

Effects of Solid Waste Disposal on the Physicochemical Properties of Borehole Water along FUTO Road, Eziobodo, Owerri-west, Nigeria.

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Abstract

Non-adherence to adequate refuse disposal and increase in population of inhabitants dominated by students who continue to seek residence in Eziobodo community have been identified as one of the major threats to groundwater source in the study area. Borehole water samples were obtained from two boreholes along FUTO road, Eziobodo, and analyzed for the following physico-chemical parameters: pH, electrical conductivity, Turbidity, Nitrate (NO_3^-), Nitrate-Nitrogen (NO_3^- -N), Phosphate (PO_4^-), Phosphorus (P), Total Hardness and Total Chloride using standard methods and compared with the World Health Organization Standards for drinking water. The experiment was repeated after a period of five months. The pH values obtained from analysis of both samples decreased slightly from 6.8 and 5.7 at the beginning of the experiment and to 6.2 and 4.9 after the time interval indicating that groundwater in the study area were acidic. The Electrical Conductivity value for both samples was $30\mu\text{S}/\text{cm}$ at start of experiment while values increased slightly to 34 and $31\mu\text{S}/\text{cm}$ after the time interval. The samples showed 0.00 for Turbidity. Nitrate values were $38.50\text{mg}/\text{l}$ and $36.00\text{mg}/\text{l}$ at start of experiment with very slight increase after the time interval. Nitrate-nitrogen values for both samples were $8.70\text{mg}/\text{l}$ and $8.10\text{mg}/\text{l}$ with slight increase after the time interval. Phosphate values for both samples were $46.80\text{mg}/\text{l}$ and $0.60\text{mg}/\text{l}$ at start of experiment and increased to $48.10\text{mg}/\text{L}$ and $7.40\text{mg}/\text{L}$ after the time interval. Phosphorus values increased from $15.20\text{mg}/\text{l}$ and $0.20\text{mg}/\text{l}$ to 16.10 and $3.30\text{mg}/\text{L}$. The Phosphate and Phosphorus values for Borehole Water Sample1 (BHWS1) were above the WHO permissible limits. Total Hardness values for both samples were $0.30\text{mg}/\text{l}$ and $0.28\text{mg}/\text{l}$ and remain virtually the same after the time interval. Total chloride values increased slightly for both samples from $186.00\text{mg}/\text{l}$ and $208.50\text{mg}/\text{l}$ to 186.08 and $210.1\text{mg}/\text{l}$ after the time interval. Generally, the concentrations of the analyzed parameters were within the WHO Standards except for pH, Phosphate and Phosphorus. These results indicated that the water sources were contaminated and maybe unfit for human consumption except when treated. This,

therefore, calls for appropriate treatment measures before the consumption of these waters by the populace in order to avoid long term accumulative health problems of these pollutants. Proper waste management strategies such as incineration, composting, should be adopted to avoid indiscriminate waste disposal and unnecessary seepage into the underlying groundwater. The study also identified rising groundwater level as a factor making the groundwater more vulnerable to pollution. Hence, the need to have a programme of effective and periodic monitoring of ground water quality.

Keywords: borehole water, physicochemical properties, solid waste

Introduction

Solid waste is a part of our everyday lives. This is because we generate wastes from all our day to day activities, such as; cooking, disposal of unwanted items like beverage cans, old furniture, mulch from gardening, etc. These are items that stare us in the face everyday, either in the form of dumpsites, landfills, truck pushers, and even in front of our houses as old and/or forgotten furniture or appliances.

Open dumps have been identified as one of the major threats to groundwater source. Open dumping system of waste disposal is the most common method of waste disposal in Nigeria [1]. It is a kind of system where waste is disposed of by infilling depression on land which may include valleys and excavations, without the consideration of the composition of the waste [2]. Waste disposed in an open dumpsite can be subjected to infiltration from precipitation. As water percolates through the waste, it picks up a variety of organic and inorganic compounds flowing out of the waste and accumulates at the bottom of the dumpsite. The resulting contaminated water termed leachate can migrate through the soil and eventually contaminate the groundwater if not adequately managed [3]. When a dump is situated close to a water source, it deters people from going to fetch from it. It also contaminates the water through the infiltration of leachate from the waste into the soil. The soil possesses filtering properties which help to lessen the amount of contaminants which descends towards the water table. But, even though the soil carries out this filtering function, man has got a role to play in lessening the generation and presence of this leachate [4,5]

Contamination of water bodies has increasingly become an issue of serious environmental concern. Availability of clean drinking water is a basic right for all people. Unfortunately, many of the boreholes offer water which is either unsafe for human consumption or rather has such unaesthetic quality that no one will want to use [5]. Groundwater is particularly important as it accounts for about 88% safe drinking water, both in the rural and urban areas, where population is widely dispersed; and infrastructure needed for treatment and transportation of surface water does not exist. It has become an important water resource due to increasing trend of pollution on surface water and this problem is more acute in an area or areas which are densely populated and inadequately supplied with potable drinking water [6].

The availability of groundwater is neither unlimited nor is it protected from deterioration. Man, through a variety of activities like indiscriminate dumping of refuse, and modern technologies, is dramatically changing the characteristics of groundwater system [7]. Ground water pollution could be avoided when borehole wells are located far from any source of potential pollution. Good well design is also important in the prevention of underground water pollution. During the construction process of a borehole, drilling fluids, chemical casings and other materials may find

their way into the well thereby polluting the water. An open hole during the construction stage can also be a direct route for contaminants from the surface to the aquifer thereby providing an ideal opportunity for chemical and bacteriological pollution to occur. Lasting damage can be avoided if the well is completed, disinfected and piped within a short space of time. The possibility of contamination increases if there is a lengthy delay in completing the well. Even if no sources of anthropogenic contamination exist, there is potential for natural levels of metals and other chemicals to be harmful to human health. This was highlighted in Bangladesh where natural levels of arsenic in groundwater were found to be causing harmful effects on the population [8]. Unfortunately, this problem arose because groundwater was extracted for drinking without a detailed chemical investigation.

Water quality refers to the chemical and physical characteristics of water. It is the measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose [9]. The quality of groundwater is influenced by various factors. These factors are both natural and human. The parameters affecting groundwater quality are the geologic nature of the aquifer, the socio-economic activities around groundwater source; physical, chemical and biological properties of various waste waters.

As rain drops and infiltrates into the soil, harmful substances from dumpsites, landfills finds their way into boreholes, hence polluting the water body and making it unfit for domestic and other purposes. A plume of contamination occurs whenever a reasonable permeable material exist below the soil strata. Organic contaminants called leachate drains into groundwater where there is no base lining and carries along with it anions and cations of iron and manganese which contaminates borehole water easily [10]. A release of leachate to groundwater presents several risks to human health and damages to the environment. The amount of leachate produced from a dumpsite depends on the amount and distribution of rainfall, evaporation from soil cover and thawing. This process of infiltration aids the movement and transport of contaminants that have accumulated from the dumpsite. The dumpsite through the process of percolation and infiltration contaminates the groundwater in an area. This agrees with [11], who opined that water dissolves biodegradable materials in solid wastes and even some industrial wastes; it mixes with these wastes and contaminates the groundwater through infiltration and recharge process. They also affirmed that dumping of wastes close to recharge zones or on recharge zones leaks through and contaminates the aquifer.

Most Nigerian cities are epitome of urban decay and characterized by poor housing, sanitation and public health infrastructure [12]. The erratic growth of housing units coupled with rapid population explosion has resulted in environmental health hazards [13]. In rural Nigeria today, the volume of waste generated is much lesser than what is obtainable in the urban areas. This is because of the population explosion of people in the urban areas. But Eziobodo, the study area, has experienced a steady growth in population over the years due to the presence of the university community. This population growth comes with increased construction of hostels which leads to loss of arable land, more drilling of boreholes which could lead to the lowering of the water table, and the problem of waste disposal.

The major means of waste disposal in FUTO road, Eziobodo, is by dumping and periodic burning of the refuse. Every form of waste is dumped at a particular point. Be it paper, food wastes, clothes, broken furniture, plastics, aerosol cans. This shows that no sorting of waste is carried

out, no composting of biodegradable waste is carried and evacuation of waste by authorities for proper disposal is not carried out.

The problem of groundwater pollution in several parts of the country has become so acute that, unless urgent steps for detailed identification and abatement are taken, extensive groundwater may be damaged [14]. The availability of groundwater is neither unlimited nor is it protected from deterioration. Man, through a variety of activities like indiscriminate dumping of refuse, and modern technologies, is dramatically changing the characteristics of groundwater system [15].

Contaminated water prevents drinking and cooking with it. It becomes a means of infections transport and can greatly contribute to cases of cholera and tuberculosis. It causes dependence on treated water from water treatment outfits, on bottled water, sachet water even though some of these outfits do not treat their water. Boreholes are very important to students and indigenes alike, hence their existence. This study was carried out to critically assess the effects of solid waste from dumpsites, which abound in FUTO road, Eziobodo, on borehole water quality.

Materials and Method

Study area

The study was carried out in Eziobodo which lies on Latitudes 5°27'N and 5°31'N and between Longitudes 7°0'30"E and 7°4'E of Greenwich meridian. The study area is characterized by two seasons; rainy season and dry season. The rainy season begins in April and lasts till October, with annual rainfall varying from 1500mm to 2251mm. An average annual temperature above 20°C creates an annual relative humidity of 75% with humidity reaching 90% in the rainy season. The dry season experiences two months of harmattan from late December to late February.

The Eziobodo autonomous community is a university town in the Owerri-west local government area, Imo state. About 70% of the present permanent site of the Federal University of Technology, Owerri (FUTO) catchment area is in the land of Eziobodo. The presence of the university community has greatly affected the land use in the study area in various ways. One of such ways is in the construction of hostels. Due to the inability of the university to provide adequate accommodation for all of its students, an upsurge in the construction of off-campus hostels has been recorded.

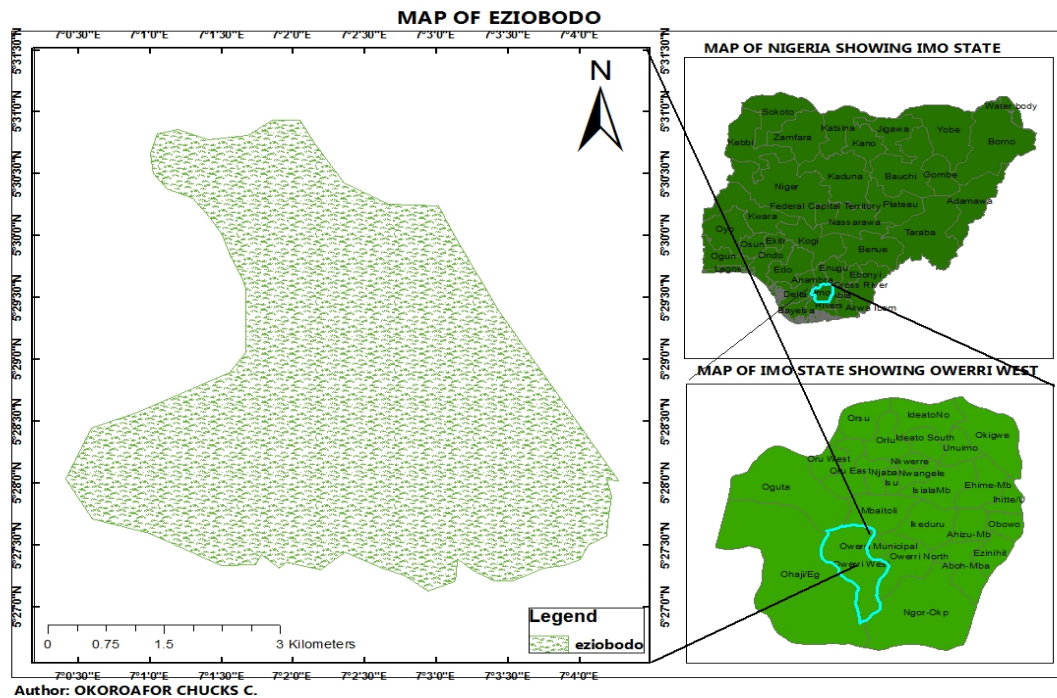


Fig. 1: Map of Study Area.

SAMPLE COLLECTION

Two sample points were located in the study area; Mothers lodge (BHW1) and Okochi lodge (BHW2). Borehole water samples for the study were collected from these points during the rainy season around April. The experiment was carried out after a period of five months interval when the water table has risen considerably. This was to enable the researcher determine if increased infiltration due to increase in rainfall would have any impact on the results. Two samples were collected from each borehole i.e. a sample was collected from the boreholes in the morning and another in the evening.

Water samples were collected directly from the taps at the boreholes into clean polyethylene bottles which were rinsed with the borehole water to be collected. The water samples were labeled with masking tapes showing time and location of sampling, and promptly sent to the laboratory for preservation and subsequent analysis.

Water quality parameters were analyzed using standard methods [16,17,18,19,20], including: turbidity (NTU), electrical conductivity ($\mu\text{S}/\text{cm}$), pH, total chloride (mg/L), nitrate as nitrogen (mg/L), nitrate (mg/L), total hardness (mg/L), phosphate (mg/L) and phosphorus (mg/L).

Results and Discussion

The mean values of the physicochemical analysis are presented below in Table 1. The pH values for BHW1 at first sampling was slightly acidic but fell within the WHO limits for drinking water, making it acceptable. But, BHW2, with its value of 5.7, fell out of the WHO permissible limits due to its acidic value. After the interval time, the pH value for both samples decreased slightly to 6.2 and 4.9. These results showed that the groundwater in the study area is tending towards acidic.

Turbidity values for both water samples recorded 0.00, indicating that the water samples were clear and free from suspended particulate matter. Electrical conductivity values for both samples were 30.00 $\mu\text{S}/\text{cm}$. The values increased slightly to 34 and 31 $\mu\text{S}/\text{cm}$ respectively. However, this value fell below the WHO standards making it unobjectionable.

Table 1: The physicochemical parameters, Mean values of samples and WHO standards

S/N	PARAMETER	BHW 1	BHW 2	BHW 1 (after 5 months)	BHW 2 (after 5 months)	PERMISSIBLE STANDARDS [21]
1	pH	6.80	5.70	6.20	4.90	6.5-8.5
2	Conductivity, $\mu\text{S}/\text{cm}$	30.00	30.00	34.00	31.00	100
3	Turbidity, NTU	0.00	0.00	0.00	0.00	5
4	Nitrate (NO_3^-), mg/L	38.50	36.00	39.10	36.20	50
5	Nitrate-Nitrogen (NO_3^- -N), mg/L	8.70	8.10	8.75	8.12	10
6	Phosphate(PO_4^{3-}), mg/L	46.80	0.60	48.10	7.40	5
7	Phosphorus(P), mg/L	15.20	0.20	16.10	3.30	0.3
8	Total Hardness, mg/L	0.30	0.28	0.31	0.28	100
9	Total Chloride, mg/L Cl^-	186.00	208.50	186.08	210.10	250

Nitrate values for both water samples within the time interval of the experiment fell below the WHO permissible limit, as BHW1 and BHW2 recorded 38.50 mg/L and 36.00 mg/L at the onset of the experiment and 39.10 and 36.20 mg/L after five months interval respectively, making them unobjectionable. Nitrate-nitrogen values for BHW1 and BHW2 were 8.70mg/L and 8.10mg/L. After five months interval, a value of 8.75 and 8.12 mg/L respectively were recorded which fell below WHO limit. Phosphate value for BHW1 was 46.80 mg/L and 48.10 mg/L within the time interval of the experiment which was extremely high. This value is higher than the WHO limit of 5mg/L. Phosphorus values were 15.20mg/L and 0.20mg/L for BHW1 and BHW2 at the start of the experiment and 16.10 and 3.30mg/L after the time interval of five months. This is on the high side against the WHO limits of 0.3mg/L. BHW1 and BHW2 after the time interval recorded a value higher than the limit. Total hardness values changed only slightly in BHW1 during the time interval. The values however fell below the WHO limit. Total chloride values for BHW1 were 186.00mg/L and 208.50mg/L for BHW2 at the start of the experiment with slight increase in values of 1.86.08 and 210.10 mg/L after the time interval. These values fell below WHO limits making them unobjectionable.

Conclusion

The effects of solid waste disposal on the physicochemical properties of groundwater was evaluated using two (2) existing two boreholes along FUTO road, Eziobodo. Samples were collected and analyzed within a time interval of five months during the rainy season. Result of the study showed that most of the water quality parameters measured in the studied boreholes fell below permissible standard making the groundwater seemingly unobjectionable. However, the observation that one of the borehole samples (BHW1) showed phosphate (PO_4^{3-}) and phosphorus (P) values above the permissible standard is indicative of significant anthropogenic inputs possibly from nearby dumpsites and other domestic practices in addition to natural sources of

rock weathering and phosphate cycles in water. $\text{PO}_4^{3-}\text{-P}$ level in the groundwater reservoir can be considered to be approaching critical threshold level that may impose negative interference on water treatment processes. Also, the pH values for one of the borehole (BHW2) fell out of the WHO permissible limits due to its acidic value. Low pH levels can encourage the solubility of heavy metals. As the level of hydrogen ions increases, metal cations such as aluminum, lead, copper and cadmium are released into the water instead of being absorbed into the sediment. As the concentrations of heavy metals increase, their toxicity also increases (22).

The study showed that there is need for better waste disposal means in Eziobodo. The repeated experiment carried out after a time interval of five months showed a very slight change in the values of parameters measured. This could be as a result of increasing human activities that are detrimental to the groundwater integrity including continuous neglect of appropriate disposal method. The increasing water table during the interval of time the experiment was conducted could also be a factor. Groundwater levels naturally rise and fall seasonally and there are many places, such as wetlands, where groundwater levels are close to the ground surface. High groundwater levels can cause the mobilisation of pollutants in the ground (23). Hence, the need to have a programme of effective and periodic monitoring of ground water quality and employment of better waste management practices in the area. Use of incinerators, composting should be considered by the local authorities.

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