution potential are higher in samples from sites at Sorandinki, then those from sites at Bola and court road respectively. This could be due to the fact that there wasmore volume of refuse dumps in sorandinki then Bola and court road.

IV. Figures And Tables

Table 1 wells and borehole characteristics.

Samples	Distance from the pollution Source (m)	Distance to water table (m)
B1	54	6.3
B3	98	6.7
B2	123	6.5
K	42	2.5
S1	26	BR
S2	108	5.6
S3	137	5.9

BR: Borehole

Table 2 Physiochemical Quality Parameters

Quality Parameters	Sites	Concentrations of the quality parameters.		
ALK	B1	735	702	693
ALK	B2	698	685	657
ALK	B3	632	607	591
Ca^{2+}	B1	56	45	43
Ca^{2+}	B2	60	47	37
Ca^{2+}	B3	49	46	34
EC	B1	2590	2502	2411
EC	B2	2601	2490	2436
EC	B3	2445	2404	2372
Cl^-	B1	138	153	121
Cl^-	B2	134	143	118
Cl^-	B3	128	139	110
Mg^{2+}	B1	43	41	36
Mg^{2+}	B2	57	54	39
Mg^{2+}	B3	52	48	44
pH	B1	7.33	7.29	7.28
pH	B2	7.41	7.34	7.31
pH	B3	7.28	7.26	7.26
TEMP.	B1	24	24	24
TEMP.	B2	24	24	24
TEMP.	B3	24	24	24
TDS	B1	694	678	670
TDS	B2	619	596	585
TDS	B3	572	568	540
ALK	K	503	426	406
Ca^{2+}	K	40	43	31
EC	K	1700	1578	1522
Cl^-	K	136	140	133
Mg^{2+}	K	45	39	36
pH	K	7.18	7.15	7.14
TEMP.	K	24	24	24
TDS	K	553	536	531
ALK	S1	811	745	694
ALK	S2	712	694	643
ALK	S3	681	677	637
Ca^{2+}	S1	73	67	64
Ca^{2+}	S2	68	62	59
Ca^{2+}	S3	64	61	55
EC	S1	2723	2511	2506
EC	S2	2801	2615	2273
EC	S3	2535	2470	2468
Cl^-	S1	96.7	102	92.4
Cl^-	S2	90.8	97	83.0
Cl^-	S3	82.9	86	80.7
Mg^{2+}	S1	73	60	56
Mg^{2+}	S2	69	58	53
Mg^{2+}	S3	65	62	50
pH	S1	7.15	7.09	7.10
pH	S2	7.17	7.14	7.13
pH	S3	7.21	7.12	7.15
TEMP.	S1	24	24	24
TEMP.	S2	24	24	24
TEMP.	S3	24	24	24
TDS	S1	894	858	837
TDS	S2	813	775	752
TDS	S3	736	723	701

pH is dimensionless; Temperature (Temp.) ^oC, electrical conductivity (EC) in µsem/m, alkalinity(ALK.), calcium (Ca^{2+}), chloride(Cl^-) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively.

Table 3 Descriptive statistics of Quality parameters of site Bola.

Quality parameters	Range	Minimum	Maximum	Mean	S.D.	NSDWQ	WHO
ALK	144.00	591.00	735.00	666.67	48.10	250	250
Ca^{2+}	26.00	34.00	60.00	46.33	8.22	50	50
EC	229.00	2372.00	2601.00	2472.33	80.74	1300	1400
sCl^{-}	43.00	110.00	153.00	131.56	13.54	250	250
Mg^{2+}	21.00	36.00	57.00	46.00	7.18	75	75
pH	0.15	7.26	7.41	7.31	0.05	6.5-8.5	6.5-8.5
TEMP.	0.00	24.00	24.00	24.00	0.00	28	28
TDS	154.00	540.00	694.00	613.56	54.97	500	500

Standard Deviation (S.D), pH is dimensionless; Temperature (Temp.) ^{o}C, electrical conductivity (EC) in µsem/m, alkalinity(ALK.), calcium(Ca^{2+}), chloride(Cl^{-}) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively.

Table 4Descriptive statistics ofQuality parameters of site court road.

Quality parameters	Range	Minimum	Maximum	Mean	S.D	NSDWQ	WHO
ALK	97.00	406.00	503.00	445.00	51.21	250	250
Ca^{2+}	12.00	31.00	43.00	38.00	6.25	50	50
EC	178.00	1522.00	1700.00	1600.00	91.02	1300	1400
Cl^{-}	7.00	133.00	140.00	136.33	3.51	250	250
Mg^{2+}	9.00	36.00	45.00	40.00	4.58	75	75
pH	0.04	7.14	7.18	7.16	0.02	6.5-8.5	6.5-8.5
TEMP.	0.00	24.00	24.00	24.00	0.00	28	28
TDS	22.00	531.00	553.00	540.00	11.53	500	500

Standard Deviation (S.D). pH is dimensionless; Temperature (Temp.) ^{o}C, electrical conductivity (EC) in µsem/m, alkalinity(ALK.), calcium (Ca^{2+}), chloride(Cl^{-}) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively.

Table 5 Descriptive statistics ofQuality parameters of site Sorandinki.

Quality parameters	Range	Minimum	Maximum	Mean	S.D	NSDWQ	WHO
ALK.	174.00	637.00	811.00	699.33	53.23	250	250
Ca^{2+}	18.00	55.00	73.00	63.67	5.29	50	50
EC	528.00	2273.00	2801.00	2544.67	154.29	1300	1400
Cl^{-}	21.30	80.70	102.00	90.17	7.47	250	250
Mg^{2+}	23.00	50.00	73.00	60.67	7.50	75	75
pH	0.12	7.09	7.21	7.14	0.04	6.5-8.5	6.5-8.5
TEMP.	.00	24.00	24.00	24.00	0.00	28	28
TDS	193.00	701.00	894.00	787.67	66.26	500	500

Standard Deviation (S.D). pH is dimensionless; Temperature (Temp.) ^{o}C, electrical conductivity (EC) in µsem/m, alkalinity(alk.), calcium(Ca^{2+}), chloride(Cl^{-}) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively.

Table 6 The result of bacteriological analysis of ground waters.

Samples	Total coliform (CFU/100ml)	E. Coli
NSDWQ	10	nil
WHO	nil	nil
B1	34	nil
B2	22	nil
B3	21	nil
K	26	nil
S1	40	nil
S2	33	nil
S3	38	nil

Table 7The statistical Correlation of physiochemical parameters in site Bola.

Quality parameters	ALK	Ca^{+2}	Cl^{-}	EC	Mg^{+2}	pH	TEMP	TDS
ALK.	1.00	------	------	-----	-----	----	-----	----
Ca^{2+}	0.50	1.00	-----	-----	-----	-----	----	-----
EC	0.48	0.48	1.00		------	-----	-----	----
Cl^{-}	0.83	0.78	0.52	1.00	----	------	-----	-----
Mg^{2+}	-0.17	0.65	0.28	0.33	1.00	------	----	----
pH	0.70	0.61	0.33	0.87	0.33	1.00	----	---
TEMP.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	----
TDS	0.98	0.40	0.45	0.78	-0.33	0.60	0.00	1.00

pH is dimensionless; Temperature (Temp.) °C electrical conductivity (EC) in µsem/m, alkalinity(ALK.), calcium,(Ca^{2+}), chloride(Cl^-) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively.

Table7 The statistical Correlation of physiochemical parameters in site court road.

Quality parameters	ALK	Ca^{+2}	Cl^-	EC	Mg^{+2}	pH	TEMP.	TDS
ALK	1.00	----	-----	----	------	-----	------	----
Ca^{2+}	0.50	1.00	------	-----	------	------	-----	-----
EC	0.50	1.00	1.00	----	------	-------	-----	----
Cl^-	1.00	0.50	0.50	1.00	------	-------	----	----
Mg^{2+}	1.00	0.50	0.50	1.00	1.00	--------	----	----
pH	1.00	0.50	0.50	1.00	1.00	1.00	------	-----
TEMP.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-----
TDS	1.00	0.50	0.50	1.00	1.00	1.00	0.00	1.00

pH is dimensionless; Temperature (Temp.) °C, electrical conductivity (EC) in µsem/m, alkalinity(ALK.), calcium (Ca^{2+}), chloride(Cl^-) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively

Table 8 The Correlation analysis of quality parameters in site Sorandinki.

Quality parameters	ALK	Ca^{2+}	Cl^-	EC	Mg^{2+}	pH	TEMP	TDS
ALK	1.00	------	-------	------	------	-----	-----	----
Ca^{2+}	0.95	1.00	--------	-------	-----	------	-----	----
EC	0.82	0.60	1.00	------	------	-------	-------	-----
Cl^-	0.80	0.84	0.50	1.00	-----	------	-------	-----
Mg^{2+}	0.70	0.82	0.30	0.80	1.00	-------	-------	----
pH	-0.08	0.14	-0.50	0.45	0.40	1.00	-------	-----
TEMP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-----
TDS	0.92	0.84	0.82	0.57	0.45	-0.27	0.00	1.00

pH is dimensionless; Temperature (Temp.) °C, electrical conductivity (EC) in µsem/m, alkalinity(Alk), calcium (Ca^{2+}), chloride(Cl^-) magnesium(Mg^{2+}) and total dissolved solid(TDS) are in mg/L respectively

Figure 1 One of the refuse dumpsite court road.

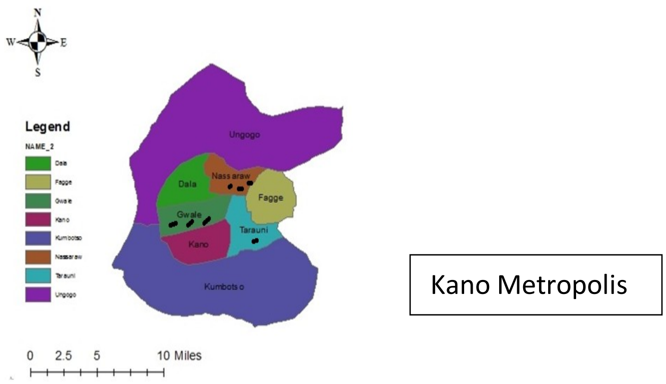

Figure1. Map of Kano metropolis

V. Conclusion

The results of this study proved that the mean values of the physiochemical parameters are highest at site sorandinki then those at site Bola and court road when compared with [18] [14]. The correlation between the alkalinity, TDS, pH and Cl^- is an indication of depositionsof wastes from acidic sources.The bacteriological examination showed that the presence of total coliform is an indication of some enteric microbiological organism from human or animal's wastes while absence of E.coli in samples has proved no threat to human consumptions.

The higher in the means of physiochemical quality parameters and the total coliforms of water samples at sorandinki could be due to the larger volume of wastes dumps then those at Bola and court road respectively. All the sample waters in the study areas were acidic in nature. Therefore, it is recommended that uncontrolled dumping of MSW in the study areas shouldbe discourageand the frequency for the collectionof wastes dumps should be increased. The sample waters in study areas could be used for drinking and other domestic uses when treated and that the quality of waters shouldadequately beexaminedespecially of sample waters at sorandinki.The persistent environmental management campaigns through public health educators or the community based health workers and community sanitary self-help project should be encouraged.

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