EVALUATION OF THE WATER QUALITY FROM MANUALLY OPERATED SUCTION PUMPS IN DANRAKA, SAMARU ZARIA, KADUNA STATE

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Abstract
Water is essential for growth and maintenance of life for all living organisms on earth. The aim of this study is to evaluate the water quality from manually operated suction pumps in Danraka, Samaru for domestic water use. To study the domestic water quality from manually operated suction pumps in Danraka, Samaru water quality samples were collected at three selected water pumps. The parameters that were analyzed in the water samples are; Physical parameters such as temperature, conductivity, total dissolved solids (TDS), appearance, odor, turbidity, total suspended solids (TSS), and Chemical parameters such as iron, sulphate, chromium, and chlorine. The samples were digested and analyzed by the colorimetric/ atomic absorption spectroscopic method. The analysis showed that pH values of the samples range from 6.14 - 6.71, Temperature range is 22.5^{0}C – 22.8^{0}C, conductivity 0.289ms/cm – 0.504 ms/cm, TDS 1830ppm – 2300ppm, turbidity 0.000mg/l – 1mg/l, TSS 0.000mg/l - 4.00mg/l. Appearance of is clear and it is odorless. The chemical parameters showed that chlorine range from 0.00mg/l -0.08mg/l. The iron value range from 1.8mg/l – 8.0mg/l, sulphate value range from 3.00mg/l – 10.0mg/l and chromium varied from 0.01mg/l – 0.05mg/l. The result indicated that water from the manually operated water suction pumps in Danraka, Samaru which is the major source of drinking water in Danraka is not suitable for drinking when compared with the Drinking Water Quality Standar (DWQS) because it contains a high level of dissolved iron.

Keywords: water quality, manually operated suction pumps (MOSP), physical parameters, chemical parameters, drinking water.

INTRODUCTION

Water is one of the most vital natural resources for all lives and living creatures on earth. The availability and quality of water always plays an important part in determining not only where people can live and also their quality of life. Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking or swimming. The new target for drinking water according to the Sustainable Development Goals(SDGs) Target 6.1, calls for "universal and equitable access to safe and affordable drinking water for all" by 2030 (WHO, 2017).

According to the National Marine Sanctuaries (2009), water quality is measured by several factors, such as the concentration of dissolved oxygen, bacterial levels, the amount of salt (or salinity) or amount of materials suspended in the water (turbidity). In some bodies of water, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals, and other contaminants may also be measured to determine quality. Although scientific measurements are used to define water quality, it is not a simple thing to say "that water is portable and wholesome" or "that water is not portable and unwholesome" so the determination is typically made relative to the purpose of water- is it for drinking or to wash a car with or for some other purpose. Poor water quality can pose a health risk for people. Poor water quality can also pose a health risk for ecosystem. The US Environment Protection Agency (2008) define water quality criteria as the levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming fish production or industrial process.

Potable water is one basic need that is lacking in our communities. The estimated 663 million people still using unimproved drinking water sources primarily reside in low income countries (LICs) with the majority living in two regions, nearly 50% in Sub-Saharan Africa (SSA) followed by 20% in Southern Africa (UNICEF/WHO, 2015; WHO, 2017). For water to be tagged potable, it has to be a water of quality acceptable for human consumption and initially free from or treated to remove tastes and odor, dissolved solids, suspended solids and pathogens. The rule here is that all drinking water must not carry disease-causing organisms or toxic substances. Guyer (2012) also noted that population and water consumption estimates are the basis for determining the flow demand of a water supply and distribution. Pumps are a common means of lifting water from a clean ground water source to a useful point of access, but all pumps have moving parts and are therefore destined to break, proper selection of a pump will reduce undesirable downtime and will empower the local community to manage their water source (Sermaraj, 2017).

Manually operated suction pumps are one of the principal technology options used to supply water to rural people in developing countries. This is the case for most communities in the northern part of Nigeria. This is because manually operated suction pumps are one technology option that allows people to access shallow water and in most cases; they represent the most cost-effective option for supplying safe water to low income communities. They have several advantages (including being relatively robust, low cost, and feasible to manufacture locally), but the depth from which they can lift water is a limitation (Marshall, 2017). Manually operated pumps provide irrigation and drinking water where electricity is not available. It frees the user from rising energy costs, can be used anywhere, produce no pollution and provide healthy exercise (Rao and Naidu, 2016). However, the trouble with most manually operated suction pumps (MOSP) used in developing countries is that they are not hardy and require frequent maintenance. The main types of MOSP we have are the India mark III and the AFRIDEV deep well (30-40m deep) pumps. The major way of providing water in developing countries like Nigeria is to invest in low cost options like tapping groundwater in form of hand pumps to bring clean water therefore focused on the use of groundwater for domestic purposes, the quality of such water sources is of prime importance. This study was carried out in Northern Zaria, Danraka in Samaru. The surface water in this area is muddy and not suitable for drinking and the inhabitants are dependent on groundwater sources.

Consequently, in the absence of frequent maintenance of MOSP may change overtime, or even suddenly. This change can go unnoticed as the water may have been contaminated but still look, smell and taste the same, thereby posing as a health risk to the community at large. Most of the communities in Zaria and other Northern States are dependent on the MOSP. The main cause of pumps deterioration is frequent use and the quality of the pumped water (groundwater). If water is corrosive or contaminated, it can cause premature ageing of the parts. The water takes on a bitter taste and affects the color of food cooked with it and clothing washed with it. Another factor is sand in the pumped water. Accordingly, the objective of this study is to evaluate and test the water quality of the manually operated suction pumps and ascertain its effect on human health generally.

Materials and Method

The study area

Samaru is a growing urban settlement within Zaria. The area has a cosmopolitan characteristic owing to the presence of several educational institutions which attracts people all over Nigeria for academic and employment purposes. Samaru stream ($11^0$08' and 11^0 10' North and longitudes 07^0 41' and $07^0$42' East) flows in a North-South direction along a gully situated in Samaru Village and the main campus of the Ahmadu Bello University, Zaria (Tiseer et al., 2008). The area is found in Sabon Gari LGA located between ABU, Basawa and Bomo (Fig 1). The origin of Samaru is traced to a primordial stream with a tree in a place known as GanganUku or old Samaru, its expansion started with the establishment of the Nigerian College of Art, Science and Technology in 1951. Later in 1962 the college was transformed to Ahmadu Bello University (ABU) and this led to a rapid influx of people into the area for both educational and occupational reasons. Today other institutions are added to ABU leading to further increase in population. Samaru has a climate similar to Zaria with a distinct variation in rainy and dry seasons (Sawa and Abdulhamid, 2009). According to Bako (2006) Samaru is predominantly residential. Samaruas used here includes the settlement behind the rail line to Kaura Namoda known as Hayin Dogo. Using a 3.0 growth rate, the population is expected to be about 5,920 by 2009.With a population like this occupying 2275 Ha (Bako, 2006) a substantial volume of waste will be generated on a daily basis. However, there is no government-authorized waste disposal Infrastructure in the area hence residents dispose waste in open spaces and drainage channels. In fact, presently a ―whale back‖ of waste has been formed behind the old 37 cemetery along the rail lines separating Samaru from Hayin Dogo due to accumulated deposit of waste. Waste disposal in Samaru is similar to the experience in other urban centres in Nigeria hence used for the Study.

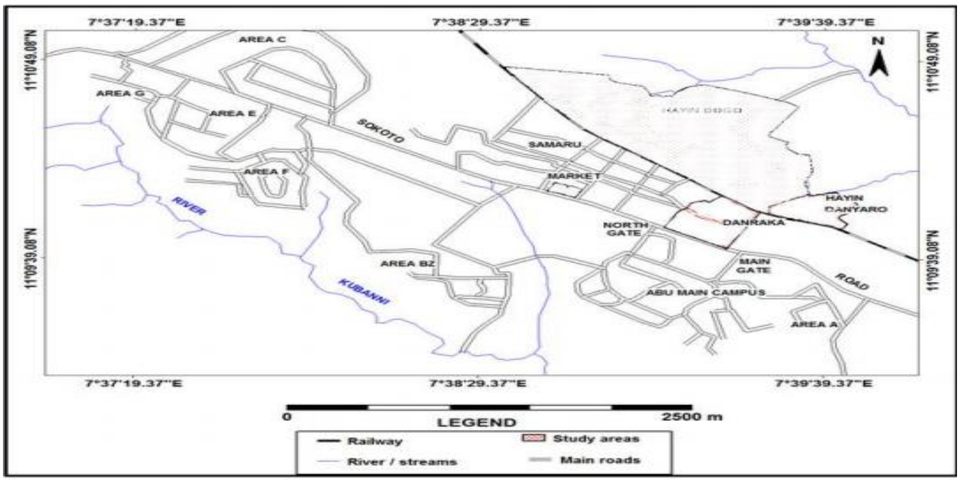

Fig. 1: Map of Samaru
Source: Modified from Google earth map of Samaru, 2011

Climate

The climatic condition of Samaru is the same with that of the whole Zaria urban region which is that of tropical savanna climatic type. There are two marked seasons in the area, the dry windy season and the rainy (wet) season. The wet season is usually from April through October with an average rainfall of about 1016mm (http://www.britanicca.com). The dry season is from November through March which is characterized by the harmattan winds.

Soil and Vegetation

The soil type of the study area is alluvial soil. Also, the area constitutes dark vertisol referred to as fadama soil (In Hausa language) this soil is classified as hydromorphic soil. The fadama soil is usually found in the upstream and downstream of the river system, while the alluvial soil is predominately at the middle of the stream. The soil is composed of fine grey–brown sands, clay, red sand and gravel. The upper parts of the soil are a mixture of quartz, mica and windblown particles. The region generally falls within the Guinea Savannah vegetation. The vegetation of the area ought to be northern Guinea Savannah, but because nearly all vegetation within the stream system has been degraded due to man’s activities such as intense cultivation, and fuel wool felling, the real climax vegetation is almost absent. What is seen presently are few scattered trees interspaced with tall grasses about 1-15m and 25m respectively. Trees found here includes Isorberlinadoka, grass type includes Adropogonaeaspp, Schizachiriumsemiberbe and Monocynbiumceresti (Nyagba, 1986).

Drainage and Geology

The study area is underlain by rocks of a basement complex (igneous and metamorphic) of the Precambrian age. The complex is composed of granodiorite, biotite granite, granite igneiss, schist and quantize. They are usually overlain by the overburden materials except in few places where they are exposed as inselbergs whalebacks and platforms. The ground is sandy-clay-loam and permeable. (Alagbe, 2002). The drainage system focuses on River Galma and Kubanni River. River Galma is a major tributary of Rivers Kaduna and Kubanni, on which Ahmadu Bello University Dam is situated. They are seasonal and supply water to Ahmadu Bello University and its 39 environs. Samaru stream flows in north-south direction through the main campus of Ahmadu Bello University Zaria, situated along a valley west to Samaru village into the Kubanni River (Yusuf and Shuaib, 2012).

Population

Samaru is predominantly residential. According to the 1991 population census, Samaru had 12,978 people with 7,417 males and 5,561 females. Based on the 3.0% growth rate of the 1991 census, the population of Samaru was projected to about 29,693 by 2019. With such a population growth, it is expected that a substantial volume of waste would be generated daily (Benedine and Yusuf, 2011).

Human Activities

Samaru evolved from a small colonial farming settlement to become a large community, a melting-pot, often referred to as "the University village" (Maplandia.com, 2005). Samaru is considered by some to be a main centre of Hausa agriculture. It is a market town for the surrounding area. Samara is one of the major settlements that make up the Urban Zaria. It is an educational and administrative settlement for non-residents of Zaria City. It has grown as a result of the establishment of Ahmadu Bello University, which was established in 1962 and other Institutes like Nigeria Institute of Leather and Science Technology, Federal Institute for Chemical and Leather Research, Federal College of Aviation, Nigerian Research Institute and Chemical Technology and Nigerian Institute of Transport Technology (Ugochukwu et al., 2015).

Sample Collection

Random sampling technique was applied to select three manually operated suction pumps from which water samples for the essay were collected. Sampling was carried out on three selected manually operated suction pumps. Water samples were taken early in the morning just when people came out to fetch from the water pump. The methodology was based on laboratory survey. Data for the study was sourced through primary sources and the samples analyzed in the laboratory using atomic absorption spectroscopic method. pH and temperature of the water sample were taken on site and samples were stored in a refrigerator to avoid any form of contamination before the analysis was carried out. The samples were digested by first acidifying it with concentrated nitric acid per liter of sample. A 100ml of 1:1 Hydrogen chloride was transferred. After the digestion process, the sample was filtered to get a pure solution removing insoluble materials. The digested sample pH was reduced to 4 by a drop of 5.0ml of Sodium hydroxide standard solution. It was mixed thoroughly and pH was checked after each drop. The sample was transferred to a 100ml volume flask and diluted to a volume with distilled water. The same was done for the blank without adding the sample, but all reagents used. The samples were analyzed for temperature, pH, conductivity, total dissolved solids (TDS), appearance, odor, turbidity, total suspended solids (TSS), iron, sulphate, chlorine and chromium.

The temperature and the pH were determined in-site using the thermometer and pH meter respectively. The turbidity was determined by the turbidity instrument. Ultraviolet spectrometer was used to determine the TDS in accordance with the standard methods for examination of water and waste water. This instrument gives a reading of TDS based on the electrical conductivity of the sample to be tested. Fe was determined by ferozine method using ferozine iron reagent solution. Sulferver 4 method was used to determine sulphate. Chlorine was determined by using the mercury thiocyanate method and chromium was determined by using the 1.5-diphenylcarboxdrazide method.

Table 1: The Water Quality Parameters That Were Analyzed, There Significance and Means of Measurement

S/N	Quality Parameter	Indicators studied	Method of Analysis and Results
	Color (apparent)	Suspended and dissolved solids	Colorimetry method. Visual comparison method; the platinum-cobalt method of measuring color is the standard method, the unit of color being produced by 1 mg platinum/l in the form of chroplatinate ion.
	Odor	Most organic and some inorganic chemicals	Subjective perceived odor. Threshold odor number
	Turbidity	Estimate of suspended matter	Jackson candle turbidity (Jackson unit) or nephelometry units (formula)
	Total suspended solids	Turbidity treatment efficiency	Gravimetry mg/l
	Total dissolved solids	Salinity may affect ecosystem and domestic and agricultural usefulness	Gravimetry mg/l
	Sulphate	Possible reduction to H_2SO_4. Corrosion of concrete, possible gastrointestinal irritation	Gravimetry or colorimetry mg/l of sulphate as SO_4
	Iron	Taste, discoloration, water turbidity, growth (iron) bacteria	Colorimetry or atomic absorption spectroscopy. mg/l of iron
	Ph value	Intensity of acid or alkali present, nitrates of effluents affects many chemical and biological properties	Trimetry mg/l of $caco_3$
	Chlorine	Degree of pollution sewage degree of salt water instruction, taste, corrosion in the water.	Trimetry or colorimeter mg/l of cl

Results and Discussion

It has been observed that the major source of drinking water in Danraka, Samaru is manually operated suction pumps, which from the research is not potable water.

Table 2: Water Analysis for Case Study

S/N	Parameters	Case A	Case B	Case C	WHO Limit
1	Temperature	22.5^oc	22.3^oc	22.8^oc	
2	Conductivity	0.289ms/cm	0.37ms/cm	0.04ms/cm	1000
3	pH	6.14	6.63	6.71	6.5– 8.5 (7.5)
4	Total dissolved solid (TDS)	1830ppm	2010ppm	2300ppm	600
S/N	**Parameters**	**Case A**	**Case B**	**Case C**	**WHO Limit**
5	Appearance	Clear	clear	Clear	
6	Odor	Odorless	odorless	Odorless	

7	Turbidity	1 mg/l	1.00 mg/l	0.000 mg/l	5
8	Total suspended solids (TSS)	4.00 mg/l	1.00 mg/l	0.00 mg/l	NA
9	Sulphate	3.00 mg/l	10.0 mg/l	9.00 mg/l	250
10	Chlorine	0.04 mg/l	0.08 mg/l	0.0 mg/l	5
11	Chromium	0.01 mg/l	0.05 mg/l	0.01 mg/l	
12	Iron	8.0 mg/l	1.8 mg/l	7.0 mg/l	0.3

Source: Laboratory analysis (2018)

To test if there is any significant difference between the three cases (Case A, B and C) and WHO standard, Oneway ANOVA was used.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Case A	Between Groups	2997968.876	7	428281.268	8.131E4	.000
	Within Groups	10.534	2	5.267		
	Total	2997979.410	9			
Case B	Between Groups	3619170.706	7	517024.387	1.773E6	.000
	Within Groups	.583	2	.292		
	Total	3619171.289	9			
Case C	Between Groups	4740529.694	7	677218.528	2.032E10	.000
	Within Groups	.000	2	.000		
	Total	4740529.694	9			

From the test statistics result, there are significant differences between the cases (Case A, B and C) and WHO standards ($p < 0.05$).

From the laboratory analysis, all the parameters sampled are within WHO limits except for Total Dissolved Solid (TDS) and Iron which were above the limits set by WHO. The high-level content of Total Dissolved Solids and Iron, the pH which is less than 6.5 for Case A, suggests that the continuous consumption of this water is not healthy. The results also show that the ground water in the study area has no odor. The turbidity is minimal, but it has a peculiar taste. It had been however observed that, on standing the water collected from case **A** hand pump, it gradually acquires a yellow-to-brown color. This study therefore leads to support the fact that the water sample in question has not to some extent met up with the drinking water standard. And research has shown that these water pumps were made specifically to supply drinking water to the community.

Conclusion

The primary sources of iron in drinking water are the natural geology and aging, corroding distribution systems and household plumbing. Iron based material such as injection cast iron and galvanized steel have been widely used in our water distribution system and household plumbing. Iron injection is not associated to adverse health effects. Iron is essential to human health in small concentrations (Iron deficiency can lead to anemia) although iron does not pose a direct health risk, trace impurities and microorganisms that are absorbed by iron solid may pose health concerns. The effects associated to iron contamination can be grouped into two categories; Aesthetic and Physical effects. Aesthetic effects are undesirable tastes, odour or colour. Iron in quantity greater than 0.3mg/l (which is the WHO limit) in drinking water can cause rusty colour that can stain laundry or household fixtures. Discoloured water is one of the most frequent consumer complaints about drinking water. Physical effects are damage to water equipment and reduced effectiveness of treatment for other contaminants. Corrosion of distribution system pipes can produce sediments or loose deposits that block water flow. Deep well water or even surface water supplies that pass-through iron contaminated bed rocks carry dissolved ferrous hydroxide, which readily oxidizes in contact with air, into brownish ferrous hydroxide.

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