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Environmental Impact of Leachate Pollution on Ground Water Quality at Yelwa Kagadama, Bauchi, Bauchi State. Nigeria

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ABSTRACT: The effect of solid waste dumpsites leachate on groundwater quality of Yelwa Kagadama Bauchi, in Bauchi State, Nigeria was evaluated using appropriate standard techniques. The parameters determined included nitrite, magnesium, total alkalinity, sulphate, calcium, phosphate, temperature, TDS, conductivity, pH, colour and turbidity. It was discovered that the wells have high level of colour ranges from 0 to 85 which shows that well I 25, well II 60 and well IV 85 did not falls within the standard compared to WHO and NSDWQ standard of 5.00, but other parameters are within the NSDWQ standard. Hence such water should be treated by employing some measures such as applying alum and disinfectant before use which will help to reduce pollutants, but majorly an improved water supply to the study area will go a long way to correct the unhealthy condition. The pH ranges from 6.33 to 7.79 indicating toxic pollution, turbidity was between 0, 1, 8, 12 and 29 NTU respectively and the concentration of nitrite ranges from 0.010 to 0.008 mg/l which falls within the standard, calcium ranges from 83 to 166 mg/l which does not fall within the standard, which shows the presence of hardness in water. The implication is that forming lather with soap. The results show that all but some of the well was strongly polluted but will require certain levels of treatment before use. Also casing of the wells is of critical importance in addition to siting dump site at reasonable distances from wells, sorting, and adoption of clean technology to prevent further contamination of ground water flow are recommended.

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The problem associated with refuse generation and its impacts on dumpsite in urban areas has attracted the attention of many researchers including this present research work. Waste is defined as any gaseous, liquid or solid material that is thrown away because it has no further use by the owner Herbert, (2007). These unwanted and undesirable materials according to Olushogun; Ebule, (2011) originate from industrial and mining project, domestic, agriculture and livestock from residential commercial and municipal activities in urban areas. Leachate migration from wastes sites or landfills and the release of pollutants from sediments resource if not adequately managed, can result to adverse health hazard, hence the need to protect ground water from being polluted. (Longe; Balogun 2010; Ikem; Osibanjo (2009). Waste management has become increasingly complex due to the increase in human population, industrial and technological revolutions and the processes that control the fate of waste in the soil is complex and many of them are poorly understood by many. The issue of refuse disposal has transcended individual and

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local organization to national and even international organization's concern. Longe; Anekwechi (2007), observed that refuse waste is being accumulated due to large continuous increase in population thereby polluting the environment, it not properly managed. Ogedengbe et al; (2004) noted that only 5% of refuse waste in Nigeria are recycled. Waste generation is continually decreasing the availability of land suitable for disposal. These problems can have considerable impact on the environment where adequate environmental policies have not been put in place and implemented to checkmate the growing generation of domestic or municipal refuse waste. Yelwa Kagadama have no organized manner of waste disposal, poor sanitary condition. Due to the rampant cases of water related diseases it is necessary to investigate the impact of the indiscriminate waste disposal to the quality of ground water in the study area, hence this work

MATERIALS AND METHODS

The Study Area: Yelwa Kagadama in Bauchi, Bauchi state is located between latitude 10^0 17' 0" N and longitude 9^0 47' 0" E. It has a dry climate with two distinct seasons. Bauchi has a relatively dry season from November to April and rainy season from May to October, socio-economic setting and population

Reconnaissance Survey: As the preparation for the study, a reconnaissance survey was undertaken to properly study the area before starting the full research. The objective is to get relevant information on the study area and seek corporation of residents residing around the dumpsites and to select the wells that are close to the dumpsite for laboratory analysis

Water Analysis: Five existing 1.3, 1.1, 1.2, 1.1.and 1.2" diameter wells with average depth 10.24 meters in basement formation located within the distance of 1.2m, 12m, 11.7m, 14m and 17m respectively away from the Centre of the dumpsite were used as sampling points for groundwater quality testing. From each well, 5 liters of the groundwater samples were collected in 600 mL sterilized polyethylene bottles, stored at 4^0C and analyzed. The analyses covered physical, chemical and bacteriological parameters.

Water Sampling: A 600ml sterilized polythene bottle was used to collect water sample around the dump site, each sample bottle was labelled for easy identification. Care was taken to avoid contamination and exposure to light. It was kept cool in an insulated container and transported to the laboratory for analysis.

Sampling Procedure: The cover/stopper of the sample bottle was be removed and retained in one hand. A string was tied to the sample bottle and then lowered into the well, when the bottle was filled the sample was brought out and covered immediately.

Determination of Quality Parameters: A simple thermometer was immediately used to determine the samples temperature in ^{0}C apparent colour was determined using platinum cobalt standard method. Also, a pH meter (Mettler Teldo, MP220 model, USA) was probed into the sample to determine the pH, in similar manner the Electrical conductivity was determined. Total dissolved solid was determined with the use of HACH DR 5000 spectrophotometer (HACH Company, Loveland, USA). A Turbidimeter – Model 2100P (HACK Company, Loveland, USA) was used to determine the turbidity and result was expressed in nephelometric turbidity unit (NTU). All procedure was according to the standard Methods for the Examination of Water and Wastewater (APHA, AWWA &WPCF, 2005; HACH, 2012). Chemical parameters test for nitrite, magnesium, sulphate, alkalinity, phosphate and calcium were carried out with the aid of HACH DR 5000 spectrophotometer and their respective results were obtained in mg/l. Total bacterial count was determined by taking one ml of well mixed water sample was pipette into a sterile petri dish and mixed with 100ml of sterile nutrient gelatin of agar. The gelatin was stored under sterile conditions in tubes liquefied at 30^0C before pouring. Tubes of nutrient agar are liquefied in boiling water and cooled to 4^0C before pouring into petri dish. The culture plates are then inverted and incubated at 20^0C. The visible calories are then counted with aid magnifying glass. The total bacterial count is given in terms of 1ml of water sample.

RESULTS AND DISCUSSION

The underground water samples collected from five wells in the study area were analyzed for Physical, Chemical and Bacteriological parameters and the results are presented in the charts. Figure 1 – 6 shows the physical characteristics, while the chemical characteristics are plotted in figure 7 – 12 and figure 13 shows the bacteriological quality of the samples. These are compared with the standard as stipulated by WHO, (2004). The results and comparison of the physical parameters with Nigerian Standard for Drinking water quality (NSDWQ) and WHO presented above are here discussed. The temperature, turbidity, colour, TDS, conductivity and pH as analyzed from the ground water samples are shown in fig, 1 to 6. The temperatures which ranged from 28.3^0C to 30.9^0C as shown in fig 1 of all the samples, wells were found outside the range of the NSDWQ standard of 5^0C for domestic water hence indicating the presence of foreign bodies. The high temperature signified presence of active microorganisms which resulted in the temperature increase.

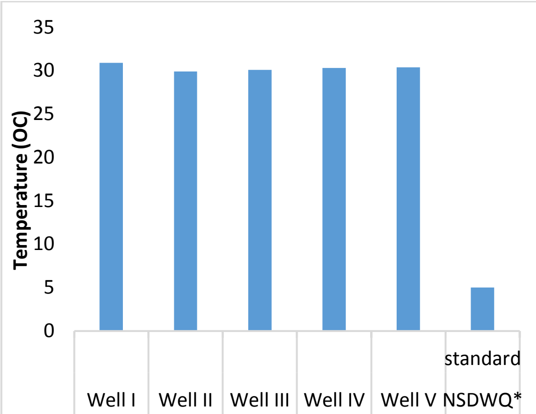

Fig. 1: Analyzed wells against Temperature (^{O}C)

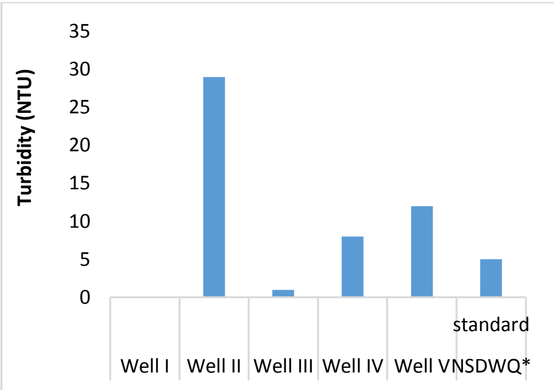

Fig. 2: Analyzed wells against Turbidity (NTU)

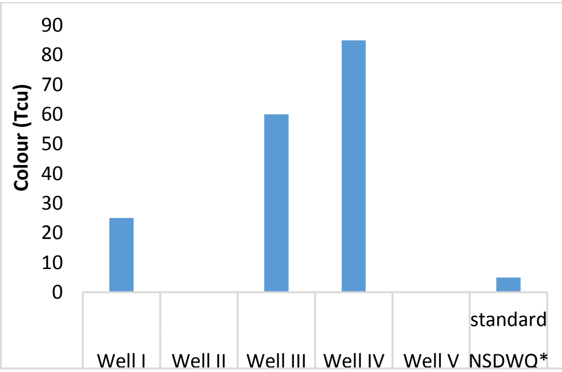

Fig. 3: Analyzed Wells against Colour (Tcu)

The turbidity readings represented in fig 6, reveals that the samples have values above the NSDWQ standards with samples W [II], W [IV] and W [V] high turbidity values of 29 NTU, 8 NTU and 15 NTU respectively. Presence of suspended particles and other materials are usually responsible for high turbidity values. Soil particles may have found their way into the wells from the unstable side walls thereby increasing turbidity of the water. The recommended value of 5 NTU (nephelometric turbidity unit) as the maximum above which disinfection is inevitable. The observed turbidity value in sample W [II] is slightly higher than the recommended value and may be due to proximity to the dumpsite indicating higher sediment flow when compared with others. All the values were however lower than the ones reported in Samples W [I] and W [III], in these cases, treatment is not required. The presence of colour in fig 5is an indication of pollution and confirmed leachate infiltration into wells [I], [III], and [IV]. Potable water must be colourless, odourless, tasteless, and free from objectionable and pathogenic organisms and fit for consumption. Results as shown in fig 7, revealed that the total dissolved solids exceeded the permissible level, this could be attributed to substances that find their way into all the wells under investigation. The well operators may not have been careful in their usage, this is in addition to run-off that transports decomposable substances into these wells.

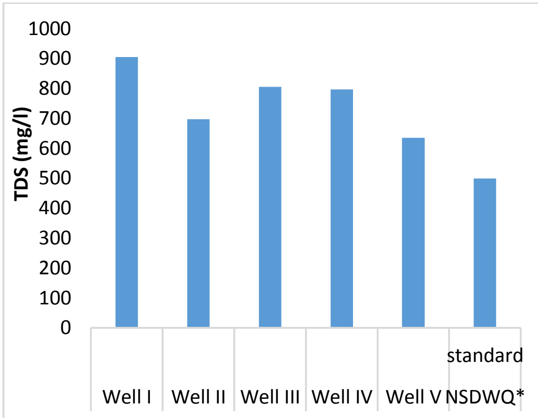

Fig. 4: Analyzed wells Against TDS (mg/l)

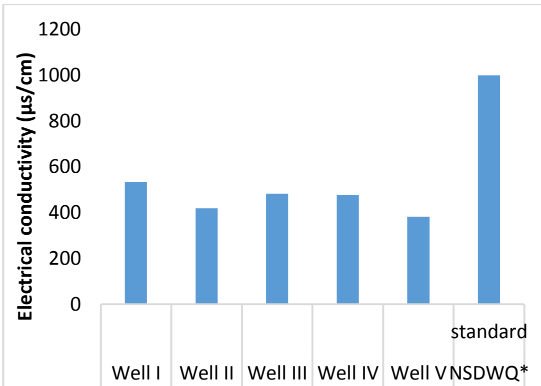

Fig. 5: Analyzed wells against Electrical conductivity (µs/cm)

Electrical conductivity of the five wells waters as seen in figure 5 being studied is within the acceptable limit, by this, the amount of dissolved mineral is tolerable and hence may not conduct electricity which is not an objective in this work. From fig 4, pH ranged from 6.36 to 7.79 which is acidic and indicated presence of metals in the samples particularly toxic metals, which can be attributed to dissolved solid waste with metallic constituent and by run-off reaches the wells.

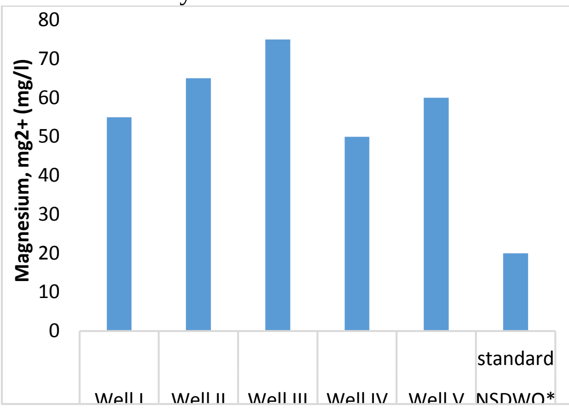

Fig. 7: Analyzed wells against Magnesium

This falls below NSDWQ and WHO permissible range of 6.5-8.5 and confirmed the acidic and partly alkaline nature of the water from the wells. Metals such as zinc, damaged battery cells (lead, mercury and alkaline) and improperly disposed used cans of aerosol and other disinfectants deposited in the dumpsite as waste, after exposure to air and water and may have found their ways to the well-water through seepage to give the toxic, acidic nature it currently has. It was remarked that though 7.0 is the neutral, up to 9.2 may be tolerated. The high pH value recorded in well 1 could be attributed to its proximity to the dump site.

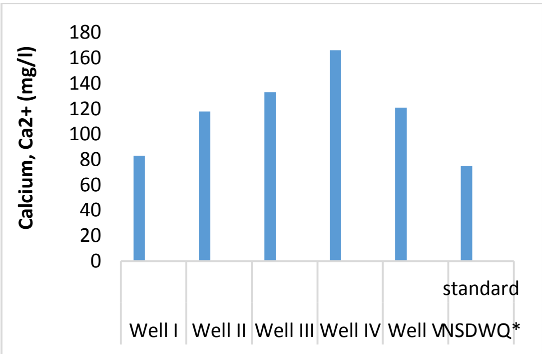

Fig. 8: Analyzed wells against Calcium, Ca^{2+} (mg/l)

With respect to the chemical parameters being analyzed, Magnesium and calcium are also visibly high most especially in the samples of well 3, 4 and 5 for calcium as seen in figure 8, while in the case of Magnesium, it is shown in figure 7, where all the wells are implicated. Fig 9 shows that Nitrite ranged from 0.001 to 0.008 mg/L which is below the maximum permissible level of 0.2 mg/l. though below the levels, its presence require treatment before use. Nitrites are relatively short-lived because they are quickly converted into nitrates by bacteria which exist in the air. Nitrites react directly with hemoglobin in human blood to produce methemoglobin, which destroys the ability of blood cells to transport oxygen.

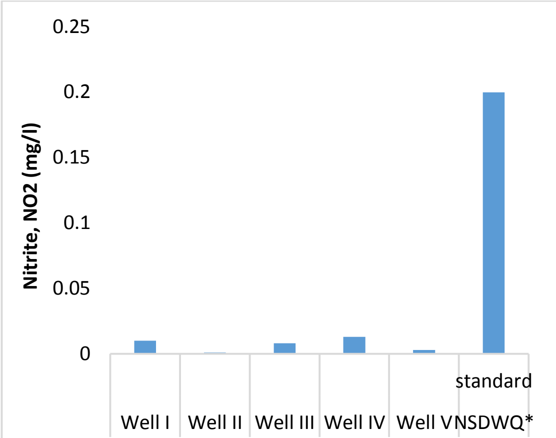

Fig. 9: Analyzed wells against nitrite, No_2 (mg/l)

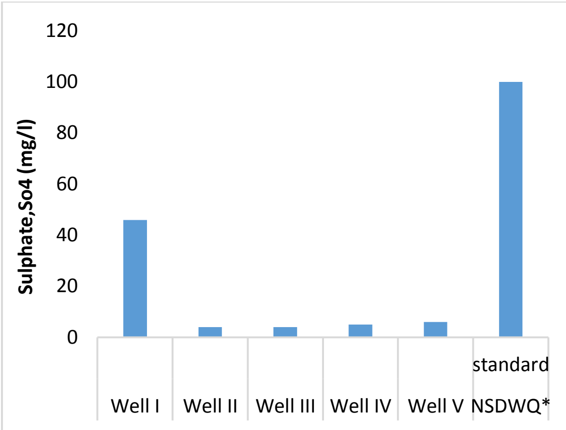

Fig. 11: Analyzed Wells against Sulphate, SO_4 (mg/l)

This condition is especially serious in babies under three months of age as it causes a condition known as "blue baby" disease. Water with nitrite levels exceeding 1.0 mg/L should not be consumed by humans let alone given to babies. Nitrite concentrations in drinking water seldom exceed 0.1mg/L. With the values higher than the 'safe value,' it therefore constitutes a menace if consumed without treatment. Nitrate is a major ingredient in farm fertilizer and necessary for crop production. After rainfall, varying quantities of nitrate are washed from farmland into nearby waterways and also to groundwater table through infiltration, percolation and seepage. Calcium levels is high in all the samples as seen in fig 8, which ranged from 83 to 188 mg/L still portend danger of hardness in water. The implication is that forming lather with soap will be a major challenge for domestic users though it does not have health implication. The alkalinity shown in fig 10, ranged from 10 to 175 mg/L fall within the range of the WHO (2004) and NSDWQ except well which have high alkalinity due to the pollution of leachate from the dumpsite which is very close to the well. Hardness refers to reaction with soap and scale formation which increases boiling point of water but does not have any adverse effects on human health. The hardness of water samples may be due to leaching of Ca^{+} and Mg^{+} ions into the groundwater. The magnesium (mg^{+2}) values from all the analyzed wells as shown in fig. 7 are higher than the desired concentrations for domestic water consumption hence unfit for use as potable water, the same condition applies to phosphate in fig. 12. This agreed with the findings of Lorge and Balogun (2010), which is a clear indication of health hazard when consumed.

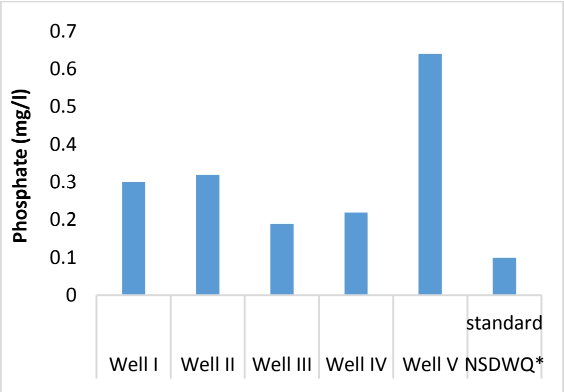

Fig. 12: Analyzed wells against Phosphate (mg/l)

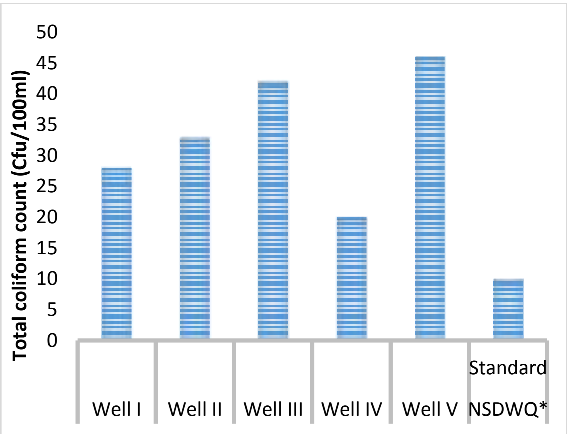

Fig. 13: Anlysed Wells against Total coliform count (Cfu/100ml)

With respect to microbial parameters, the total coliform (CFU/100ml) count in 12 indicate that the bacteria count in the samples reveals microbial contamination which is higher than the WHO standard. The health implication with indication of faecal contamination can result in urinary tract infections, bacteremia, meningitis and diarrhea. In this case, all indicators showed deterioration in bacteriological quality and deserve urgent attention to avert the imminent catastrophe its continued existence in both the soil and water bodies will pose to the end users.

Conclusion: The study revealed that the concentration of waste materials in the dump site had systematically polluted the soil and groundwater over time. Presence of total coliform bacteria indicated microbial pollution of the groundwater by anthropogenic activities. Water hardness was higher due to the leaching of both Calcium (Ca) and Magnesium (Mg) into the groundwater table increase day-time temperature also results in microbial activities. All wells analyzed are unfit for human consumption and hence require treatment.

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