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Research Paper

The Physico-Chemical And Bacteriological Assessment of Hand Dug Wells In Tudun Nupawa and Environs,Kaduna South L.G.A,Kaduna State.

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ABSTRACT: *The Assessment of Physico-Chemical and Bacteriological Parameters of Hand Dug Wells in TudunNupawa and environs is vital in the monitoring of groundwater quality. Twelve samples of water from hand dug wells were taken randomly using the standard method. The parameters determinedin situinclude the pH, temperature, electrical conductivity and turbidity using pH meter, thermometer, conductivity meter and turbidiometer respectively.The chemical parameters such as* Na^{+}, Mg^{2+}, Ca^{2+}, Cl^{-}, HCO_3, NO_3, *and* SO_4^{2-} *were done using the fast sequential Atomic Absorption Spectrometer AAS, the Total coliform(T Coli), EscherichiaColiform(E Coli) were determined using membrane filter method.The results of the Physico-chemical parameter indicates that the concentration of the major and minor cat ion are within the permissible limit of WHO 2011 and NSDWQ 2007. It is important to note that only few has elevated concentration, such as nitrate and phosphate. However the water in the area is poor bacteriologically due to feacal contamination by human and animal feaces.This may be responsible for the prevalence of water borne diseases. The residents spent a lot af time and money in seeking medical treatment.It is recommended that open defecation be discouraged and boiling of water is advocated for any usage.*

Keywords*- Physico-chemical, hand-dug wells, bacteriological, contamination,groundwater.*

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I. INTRODUCTION

Access to groundwater is very crucial for the existence of life and important ingredient for the sustainable development of any community.The world health organization (WHO) discovered that about 1.1 billion people globally do not have access to potable water supply while 2.4 billion people do not have access to good sanitation. (Efe et al., 2005).

Urban centres in many developing countries such as Nigeria,lack adequate supply of potable water for various activities from municipal water supply agencies.In Kaduna metropolis,water supply consists of intake of water from river Kaduna and back up from river kingimi reservoir which is inadequate to cater for the growing population (KDSG2005). This is usually augmented by sinking hand dug wells or rather drilling boreholes depending on the area concern.

TudunNupawa area houses a close knit combination of both residential dwellings and commercial/micro industries from the old Panteka.Panteka symbolizes a small informal industry that fabricate so many items using scrap metals,battery,iron and aluminium.The micro industries are majorly into Metal works(fabrication, sale and storage),woodworks (cutting & preservation),ceramic and paint works.These industrial activities and processes require the use of dangerous chemicals as input and also have other dangerous chemicals as by products.Over the years huge amounts of these dangerous chemicals have been indiscriminately used and improperly disposed within the area.

More so, open defecation along the water channels is rampant,increasing the chance/risk of infiltration and contamination of the groundwater that serves as the primary source of water for thousands of the residents of the area.The effect of these activities on ground water necessitate this research.Groundwater contamination occurs due to any deviation in physical,chemical and biological characteristic that impedes its usage. It could be naturally through weathering of rocks or human activities.

Many other groundwater research works such as that of Nur and Ayeni (2004) that investigated the quality of groundwater in Jalingo metropolis found that some of the water samples do not conform to WHO (2006) permissible standard in terms of pH, iron, magnesium and coliform counts. It further stated that the water samples have low concentration of anions and cat ions and classified the dominant water type as $Na^{+}K^{-}CL^{-}SO_4$ water type.

Adesina and Omayi (2005) analyzed groundwater chemistry of weathered zone aquifers of an area underlain by basement complex rocks in Akure, south western Nigeria.The result showed human activity imprint on the groundwater chemistry, which overshadows the normal expected syngenic influence of weathering of bedrock geology.

Offodile (2000) determined the impact of human activities on groundwater quality of shallow aquifers in Jimeta -Yola, the study revealed elevated concentration for contamination/pollution tracers ($NO_3^{-}Cl^{-}$ SO_4^{2-}) and electrical conductivity. They suggested that the contamination is due to human activities..

In many developing countries like Nigeria, increasing agricultural activities, urbanization and industrialization lead to increasing contamination of soils, rivers/drainage systems,lakes and reservoirs with attendant threat to drinking water sources including shallow groundwater systems (Tijani,et al.,2004). Apart from that, a number of heavy metals are generally implicated in many diseases' conditions including hypertension,heart and liver problems, renal poisoning, bronchitis,cancer and sudden deaths.long term exposure may result in slowly progressing physical muscular and neurological degenerative processes.

The concentration of heavy metals in soil is an indication of pollution. (Hajara, 2010) Hence,it is important to inform ourselves about heavy metals so as to take protective measures against excessive exposure.

Therefore,as part of this study,a number of selected trace metals were analyzed as part of the water quality assessment.

II. MATERIAL AND METHOD

2.1 STUDY MATERIAL

The research area Tudun Nupawa and environs is within Kaduna metropolis, in Kaduna South Local Government area of Kaduna State and very close to the famous Kaduna Polytechnics. It lies between Longitudes 7°25′ 09 and 7°26′36″ E to Latitude 10°31′21″and 10°32′39″ N, the area covers twelve and a half kilometers (12.5km), with an elevation of 607m above the sea level. Fig 2.0

Geologically, the area like Kaduna state generally comprises metamorphic rocks of the Nigerian Basement Complex characterized by rocks such as:Migmatite-gneiss complex and the Meta-sedimentary series. There are three types of aquifer in the study area weathered overburden aquifer,fractured bedrock aquifer and the stream alluvial deposits aquifer which are interconnected to form one hydraulic system with unconfined water table.(Adannu and Scheneider, 1988)

2.2 Water sampling and analyses

A total number of 12 groundwater samples were randomly collected from hand –dug wells within the area. The water sampling and analyses were carried out in line with known standards (APHA,2012) guideline for sampling and analysis of water and waste water. Prior to the collection of the samples,the containers were prewashed thoroughly with distilled water and then the water to be sampled was finally used to wash the container.Then the samples were collected, labeled, and geo-referenced using the global positioning system,Consequently in the field.

The in-situ parameters such as, pH, temperature, turbidity and conductivity were determined using the standard equipment,such as pH test for acidity and alkalinity,mercury thermometer for temperature, turbidiometer for turbidity,etestr.+eutech instrument,for conductivity,dist-3 by Hanna instrument for dissolve solid, and hence the sample collected were packaged stored under $4^{o}C$ temperature and taken to the laboratory for the other chemical and bacteriological tests.The result obtained will be compared to (WHO) World health Organization standard,which is the yardstick for determining the suitability of water for drinking,domestic,agricultural,industrial and recreational purposes.

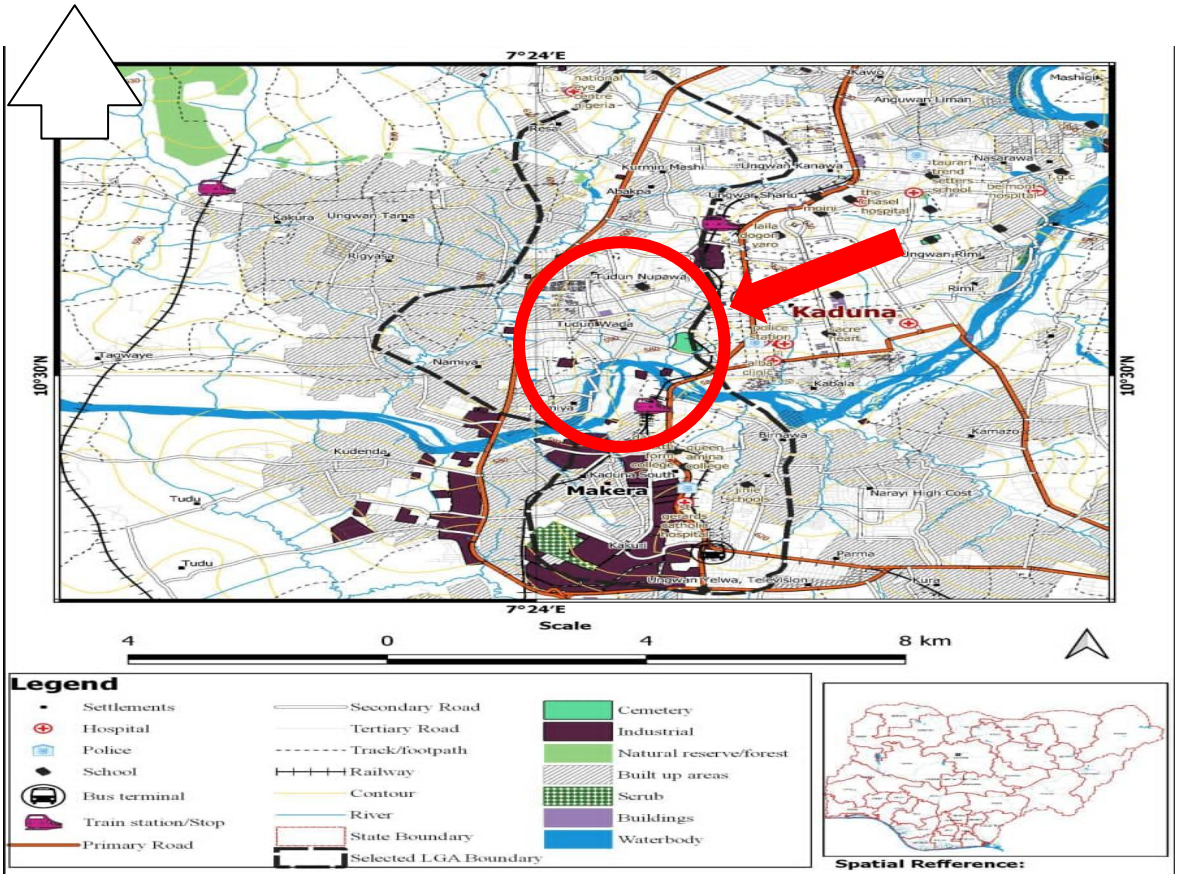

Figure.2.0: Topographical map of Kaduna south L.G.A, showing the study area.(source:modified after Abubakar,et. al 2021)

III. RESULT AND DISCUSSION

The statistical summary of the Physico-chemical and bacteriological analysis of the water sample is shown in (Table1).The pH values ranges from 6.5-6.9mg/l while the temperature varies from 27.90 to 32.80^{0}C,the measure of degree of acidity and alkalinity is referred to as pH while the degree of hotness or coldness of a material is the temperature.These are important water quality indicators which play roles in dissolution of substance in water.The pH and temperature falls within the limit recommended by World Health organization (WHO) standard. The bacterial activities in water is influenced by their changes, chemical substance dissolves more readily in water with high temperature and low pH levels .(Amadi et al;2013) The consequence of low pH may include corrosion,solubility of heavy metals and metallic taste in water (Usepa, 2007)

Table 1: The Total result of physicochemical and bacteriological analysis of ground water samples from hand dug wells in TudunNupawa and environs in Kaduna South L.G.A of Kaduna state.

S/N	Parameter	Unit	Min.	Max.	Average	WHO 2011	NSDWQ, 2007
1	Dissolved Oxygen	Mg/l	0.5	0.8	0.67	NS	5.0
2	Nitrate	Mg/l	I26.93	340	221	50	50
3	Alkalinity	Mg/l	4.82	9.40	6.36	NS	NS
4	Sodium	Mg/l	7.14	11.64	8.827	200	250
5	Total hardness	Mg/l	55	I70	67	500	-
6	Magnesium	Mg/l	8.568	10.229	9.56	50	0.20
7	Calcium	Mg/l	823.013	82.161	55.913	100	7.50
8	Potassium	Mg/l	4.50	36.0	2.40	10	I5
9	Iron	Mg/l	0.00	0.16	0.38	0.3	0.3
10	Zinc	Mg/l	0.113	0.201	0.113	3.0	3.0
11	Chromium	Mg/l	ND	ND	-	0.05	0.05
12	Cadmium	Mg/l	0.00	0.019	0.01	0.003	0.003
13	Lead	Mg/l	0.00	0.53	0.21	0.01	0.03
14	Arsenic	Mg/l	0.00	0.81	0.04	0.01	0.01
15	Chloride	Mg/l	53.53	132.49	961.55	250	250

16	Phosphate	Mg/l	0.03	0.I0	0.043	NS	NS
17	Bicarbonate	Mg/l	9.40	218	I3.267	50	I00
18	Sulphate	Mg/l	10.46	20.80	16.463	250	100.0
19	TDS	Mg/l	60	930	230	1000	500
20	Temperature	^{0}C	27.90	32.80	31.10	20	Ambient
21	pH	-	4.8	6.9	6.8	6.5-6.8	6.8-8.5
22	EC	(µS/cm)	43	368	189	400	1000
23	E COLI	cfu/100ml	0	9	5	0	0
24	TC	cfu/100ml	0	5	3	0	10

ND =Not detected, NS= No Standard
Source: Authors' computation.

The total dissolved solids is an indication of the amount of substance dissolved in water,its concentration ranged from 60-930mg/l.This falls within the permissible limit of 1000mg/l while the electrical conductivity ranged from 43 to 368mg/l. This is within the permissible limit of 1000mg/l for conductivity (NSDWQ,2007).The EC and TDS are pollution tracers and important water quality indicators, showing an indication that certain material are either partially ionized or completely dissolved in water, the water samples with higher values correspond to the sampled area with poor on site sanitation.

The turbidity value ranged from 0.00 to 43.00NTU as against the allowable limit of 5.00 NTU. It was discovered that the hand-dug wells with high turbidity value were not covered and close to area with hub of activities along the road.The presence of suspended material in water makes it turbid and invariably affects the colour and transparency of the water. Runoff could also enhance the areas without build up base. The total hardness ranged from 55 to 170mg/l while the alkalinity content is from 4.0 to 9.40mg/l,it is believed to be as a result of the presence of calcium and magnesium. It can lead to build up lime scale in pipes and appliances.The lesser alkalinity justifies the high amount of chloride and nitrate as shown in table1.

The dissolved Oxygen DO is the measure of the amount of oxygen required to oxidize organic matter by bacterial action, which gives an idea of the oxidized matter actually present in a sample of water and allow pollution load to be estimated. The concentration of DO ranges from 0.05 to 0.08mg/l with an average value of 0.067mg/l shown in table1.These values fall within the permissible limit of water standards (NSDWQ,2007) and (WHO,2011) for both drinking and other domestic uses.The concentrations of the major anions (chloride, nitrate and phosphate) were observed to be higher while that of sulphate and bicarbonates were within the recommended standard values(NSDWQ 2007 and WHO 2011).In the studies of(Dan Hassan et al.,2001;Amadi et al 2009) high concentration of chloride, nitrate and sulphate in non-coastal areas was attributed to pollution due to poor sanitation, leachate from dumpsite, industrial effluents and fertilizer application or geo-genic ally induced via chemical weathering or bedrock dissolution and also Etu-Efeotor(1998) concluded that concentration of nitrates, phosphates and sulphates in surface water resulted from human and agricultural activities in the area.

The concentration of major cat ions (sodium,calcium,magnesium and Potassium) were within their respective recommended permissible limit (NSDWQ 2007,) table 1. The concentration of iron, zinc, lead, arsenic is in the range of 0.16 to 0.38mg/l, 0.113 to 0.0201mg/l, 0.00 to 0.53mg/l, 0.00 to 0.81mg/l respectively.All were found to be higher than the recommended values except for chromium that is not detected at all. These high values in heavy metal may be attributed to decomposition and subsequent leachate of abandoned metallic objects from Panteka metal works in the area,chemical weathering of rock and urban surface run-off.

These heavy metals are highly toxic even in minute quantity,could cause severe health problems such as carcinogenic from arsenic and cadmium and lead. Ferner (2001) discovered that Lead is the most toxic of the heavy metals. Its inorganic forms are absorbed through ingestion by food, water and inhalation. Humans exposure to lead result in a range of effects depending on the level and duration. High levels of exposure may result in toxic effects in humans which in turn cause problems in the synthesis of haemoglobin, kidneys, gastrointestinal tract, joints and reproductive system, and acute or chronic damage to the nervous system (Duruibe *etal*., 2007).The continual consumption of heavy metals risk acute and chronic toxicity,liver,kidney and intestinal damage.

The concentration of Escherichia coli (E.Coli) ranged between 0-9cfu/100ml while total coliform(T.C)ranged from 0-5 cfu/100ml.The E. coli and T.C bacteria cause foodborne and water illness.They are commonly found in the intestines of animals and humans.Their presence in water is a strong indication of recent sewage or animal/human waste contamination.Rain washes the E.coli from human and animal wastes especially where open defecation is practiced, into the open hand-dug well and get them contaminated.The practice of open defecation along stream channel is commonly practice in the area and this favours bacteria contamination of the wells. Furthermore the siting of shallow hand dug wells near sewage tract, unlined pit latrine and soak away exposes the shallow hand dug wells to fecal contamination and these explains the prevalence of water borne diseases such as cholera, typhoid and diarrhea among children in the area.Considering

the concentration of total coliform, Escherichia coliform and fecal steppes in the groundwater samples and their corresponding permissible limit in table1 confirmed the fact that the hand dug wells in TudunNupawa and environs is contaminated.The sickness generated from these diseases stress themedical facilities aroundthe area and also affect economic wellbeing of the workers. This is because the time and money they spend to recover form sickness affect their productivity in work place.

IV. CONCLUSION

The background value of the chemical elements in groundwater should have direct bearing with the geology of the environment where the water sample is taken(Adannu et al,2013).The chemical composition of groundwater is the imprint of the rock water interaction and chemical processes such as weathering,dissolution plus ionic exchange and human activities.The cat ion concentration is in conformity with both the WHO and NSDWQ standard however, the well waters is poor bacteriologically due to feacal contamination by humans and animals feaces as found in most of the samples. This is in conformity with the work of Muhammad (2012) in parts of kaduna metropolis. Also,the concentration of heavy metals is alarming as iron,cadmium,arsenic,lead Concentration is higher than the permissible limit set by WHO and NSDWQ standard.

V. RECOMMENDATION

Water used for drinking purposes and bathing should be boiled to kill the disease pathogens as they cannot withstand high temperature.Wells must be properly covered and cased.There is need to sensitize the people on the need for personal hygiene and good sanitation.Government should also make sure that there is adequate supply of quality water from the water board to meet the needs of increasing population

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