GROUNDWATER QUALITY ASSESSMENT AT JOBBORE COMMUNITY, GIREI LGA ADAMAWA STATE, NIGERIA

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ABSTRACT

Access to safe and clean groundwater is essential for human health, yet increasing anthropogenic activities have raised concerns about contamination in many developing regions. In the study area of Jobbore, Girei Local Government Area, Adamawa State, the population relies heavily on groundwater sources such as hand-dug wells for domestic use despite limited quality monitoring. This study aimed to assess the groundwater quality and determine its suitability for drinking and domestic purposes. The specific objectives were to evaluate the physicochemical and heavy metal concentrations in the water samples and compare them against WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) limits. A total of three groundwater samples were collected from hand-dug wells across three different locations. Laboratory procedures outlined in standards were used to analyze key parameters including pH, turbidity, and concentrations of iron (Fe), manganese (Mn), chromium (Cr), cadmium (Cd), and zinc (Zn). The results revealed that pH values were within acceptable limits, and no traces of iron and zinc were detected. However, concentrations of manganese, chromium, and cadmium exceeded the permissible limits, indicating potential contamination from agricultural runoff and improper waste disposal. These findings suggest a localized risk of heavy metal pollution and potential public health threats. It is concluded that groundwater in the study area is not entirely safe for consumption without treatment. The study recommends regular water quality monitoring, public sensitization on environmental hygiene, and appropriate treatment methods such as filtration and metal removal before domestic use.

Keywords: Groundwater, Solid Waste, Leachate, Heavy Metals, Water Pollution, Jobbore

1 INTRODUCTION

The transformation of rural settlements into urban centers in developing countries has led to pressing environmental challenges, particularly in waste management [1]. Jobbore community, like many others, faces uncontrolled dumping of domestic and commercial solid waste near its groundwater sources. The proximity of dumpsites to water wells in Jobbore poses a direct threat to groundwater quality, which serves as the primary source of drinking water for most residents. Solid waste from municipal, institutional, and domestic sources contains both organic and inorganic pollutants that degrade slowly [2]. Rainwater and surface runoff percolate through waste layers, forming leachates rich in heavy metals, pathogens, and toxic substances. When this leachate reaches aquifers, it contaminates water with substances like cadmium, manganese, and chromium many of which are carcinogenic or nephrotoxic even at trace levels [3]. The World Health Organization [4] and Nigerian Standard for Drinking Water

Quality [5] both define strict thresholds for these pollutants, which are frequently exceeded near uncontrolled dumpsites as observed in this study.

1.1 Groundwater Supplies

The precipitation from the sky and the infiltration from river runoffs on ground surface are the major sources of ground water which exists in the pore spaces and fractures in rocks and sediments beneath the Earth's surface. It originates from hydrological cycle as precipitation and infiltration. It percolates through the soil profile into the ground water system. It is used extensively for domestic, industrial and agricultural purposes; groundwater resources constitute an important component of water supply systems in many parts of the world. The water source has wide distribution, inexpensiveness, dependability, and has less chemical and microbial quality than surface water, and requires little treatment before use [5]. About half of the populations of the world's population rely on groundwater for portable water supplies [6]. In Africa, about 75% of the populations rely on groundwater for water supply. In other countries that receive minimal precipitation such as Libya, Namibia, Libya and Botswana; groundwater is the only source of portable water [7].

1.2 Pollution of Groundwater

The vulnerability of groundwater to pollution relies on the combinations of geological and hydrological parameters which give raise to groundwater pollution than any other combinations [8]. Groundwater aquifers are hydraulically connected to the overlying land surface through interwoven pore fringes. The vulnerability of an aquifer to Contamination depends on the groundwater that receives water and contamination from land surface is considered more vulnerable than groundwater that receives water and contaminants more slowly and in lower quantities. The quality of groundwater depends on the relative quantity of contaminants that reach the aquifer, travel time of contaminants, and the geological system contaminant-attenuation capacity. The degree of attenuation occurs depends on soil and rock type and type of contaminant and the related activity [4]. Any effort to control groundwater pollution in any area requires, adequate proper understanding of such natural intrinsic characteristics of any targeted aquifer in terms of vulnerability to contamination and the background information of the activities in the area in consideration.

1.3 Effects of Municipal Solid Waste dump on the Environment

Uncontrolled solid waste dumping exposes the environment and residents, to potential risks from polluted water particularly those living adjacent to dumpsites, unhealthy food sources, air, land and vegetation pollution. Poor solid waste disposal and mishandling of wastes leads to environmental degradation, ecosystem destruction and high risks to public health. Such accumulations of solid wastes are health hazard not only to urban residents but threaten the environment [9]. Environmental problems associated to solid waste range from health hazards, water pollution and soil, offensive odors and repulsive sight. The outcome of this all is degradation of our environmental state [10]. Most dumpsites are sited within the vicinity of living communities and wetlands. These dumpsites are often not technologically sited for adsorption of toxic substances. Therefore, makes them responsive to discharge pollutants to nearby water bodies and to the air through leachates discharge [11]. Many water resources have been marked as being hazardous to man as well as the ecosystem [1]. The highest numbers of the uncontrolled dumping sites are many years old with unmanaged waste disposal techniques. Such dumping sites have significant environmental impacts. Solid waste dumb poses significant life-threatening potential to health and the ecological environment [12].

1.4 Effects of Pollutants on Health

Water naturally contains small amounts of dissolved substances such as zinc, calcium, magnesium and even impurities like silt, sand and microbial substances under normal circumstances. These quantities are considered safe for human use; however, when they exceed recommended limits, then the water is considered polluted [13]. Metal ions and their complex exhibit a wide range of toxicity to organisms ranging from sub-lethal to lethal depending upon the time of exposure and the ambient temperature. For example, the heavy metals; Pb, Zn, Mn, Cd, As, Ni and Hg are highly toxic even in low concentrations [14]. Cadmium and lead are significantly hazardous to human health; long term exposure to lead may cause severe disruption of biosynthesis of hemoglobin and anemia, damage of kidneys, high blood pressure, brain damage, miscarriages, disruption of nervous system and sperm damage in males. Zn reaches the water bodies through artificial pathways like by-products of steel Production or coal-fired power stations, as well as burning of waste materials [15]. This study aimed at evaluating the contamination of groundwater in Jobbore by assessing physical properties and heavy metal concentrations of samples collected from wells near municipal dumpsites.

1.5 Study Area

Jobbore is located in Girei Local Government Area, Adamawa State, Nigeria. It lies between 9°18′N and 12°28′E at an elevation of 158 meters above sea level see the shaded portion figure 1. The community experiences tropical savanna climate with an average annual temperature of 38°C and about 1208 mm of rainfall. The population is growing rapidly, with significant crowding and pressure on infrastructure.

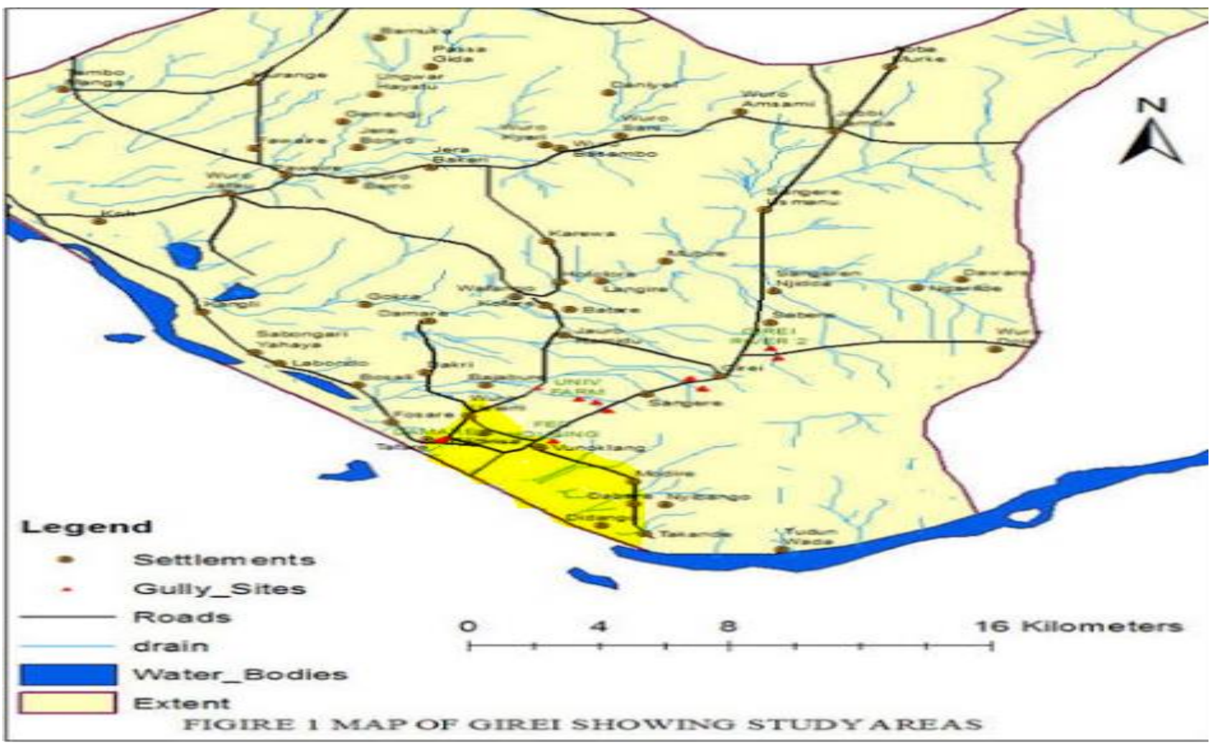

Figure 1. Map of study area

2 MATERIALS AND METHODS

2.1 Materials

The materials used in this study include: Water, Buffer solution, Nitric acid, Metal solutions. The equipment used are glassware, deionizer, analytical balance, oven, stirrer sample collection bottles, atomic absorption spectrophotometer (AAS), turbidimeter, and pH meter.

2.2 Methods

2.2.1 Sampling Collection

Three wells were selected near the municipal dumpsite using purposive sampling. These were denoted L1, L2, and L3. The locations were selected based on proximity to leachate flow and direction of surface runoff. Water samples were collected in compliance with [16], in 1.5-liter plastic bottles, cleaned, and rinsed with distilled water and the sourced water. Samples were transported to the laboratory at Modibbo Adama University, Yola for analysis. Parameters measured include turbidity, pH, and concentration of cadmium (Cd), chromium (Cr), manganese (Mn), iron (Fe), and zinc (Zn).

2.2.2 Turbidity and pH

Turbidity was measured using a Nephelometric Turbidimeter following the procedure of [17]. And the pH was measured with a calibrated LI-614 pH meter in compliance with [18].

2.2.3 Heavy Metal Testing

Atomic Absorption Spectroscopy (AAS) was used to determine concentrations of heavy metals using the procedure specified in [19]. Stock solutions of each metal were prepared using dilution and deionized water, and calibrated to ensure detection within the AAS range.

3 RESULTS AND DISCUSSION

3.1 Turbidity and pH values

The turbidity values for L1 (130 NTU), L2 (150 NTU), and L3 (140 NTU) exceeded WHO and NSDWQ limits of (<1 NTU). This high turbidity indicates significant leachate infiltration and suspended particles from waste decomposition. On the other hand, the pH values are within the WHO and NSDWQ standards (6.5–8.5). These readings suggest a neutral to slightly alkaline condition, indicative of the methanogenic stage of landfill degradation (Table 1).

Table 1. Turbidity and pH Tests Results

S/No	1	2	3
Sample no.	L1	L2	L3
Turbidity (NTU)	130	150	140
pH Value	6.8	7.4	7.6

3.2 Cadmium (Cd)

Levels ranged from 4.23 ppm to 5.21 ppm — drastically higher than the permissible limits of 0.003–0.005 mg/L set by [4, 5]. Cadmium is known to damage kidneys, lungs, and bones and is considered carcinogenic [2].

3.3 Chromium (Cr)

Detected concentrations were 0.10–0.16 ppm. The recommended maximum limit is pegged at 0.05 mg/L by [4, 5]. Chromium compounds can cause DNA damage and are linked to cancer and liver dysfunction [2]. Manganese (Mn): Ranged between 4.19 and 5.10 ppm, surpassing [4, 5] safe limits of 0.5 mg/L. Elevated levels of manganese have neurological effects and can mimic symptoms of Parkinson's disease [3]. Lead (Pb): Detected concentrations were 1.02–2.21 ppm. The recommended maximum limit is pegged at 0.01 mg/L by [4, 5] was greatly exceeded (Table 2).

3.4 Iron (Fe) and Zinc (Zn)

Both were not detected (ND) in the sampled wells. This may be due to dilution or low leachate concentrations of these elements. The elevated levels of cadmium, manganese, and chromium indicate direct contamination from waste percolation into the aquifer. Results support similar findings from leachate-contaminated aquifers by [2, 8].

Table 2. Heavy Metals Test Results

S/No	1	2	3
Sample no.	L1	L2	L3
Cadmium (Cd), ppm:	4.23	4.87	5.21
Chromium (Cr), ppm:	0.10	0.12	0.16
Manganese (Mn), ppm:	4.19	4.80	5.10
Lead (Pb)	1.02	2.21	1.77
Iron (Fe), ppm:	0	0	0
Zinc (Zn), ppm:	0	0	0

4 CONCLUSIONS

This study concludes that indiscriminate dumping of solid waste in Jobbore significantly compromises the quality of groundwater. Although the pH levels remained within acceptable limits, both turbidity and concentrations of cadmium, chromium, Lead, and manganese exceeded WHO and NSDWQ standards. These pollutants present serious public health risks to residents relying on groundwater. Mitigation strategies such as improved waste management, relocation of dumpsites away from water sources, and enforcement of environmental protection laws are urgently needed. Regular monitoring of water quality should also be institutionalized.

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