Hydrogeology and Groundwater Quality of Deep and Shallow Boreholes in Kano Metropolis, Northwestern Nigeria

Tahir A.G. Garba M. L. Hamidu I.
Department of Geology, Ahmadu Bello University Zaria, Nigeria
E-mail of the corresponding author: andaza98@gmail.com

Abstract

The study area is located in the Kano Municipal. It is bounded by latitudes 11°51´ to 12°06´N and longitudes 8°23´ to 8°38´ E covering an area of about 770.063 Km^2. It lies on the average altitude of 478m above sea level, and is generally undulating lowland. The relief is greatly influenced by the geology; characterized by small, blocky and low laying outcrops. Twenty (20) samples of groundwater collected from the study area from both deep (about 200m) and shallow boreholes, following the standard procedure as prescribed by APHA Guidelines. The analysis was achieved using Atomic Absorption Spectrometer (AAS-Varian AA240Fs), Direct reading Photometer (Hanna model), Titrimetric method, and Flame photometer (FPF9 Jenwy model).The interpretation of groundwater chemistry of the samples suggest that most of the samples analysed are within the WHO and Nigerian Standards for drinking, while some have concentrations beyond desirable limits. However, the concentrations of some elements such as Pb, above permissible limits in the samples analyzed have created a concern over the suitability of the water for drinking and other domestic uses. The assessment of water for irrigation indicates that most of the samples are suitable for irrigational purposes. The result of the laboratory analysis revealed that the selected ions were present in varying concentrations in the study area. The chemical parameters of water samples from the boreholes were plotted using AquaChem and revealed interaction between the groundwater and aquifer materials, and identified important data trends and groupings.

Keywords: Water quality, analysis, WHO, SON, AquaChem, permissible limits, anion, cation, Kano.

1. Introduction

Groundwater is a vital resource, with a large fraction of the world's population relying on the resource directly or indirectly for livelihoods (Sanjay, 2010). Much of the groundwater can be said to be meteoric in origin, which is originating from the atmosphere. Also, a small percentage is known to enter the hydrologic cycle from subterranean sources and is described as juvenile water. This water includes water of magmatic and volcanic sources, while connate water is entrapped between the interstices of sedimentary formations.

The aim of evaluating ground water quality is to determine if it meets the requirements for its many different uses. Ground water quality can be affected or degraded as a result of human activities that introduce contaminants into the environment. It can also be affected by natural processes that result in elevated concentrations of certain constituents in the groundwater.

Recently, groundwater quality has become a matter of concern due to discharge of industrial and domestic effluents directly into both surface and underground, the use of agricultural chemicals, land use and cover changes. Thus water quality is influenced by many factors, including atmospheric chemistry, the underlying geology, climate change and anthropogenic activities. The quality of water should satisfy the requirements or standards set for specific uses, such as drinking, domestic, agricultural, industrial and recreational purposes.

2. Geology and Hydrogeology of the Study Area

Kano area is underlain by rocks of the Nigerian basement complex comprising migmatites-gneiss complex, younger metasediments, older and younger granites (Bala *et al*., 2011). MacDonald *et al*., (1986) established that, it is dominantly underlain by undifferentiated metamorphic suite, older granite, coarse pink granite and porphyritic biotite granite. The predominant rock type is older granite. The older granite is composed of coarse-grained granite, granodiorite, diorite and aplite. The lithological varieties are less common than in metamorphic suite, which were emplaced during the Pan African orogeny and was dated about 650-850 ma (Geological survey of Nigeria, 1994). The most abundant and typical member of the older granite suite is a coarse porphyritic granite (Oyawoye, 1972). It is typified by the abundant large feldspar set in a ground mass rich in biotite or hornblende. The feldspar may be white, purple, pink, yellowish brown and dark grey.

The schists are considered to be Upper Proterozoic supracrustal rocks which have been infolded into the migmatites-gneiss-quartzite complex (Obaje, 2009). They occupy an area within the ''walled city'' to the north central part of Kano. They are reddish to greenish grey in colour and highly weathered. They are found to be associated with diorite. This association indicates that schists have been intruded by small dioritic bodies, and are considered older than diorites in the area.

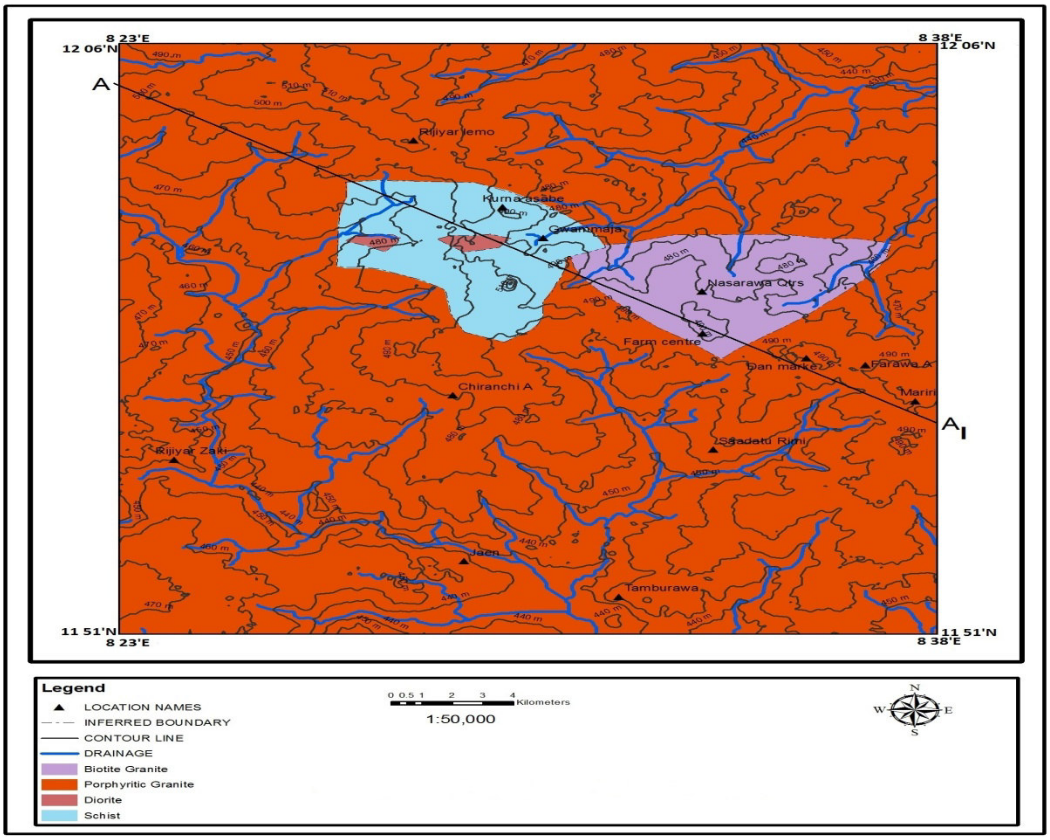

Fig. 1: Geological map of the study area

In the study area, groundwater occurs within the weathered mantle or in the joint and fracture systems of the unweathered or partly weathered rocks (MacDonald *et al*., 1986). Du preez and Barber, (1965) proposed that aquifer is located in the weathered mantle and fractured rock where permeability and porosity are sufficient to allow appreciable amount of water to accumulate in storage. The high groundwater yield in the area is found where thick overburden overlies fractured zones. The aquifer types described by Olorunfemi and Fasuyi (1993) from the study area include:-

- Weathered layer aquifer;
- Weathered/ fractured or partly weathered aquifer; and
- Fractured aquifer.

The older granite has been subjected to many tectonic movements and pressure through geologic history such that they often have several fracture lines.

3. Methodology

Twenty (20) water samples from boreholes in the study area were collected, and at each sampling point; P^H, Temperature, Total Dissolved Solids (TDS), and Conductivity parameters were measured directly in the field using Mi 806 (4 in 1) combined meter. This allows an initial, rapid assessment of water quality at the site of sampling. This was followed by the acidification of one set of the sample for the cation analysis with some few drops of Nitric acid (HNO_3) to prevent adsorption of ions on the walls of the containers, similarly to prevent bacterial activities. The sample was labeled and stored in container containing ice blocks before taken to the laboratory for analysis.

The samples were analysed at the Multi-user laboratory, Department of Water Resources & Environmental Engineering, and Multi-purpose laboratory, in the Department of soil Science, ABU, Zaria.

The result of the chemical analysis of water samples from the boreholes were plotted using AquaChem software developed specifically for graphical and numerical analysis and modeling of water quality data.

4. Results and Discussion

Table 1: Physical parameters

S/N	Location	Coordinates	Elevation (m)	Bh depth (m)	P^H	Temp. (^{0}C)	Electr. Cond. mS/(uS/cm)	TDS ppt/ (mg/l)	Sample ID
1	Fortia	11^{0}58′38″N 08^{0}33′01″E	493	148	6.56	33.8	0.59/590	0.34/340	KN 1
2	Farm Centre	11^{0}57′56″N 08^{0}34′51″E	492	175	7.25	36.5	0.17/170	0.09/ 90	KN 2
3	Capital Road	11^{0}51′40″N 08^{0}30′53″E		180	6.94	34	0.14/140	0.07/70	KN 3
4	Magwan	11^{0}51′40″N 08^{0}30′53″E	496	170	6.50	32.7	0.27/270	0.15/150	KN 4
5	A.M. Bindawa, R/lemo	12^{0}04′10″N 08^{0}28′06″E	492	200	5.75	37.4	1.04/1040	0.58/580	KN 5
6	FTZ, Fanisau	12^{0}04′31″N 08^{0}30′06″E	475	190	6.55	41	0.27/270	0.15/150	KN 6
7	Nasiru Ahali	12^{0}02′44″N 08^{0}28′49″E	493	180	7.45	37.4	0.21/210	0.11/110	KN 7
8	G/w R/lemo	12^{0}02′31″N 08^{0}29′02″E	491	160	5.89	33.1	0.24/240	0.13/130	KN 8
9	Brigade	12^{0}03′05″N 08^{0}34′31″E	459	170	5.90	33.1	1.70/1700	0.96/960	KN 9
10	Al-furqan	11^{0}50′35″N 08^{0}29′51″E		130	6.20	33.4	0.87/870	0.49/490	KN 10
11	Filin cashew	11^{0}57′38″N 08^{0}34′02″E	442	36	5.87	30.9	0.76/760	0.42/420	KN 11
12	Naibawa	11^{0}55′39″N 08^{0}33′06″E	475	27	6.13	31.9	0.31/310	0.17/170	KN 12
13	Karkasara	11^{0}57′02″N 08^{0}32′52″E	470	32	6.80	31	1.32/1320	0.75/750	KN 13
14	Gandun Albasa	11^{0}58′33″N 08^{0}31′02″E	484	36	7.02	30.8	0.59/590	0.33/330	KN 14
15	Kabuga	11^{0}58′59″N 08^{0}28′37″E	467	40	5.93	31.3	0.66/660	0.37/370	KN 15
16	Goron Dutse	12^{0}00′18″N 08^{0}29′51″E	493	50	5.72	34.3	0.44/440	0.25/250	KN 16
17	Dakata	12^{0}01′41″N 08^{0}34′26″E	473	56	5.79	31.9	0.34/340	0.19/190	KN 17
18	Yankaba	12^{0}00′04″N 08^{0}35′09″E	475	55	6.11	33.9	0.53/530	0.30/300	KN 18
19	GGSS Mariri	11^{0}56′53″N 08^{0}36′48″E	483	36	5.95	32.7	0.22/220	0.12/120	KN 19
20	NNPC Hotoro	11^{0}57′49″N 08^{0}34′43″E	486	34	5.91	31.1	0.49/490	0.27/270	KN 20

The electrical conductivity measured from the deep boreholes in the study area ranges from 140-1700 uS/cm, with an average of 550 uS/c m (Table 1 and 2). The range falls within the maximum permissible limit of the Nigerian Standards for Drinking Water; except two samples KN 5(A.M.Bindawa) and KN 9 (Brigade) that have values above maximum permissible limit. For shallow boreholes sampled, they ranges from 220-1320 uS/cm, with an average of 566 uS/c m, here one sample KN13 (Karkasara) is above the maximum permissible unit.

According to (WHO 2003 and 2011), the desirable limit for P^H of water for drinking and domestic use is 7.0-8.5, while the permissible limit 6.5-9.2. Most of the deep boreholes have P^H within the permissible limit, except KN 5(A.M. Bindawa), KN 8 (Gidan wanka), KN 9Brigade) and KN 10 (Alfurqan) with weakly acidic P^H . For shallow boreholes, only two (2) i.e. KN 13 Karkasara) and KN 14 (Gandun albasa) have a P^H within the permissible limit of WHO, the remaining eight (8) are not within the permissible limit.

Most of the boreholes sampled have a temperature typical of ambient condition. However, four (4) deep boreholes shows a slightly high temperature; KN 2(Farm centre) (36.5^{0}C), KN 5 (A.M.Bindawa) (37.4^{0}C), KN 6 (FTZ Fanisau) (41^{0}C) and KN 7 (Nasiru Ahali) (37.4^{0}C). It could be due to their depth; 175m, 200m, 190m, and 180m respectively.

The mineralisation (TDS) of groundwater in the boreholes sampled from the study area range from 70 mg/l to 960 mg/l with an average of 307 mg/l for deep boreholes. For shallow boreholes the TDS values range from 1200 mg/l to 750 mg/l with an average of 317 mg/l. Therefore, the water sampled from those boreholes within the study area good for drinking, as they are within maximum permissible limit.

Table 2: Results of Water quality analyses of samples in the Study area (Cations)

S/N	Sample ID	Location	Coordinates	Depth (m)	Ca^+ mg/l	Na^+ mg/l	K^+ mg/l	Fe^{3+} mg/l	Mg^{2+} mg/l	Cu^{2+} mg/l	Zn^{2+} mg/l	Cr mg/l	Ni mg/l	Cd mg/l	Mn^+ mg/l	Pb mg/l
1	KN 1	Fortia	11^{0}58′38″N 08^{0}33′01″E	148	30.978	42	4.2	**0.178**	7.855	0.003	**0.0997**	0.000	0.009	0.004	0.000	**0.133**
2	KN 2	Farm Centre	11^{0}57′56″N 08^{0}34′51″E	175	9.511	13	5.4	**0.238**	2.565	- 0.005	**0.0725**	0.000	0.006	0.001	0.000	**0.094**
3	KN 3	Capital Road	11^{0}51′40″N 08^{0}30′53″E	180	8.969	6.6	4.4	**0.151**	2.659	0.000	**0.0924**	0.028	0.012	0.001	0.000	**0.093**
4	KN 4	Magwan	11^{0}51′40″N 08^{0}30′53″E	170	14.918	20	3.2	**4.697**	2.706	0.006	**19.2005**	0.025	0.005	**0.004**	0.321	**0.180**
5	KN 5	A.M. Bindawa	12^{0}04′10″N 08^{0}28′06″E	200	**106.964**	38	**18**	0.074	11.240	0.007	0.0128	0.000	0.002	**0.005**	0.038	**0.137**
6	KN 6	FTZ, Fanisau	12^{0}04′31″N 08^{0}30′06″E	190	9.670	14	**19**	0.116	3.170	0.008	**0.0326**	0.036	0.006	**0.004**	0.000	**0.103**
7	KN 7	Nasiru Ahali	12^{0}02′44″N 08^{0}28′49″E	180	4.545	12	7.4	0.055	3.048	0.005	0.0003	**0.072**	0.011	**0.004**	0.000	**0.110**
8	KN 8	G/w, R/lemo	12^{0}02′31″N 08^{0}29′02″E	160	6.041	15	8.5	0.080	3.629	0.008	0.0000	**0.079**	0.0000	**0.005**	0.000	**0.097**
9	KN 9	Brigade	12^{0}03′05″N 08^{0}34′31″E	170	**212.911**	**78**	**16**	0.024	18.376	0.012	0.0673	0.031	0.001	**0.004**	0.131	**0.089**
10	KN 10	Al-furqan	11^{0}50′35″N 08^{0}29′51″E	130	91.726	43	6.0	0.035	19.972	0.005	0.0103	**0.062**	0.000	**0.006**	0.000	**0.123**
11	KN11	Filin cashew	11^{0}57′38″N 08^{0}34′02″E	36	47.634	40	20	0.032	9.042	0.000	0.0206	0.047	0.012	0.007	0.000	**0.104**
12	KN12	Naibawa	11^{0}55′39″N 08^{0}33′06″E	27	9.168	24	14	0.031	3.688	0.009	0.0261	0.063	0.011	0.006	0.000	**0.116**
13	KN13	Karkasara	11^{0}57′02″N 08^{0}32′52″E	32	87.898	126	1.3	0.028	14.356	0.000	0.0199	**0.091**	**0.022**	0.007	0.007	**0.112**
14	KN14	Gandun Albasa	11^{0}58′33″N 08^{0}31′02″E	36	27.170	44	7.6	0.036	7.004	0.009	0.0072	0.027	0.003	0.005	0.000	**0.121**
15	KN15	Kabuga	11^{0}58′59″N 08^{0}28′37″E	40	31.647	53	**28**	0.061	6.016	0.051	0.0286	0.000	0.021	0.005	0.000	**0.092**
16	KN16	Goron Dutse	12^{0}00′18″N 08^{0}29′51″E	50	12.256	24	**46**	0.015	4.819	0.000	0.0239	0.044	0.012	0.007	0.000	**0.078**
17	KN17	Dakata	12^{0}01′41″N 08^{0}34′26″E	56	9.524	25	14	0.036	2.910	0.000	0.0082	0.000	0.006	0.005	0.000	**0.070**
18	KN18	Yankaba	12^{0}00′04″N 08^{0}35′09″E	55	31.946	20	7.2	0.016	6.698	0.005	0.0324	0.000	**0.035**	0.008	0.000	**0.089**
19	KN19	GGSS Mariri	11^{0}56′53″N 08^{0}36′48″E	36	2.868	26	18	0.025	0.864	0.000	0.0111	0.122	**0.022**	0.009	0.000	**0.091**
20	KN20	NNPC Hotoro	11^{0}57′49″N 08^{0}34′43″E	34	21.937	27	8.5	0.014	5.738	0.000	0.0126	0.109	0.019	0.011	0.000	**0.073**

Journal of Environment and Earth Science www.iiste.org
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.1, 2015

Table 3: Results of Water quality analyses of samples in the study area (Anions)

S/N	Sample ID	Location	Coordinates	Depth (m)	HCO_3^{2-} mg/l	SO_4^{2-} mg/l	NO_3^- mg/l	CO_3^- mg/l	Cl^- mg/l
1	KN 1	Fortia	11⁰58′38″N 08⁰33′01″E	148	1.0	20.5	11.0	0.00	0.02
2	KN 2	Farm Centre	11⁰57′56″N 08⁰34′51″E	175	1.2	21.2	12.3	0.00	0.02
3	KN 3	Capital Road	11⁰51′40″N 08⁰30′53″E	180	0.6	18.5	10.7	0.00	0.00
4	KN 4	Magwan	11⁰51′40″N 08⁰30′53″E	170	1.5	22.4	13.2	0.2	0.04
5	KN 5	A.M. Bindawa	12⁰04′10″N 08⁰28′06″E	200	2.1	20.5	10.2	0.4	0.02
6	KN 6	FTZ, Fanisau	12⁰04′31″N 08⁰30′06″E	190	3.2	18.2	12.6	0.00	0.04
7	KN 7	Nasiru Ahali	12⁰02′44″N 08⁰28′49″E	180	2.5	22.5	18.3	0.00	0.03
8	KN 8	G/w R/lemo	12⁰02′31″N 08⁰29′02″E	160	1.7	30.5	26.2	0.00	0.00
9	KN 9	Brigade Market	12⁰03′05″N 08⁰34′31″E	170	2.6	19.5	16.8	0.00	0.02
10	KN 10	Al-furqan	11⁰50′35″N 08⁰29′51″E	130	3.5	20.2	14.3	0.00	0.00
11	KN 11	Filin cashew	11⁰57′38″N 08⁰34′02″E	36	1.2	15.0	9.8	0.00	0.00
12	KN 12	Naibawa	11⁰55′39″N 08⁰33′06″E	27	0.9	15.5	11.8	0.00	0.00
13	KN 13	Karkasara	11⁰57′02″N 08⁰32′52″E	32	0.9	60.0	**49.4**	0.00	0.00
14	KN 14	Gandun Albasa	11⁰58′33″N 08⁰31′02″E	36	6.8	19.5	16.6	0.00	0.02
15	KN 15	Kabuga	11⁰58′59″N 08⁰28′37″E	40	2.2	12.2	7.4	0.00	0.00
16	KN 16	Goron Dutse	12⁰00′18″N 08⁰29′51″E	50	1.4	20.4	11.8	0.00	0.03
17	KN 17	Dakata	12⁰01′41″N 08⁰34′26″E	56	1.0	20.2	11.9	0.00	0.00
18	KN 18	Yankaba	12⁰00′04″N 08⁰35′09″E	55	1.3	21.5	14.5	0.00	0.00
19	KN 19	GGSS Mariri	11⁰56′53″N 08⁰36′48″E	36	1.2	25.0	18.6	0.00	0.04
20	KN 20	NNPC Hotoro	11⁰57′49″N 08⁰34′43″E	34	1.2	20.5	15.3	0.2	0.03

The high concentrations of some metals could be due to weathering of rocks in the area. High concentrations of Pb and Cd may results from discharge of wastes from industries. The analysis of eleven (11) groundwater samples from the area by Iliyasu (2014) indicates a concentration above permissible limits of heavy metals (As, Cr, Pb, U, Co, Ni, Mn, and V) in at least five (5) samples. He attributed it to discharge of wastes from industries into Kano and Challawa Rivers, which in turn recharges the aquifers mostly during the dry season. The low values of Cl ion from the study area could be due to the indirect method of analysis used for Cl^- during the analysis. According to Fetter (2001), indirect method of analysis tends to produce low values of mineralization. Direct method does not includes pre-dilution of the samples, while in indirect method samples are diluted before analysis, which sometimes interfere with the results.

To determine the variation in the groundwater chemistry based on the lithology of the area where the boreholes were sampled; three groups of water facies were identified. Each member in a group is similar to each other, but distinct from other groups. Water types are used to understand the controlling factors of the water Chemistry. The water types in the area are as follows:-

1. Na-Ca-SO_4 (Biotite granite)
2. Ca-Na-SO_4 (Porphyritic granite)

3. K-Na-Ca-SO_4 (Schist)

The three (3) groups shown above represent trends between the water facies observed in the study area. Group 1 is characterized by enrichment in Na and Ca. The Na is believed to have been released into the water by weathering of plagioclase feldspars. Group 2 is rich in Ca and Na. The rock type is affected by intense weathering and fracturing, hence groundwater is actively being mixed. Group 3 is distinguished by higher K. It could be released by weathering of orthoclase and microcline feldspars. The change in water chemistry in the study area is as a result of increasing rock-water interactions along hydrological flow paths.

Piper Plot

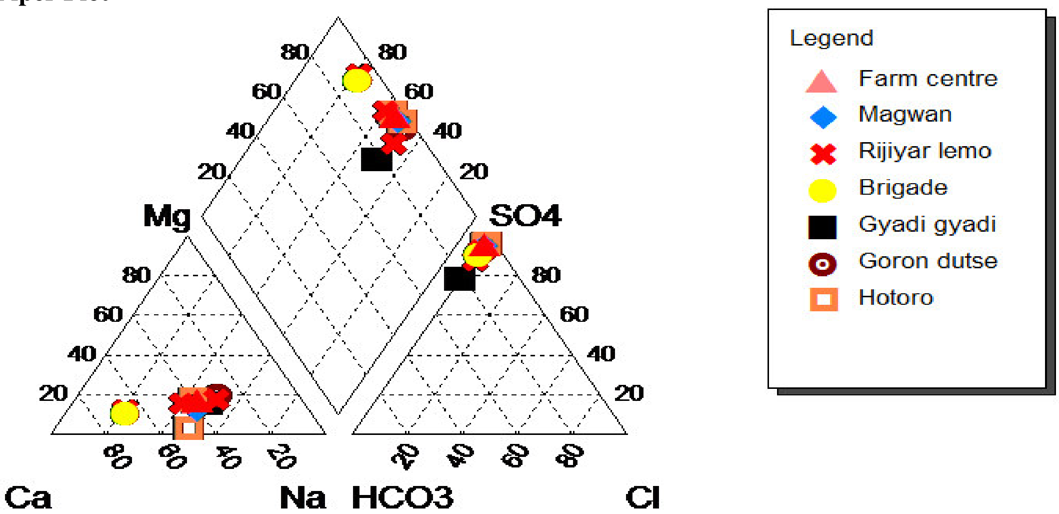

Figure 2: Piper Trilinear Plot showing different water facies in the study area.

In the above plot, trends in major ions were observed; major cations are Na, and Ca, while the major anion is SO4.

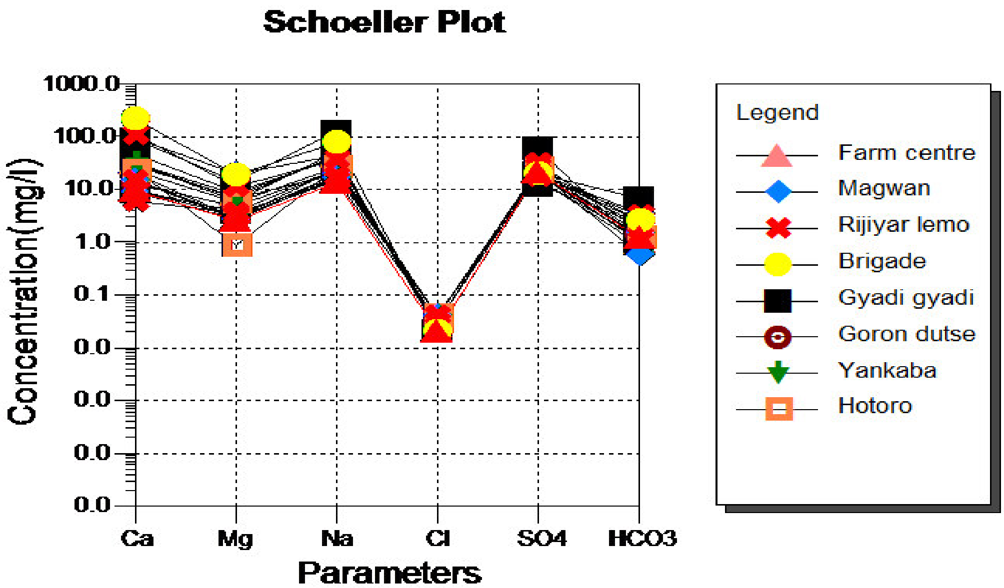

Figure 3: Schoeller plot showing concentration of major ions in the study area.

The above plot displays actual concentrations of the major cations and anions analysed. From the plot, Ca has the highest concentration ranging from < 10 mg/l to about 300 mg/l. Mg ranges from <1 mg/l to about 20 mg/l. Na has a concentration from about 10 mg/l to over 100 mg/l. SO_4 concentration ranges from 10 mg/l to about 100 mg/l. HCO_3 have concentration from <1 mg/l to about 10 mg/l. The ion with least concentration is Cl with < 1mg/l.

Wilcox Plot

A Wilcox plot can be used to quickly determine the viability of water for irrigation purposes. The Wilcox plot has the following sections:

Conductivity (us/cm)

C1: Low (0-249) (Excellent for irrigation);

C2: Medium (250-749) (Good for irrigation);

C3: High (750-2249) (Moderately good for irrigation); and
C4: Very High (2250-5000).

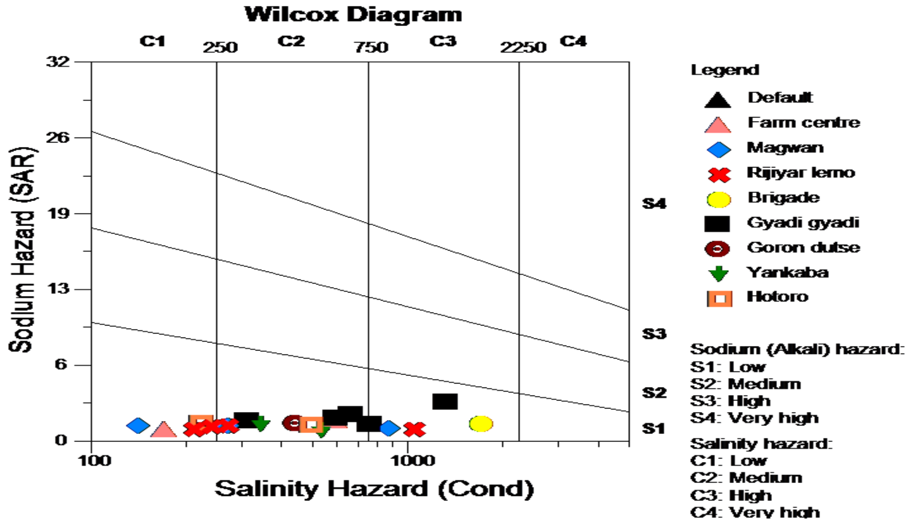

Figure 4: Piper Wilcox Diagram showing suitability of water for irrigation.

Using the Wilcox diagram plotted above, and conductivity values of the samples presented in table12 and 13; the salinity hazard of the samples from the study area can be classified as follows:-

1. C1: KN2 (New layout), KN3 (Kano capital Rd), KN4 (Magwan), KN6 (FTZ Fanisau), KN7 (Nasiru Ahali), KN8 (Gidan wanka), and KN19 (Mariri). They are excellent for irrigation.
2. C2: KN1 (Fortia), KN12 (Naibawa), KN14 (Gandun albasa), KN15 (Kabuga), KN16 (Goron Dutse), KN17 (Dakata), KN18 (Yankaba) and KN20 (NNPC Hotoro). These are considered good for irrigation.
3. C3: KN5 (A.A. Bindawa), KN9 (Brigade), KN10 (Alfurqan), KN11 (Filin cashew) and KN13 (Karkasara). These are regarded as moderate for irrigation.

References

Bala, A.E., Eduvie, O.M., and Byami J. (2011). Borehole depth and regolith aquifer hydraulic characteristics of bedrock types in Kano area, Northern Nigeria. *African Journal of Environmental Sciences and Technology* Vol. 5(3), pp. 228-237.

Dupreez, J.W. and Barker, W. (1965). The distribution and chemical quality of Groundwater in northern Nigeria. Geological Survey of Nigeria Bulletin

Geological Survey of Nigeria (1994). Geological Map of Nigeria. Federal Ministry of Mines and Steel, Nigeria.

Iliyasu, G. (2014). Hydro geochemistry of Kano River from Its Headstream down to Hadejia-Nguru Wetland, Northwestern Nigeria. Unpublished PhD thesis, Geology Department, Ahmadu Bello University Zaria, pp 51-61.

MacDonald and Partners (1986). Rural water Supplies Report, Vol. 1 (Published).Sir MacDonald Press Ltd, Deterner, England.

Mukhtar, I. (2011). A Comparative Analysis of Water Quality in the Kano River and the New Tamburawa Treatment Plant in Kano, Nigeria. Unpublished Msc thesis, Geography Department Ahmadu Bello University Zaria, pp 26-40.

NIS (2007): Physical/Organoleptic Parameters.

Nigerian Industrial Standard Nigerian Standard for Drinking Water Quality p.554

Specialized Modules-Water Supply (2010). Induction Course for New Entrants into the Water sector. National Water Resources Institute, Kaduna, pp 94-110.

Obaje, N.G. (2009).Geology and Mineral Resources of Nigeria. Springer-Verlay Berlin.pp 19-20.

Olorunfemi, M. O. and Fasuyi, S.A. (1993).Aquifer types and geoelectric/hydrogeologic characteristic of part of the central basement terrain. *Journal of mining geology* 16, pp 309-317.

Oyawoye, M.O. (1972). The basement complex of Nigeria. In Dessauvagie F. and Whiteman J. Africa Geology. University Press Ibadan, pp 18-27.

Sanjay P. (2010). Deep Wells and Prudence: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India. Published by World Bank, pp1-19.

Schoeneick, K. (2001).Water quality. Lecture notes for postgraduate students of hydrogeology A.B.U. Zaria.

SON 2007. Nigerian Standards for Drinking Water. UNICEF Handbook on Water Quality (2008). New York.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar