

IMPACT OF REFUSE DUMP SITES ON GROUND WATER QUALITY IN JOS, BUKURU AND ENVIRONS, NIGERIA

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ABSTRACT

Well (ground) water samples obtained from Jos, Bukuru and their environs were analysed. The aim was to determine the extent to which wastes from refuse dump sites could affect the quality of ground water in the vicinity of such dump sites.

Results obtained indicated that well water quality was affected by refuse dump sites located near the wells. Water samples in the area under investigation were found to have pH values ranging from 5.5 to 8.5 indicating that some of the samples were more acidic than WHO (1984) standard of 6.5 - 8.5. The colour intensity recorded for samples D ($58.8 \pm 0.05^{\circ}\text{H}$) and E ($75.2 \pm 0.15^{\circ}\text{H}$) were higher than the maximum tolerable limit of 50°H . Nitrate concentration of as high as $163.97 \pm 0.48\text{mg/dm}^3$ was obtained as against WHO (1984) maximum tolerable limit of 45mg/dm^3 . Higher concentrations of heavy metals were recorded as compared with WHO (1984) standard indicating that the refuse dumps have altered the quality of the water samples. For example the concentration of lead was found to be higher in some of the samples than the maximum tolerable limit of 0.05mg/dm^3 (WHO, 1984).

Generally the levels of most of the determinants were lower for the wells situated much farther away from refuse dumps than those located quite close. It was concluded that waste from refuse dump sites had lowered the quality of ground water in its immediate surrounding. Refuse dump sites should therefore not be sited close to ground water sources meant for domestic or industrial application

Key words: Refuse dump sites, ground water

INTRODUCTION

Background to study

Water is an indispensable social amenity which touches on the lives of every living thing. The total absence of it can spell doom. The quality of water is of importance. To this end the World Health Organisation (WHO, 1984) has spelt out quality requirements of water for various application. Water often gets polluted as a result of the activity of man in his everyday life. The pollutants may not be released intentionally into the water source.

Ground water (well water) just as any source of water does not exist pure in nature when purity is related to its chemical composition (Sybit, 1980). The quality of water is influenced by the geological source and the local surroundings. For instance rain water dissolves soluble substances in the atmosphere (e.g. CO_2) as it falls forming carbonic acid (H_2CO_3) capable of dissolving

mineral elements of soils and rocks, thereby leaching same. Water pollution is the modification of the physical, chemical and biological properties of water restricting or preventing its application (Sax, 1974). Wastes from domestic, industrial and agricultural activities are major sources of water pollution. Domestic waste causes water pollution when mineral and organic substances for example refuse, faeces and urine as well as decomposed organic matter are channeled into water bodies such that the water bodies serve as dumping places. Water meant for domestic application could become polluted by industrial sewage. For instance ground water in the vicinity of a tannery was found to be polluted to an extent that the water became unfit for drinking and irrigation (Gopalakrishnam and Basker, 1994). A report has also indicated that tannery effluents drastically lowered the quality of water down stream to the extent

that organic matter, heavy metal contents among others increased sharply (Dura and Jekel, 1980). The presence of contaminants in water that can serve as medium for harmful microorganisms is undesirable as microorganisms (bacteria, viruses, fungi and protozoa) are causative agents of typhoid, cholera, poliomyelitis, meningitis among others (WHO, 1984).

Study Area Description

The area under study (Jos-Bukuru) lies between latitude $9^{\circ}45'$ and 10° North and longitude $8^{\circ}50'$ and $8^{\circ}55'$ East. It has an average elevation of about 1250m above sea level. The climate is wet and dry type classified as tropical rainy characterised by annual rainfall of 1260mm and mean temperature of about 22°C . The area has a geology that is predominantly younger granite.

Present investigation

In this work we determined the suitability or otherwise of water from wells situated at some distance to refuse dump sites in Angwan Rogo (A), Angwan Rukuba (B), Dogon Dutse (C), in Jos, Angwan Doki (D), Kugiya quarters (E), and Gero Road (F) in Bukuru, Plateau State.

STUDY METHODOLOGY

Field work

Water samples were collected in 5dm^3 clean plastic containers. The samples were obtained from Angwan Rogo, Angwan Rukuba, Dogon Dutse, Angwan Doki, Kugiya quarters and Gero Road, Plateau State. They were collected at mid-depth of wells (Kashef, 1987). The wells were located at distance of (A) 2.50m, (B) 2.35m, (C) 10m, (D) 4.30m, (E) 2.00m and (F) 10.91m respectively from refuse dump sites. F was the control. The sample locations are shown in Fig. 1. In each case, the sample was properly stoppered and taken to the laboratory for immediate analysis, otherwise it was refrigerated and analysis carried out with minimum delay. All reagents used were of analytical grade obtained from British Drug House, May and Baker unless otherwise stated. Standard solutions were prepared using high quality distilled water where water was the solvent and all solutions were stored in clean plastic

containers and refrigerated until needed. The temperature of the samples was taken on the spot using a thermometer.

Laboratory analysis

The pH was measured using a standardised pH meter of the glass electrode type. The absorbance of the samples was measured in a 10 mm cell at 430 nm and the colour in Hazen units (°H) calculated (Welcher, 1975). The electrical conductivity of the samples was determined using a standardised conductance cell. Total dissolved and suspended solid was determined using a standard method (Tebbut, 1977). The total hardness, magnesium and calcium hardness of the samples were determined using standard method (Tebbut, 1977). 5 cm^3 of sample was titrated with 0.01M silver nitrate solution using potassium chromate indicator and chloride determined as described by Christian (1986). Nitrate content was determined spectrophotometrically at 220 nm (Welcher, 1977). Sulphate was precipitated and estimated

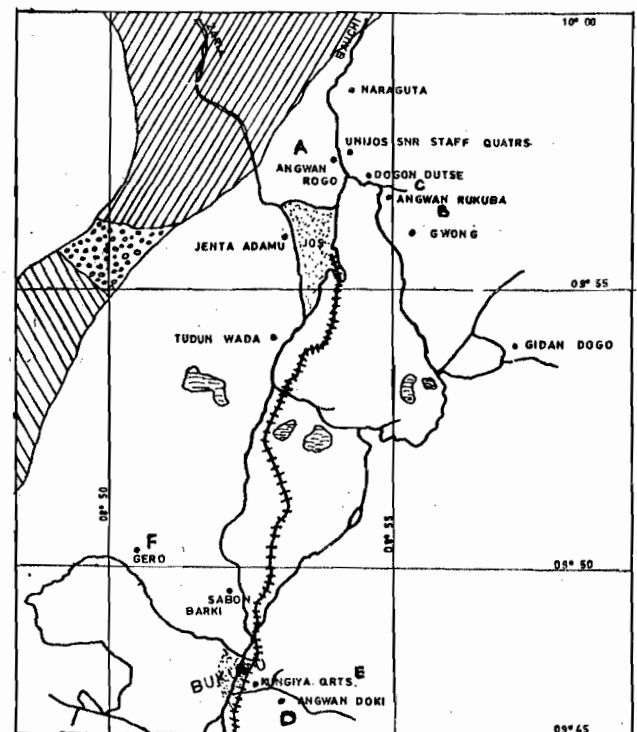


FIG.1 GEOLOGICAL MAP OF JOS-BUKURU AREA NIGERIA SHOWING SAMPLING LOCATIONS. SCALE 1:100,000

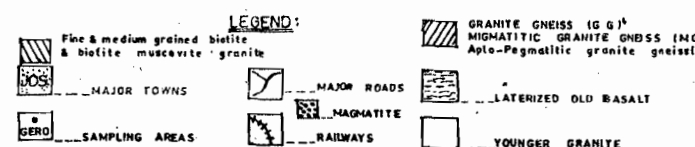


TABLE 1: PHYSICAL PARAMETERS OF WATER SAMPLES

Sample/Determinants	A	B	C	D	E	F	WHO 1984
Temperature, °C	29.30	29.30	29.40	29.40	29.30	28.29	24 - 29
Colour, °H	48.36 ± 0.12	45.30 ± 0.07	41.10 ± 0.02	58.5 ± 0.05	75.20 ± 0.15	27.13 ± 0.13	50
Turbidity, NTU	10.21 ± 0.02	9.57 ± 0.01	12.03 ± 0.01	8.57 ± 0.04	9.61 ± 0.01	1.51 ± 0.06	
Conductivity, $\mu\text{S cm}^{-1}$	320 ± 0.71	319 ± 2.00	483 ± 3.00	562 ± 2.9	319 ± 0.05	88.50 ± 2.40	

TABLE 2: CHEMICAL PARAMETERS OF WATER SAMPLES

Sample/Determinants	A	B	C	D	E	F(control)	WHO 1984
pH	7.5 - 8.0	5.5 - 7.0	5.5 - 6.5	7.5 - 8.0	7.5 - 8.5	8.0 - 8.5	6.5 - 8.5
Total solid mg/dm^3	485.7 ± 1.52	441 ± 1.83	523.3 ± 2.31	571.3 ± 1.18	566 ± 1.84	68.4 ± 1.63	500
Suspend Solid "	358 ± 1.0	291.7 ± 1.16	300 ± 1.00	310 ± 1.00	299 ± 0.60	29.7 ± 1.18	
Dissolved solid "	147.7 ± 1.53	149.7 ± 1.15	223.3 ± 2.08	261.3 ± 0.58	166.7 ± 1.53	38.7 ± 1.15	
Total hardness	82.27 ± 0.31	1447.5 ± 2.19	840.3 ± 0.60	1031 ± 1.40	1025 ± 1.25	70.78 ± 0.32	500
Calcium hardness "	26.38 ± 0.02	450.8 ± 4.20	400.4 ± 0.13	531.0 ± 0.57	526.8 ± 3.37	21.47 ± 0.50	
Magnesium Hardness	55.91 ± 0.31	997.5 ± 5.27	439.9 ± 0.61	500 ± 1.55	498.2 ± 3.57	49.31 ± 0.80	
Chloride "	157 ± 0.25	152.4 ± 0.12	285.1 ± 0.12	162.8 ± 0.37	182 ± 0.27	30 ± 0.08	250
Nitrate "	163.97 ± 0.48	15.84 ± 0.00	22.28 ± 1.11	128.08 ± 1.02	156.5 ± 0.76	22 ± 0.88	45
Sulphate "	10.00 ± 0.00	15.87 ± 0.58	2.57 ± 0.58	12.00 ± 0.00	13.0 ± 0.00	12.57 ± 0.58	400
Lead "	0.10 ± 0.00	0.03 ± 0.00	0.20 ± 0.01	0.03 ± 0.00	0.06 ± 0.01	0.01 ± 0.00	0.05
Copper "	0.20 ± 0.01	0.20 ± 0.01	0.10 ± 0.00	0.16 ± 0.03	0.10 ± 0.00	0.30 ± 0.02	1.00
Zinc "	1.10 ± 0.00	1.21 ± 0.05	1.13 ± 0.05	0.12 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	1.50
Iron "	1.80 ± 0.06	4.00 ± 0.02	2.30 ± 0.07	2.50 ± 0.01	3.50 ± 0.07	0.20 ± 0.06	0.3
Cadmium "	0.06 ± 0.00	0.07 ± 0.01	0.05 ± 0.03	0.02 ± 0.00	0.78 ± 0.00	0.01 ± 0.00	0.01
Potassium "	18.00 ± 0.60	7.00 ± 0.10	23.25 ± 0.05	8.00 ± 0.04	2.00 ± 0.81	1.94 ± 0.20	
Sodium "	24.00 ± 0.11	8.50 ± 0.03	11.00 ± 0.25	23.01 ± 0.02	4.15 ± 0.07	7.10 ± 0.70	20

using the method reported by Vogel (1978). Lead, copper, zinc and iron were determined using atomic absorption spectrometry as earlier reported (Fache, 1988) after the samples have been concentrated using ammonium pyrrolidine dithiocarbamate and methyl isobutyl ketone (APHA-AWWA-WPCF,

1989). Sodium and potassium were determined by flame emission spectrometry.

Results and Discussion

Tables 1 and 2 show the results obtained in respect of the physical and chemical parameters of the water samples.

Physical parameters

The fairly higher colour intensity of samples D ($58.8 \pm 0.05^{\circ}\text{H}$) and E ($75.2 \pm 0.15^{\circ}\text{H}$) as compared to the maximum tolerable limit of 50°H makes such water samples unfit for domestic application (WHO, 1984).

Chemical parameters

The pH values obtained for samples E (7.5 - 8.5) and F (8.0 - 8.5) are higher than those of B (5.5 - 7.0) and C (5.5 - 6.5), indicating that the former samples are more alkaline than the latter two. Alkaline medium has the tendency of precipitating heavy metals as hydroxides thereby concentrating the metals in the water bed. The pH value for sample D (7.5-8.0) is higher than the value 5.88 obtained for water samples for National Film Corporation, Jos (Gye, 1995). The pH values obtained in the present study are fairly within the range of 6.5 - 8.5 recommended by WHO (1984). The electrical conductivity of sample D ($563 \pm 2.9 \times 10^{-3} \mu\text{Scm}^{-1}$) was higher than those of the other samples. This is attributed to the high level of dissolved solids in D ($261.3 \pm 0.58 \text{ mg/dm}^3$) as compared to sample F ($38.7 \pm 1.15 \text{ mg/dm}^3$) and sample A ($147.7 \pm 1.53 \text{ mg/dm}^3$) since the electrical conductivity of an aqueous solution depends on the total concentration of the ionised substances dissolved in the solution. It should be noted that sample F is at the greatest distance (10.91m) from the refuse dump. The value of total hardness is highest in sample B ($1447 \pm 2.19 \text{ mg/dm}^3$) and lowest in sample F ($70.78 \pm 0.32 \text{ mg/dm}^3$). However, most of the samples gave values of total hardness higher than the maximum tolerable limit of 500 mg/dm^3 (WHO, 1984).

The lowest concentration of chloride was obtained for sample F ($30 \pm 0.8 \text{ mg/dm}^3$) while sample C gave the highest value (285.1 ± 0.12) although most of the values are a little lower than the maximum tolerable limit of 250 mg/dm^3 (WHO, 1984). High chloride ion concentration of the samples resulted from the leaching of chloride from wastes in the vicinity of the

sampling area. Nitrate concentration was highest in sample A ($163.97 \pm 0.48 \text{ mg/dm}^3$). The values for samples A, D and E are higher than the maximum tolerable limit of 100 mg/dm^3 (WHO, 1984). Reactions occurring in the wastes in refuse dumps release nitrates into water sources. For example, bacteria decompose uric acid content of the sewage releasing ammonia which is eventually converted to nitrate. Water with nitrate concentration higher than the recommended value is unfit for the preparation of infant food as this can lead to a disease condition methamoglobinaemia induced by intestinal bacteria capable of converting nitrate to nitrite (WHO, 1984). The concentration of sulphate ions in all the samples were below the maximum tolerable limit of 400 mg/dm^3 (WHO, 1984).

The concentration of lead in samples A (0.10 mg/dm^3) and C (0.20 mg/dm^3) are higher than the maximum tolerable limit of 0.05 mg/dm^3 (WHO, 1984). Accumulation over a long period of time could bring the level much higher than the maximum tolerable limit thereby creating a health hazard. The concentration of the element was very low in sample F ($0.01 \pm 0.00 \text{ mg/dm}^3$), possibly because of the greater distance of refuse dump from this water sample. Sources of water for provision of portable water must be carefully chosen to avoid unnecessary high concentration of undesirable elements. A possible source of lead is the leaching of the element from leaded fuels and from lead accumulators used in motor vehicles. Some of the values obtained in the present study are lower than the 0.05 mg/dm^3 recorded for waste water (Chang, 1980) although some are much higher. The highest concentration of iron was obtained for sample B ($4.0 \pm 0.02 \text{ mg/dm}^3$) while the lowest was obtained for sample F ($0.20 \pm 0.00 \text{ mg/dm}^3$). Most of the samples gave high values of iron than the maximum tolerable limit of 1.00 mg/dm^3 (WHO, 1984). It can easily get into the water supply system as the effluents of mining operations within the homes are often carelessly discharged into public sewage. Rusted iron containers or scraps also release substantial amount of iron into water bodies. Some of the samples have sodium contents higher than

maximum tolerable limit of 20 mg/dm³ (WHO, 1984). Sample A(24 ± 0.11 mg/dm³) has highest sodium content while sample E has the lowest value (4.15 ± 0.00 mg/dm³). High level of sodium is undesirable in water samples meant for domestic application as this tends to increase muscular twitching and rigidity (Bell and Paterson, 1986). Sample C contained higher level of potassium (23.25 mg/dm³) than the others.

In conclusion, the study revealed that the levels of most of the determinants from wells close to refuse dump sites were higher than WHO(1984) standards. To a great extent, refuse dump sites have adverse effect on the quality of ground water.

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