Research Article – Environmental Science

Impact of Aisami Solid Waste dumping site, Kano Metropolis, Nigeria on the quality of ground water of the neighbouring environment

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(Received: 08-11-2019; Accepted 10-12-2019; Published Online 31-12-2019)

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Abstract

Open dumping and uncontrolled landfilling of solid wastes are the most widely practiced waste disposal methods in many cities of the less-developed regions, especially those in sub Saharan Africa. These practices are unsustainable and pose a major threat to the environment and public health. Of particular concern is the leachate produced at the disposal sites, which is concentrated with biological and chemical substances that could contaminate the soil, surface and groundwater sources in the environment. The effects of leachate percolation on the quality of groundwater sources is of great concern especially in sub Saharan Africa, where untreated self-supply groundwater options represent a major source of water supply for many inhabitants. Given this perspective, the physicochemical characteristics of some groundwater samples from wells around a major waste disposal site; Aisami in Kano metropolis, Nigeria, were examined. The samples were collected from the north, east, south and west directions around the disposal site and analysed for parameters that include: pH, turbidity, total dissolved solids, electrical conductivity, total alkalinity, total hardness, Ca^{+2}, Mg^{+2}, Na^+, K^+, NO_3^-, $SO_4(2-)$, Cl^-, Cu^{+2}, Fe^{+2}, Mn^{+2}, Pb, Zn, and Cr. Significant concentrations of most parameters were revealed, often above the WHO recommended thresholds. Accordingly, some measures were highlighted towards protecting, preserving and sustaining groundwater quality as a strategic source of water supply in the area and beyond.

Keywords: Solid waste, open dumping, landfilling, leachate, groundwater, contamination, water quality, Kano

Introduction

Most Nigerian cities are epitome of urban decay and characterized by poor housing, sanitation and public health infrastructure (Akinbiyi, 1992). Their erratic growth of housing units coupled with rapid population explosion has resulted in environmental health hazards (Adefehinti, 2001). Wastes are generated from human activities and in most cases not properly managed in most Nigerian cities (Adefehinti, 2001; Aurangabadkar *et al.,* 2001). This leads to low environmental quality which accounts for 25% of all preventable ill health in the world (WHO, 2002). In most cases, wastes are collected and disposed off in uncontrolled dumpsite sited near residential buildings. These wastes are heaped up and/or burnt, polluting water resources and air (Akpan, 2004). Waste generally leads to proliferation of pathogenic microbes and heavy metals which can transfer significantly to the environment (Uffia *et al.,* 2013). Leachates from dumpsites constitute a source of heavy metal pollution to both soil and aquatic environments (Ali and Abdel-Satar, 2005). This may have detrimental effects on soils, crop and human health (Bahnasawy *et al.,* 2011). Most human activities revolve around water, and its quality in a long way affect health and the socio-economic development of man. Anthropogenic factors contribute highly to contamination of both surface and underground water (Singh and Mosley, 2005). Water contaminants are mainly biological and chemical in nature (Uffia *et al.,* 2013; Fecham and Mara, 1986). The quality of underground water could be compromised if it is not shifted to a distant place from constant source of pollution.

According to the 2006 national census, Kano State is the most populous State in Nigeria with a population of 9,401,288 inhabitants spread over forty four local government areas. Kano city is one of the fastest growing cities in the world due to rapid uncontrolled rural urban migration. Pipe borne water in the last few years in Kano metropolis is in short supply. Most of the developing areas of the metropolis are not connected to pipe borne water network. Therefore, majority of Kano inhabitants, regardless of social status, depend on hand-dug wells and bore-holes for their daily water supply needs. The quality of ground water has received much attention by different researchers as poor quality water has huge health and economic implications (Tanko, 2002).

Material and methods

Study Area

The study was conducted in Aisami Gwale Local Government area of Kano state 11°59'39.4"N, 8°29'55.3"E (Latitude: 11.994277; Longitude: 8.498687).

Methodology

Water samples were taken using cleaned and sterilized containers at different hand dug wells located at various distances from Gyadi-Gyadi waste dumping site as summarized in Table 1. Physicochemical analysis of underground water samples were performed using standard analytical methods of water analysis in accordance with the American Public Health Association recommendations (APHA, AWWA and WPCF 1998). Each sample was analyzed in duplicate and the averages of the results were recorded. Generally, laboratory quality assurance measures

Table 1: Average values of the water quality parameters of the wells under investigations

Parameters	Sample A	Sample B	Sample C	Sample D	WHO Standard
TEMP(C)	28	28	28	27	27-28
pH	7.60	7.65	7.60	7.60	6.5-8.5
DO	5.47	5.47	5.50	5.50	7.50
TDS	429	430	428	430	500
EC	758	758	760	760	1400
Na	39	39	38	39	50
Ca	41	40	41	42	50
Mg	73	72	72	70	75
CL	32	31	32	31	250
PO	5.70	6.00	5.80	6.00	05
MN	0.49	0.50	0.49	0.49	0.50
Fe	0.22	0.22	0.22	0.23	0.30
Pb	0.19	0.19	0.19	0.20	0.01
Zn	0.13	0.13	0.13	0.13	03
Cr	0.13	0.13	0.13	0.13	0.05

Key: EC = Electric conductivity; TDS = Total dissolved solids; DO = Dissolved oxygen; EC=electric conductivity; Ca= calcium Na= Sodium; Mg= magnisium Cl= Chloride; PO= Phosphate; Mn = Manganese; Fe = Iron; Zn = Zinc; Cr =Chromium and Pb=Lead

were observed in order to prevent sample contamination and instrumental error. The laboratory water used in the analyses was doubly distilled before it was deionized. Wavelengths settings of the spectrometer were carried out using the standard instrument procedure and all others equipment used were also calibrated against reference standards (APHA, AWWA and WPCF 1998). The analyzed ions are: sulphate, nitrate, chloride, phosphate, iron and manganese. Temperatures of the samples were determined at the field using an alcohol thermometer. The pH of the samples was measured with a Suntex pH meter that has been calibrated with a buffer solution. Dissolve Oxygen of the samples were measured with a dissolve oxygen meter (Model:Jenway 9071). For hardness measurements, 50ml of samples was mixed with 0.005N volume of hydrochloric acid in a conical flask. The solution was boiled and allowed to cool to about 50ºC. 2ml of buffer solution was added, and then titrated with NaOH solution till faint pink end point was observed. The volume of titrate used was recorded (WHO, 2011).

Result and discussion

From the result obtained, the temperature of the groundwater in the study area is virtually constant throughout (28 °C). This temperature depends on the environmental condition at the time of collection of the samples. Generally, increase in temperature leads to low dissolve oxygen content of water. Most of the samples fall within the neutral pH range and the WHO recommended guideline values. On its own, however, pH has no direct effect on human or animal health, but because it is so closely associated with other chemical constituents of water, is often regarded as having an indirect effect on health (WHO, 2011).

Likewise, the concentrations of Ca^{+2} and Mg^{+2} are not of health concern in drinking water, but are easily precipitated. In particular, they react with soap to make it difficult to remove scum; therefore, they are the primary contributors to TH. In this study, Ca^{+2} and Mg^{+2} concentrations in all the samples ranged between the normal range. TH concentrations are usually expressed as the total concentration of Ca^{+2} and Mg^{+2} in mg/l equivalent $CaCO_3$. For all the samples of this investigation, TH is also not of health concern as per the WHO guidelines for drinking water, but at concentrations above 200 mg/l may cause scale deposition in the treatment works, distribution system and pipe work and tanks within buildings (WHO, 2011).

As a valuable indicator of the levels of dissolved minerals in water, EC values in the studied samples ranged from 758 µS/cm to 760 µS/cm in sample, and were found to be low in all of the samples. The observed low conductivity values indicate low contamination. As in the case of EC, TDS concentration is also not a health concern as per the WHO guidelines, but may affect the acceptability of drinking water. Hence, EC and TDS are often used as rapid indicators of water quality (HA, AWWA and WPCF, 1998).

Dissolve oxygen is the amount of oxygen found in water. Dissolve oxygen sustain life of aquatic organisms. Very low dissolve oxygen may result in anaerobic conditions that cause bad odors. The WHO limit for dissolve oxygen in drinking water is 7.5mg/l. The amount of dissolve oxygen of the wells analyzed ranges from 5.47-5.50mg/l. These values suggest that the water can be used for household and industrial applications. Nitrogen may also enter ground water from sewage discharge on land,the safe concentration of nitrate for domestic water set by the W.H.O is 50mg/l. Nitrate concentration above the recommended value of is dangerous to pregnant women and poses a serious health threat to infants because of its ability to cause blue baby syndrome in which blood loses its ability to carry sufficient oxygen. High phosphate in water cause serious problems of water pollution. The WHO maximum permissible limit of phosphate in drinking water is 5mg/l. All the wells analyzed show high amount of phosphate. Traces of phosphates increase the tendency of algae to grow in the water (Ikem *et al.,* 2002). Iron is often present in groundwater because iron is commonly found in many aquifers and is found in trace amounts in practically all sediments and rock formations. The iron content of groundwater is important, because small amount of iron seriously affect water quality. Iron stains plumbing fixtures, stains cloth during laundry and clog pipes. The World Health Organization recommends that the iron content of drinking water should not be greater than 0.3mg/las the permissible limit. The concentration of iron in all the wells analyzed around Aisami dumping site falls within the acceptable range. Manganese occurrence in groundwater is more common than that of iron. Manganese occurs as soluble manganese bicarbonate which changes to insoluble manganese hydroxide when it reacts with atmospheric

oxygen. The WHO set a maximum acceptable value of 0.05mg/l, as the permissible limits of manganese in drinking water. The levels of manganese in the analyzed wells are found to be within the recommended values set by the WHO (Groen *et al.,* 1988). Chloride ions enter the groundwater aquifers from solid waste when it comes in contact with rain water and then gain entrance into aquifers. High chloride content may corrode metallic pipes. Water that contain less than 150mg/l chloride is satisfactory for most purposes. A chloride content of more than 250mg/l is generally objectionable for municipal uses (Sridhar, 2000).

The heavy metal level in all the samples collected at four different sampling sites where found to be within the W.H.O range except for lead (Pb) which indicates the disposal of Pb batteries, chemicals for photograph processing, Pb-based paints and pipes at the landfill sites. At high levels of exposure, lead attacks the brain and central nervous system to cause coma, convulsions and even death, most vulnerable among children (WHO, 2019).

Conclusion

The study determines the impact of solid-waste generation and disposal in Aisami of Gwale Local government area of Kano, Nigeria. The result of the analyses suggests that the population is strongly related to the volume of solid-waste generation in Onitsha metropolis. This implies that the volume of solid waste generation in Aisami metropolis increase with increase in the city's population. However, the volume of solid waste generated is not related to the rate of waste disposal during the study period. In other words, solid waste is poorly disposed in kano metropolis. This is mainly responsible for the city's poor sanitary condition. The study recommends among others the privatization of solid waste management as well as adequate funding of agencies responsible for waste collection and disposal in Kano metropolis. The outcome is capable of enhancing measure aimed at providing effective solid waste management system in metropolis and indeed other Nigeria cities.The policy implication of this study is that population should be considered as a very important factor in the design of solid-waste management programme for Nigerian cities.

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