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Effect of refuse dumps on ground water quality

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ABSTRACT

This study was conducted to evaluate the effect of solid waste dumps on ground water quality. In order to achieve this, water samples were obtained during dry and wet seasons from hand dug well. Hand dug wells were selected close to the dumps site. pH and conductivity were determined using pH/conductivity meter, TDS, Ca, Cl, P, Ni, total hardness, DO, BOD were determined using standard method. Most the values are within the permissible limit but the all samples are not in conformity with WHO limit for bacteriological values which make the water to be unsafe for drinking, further treatment is recommended for the water. The study concludes that the hand dug well water around the refuse dumps sites are not safe human consumption.

Key words: Groundwater, Solid waste, Leachate, Refuse dump, contamination.

INTRODUCTION

Open dumping of solid waste remain the prevailing form of waste disposal in developing countries like Nigeria. Contamination of water bodies has become an issue of serious environmental concern [1]. Since urban population is increasing due to various factors like better employment opportunities, and concentration of industries than the rural areas. Municipal solid waste management gets the lowest priority, mainly because disruptions and deficiencies in it do not directly and immediately affect public life and cause public reaction [2]. Lack of proper municipal bodies to manage the solid waste generated from residential, commercial and institutional activities, therefore the populace decided to dump their solid waste in any available space within the community, by so doing it get accumulated with time.

Therefore, supply of adequate fresh water in large quantity to meet the increasing population's demand and maintaining the quality is now a thing of concern [3]. Hence, contamination of ground water through the infiltration of leachates via the soil and rocks needs to be avoided. It normally takes many years and takes place within a particular distance from the dump site. Since pipe born water is not readily available in many parts of the country and even in the urban areas the pipe water supply is not adequate [4]. With these problems there is need for another source of water supplies which is ground water, but due to lack of proper waste management the ground water is usually affected by the refuse dump site. Water is said to be polluted when the water body is adversely affected by both the organic and inorganic contaminants [5].

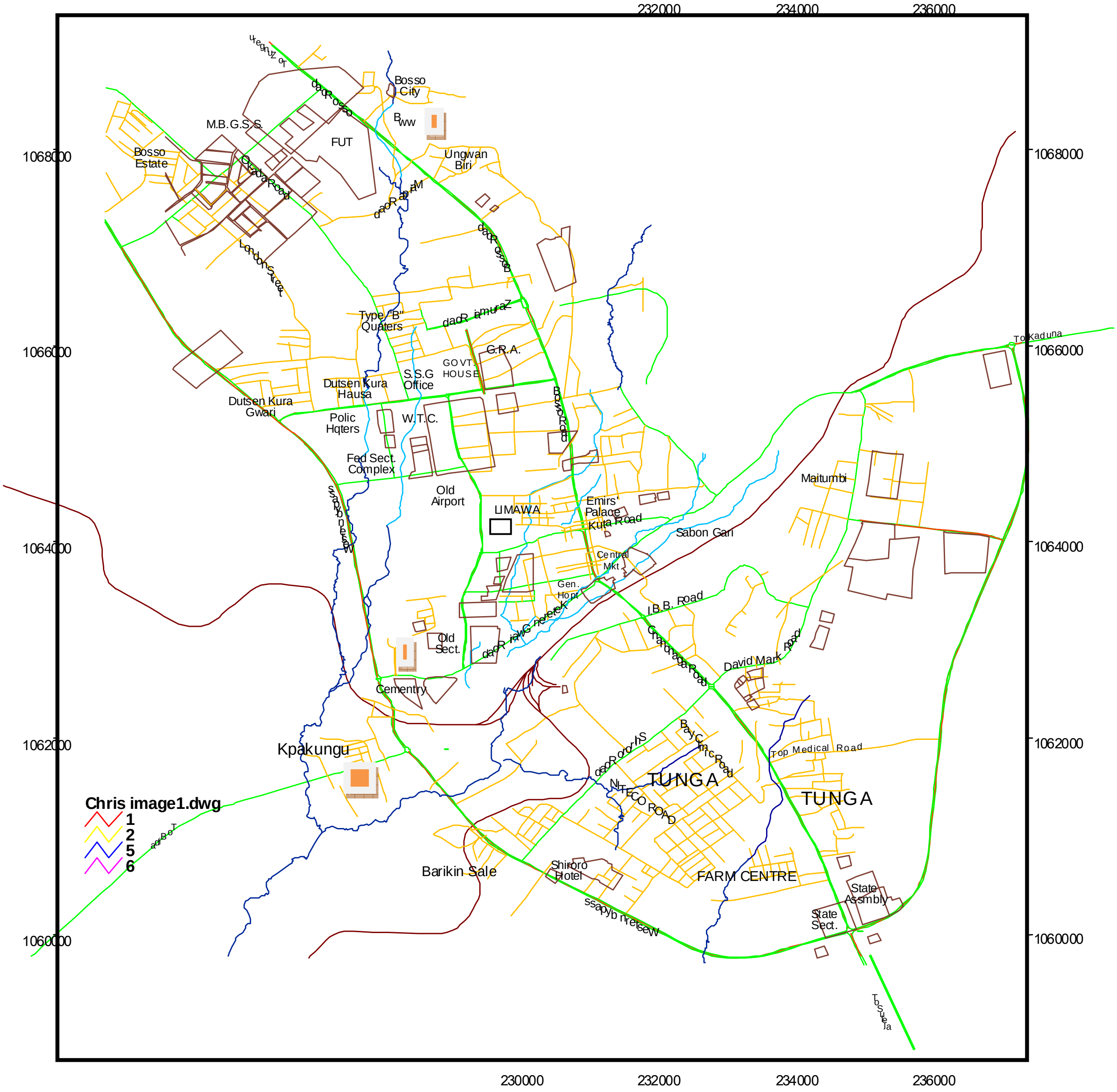

Figure 1. Minna town layout map

A hand dug well was used since it is the main sources of water due to inadequacy of pipe born water supply. A hand dug well is constructed with hand tools or power machinery with large diameter instead of drilling and driving in drilled well (bore hole) [4]. The usual and most neglected cause of water pollution is uncontrolled dumping of municipal solid waste [6]. But monitoring the water quality is very important for environmental safety, in a related study it was suggested that constant natural water analysis for physical and chemical properties including traces of element content are very important for public health studies [7]. Since solid waste dumps is heterogeneous in nature, and the degradation time results in longer retention of the waste thereby increasing the chances of movement of leachate down the ground water source and contaminating the water [6]. The effect of refuse dump in Minna is becoming a serious problem, refuse dumps are common in the town and left unattended to and therefore affect the environment. The aim of this research was to evaluate the effect of solid waste refuse dump on ground water quality in Minna.

Study area

The study area is Minna, which is the administrative headquarters of Niger state; it lies at latitude 90'37" North of the equator and longitude 6'33" East of the Greenwich Meridian on geological base of undifferentiated basement complex of mainly gneisses and magnetite. The town is located at the North-West direction of the Federal Capital Territory, Abuja, which is about 138Km from Minna. It has a mean annual rainfall of 1334 mm and the highest mean monthly rainfall in September with most 300 mm.The mean monthly temperature is highest in March at $30.5^{O}C$ and lowest in August at $25.1^{O}C$.

MATERIALS AND METHODS

Sample collection

The well samples were collected using a 2-liter hand plastic and screw-capped bottles that have been sterilized to avoid contamination by any physical, chemical or microbial means. The collected well water samples were aseptically transferred into sterile 2 plastic containers. After collection, the samples were immediately placed in ice coolers for transportation to the laboratory and stored in refrigerator. The samples were collected during wet and dry seasons. The water quality deals with physical, chemical and biological characteristics of water [8]. Water quality parameters analyzed in accordance to standard method [9], were pH, temperature, conductivity, total suspended solid (TSS), total dissolved solid (TDS), turbidity, nitrite, phosphate, copper, dissolved oxygen (DO), biochemical oxygen demand (BOD) of the samples were determined.

RESULTS AND DISCUSSION

The results of both physico-chemical and bacteriological analysis are present in tables 1 and 2. Table 1 below gives the dry season results while table 2 gives the wet season results. The physical characteristics of the water samples were studied. Throughout the two season (dry and wet seasons), it was observed that all the samples wells water tested were slightly salty and odourless. This salty taste could be due to effect of underlain geological formation. The colour of the samples in the two season shows well 1 and well 3 slightly coloured this could be due to lack of proper cover on the wells, hence well 2 and well 4 are clear an indication of good colour.

Table 1. Results obtained during Dry season

S/No	parameter	UNIT	Kpakungu (well1)	Anguwan biri (well 2)	Old sec (well3)	Limawa (well 4)
1	pH	-	7.80	7.24	8.00	8.41
2	TurbidIty (NTU)	NTU	5.50	38.7	29.4	12.00
3	Conductivity	(μ/cm)	1191	501	800	910
4	Temperature	(^{o}C)	26.0	27.5	27.0	26.00
5	TDS	(mg/l)	738.99	285.05	510.7	210.00
6	Calcium	(mg/l)	139	71	320	78
7	Chloride	(mg/l)	66.40	28.10	158.00	40.00
8	Phosphate	(mg/l)	0.41	0.69	0.92	0.33
9	Nitrite	(mg/l)	0.001	0.05	0.143	0.004
10	Total hardness	(mg/l)	200	112	440	120
11	DO	(mg/l)	8.80	6.69	3.70	9.50
12	BOD	(mg/l)	5.90	7.00	8.10	6.90

Table 2. Results obtained during Wet season

S/No	parameter	Unit	Kpakungu (well1)	Anguwan biri (well 2)	Old sec (well3)	Limawa (well 4)
1	pH	-	7.82	7.95	8.02	8.41
2	TurbidIty	NTU	4.48	37.7	27.5	13.62
3	Conductivity	(μ/cm)	1091	406	705	344
4	Temperature	(^oC)	25.8	26	26.4	26.3
5	TDS	(mg/l)	730.97	272.02	502.5	230.98
6	Calcium	(mg/l)	142	72	327	80
7	Chloride	(mg/l)	74.48	30.49	167.95	43.49
8	Phosphate	(mg/l)	0.39	0.63	0.90	0.30
9	Nitrite	(mg/l)	0.01	0.07	0.15	0.005
10	Total hardness	(mg/l)	215	119	444	128
11	DO	(mg/l)	8.78	6.04	3.66	7.47
12	BOD	(mg/l)	4.10	6.50	7.90	5.70

Chemical characteristics of the sample water were analyzed, the pH of the water ranges from 7.24 – 8.41, and the pH remains relatively within the allowable WHO range of 7.0 – 8.5. Based on the WHO guidelines, the pH of the entire sampling location would not adversely affect its use for domestic uses. Turbidity (in NTU) ranges from 4.48-13.62, the WHO allowable is 5 NTU but from the results of the two season it shows only well 1 during dry season that falls below the standard and other wells during the dry and wet season are above the allowable standard, this an indication that there could be microbial contamination which can cause significant damage to human and turbid water is more expensive to treat. The conductivity of the water samples ranges from 344 – 1191 for the all the samples in the two seasons, this values exceeded the WHO except sample from well 4 during wet season which is 344 μ/cm and allowable standard is 440 μ/cm, the increase in the levels may be due to effluent from different waste.

The total dissolve solid ranged from 210 -738 mg/l, all the water sample falls within the allowable range except well 1 and well 3 in both the dry and wet season, since the maximum permissible limit is 500 mg/l. Therefore wells with high TDS will be a problem during treatment as it may cause filter clogging [10]. For calcium the ranges were 71 – 142 mg/l which fall below the maximum allowable limit of 500 mg/l. The low level may be due to non industrial activity, and low level of weathering rocks such as lime stone, gypsum and other related minerals in the area [3]. The Chloride content ranges from 28.1 – 167.95 mg/l in both the dry and wet season, all the sample lies within the maximum permissible limit of 200 mg/l. The phosphate ranges from 0.30 – 0.92 mg/l, the WHO maximum allowable concentration is 0.5 mg/l, thus from the results on table 1 and 2 for dry and wet seasons respectively shows that well 2 and well 3 during dry and wet seasons exceeded the allowable limit, in some cases levels as high as 0.035 mg/l is considered to cause eutrophication – related problems in temperate region [11]. These indicate that well 2 and 3 during the two seasons may purse a problem for usage. Nitrite concentration of the analysed samples ranges 0.001 – 0.15 mg/l, from the tables 1 and 2 it shows well 3 exceeding the permissible of ≤ 0.5 mg/l. Water hardness is the traditional measure of the capacity to react with soap; hard water requires considerable more soap to produce lather Hardness is one of the very important properties of ground water from utility point of view particularly for domestic purposes [4]. From the research results it ranges from 112 – 444 mg/l, all the analysed samples are within the maximum allowable limit of 400 mg/l, except well 3 during both the dry and wet season which are above the limit, this may be due to dissolution of polyvalent metallic ions from sedimentary rocks, seepage, and run off from soil.

Microbiological analysis of the well water sample was carried out, tables 1 and 2 indicates that none of the water sample analysed met the WHO guideline limit. Coli form bacteria must not be detectable in any 100 ml sample of all water intended for drinking [12]. Since water is essential to life there is need to have unpolluted pure water [13]. By implication the wells around the selected site in Minna are not free for drinking in line with microbial standard. Therefore the quality of the sample well needs to be improved with adequate treatment.

CONCLUSION

Water quality parameters in hand dug well in Minna were assessed to evaluate the level and degree of purity of the hand dug well water. The analysis was carried out during the dry and wet season, it was observed that the there is some level of contamination on the ground water within the solid waste dump site. It is recommended that effective disposal mechanism of household in Nigeria and Minna in particular. Since earth surface is acting as an effective filtrate to filter out particulate matters like leaves, soils, bugs, dissolved chemicals [14]. There is need to have, a programme of effective monitoring of ground water quality.

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