American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-9, Issue-6, pp-62-72
www.ajer.org
Research Paper Open Access

Assessment Of Groundwater Quality In Panteka, Tudun Nupawa, Kaduna South,Kaduna State, Nigeria.

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ABSTRACT: *The paper assessed the quality of groundwater in the study area. The study has the following objectives;i. to analyse some of the physical chemical, and microbial contaminants of the groundwater. ii. to Identify likely sources of groundwater contamination in the study area. iii. to determine the safety levels of groundwater in the study area by comparing the level recorded with World Health Organisation guidelines and Nigerian Standard for Drinking Water Quality. In order to achieve the above objectives water samples were collected from 10 hand-dug wells and were taken to Nigerian Geological Research Laboratory Barnawa, and National Water Resource Institute, Mando both in Kaduna metropolis, Kaduna State for analysis of some 18 physical, Chemical and Microbiological parameters. The results showed that five out of seven of the physical and chemical parameters have values within the guideline limits of the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) for potable water. Electrical Conductivity ranged between 451-1,292 and Total Hardness ranged between 170-348 mg/L. Only Total hardness and Electrical Conductivity were found to be above the guideline limits. With regards tomicrobiological parameters, fecal coliform ranged between 40-140cfu/ml whiletotal coliform ranged between 30-96cfu/ml. They were found to be remarkably high in all sampled location, which could be attributed to domestic contaminations. The high value for both total and fecal coliform makes the sampled groundwater unsafe for human consumption prior to treatment. For other parameters only Pb and Cl were found to be above the guideline limits given by WHO and NSDWQ.*

KEYWORDS: ***Groundwater quality, physico-chemical and microbiological parameters, heavy metals.***

Date of Submission: 25-05-2020 Date of acceptance: 10-06-2020

I. INTRODUCTION

Water is a valuable natural resource that is essential to human survival and the ecosystems health. Water comprises of coastal water bodies and fresh water bodies like; lakes, river and groundwater. (Usali and Ismail, 2010). Of all the natural resources, water permeates perhaps most deeply into all aspects of life. Water is no doubt one of the most essential needs of human beings, for drinking and other domestic purposes. Its presence or lack of it determines to a great extent the nature of the natural environment in which life and majority of our economic activities depend on (Akankpo. *et al.* 2009). Water is a landscape element and as a chemically active mobile substance, it is always on continuous move through the surface and subsurface of the earth. Groundwater constitutes over 90% of the world's readily available freshwater resources with the remaining 10% in lakes, reservoirs, rivers and wetlands (Asonye*et al*. 2009).

A groundwater resource is one of the most important resource available to humanity (Christophoridis*et al*., 2011). Therefore, it is necessary to provide tools that can assess its quality over space. The principal goal of groundwater management in developing countries is to assess and manage the water resources that are available. Where groundwater is the main resource, management requires information on both its quantity and quality (Mogheir and Singh, 2002). Groundwater is an important part of the hydrologic cycle. It lies beneath the surface beyond the soil moisture root zone and it is tied to surface supplies through the soil moisture pores in soil and rock.

Hand-dug well is an excavation or structure created in the ground aquifers. The well water is drawn by a pump, or using containers such as rubber or iron bucket that are drawn by hand. Well can also vary greatly in depth, water volume and may require treatment to soften it. Groundwater is sometimes referred to as the hidden source of water supply because it resides in the subsurface. It is of vital importance in areas where dry summers and extended droughts cause surface supplies to disappear. More than 1.5 billion people worldwide and more than 50% of the population of the United States rely on groundwater for their primary source of drinking water (Alley *et al.* 2002). Threats to groundwater quality have risen in importance, giving the increased dependence on groundwater supplies and the long times required for clearance of contamination.

Groundwater is precious innate resource that is crucial for human health, socio-economic progress, and functioning of ecosystems. Water scarcity owing to fast growth of inhabitants and anthropogenic actions, the eminence of groundwater is deteriorating in present days. Possibility of groundwater infectivity on existing drought-prone conditions, the crudely treated, spontaneous release of effluents of industry, municipal and domestic into the nearby streams and ponds. Temporary changing basis of water and creation of the recharged water, hydrological and human factors, may cause sporadic changes in groundwater quality. Ascertaining the quality is crucial before used for various purposes such as drinking, recreational and industrial. Therefore, monitor of groundwater quality has become indispensable (Johnson 2009).

Water pollution is an important aspect of environmental pollution considering the necessity of water for existence. Water pollution has impacts on not only humans but also animals, micro-organisms and plants through the intake of water by the living organisms. The importance of water notwithstanding, it has long been recognised as a vehicle for the spread of many diseases (Wijk-Sijbesma, 2002 and Sawyer *et al.* 2003). These diseases include the worst outbreak of Escherichia coli in Canada (Kondro, 2000) and Cryptosporidium in Milwaukee, Wisconsin, USA in 1993 (Hoxie *et al.* 1997).Water sources both surface and groundwater are often contaminated by anthropogenic activities. Among the pollutants are nitrates from domestic sewage and fertilisers and pesticides in agriculture (Salvato*et al.* 20003). Others are livestock farming that transmits pathogens from animal manure and fish farming that exacerbate eutrophication by adding biochemical oxygen demand and nutrients to the local environment (Kirby *et al.* 2003). These natural events such as torrential rainfall and hurricane cause excessive erosions, flooding, tsunamis and landslides, which in turn increase the content of suspended materials in affected rivers and lakes leading to little or no dissolved oxygen among other consequences (Meybeck*et al.* 1996). The principal groundwater quality issues relate to excess hardness and the presence of iron, manganese, chloride, nitrate and coliforms (Purcell, 2003, Kiely, 1996).

Nigeria as a developing country suffers from water contamination from anthropogenic activities. Studies have shown that the country's water resources have been contaminated from human activities such as industrial, agricultural and domestic activities in both urban and rural areas. The major contaminations affect chemical and microbiological parameters with contaminants ranging from trace elements, nutrients to coliforms. This paper therefore, assessed the quality of groundwater in Panteka area of TudunNupawa, Kaduna South Local Government Area. Groundwater mostly from hand dug wells is the main source of water supply for the residents of the study area.

Study Area

The study area, "old Panteka Market" is a big industrial village behind the Sir Kashim Ibrahim Government House within Kaduna metropolis, Kaduna State, Nigeria. It is encompassed between latitudes 10023' and 10043'N and longitude 7017' and 7037'E. The study area houses artisans involved in different crafts, including battery charging and repairs, aluminium windows, roofs and metal doors, gold smiting, building materials, key cutting, paint sellers, chemicals for perfume and soap making to mention but a few. In fact, across the West African region people come from as far as Mali, Senegal, and Chad to buy products made in this Market which include household materials ranging from candle, kerosene lamps, cooking stoves, utensils to industrial materials like shovels, rakes, diggers, some automobile parts and working tools which generate a lot of toxic wastes that eventually end up in soils and wells that are located in the vicinity of the different workshops (Funtua*et al.*, 2017).

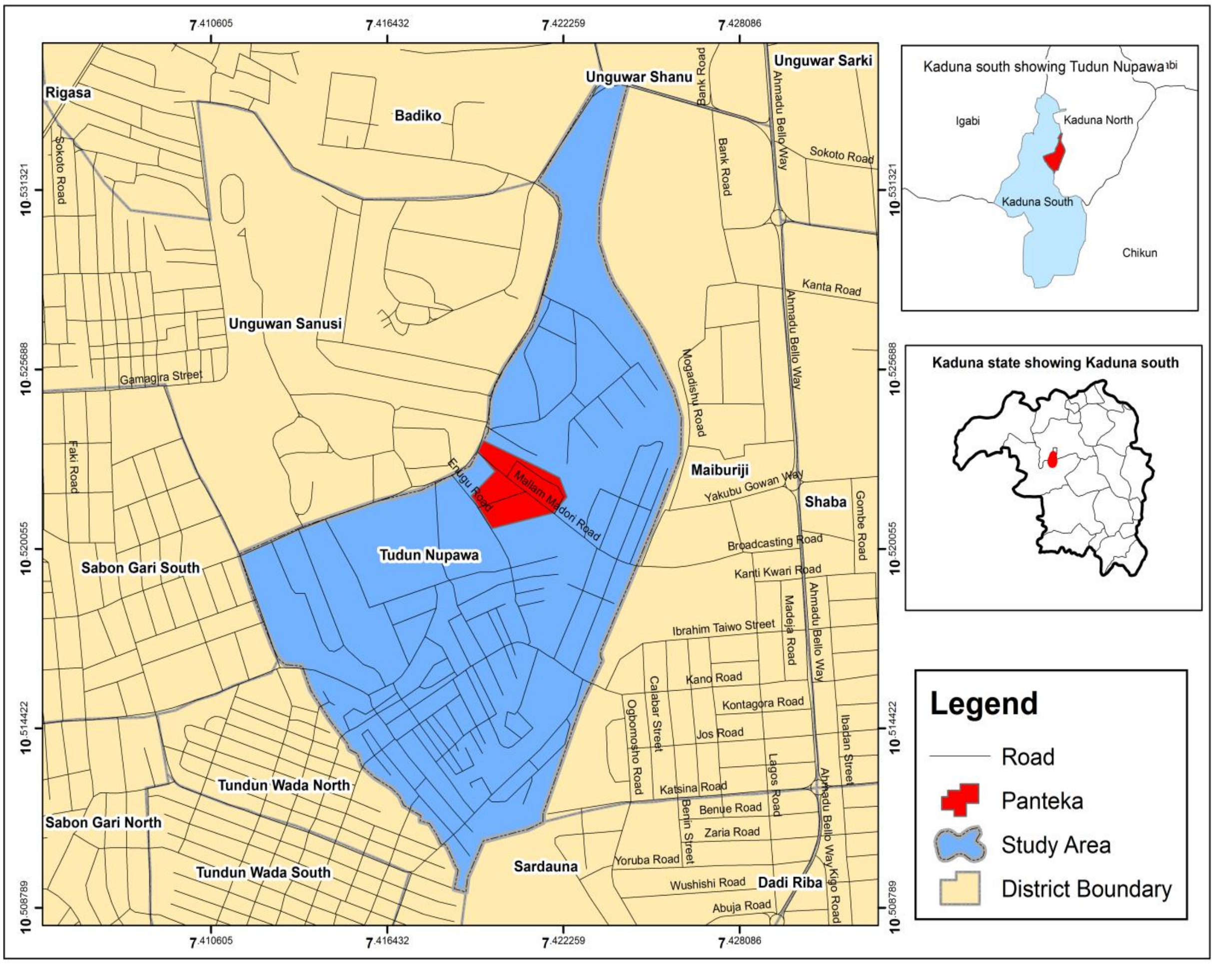

Fig 1: TudunNupawa showing Panteka.
Source; Modified from Administrative map of Kaduna State.

II. MATERIALSAND METHODS / SAMPLE COLLECTION

Samples were collected from ten hand dug wells in the study area, with their locations taken down in the GPS. Water from the wells were drawn by hand and transferred into small plastic water containers, and then transported to the laboratory immediately.

The data collected were water samples from 10 selected hand-dug wells from the study area. Samples were only collected from hand dug wells because hand-dug wells are more prone to contamination than boreholes, and also hand-dug wells are domestically used than the boreholes in the study area. These 10 hand dug wells were chosen in order to get a good representation of the groundwater condition of the study area. Hand dug wells were chosen as the preferred groundwater because after a good reconnaissance survey of the area, it became clear that hand dug wells were mostly used in households for domestic use in the study area.Water was drawn by hand using rubber buckets/containers and poured into the sample bottles, the sample bottles were rinsed thrice with the well water before taking the sample into the bottles. 1litre bottle was used to collect samples for physical and chemical parameters, while a water bottle of 250ml was used to collect samples for microbiological parameters.

The American Public Health Association (APHA, 2005) analytical methods for the examination of water were used to determine the physicochemical and microbiological parameters of the water samples. In order to prevent natural interference and unnecessary reactions, analyses of the pH and electrical conductivity were done *in situ*using meter HANNA HI 9828.while others were determined at a later time in the laboratory. Heavy metals were analysed using the Atomic Absorption Spectrophotometer(AAS). 18 water quality parameters were chosen which represent some of the important water quality parameters and also among some of the parameters that contribute to groundwater contamination.

The physical, chemical and microbiological parameters wereanalysed at the laboratory in National Water Resource Institute Mando while the heavy metals, Calcium, Potassium and sodium were analysedusing Atomic Absorption Spectrometry in the Nigerian Geological Research Institute Laboratory, Barnawaboth in Kaduna metropolis.

III. RESULTS AND DISCUSSION

The pH values of the results (Table 1) showed that only in Irra Rd and Gulubi Rd were the samples on the borderline of the minimum guideline limits. The other eight sample locations showed the water samples to be below the guideline limits. This may be due to leaching of water caused by the underlying geology. The values of total alkalinity were found to be within guideline limits. The values ranged from 106mg/L at GulubiRd2 to 192mg/L at Dikwa Rd. The values of Electrical Conductivity (EC) of water samples taken from study area were between 451 and 1292 µS/cm at Gulubi Rd and Malumfashi Rd respectively.

The guideline limit of WHO(2012) and NSDWQ (2007) is 1000 µS/cm. Water from four sampled locations were above the guideline limits given by WHO and NSDWQ while in six sampled areas the values fell within the accepted threshold of the WHO and NSDWQ and are therefore acceptable for drinking, and other domestic purposes. Lower values were observed in 5 samples during the study were found in well water samples which were within the stipulated value of 500 mg/L (Table 1) by WHO (2012) for drinking water, hence, the water is not harmful in view this parameter.

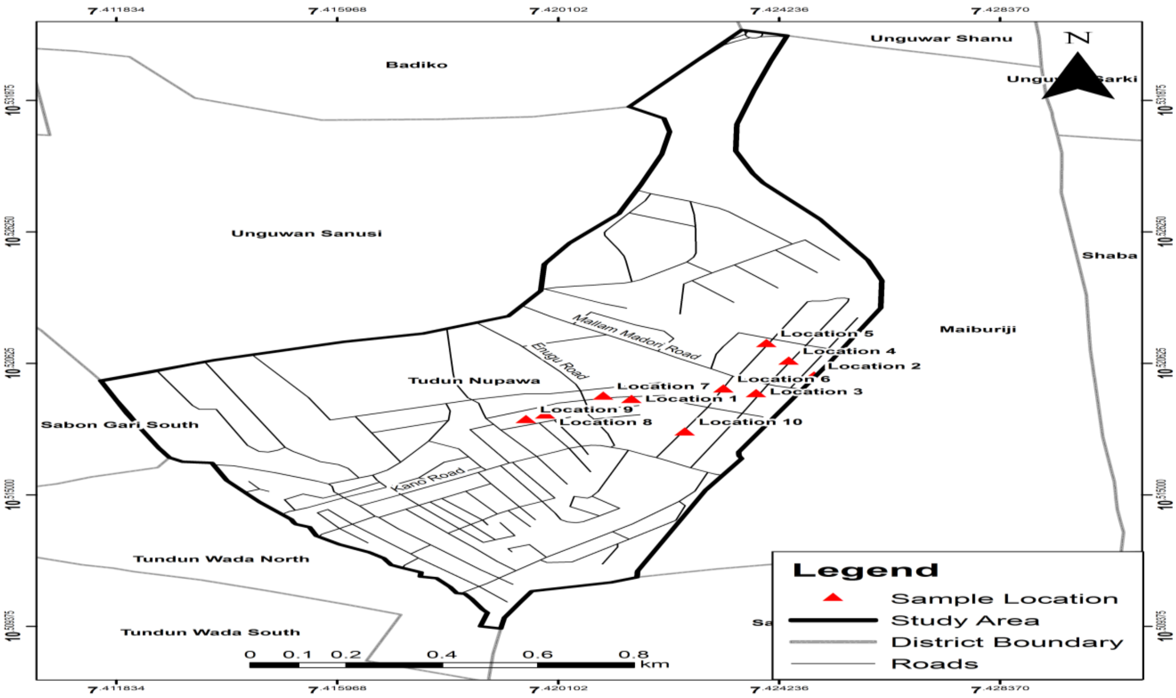

Fig 2; Sample points

Source; Analysis (2018).

The values of Total Dissolved Solids in the sample locations ranged between 225 and 645. (Table 1). TDS values were found to be above the limits of WHO and NSDWQ in four sample locations. High values of TDS in groundwater are generally not harmful to human beings but high concentration of these may affect persons, who are suffering from kidney and heart diseases (Gupta *et al*., 2004). This result is also in conformity with the correlation between EC and TDS (Saminu*et al* 2018), The higher the concentration of electrolytes in water the more is its electrical conductance. Total dissolved solids and Electrical conductivity can be used to delineate each other.

Turbidity guideline limit according to WHO and NSDWQ is 5(NTU). Result from analysis showed that all samples were not above limits above. Lowest value was gotten as 0.3mg/L at Malumfashi Rd while highest was gotten as 3.4mg/L at Gulubi Rd. Thesalinity values from four locations were found to be above limits given by WHO MPL and NSDWQ Limits. Lowest salinity value was obtained of 29mg/L at Gulubi Rd2 while highest value of 409 was found at Irra Rd2. The presence of a high salt content may render a water unsuitable for domestic, agricultural or industrial use, or may affect its suitability (Olobaniyi and Owoyemi, 2006).Total hardness values from all the samples were all above the guideline limits set by WHO and NSDWQ guidelines of 200 mg/L. Hardness is the traditional measure of the capacity of water to react with soap, hard water requiring considerably more soap to produce lather (WHO, 2011b).

The total coliform counts of all the water samples were generally high. The values exceeded the standard requirement of 10 total coliform counts per 100 ml for NSDWQ and zero total coliform count per 100 ml for WHO. The implication of this finding is that water from these wells may look clean to the eye and have no unwanted odour or taste but contains pathogenic bacteria that can cause significant illness such as gastrointestinal, urinary tract infection (UTI) tract infections, which may even become fatal in severe condition (Allamin*et al*, 2015). The results of this study correlate with the report of Bello *et al* (2013) and Allamin*et al* (2015) who showed that the water samples from well was highly contaminated with coliform bacteria. Owing that the total and faecal coliform count of these water samples was grossly contaminated. The very high contamination may be due to the non-hygienic disposal of fecal waste in pit and open defecation at the backyards of buildings and stream by the inhabitants.

The high contamination level may be due to time of data collection (July, 2018), which is a month of rainy season as a result the seepage of water contaminated with bacteria to aquifer will surely occur as recorded by (Isikwue*et al* 2011). The total coliform count analysed were all above the accepted limits given by WHO and NSDWQ. The range of Total Coliform was found between 40-144. Highest level of total coliform was gotten at 144 in Behind Poly Qtrs and lowest at 40 in Gulubi Rd2. The fecal coliform count analysed were all above the accepted limits given by WHO and NSDWQ. The range of Fecal Coliform was found between 30-96. Highest level of fecal coliform of 96 cfuwas found in Yonga Rd and lowest 30cfuwas recorded in Gulubi Rd2.

Nitrate is regulated in drinking water because high levels may cause serious illness and sometimes death. It also has the potential to cause shortness of breath, methemoglobinemia or blue baby disease, an increase in starchy deposits and hemorrhage at the spleen (Pritchard *et al* 2008). It also causes hemorrhage of the spleen. Excess of it in water is used as an indicator of poor water quality (Ndamitso*et al.*, 2013). Nitrate concentrations in all the samples were found to be below the guideline limits given by WHO and NSDWQ respectively (Table 2).The levels of Sulphate were found to be below the guideline limits of the regulatort bodies. The highest value at 118mg/L was recorded at Malumfashi Rd. The lowest value was gotten as 22mg/L at GulubiRd2 (Table 2). High sodium and chloride levels can result from upward movement of brine from deeper bedrock in areas of high pumpage, from improper brine disposal from petroleum wells, and from the use of road salt (Hem, 1985).The main source of human exposure to chloride is the addition of salt to food, and the intake from this source is usually greatly in excess of that from drinking-water (WHO, 2011a). All but two samples from the study area were within guidelines limits of WHO and NSDWQ of 200mg/L. Lowest concentration was found at Irra Rd2 at 17.5mg/L, and highest was found at Gulubi Rd2 at 248mg/L (Table 2).

Generally, significant dissolved quantities of the metal zinc occur only in low pH or high-temperature ground water (Davis and DeWiest, 1970). As shown in Table 3 all the samples analysed for Zinc fell within guidelines given by both WHO and NSDWQ (2007). Lowest value of 0.0524mg/L and highest of 0.1115mg/L at Gulubi Rd and Behind poly Qtrs. Table 3 also shows Lead values were where found to be above the limits of 0.01 mg/L of WHO and NSDWQ except for two samples which Lead was not detected. Lead in the study area was found between at lowest value at 0.0461 and highest at 0.6579 atGulubi Rd and Dikwa Rd respectively (Table 3). High concentration of lead observed could be attributed to the aerosol of both vehicular exhaust, and improper dumping of refuse into the drains of the major markets in the study area (Bayewu*et al* 2013). The study area is close to a commercial area which is attributed to a lot of vehicular exhaust which could be a reason behind the high values of lead in the study area. Another reason for the high level of Lead in some of the areas could be attributed to the activities being undertaken in the study area, which include mechanic workshops, where there's a lot of oil spillage, also there's a lot of welding activities in the study area.

Sodium affect the taste of water and the taste threshold concentration of sodium in water depends on the associated anion and the temperature of the solution. At room temperature, the average taste threshold for sodium is about 200 mg/L (WHO, 2011). All but one sample locations recorded sodium below the guideline limits. Behind Poly Qtrs recorded the highest value of 504 mg/L while the lowest value of 18.2950mg/L was obtained in Gulubi Rd2 (Table 3) in the study area. For Potassium, the lowest value was gotten in GulubiRd2 at 7.9451mg/L while the highest was gotten at Independence Rd at 44.7966mg/L. There's no guideline for potassium given by either WHO or NSDWQ. The taste threshold for the calcium ion is in the range of 100–300 mg/l, depending on the associated anion (WHO, 2011a). The water samples collected from the study area have calcium concentration ranging from 36.4-98.3 mg/l and thus satisfy the WHO (2011a) taste threshold value. Lowest value was found at 36.4 and highest at 98.3 in Kawo Rd and Malumfashi Rd respectively, in the study area (Table 3).

Table 1: Measured Physico-Chemical parameters

S/N	Locations	pH	TDS	Turbidity	EC	Salinity	Total Hardness	Total Alkalinity
1	Irra Rd	6.5	543	2.1	1,075	69	242	140
2	Irra Rd2	6.4	535	0.7	1,072	409	283	130
3	Malumfashi Rd	6.7	645	0.3	1,292	347	348	118
4	BehindPoly Qtrs	6.2	481	0.9	963	46	267	128
5	Gulubi Rd	6.7	387	3.4	775	105	263	168
6	Gulubi Rd2	6.3	225	1	451	29	170	106

7	Independence Rd	5.8	500	0.8	999	250	303	172
8	Dikwa Rd	5.9	522	0.9	1,045	314	290	192
9	Kawo Rd	6.1	274	0.6	548	144	199	105
10	Yonga Rd	5.7	306	2.5	612	31	175	114
	WHO MPL	**6.5**	**500**	**5**	**1000**	**200**	**150**	_
	NSDWQ Limit	**6.5**	**500**	**5**	**1000**	**200**	**150**	**500**

Source: Fieldwork,(2018)

<u>KEY</u>

WHO : World Health Organisation.

NSDWQ: Nigerian Standard for Drinking Water Quality.

MPL: Maximum Permissible Limits.

EC: Electrical conductivity.TDS; Total Dissolved Solids. NTU; NephelometricTurbidity Units.

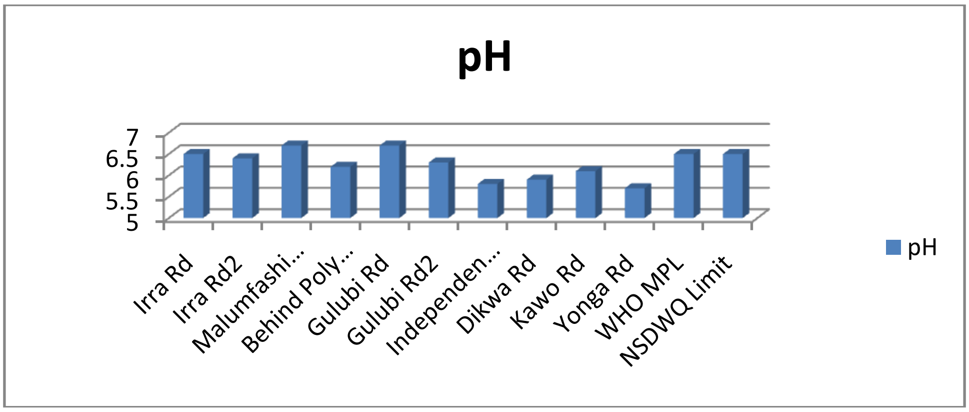

Fig 3: pH values Compared with the standards

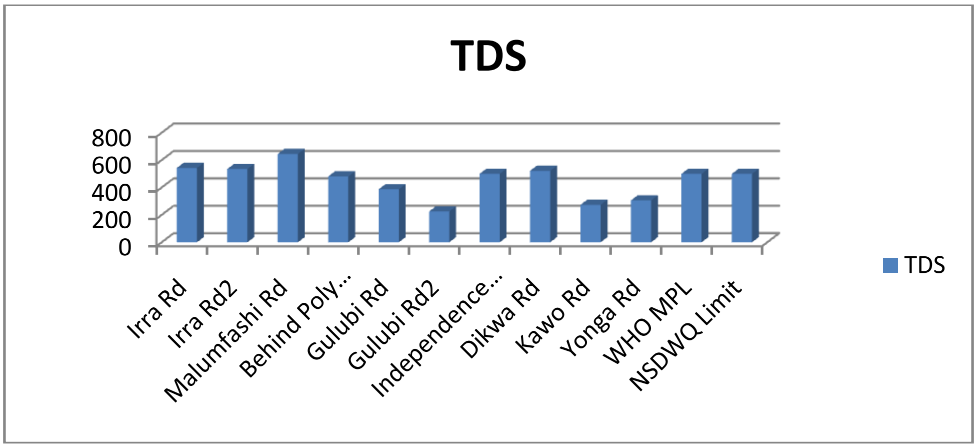

Fig4: TDS values Compared with the standards

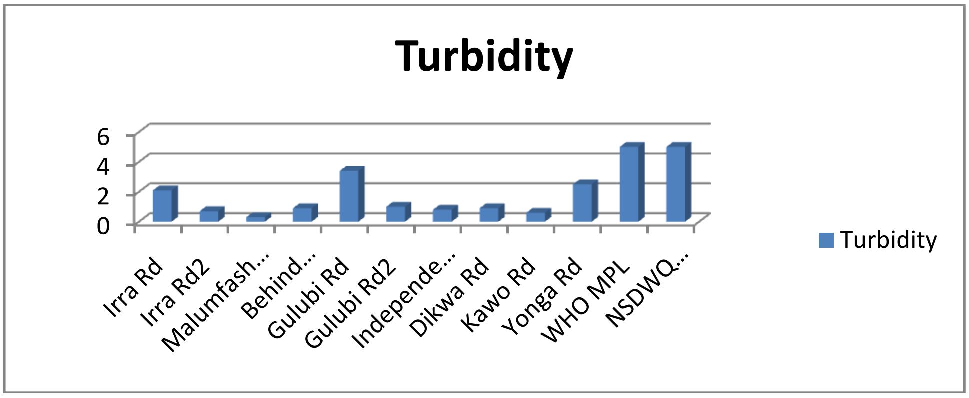

Fig5: Turbidity values Compared with the standards

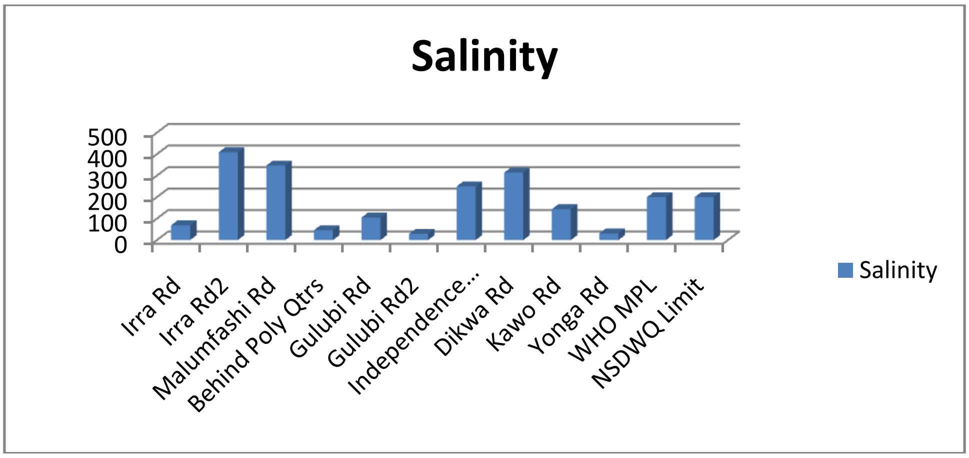

Fig6: Salinity values Compared with the standards

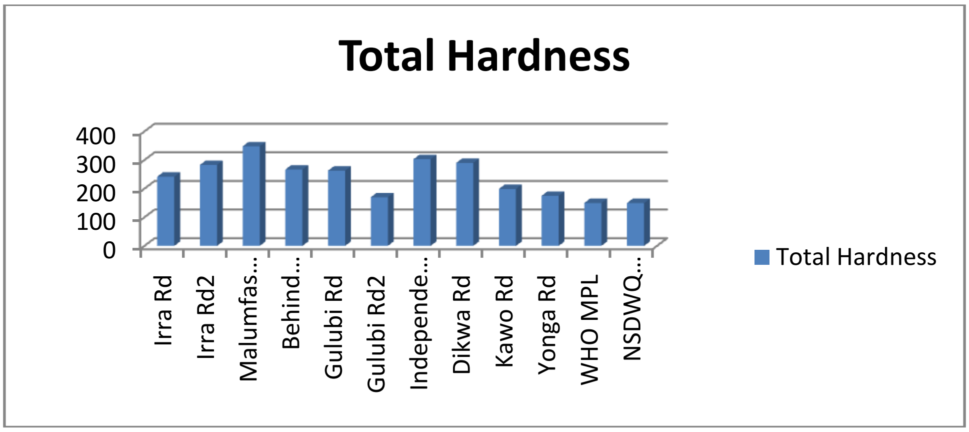

Fig7: Total Hardness values Compared with the standards

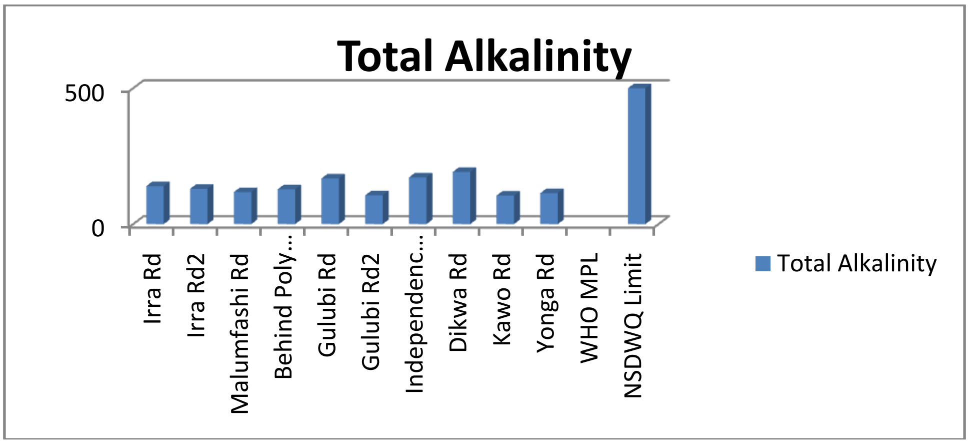

Fig 8: Total Alkalinity values Compared with the standards

The table below gives the description of Anion parameters analysed with corresponding guidelines from both WHO(2012) and NSDWQ(2007)

Table 2: Anion Parameters

S/No	Locations	Nitrate (mg/L)	Chloride(mg/L)	Sulphate(mg/L)
1	IrraRd	19	42	67
2	Irra Rd	23	248	52
3	Malumfashi Rd	5.8	210	118
4	Behind Poly Qtrs	20.4	28	63
5	Gulubi Rd	13.2	63.5	75

6	Gulubi Rd	36	17.5	22
7	Independence Rd	21.6	151.5	79
8	Dikwa Rd	23	190	86
9	Kawo Rd	36	87	31
10	Yonga Rd	21	19	25
	WHO MPL	**50**	**200**	**250**
	NSDWQ Limit	**50**	**200**	**150**

Source: Field Work, (2018)

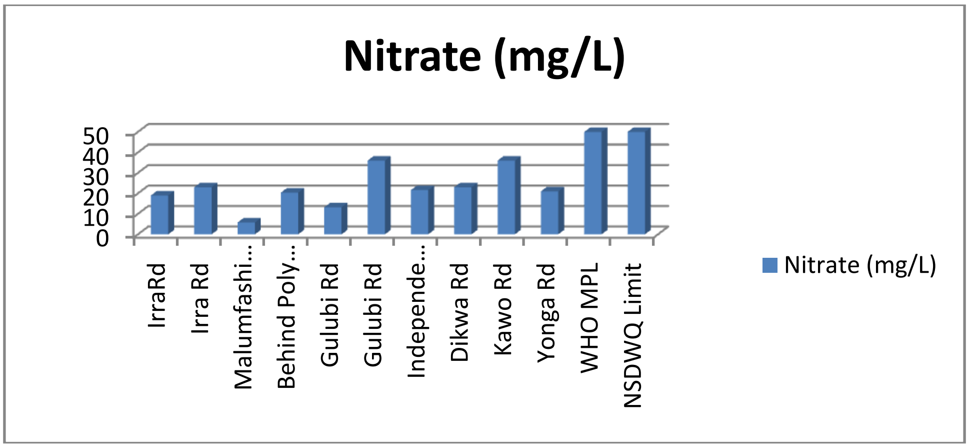

Fig 9: Nitrate values Compared with the standards

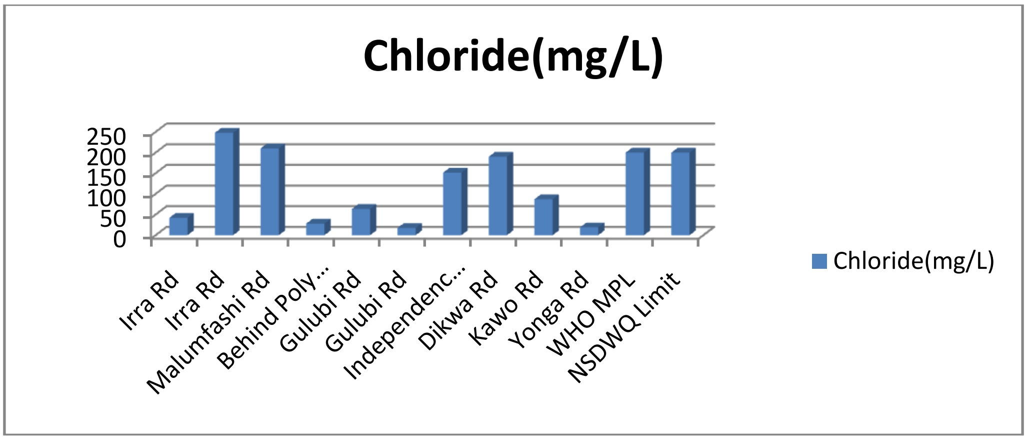

Fig 10: Chloride values Compared with the standards

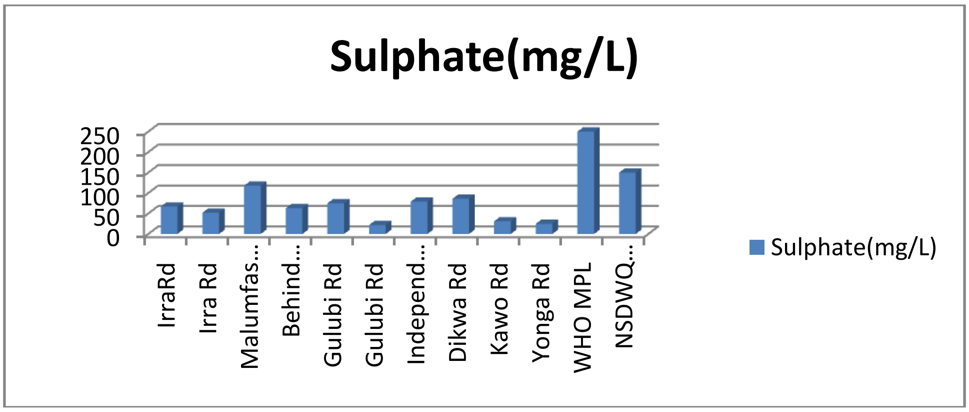

Fig 11: Sulphate values Compared with the standards

The table below gives the description of Cation parameters analysed with corresponding guidelines from both WHO(2012) and NSDWQ(2007)

Table 3: Cation Parameters

S/N	Location	Zn(mg/L)	Pb (mg/L)	Na (mg/L)	K(mg/L)	Ca(mg/L)	Mg(mg/L)
1	Irra Rd	0.1025	0.2433	147.38	43.1959	50.5806	16.5381
2	IrraRd2	0.1005	0.3785	185.082	21.8016	84.1544	19.3501
3	Malumfashi Rd	0.1021	0.539	157.888	41.2066	98.3349	13.464
4	Behind Poly Qtrs	0.1115	0.1936	504.502	32.4071	80.7444	11.0654
5	Gulubi Rd	0.0524	0.0461	40.3829	35.3044	84.6753	8.5536
6	GulubiRd2	0.0863	ND	18.295	7.9451	39.9417	9.5968
7	Independence Rd	0.0861	ND	75.8163	44.7966	60.676	14.8483
8	Dikwa Rd	0.1029	0.6579	103.527	33.2169	62.7945	20.397
9	Kawo Rd	0.1021	0.2185	33.052	24.6878	36.4295	7.1948
10	Yonga Rd	0.0955	0.0812	40.0067	22.911	79.2	8.6144
	WHO MPL	**5**	**0.01**	**200**		**75**	**50**
	NSDWQ LIMIT	**3**	**0.01**	**200**			

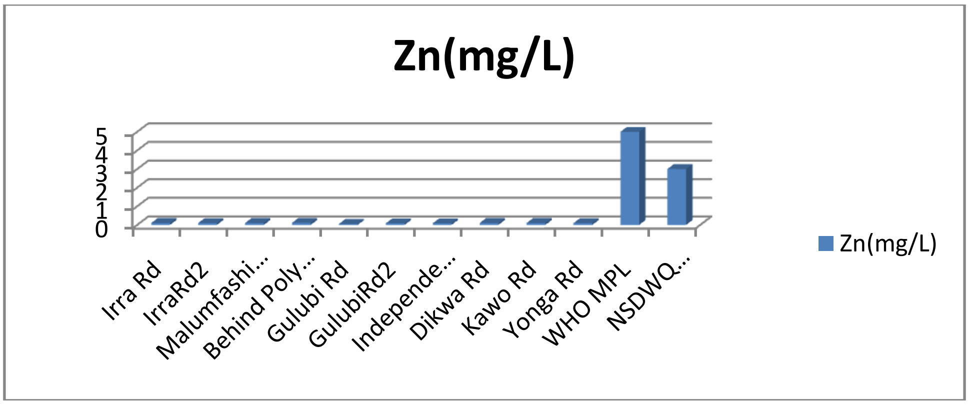

Fig 12: Zinc values Compared with the standards

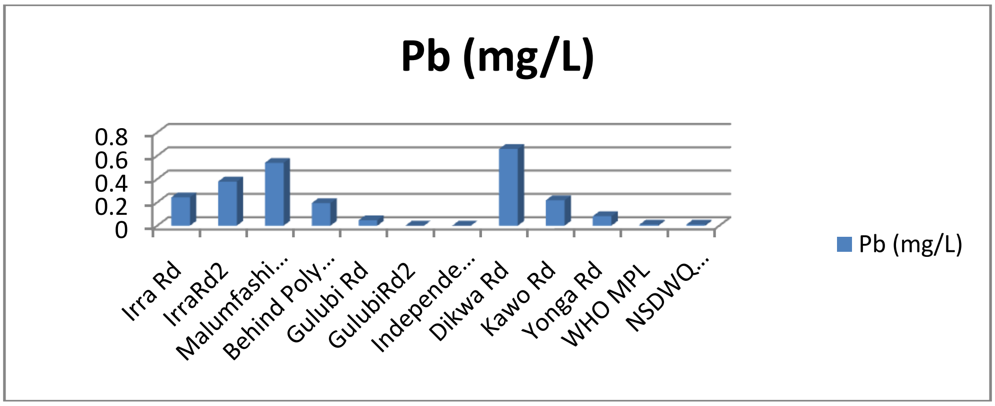

Fig 13: Lead values compared with the standards

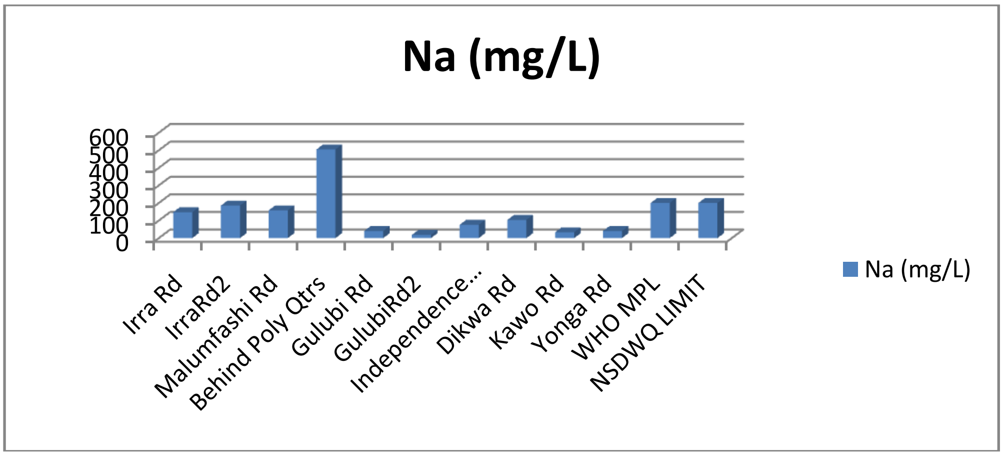

Fig 14: Sodium values compared with the standards

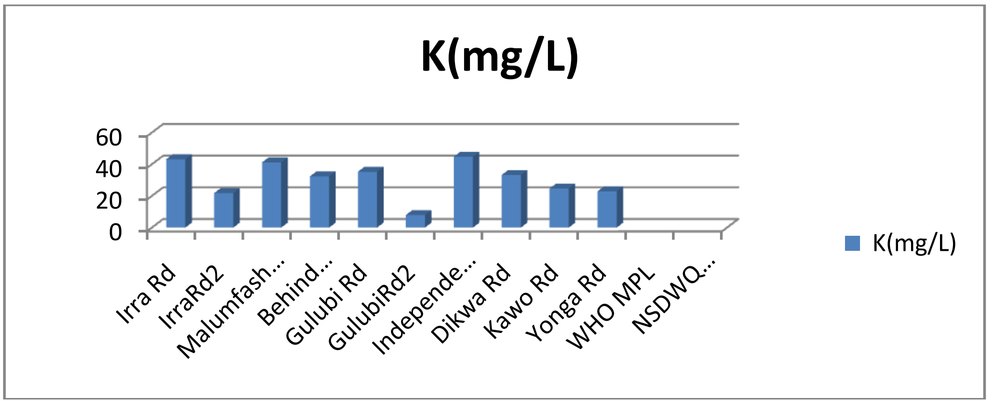

Fig 15: Potassium values compared with the standards

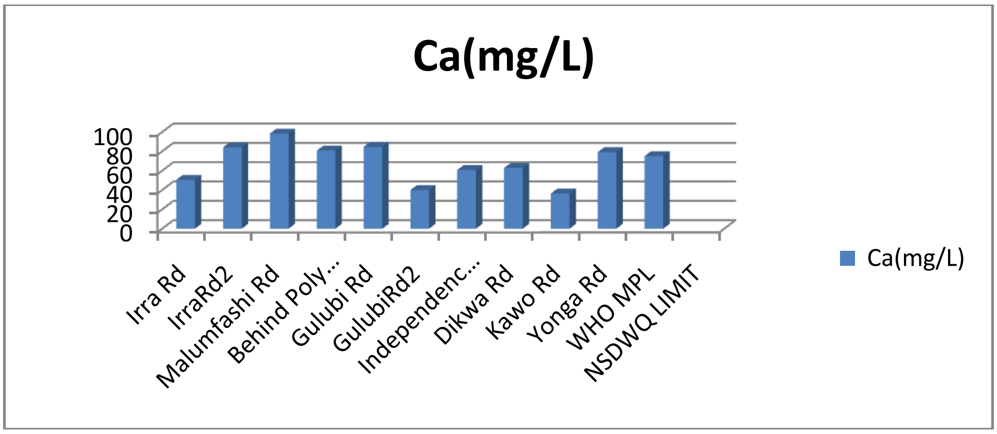

Fig 16: Calcium values compared with the standards

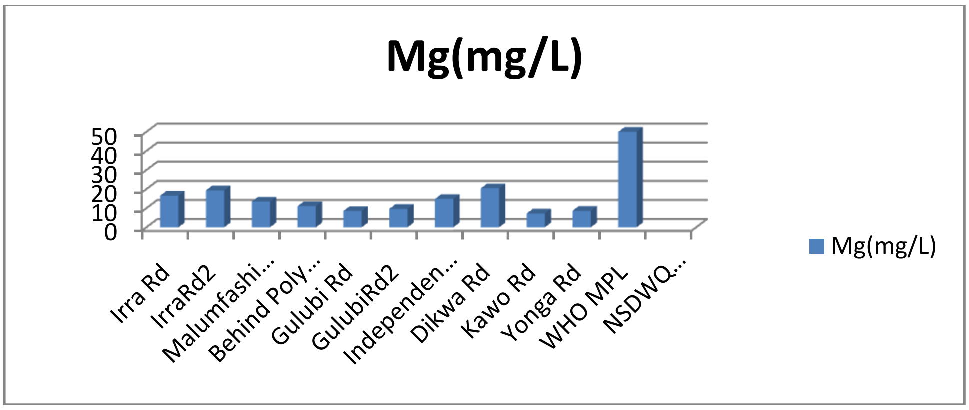

Fig 17: Magnesium values compared with the standards

IV. CONCLUSION AND RECOMMENDATION

The data collected were water samples from 10 selected hand-dug wells from the study area. Samples were only collected from hand dug wells because hand-dug wells are more prone to contamination than boreholes, and also hand-dug wells are domestically used than the boreholes in the study area. The 10 hands dug wells were chosen in order to get a good representation of the groundwater condition of the study area. Hand dug wells were chosen as the preferred groundwater because after a good reconnaissance survey of the area, it became clear that hand dug wells were mostly used in households for domestic uses in the study area. 18 groundwater quality parameters were used to assess the state of the groundwater in the study area.

The paper recommends that hand dug wells should be given properly covered in households in order to avoid harmful or unwanted substances from getting into the hand dug wells; Hand dug wells should not be built in close proximity to toilets, pit latrines and soak-away; It also recommends that Government should provide residents with potable water so as to reduce reliance on hand dug wells by the residents of the study area. Water should be regarded as human right that must be given to all residents.

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