Vol. 7 No.1 June (2024)
JOURNAL OF ENVIRONMENTAL AND TOURISM EDUCATION
ISSN: 2659-0794 (PRINT) ISSN:2659-0808(ONLINE)
Content Available at: **https://jeate.net/index.php/Jete/issue/archive**

Determination of the concentrations of heavy metals pollutants in some Residential Areas close to Auto-Mechanic Facilities in Bauchi Local Government Area, Bauchi State, Nigeria

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Keywords

Residential areas, well water, water quality, auto-mechanic and heavy metal pollutants.

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Abstract

This study ascertain the quality of well water samples from wells in four communities (Turun, Dass road, Nassarawa Jahun and Gombe road) around auto-mechanic clusters within Bauchi Local Government Area using standard methods. The collected samples were analyzed for heavy metals associated with auto-mechanic facilities (Mn, Cu, Pb, Cr and Cd). The measured parameters were compared to the Nigerian Standard for Drinking Water Quality (NSDWQ) limits in order to ascertain its suitability for drinking and other domestic use. Heavy metal concentrations were found to be within the NSDWQ acceptable limits for drinking water with the exception of Cr and Mn concentrations which in most cases exceeded the NSDWQ limits of 0.05mg/L and 0.2mg/L respectively in some of the samples. There was no trace of Pb in any of the samples and Cu was within the permissible limit in all the samples. Mn was within permissible limits except in Dass road and Nassarawa Jahun where it was above limits. Cr was above limits in most of the cases except with few samples from Dass road. The results indicated that the activities taking place at the mechanic workshops have affected the level of heavy metal concentrations of well water in the areas. High level of Mn and Cr in the water samples calls for urgent attention because of the health risk associated with the high level of these metals.

Introduction

Groundwater is a major source of water supply in automobile workshops, where it is used for washing, mixing of chemicals as well as for drinking and cooking by residents around some of these workshops. Auto-workshops in Bauchi are continuously being reclaimed for residential purposes due to dramatic rise in the population. Most residents in these reclaimed polluted workshops dig wells or sink boreholes in these areas due to water shortage while others farm on some portion of the land and use same well water for irrigation purpose. Excessive accumulation of wastes in mechanic workshops in Bauchi State can be a source of pollution of underground water, sediments and living things and this could be detrimental to the overall health status of the users. Higher metal and contaminants in these ground waters may find their way, as far as 50 meters or more, into other groundwater away from the vicinity of mechanic workshops, due to the proximity of these sites to the surrounding settlements

Artisans' activities within automobile mechanic workshops have been reported as major sources of environmental contamination in the Nigerian ecosystem. Activities conducted in these workshops involves the indiscriminate spilling of wastes such as spent oils, greases, petrol, diesel, battery electrolyte, paints and other materials which contain heavy metals and other pollutants unto bare soil (Demie, 2015; Okeke et al., 2017; Nkanu et al., 2020; Soni & Amarnath, 2021). Unfortunate these wastes end up polluting productive soils, natural water system as well as ground water.

Many of these mechanic workshops are located within residential areas, where individuals without adequate sources of portable drinking water could dig wells or even sink boreholes to access water for different purposes. In most cases, artisans also dig wells as sources of water within their workshops. The quality of the groundwater within these facilities may be compromised and the safety of its consumers is therefore not guaranteed. Studies have shown that the levels of pollution in auto-mechanic facilities are very high, resulting in heavy metal contamination of well water around these workshops (Adelekan & Abegunde, 2011; Usman et al., 2014; Sadick *et al*., 2015). According to Usman et al. (2014), major sources of well pollution include proximity of wells to drainages of sewages, refuse dumps, small scale industries and mechanic villages.

Literature Review

Groundwater and possible source of pollution

Groundwater is used throughout the world through wells and boreholes. Sometimes water which collects on the top of the impervious layers underground may only be reached by digging deep down the water table. Such openings are referred to as wells (Usman *et al*., 2013). Owing to increasing industrialization and exploding population, the demand for water supply have been increasing tremendously. There has been a deliberate shift toward reliance on groundwater for domestic and other needs Groundwater is therefore preferred as a source

of drinking water in many rural and urban communities around the world because of the relatively better quality, when compared to surface water. These sources of water are often unpolluted due to restricted movement of pollutants in the soil profile (Murhekar, 2011). However, when water travels through the ground, it dissolves parts of the soil components and so may contain objectionable concentration of salts (Igwemmar *et al*., 2013). The chemistry of this groundwater samples may be affected by poor well construction. Many hand dug wells do not have proper filter packs or are improperly grouted, so water seep down the casing from the surface or other ground water zones, thus adding to the contamination of ground water flowing through their intakes (John *et al*., 2012). Residence times in groundwater are generally orders of magnitude longer than in surface waters. Once polluted, a groundwater body could remain so for decades, or even for hundreds of years, because the natural processes of through-flushing are so slow (Chilton, 1992 and 1996). It is therefore necessary to obtain a comprehensive picture of the groundwater quality and the changes that occur in time, either naturally or anthropogenically.

Pollution of groundwater is an impairment of water quality by chemicals, heat or bacteria to a degree that does not necessarily create public health hazards, but does adversely affect such water for domestic, farm, municipal or industrial use (Muasa *et al*., 2013). Studies carried out in different parts of Nigeria have revealed that various sources of drinking water have been contaminated at varying scales by human activities (Adewoyin *et al*., 2013; Popoola and Ayodele, 2016). Abundance of organic compounds and toxic chemicals find their way into potable water and may cause adverse effects, such as cancer, chronic illness and malfunction of the human body (Federal Government of Nigeria, 2000). In 1997, the World Health organization (WHO) reported that 40 % of deaths in developing nations occur due to infections from water related diseases. Diseases contacted through drinking water kill about 5 million children annually. Also an estimated 500 million cases of diarrhoea occur every year in children below 5 years in parts of Asia, Africa and Latin America (WHO, 2004a, 2004b, 2004c, 2011). Two third of illnesses in Port Harcourt, Nigeria has been reported to have been related to water-borne diseases through metal intoxification (Utang *et al*., 2013). More than 3.4 million people die each year from water sanitation and hygiene-related causes (Okeola, 2010; Igwemmar, *et al*., 2013).

The toxicity of these chemical compounds is dependent on their solubility, which in turn, depends on the pH and on the presence of different types of anions and cations (Nduka and Orisakwe, 2007). The chemical compositions of ground water are influenced by precipitation compositions, mineralogy of the water shed and aquifers, climate and topography. These factors combine to create diverse water types that change in composition spatially and temporally (Nwankwoala and Nwagbogwu, 2012). While proximity of wells to drainages of sewage, laundry water and refuse dumps/landfills are reasons for well water pollution, the proximity of wells to mechanic village sites and small scale industries have also been identified as major sources of well pollution (Afangideh *et al*., 2011; Adedosu *et al*., 2013; Usman *et al.,* 2013; Adewoyin *et al.,* 2013; Popoola & Ayodele, 2016). There is therefore a

need to conduct regular studies in auto-mechanic in Nigerian cities groundwater to ensure that this source of water is naturally protected from chemical and other forms of contamination.

Contamination/pollution of well water in mechanic workshops

Auto-mechanic workshops are areas characterized by a moderate population of humans involved in auto-repairs and maintenance of automobiles, and other various forms of business activities involving daily use of water. A major source of water supply in these areas is well water, which is used for a number of purposes such as washing and mixing of chemicals, as well as for cooking and drinking by residents around these villages (Usman *et al*., 2013). Each of these workshops usually hosts a variety of artisans including auto-electricians, battery servicemen, vulcanizer, and panel beaters. Scrap batteries and solder, suspended solids, cyanides, alkali, organic solvents, waste engine oil, brake fluid and other fluid containing heavy metals, generated by the activities of these artisans are improperly disposed. They are usually thrown away on the soil (Ipeaiyeda and Dawodu, 2007; Adelekan and Alawode, 2011; Osakwe, 2014). These hazardous chemical substances are mobilized by the soil, from where the reach and contaminate the entire ground water in the area (Sadik *et al*., 2015; Agbaji *et al*., 2015). Generally, toxic metals cause enzyme inactivation, damage cells by acting as antimetabolites or form precipitates or chelates with essential metabolites. The presence of heavy metals in high concentrations in the environment results in adverse effects of the nervous system, blood forming, renal and reproductive systems. Others include reduce growth, reduced intelligence, attention deficit, behavioural abnormality, increase mortality and mutagenic effects, as well as its contribution to cardiovascular disease in adults (Berti & Jacobs, 1996; Akhilesh *et al*., 2009; Yurtsever & Sengil, 2009; Sam *et al*., 2015; Abaji *et al*., 2015).

A lot of researchers have examined the level of these metals in well water sources in their respective ecosystems. The observed values of Mn, Zn, As, Cd, Pb, and Cr, except Cu in boreholes and wells in Abuja, exceeded the WHO permissible limits for drinking water (Alhassan & Ujoh, 2012). Adelekan and Abegunde (2011) revealed that heavy metals concentrations, with exception of Cu in groundwater at automobile mechanic villages in Ibadan were higher, when compared to the limits set by WHO for drinking water. According to Usman *et al*., (2013), higher concentrations of Fe, Zn, Cu and Mn obtained for the reference well water samples, at 50m away from Apirl mechanic village, North Central Nigeria, might be due to the proximity of the mechanic village to the surrounding settlements, where their activities may influence metal concentrations. Adewoyin *et al*., (2013) revealed that the physicochemical parameters and heavy metals determination of groundwater from auto-mechanic villages of Ibadan metropolis showed that there is a high degree of contamination and pollution. The presence of some chemical elements/compounds in the water samples

(against the W.H.O standard) indicated that the water in Bawa area, Ado – Ekiti, Nigeria is not fit for consumption due to auto-mechanic activities (Popoola & Ayodele, 2016).

Materials and Methods

Instruments

pH: The pH and temperature of the samples were determined immediately after sampling. The pH was measured with a pH meter (Hanna instruments, model 8621) using standard procedures.

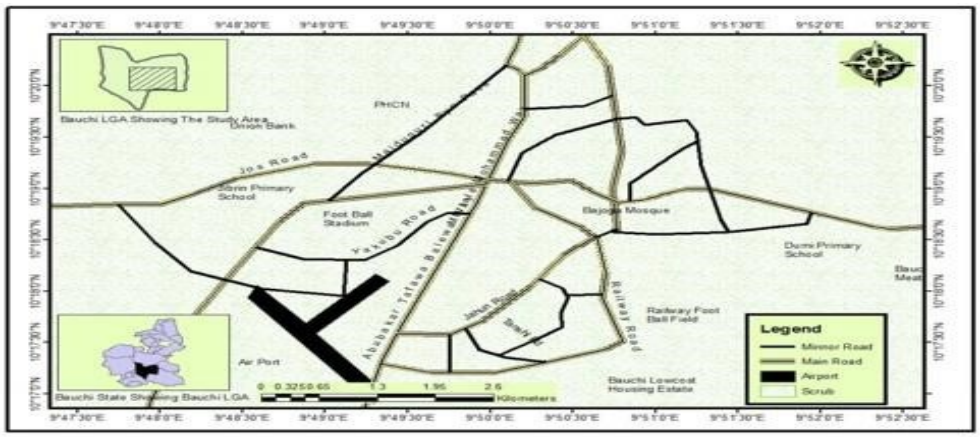
Sample Digestion and analysis

A 200 cm^3 aliquot of the sample was concentrated with some drops of concentrated HNO_3 in a beaker at 120° C to about 100 cm^3. The samples was then be analyzed for Cu, Pb, Mn, Cd, Cr, using Atomic Absorption Spectrophotometer (AAS). All assays were done in triplicates (Usman *et al*., 2013; Adedosu *et al*., 2013).

Sample location

Three partially protected shallow wells in each of the four communities around mechanic workshop clusters were assessed in order to ascertain heavy metals concentration of the well water. The workshop clusters are located at NTA along Turum road, Gombe road, opposite FGGC, Dass park, along Dass road, Nasarawa Jahum within Bauchi Local Government of Bauchi State.

Figure 1 showing site location



Pre-treatment and Sterilization of Apparatus

Prior to sampling, all glassware and sample bottles will be washed with liquid detergents, rinsed with tap water and soaked in 10% HNO_3 for 48 hours. They will thereafter be rinsed with distilled water to preclude trace metal contaminations, before oven drying. The plastic bottles meant for sampling will further be rinsed thrice on site with well waters being sampled **(**Ogunfowokan *et al*., 2013; Usman *et al*., 2013).

Samples collection

The composite water sampling method was used in collection of sample in each sampling sites and water samples drawn with a plastic bucket. A 2 liter wide mouth polyethylene container thoroughly cleaned was used to collect about 2 L well water sample for physical and chemical parameters determination from each sampling location within three months. Samples collected was adjusted to pH 2 to prevent further microbial degradation and stored below 4^0C in a refrigerator before analysis (Ogunfowokan *et al*., 2013).

Results and Discussion

Heavy metal concentration of well water in residential areas near automobile workshops

Well	pH	Mn	Cr	Pb	Cd	Cu
Turum R1	6.80	0.17	0.31	0.00	0.00	0.01
Turum R2	6.78	0.20	0.17	0.00	0.01	0.00
Turum R3	6.67	0.16	0.42	0.00	0.00	0.00
Gombe R1	6.50	0.01	0.33	0.00	0.00	0.06
Gombe R2	6.31	0.00	0.21	0.00	0.02	0.03
Gombe R3	6.60	0.02	0.26	0.00	0.01	0.04
Dass P1	6.32	0.62	0.10	0.00	0.00	0.04
Dass P2	6.23	0.32	0.05	0.00	0.01	0.03
Dass P3	6.02	0.41	0.00	0.00	0.00	0.05
Nasarawa1	7.01	2.53	0.51	0.00	0.03	0.04
Nasarawa2	6.70	1.96	0.60	0.00	0.00	0.13
Nasarawa3	7.12	2.65	0.35	0.00	0.02	0.07
Mean	6.59	0.69	27.8	0.00	0.082	0.042
NSDWQ	6.5 – 8.5	0.20	0.05	0.01	0.003	0.20

The table above shows the result of the heavy metal concentration of each auto-mechanic workshops well water samples collected from at NTA along Turum road, Gombe road, opposite FGGC, Dass park, along Dass road and Nasarawa Jahum. That is, three samples each, from four auto-mechanic workshops each, from Bauchi Local Government areas. The World Health Organization WHO (2011) and the Nigerian Standard for Drinking Water Quality (NSDWQ 2007) was used as the baseline to compare the water quality from the different sources.

A. pH

The pH values of the water samples recorded varied between 6.02 and 7.01 with sample from Dass park 3 and Nassarawa 3 having the lowest and highest pH values, respectively. Which most were below the maximum permissible limit of 6.5-8.5 set by World Health Organization and the Nigerian Standard for Drinking water quality. The result for pH in this study concurs with the findings of Adediji, Adesina, Adenji and Chikezie, (2020) in their study titled “Open

Shallow Wells Water Qualities Located Around Auto-mechanic Workshops in Some Ilorin Metropolitan". In which the study revealed that pH values of Open Shallow Wells Water Qualities Located Around Auto-mechanic Workshops samples were very low.

B. Manganese

Values obtained showed that manganese concentrations are less than 0.2 mg/l were observed in two of the locations (Turum and Gombe road), however, the values were above the permissible limit as specified by NSDWQ in the other two locations (Dass park and Nassarawa Jahun). The central nervous system is the chief target of manganese toxicity. Oral doses ranging from 1 to 150 mg/kg of body weight per day produced a number of neurological effects (Yurtsever & Sengil, 2009; Akinbile & Yusof, 2011).

C. Chromium

Values obtained showed that chromium concentrations are less than 0.05 mg/l were observed in one of the locations (Dass park), however, the values were above the permissible limit as specified by NSDWQ in the other locations (Turum, Gombe road and Nassarawa Jahun). Chromium toxicity is one of the major causes of cancer (Yurtsever & Sengil, 2009; Akinbile & Yusof, 2011).

D. Copper

Values obtained showed that copper concentration are less than 0.2 mg/l were observed in all the locations, however, all the values were below the permissible limit as specified by NSDWQ. The presence of excess copper in water can result to gastrointestinal disorder when exposed to it for long period (Brewer, 2009; Akinbile & Yusof, 2011).

E. Lead

Among the heavy metals, lead is the most significant because it is very toxic and harmful even in small concentration, it can harbor in the body tissue causing harm to humans such as cancer, brain damage, mental deficiencies, even death (Brewer, 2009; Akinbile & Yusof, 2011). Concentrations of lead were 0.00 mg/l in all locations, which indicated that all samples lead was absent; the permissive range lead is 0.01mg/l according to NSDWQ.

F. Cadmium

The presence of cadmium in ground water occurred when it comes in contact with soil contaminate with discharges from fertilizer industries, paint, petroleum hydrocarbon through leaching. High level of cadmium results to agonistic and antagonistic effects on hormones and enzymes causing several health problems such as kidney failure and cancer; (Brewer, 2009; Yurtsever & Sengil, 2009). The concentration of Cd in the study areas are within the NSDWQ acceptable range.

Conclusion and Recommendation

The results of the water samples above showed that some of the heavy metal concentrations (Cu, Cd and Pb) were within the maximum permissible limits WHO and NSDWQ recommended. However the chromium (Cr) and manganese (Mn) where above the permissible limit as recommended by WHO and NSDWQ, which suggest the affected water is unfit for drinking. High level of these heavy metals in drinking water can cause diseases which include cancer; therefore there is need for further studies of the effect of the affected water on the residents of that area

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This work is sponsored by
Tertiary Education Fund (TETfund).
Internally based research (IBR)