Assessment of thePhysico-chemical Characteristics of drinking water in Obajana, Kogi State, Nigeria

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ABSTRACT: To better assess the quality of drinking water around Obajana Kogi State Nigeria, certainphysic-chemical factors such as pH, temperature, conductivity, total dissolve solids (TDS) and depth to static water level (DSWL) were considered. These factors were determined insitu with standard measuring devices for both wet and dry seasons. The DSWL is a direct function of ground water movement. The water table contour overlaid on a slope map of the area shows great correlation as water is seen to move from zones of steep slope to relatively flat land. The results indicates more chemical interaction of elements during the dry seasons due to higher temperatures and more dissolved solids in groundwater during the wet season probably attributed to weathering intensity. The physico-chemical analyses carried out shows low to medium PH value around 5.1 to 8.1 indicating slightly acidic to alkaline environment which is in the acceptable WHO range for drinking water.

Keywords: Ground Water, Pysico-chemical Properties, Water Quality.

I. INTRODUCTION

The study area is located in Kogi State, North-Central Nigeria. It is bounded by the following coordinates; Obajana lies within longitude 6°24'E to 6°27'E and latitude 7°54'N to 7°56'N (fig.1). The Area is Accessible by a major road linking Abuja, Okene and Lagos with a complex system of minor roads and footpaths linking the various communities together (fig.2). The climate is characterized by two distinct seasons; rainy and dry seasons. The rainy season starts in April and end September. The peak of the rainfall is in July/August. Temperatures vary between 30 ^{0}C and 35 ^{0}C. The coldest temperatures are experienced during the harmattan periods when temperatures drop as low as 18^0 C. During the harmattan, the winds are cold, dry, dusty and strong. The hot season starts in March and ends in May.The stability of an ecosystem to support life forms depends to a great extension the physico-chemical properties of its various water bodies(Aremu*et al.*, 2011). The determination of these physicochemical properties (temperature, conductivity, total dissolved Solids (TDS), turbidity, alkalinity/acidity (pH) and total hardness) are key factors in water quality monitoring (Edimeh*et al.*, 2011). Developing countries experiencing rapid industrial growth are most vulnerable [W. K. Kadongola, M.Sc. Thesis, University of Botswana, Botswana, 1997]. Wetzel (1975) also made it clear that both physicochemical and geochemicalfactors influence the ecosystem. Water serves as a solvent for numerous interactions between physical and chemical factors within an ecosystem hence, it is imperative to always assess the quality of the drinking water in any given area.

II. GEOLOGY

The study area lies within the Benin-Nigeria shield (Fig. 3), situated in the Pan-African mobile zone extending between the ancient Basements of West African and Congo Cratons in the region of Late Precambrian to Early Palaeozoicorogenies (Rahaman, 1976; Odigi, 2002 and Ekwueme, 2003). The Basement Complex rocks of Nigeria are composed predominantly of migmatite gneiss complex; slightly migmatised to unmigmatisedparaschists and metaigneous rocks; charnockitic, older granite suites and unmetamorphosed dolerite dykes. (Rahaman, 1976).The Precambrian Basement rocks of Obajana area, South-western Nigeria comprise of schists and gneisses which have been subjected to major supracrustal tectonic events such as the Dahomeyan (3000± 200Ma), Eburnean (1850 ± 250Ma), Kibaran (1000± 100Ma), and Pan-African (550± 100Ma). (Ezepue and Odigi, 1993). The Obajana gneisses comprise of three types of rocks designated as quartz-biotite gneiss; quartz-biotite-hornblende-pyroxene gneiss and quartz- biotite-garnet gneiss (Odigi and Ezepue, 1993; Ezepue and Odigi, 1994; Odigi, 2002). According to these authors, igneous rocks of this area occur as small, circular to oval outcrops and include members of the older granite suite mainly Granites, Granodiorites and Syenites while associated Schists in the area are: Quartz-biotite Schist, Amphibolite Schist, Muscovite schist and Quartzitic. Also, the geologic structures around Obajana represent NE-SW, NW trend (Ejueyitsi et al., 2015).

III. MATERIALS AND METHODS

All Physicochemical properties of accessible water sources within the study area were determined insitu using Hanna Portable Conductivity, Temperature, pH and TDS meter with their locations and sources properly recorded. The most common drinking water sources are mostly hand dug wells ranging from 5 to 12 meters and slightly above 1m in diameter.50 water sources were chosen for both the dry and wet season which included 27 hand dug wells, 17 stream channels, 5 boreholes and a dam. The results are presented in Tables 1 to 4.

The depth to surface water level (DSWL) was determined with a measuring tape for each hand dug well to enable the plotting of a ground water movement trend.Figure 4 shows a cross section of the hand dug well indicating DSWL. Both physicochemical parameters and DSWL values were determined during the peaks of the dry and wet seasons (December and August). ArcGIS was used to produce the slope map of the area and the overlay analysis of the on slope in a GIS environment.The locations of determination of each geophysical parameter were plotted on the satellite image to help in environmental study of the area (Fig. 3). Also, sample locations were plotted on the satellite image (SPOT 5 image) of the area.

IV. RESULTS PRESENTATIONS

The result of the physic-chemical analysis carried out on drinking water around Obajana is shown in Table 1, 2, 3 and 4. The surface waters seem to have higher TDS, temperature and pH values compared to the ground water. In the same vein, water from hand dug wells recorded higher TDS, temperature and pH values when compared toboreholes. On the average, the temperature level of the water sample is 25 degrees Celsius. Generally, the pH levels ranges from 5.3 to 9.0 while the total dissolved solids (TDS) which is a product of conductivity in the study area ranges from 100 to as high as 700mg/l. The slope analysis shows the steepest slope to be around 30m.

V. DISCUSSION

Generally, the pH level ranges from 5.3 to 9.0 indicating a slightly acidic to alkaline environment. According to

Omada et al, 2011, strongly acidic or strongly alkaline water are hazardous to humans, animals and plants because, such water burns skin, tissue and organs.Temperature in the area is between 20 to 30 degrees Celsius for both dry and wet season. High temperature could increase the rate of chemical interaction.The total dissolved solids (TDS) which is a product of conductivity in the study area ranges from 100 to as high as 700mg/l. The analysis indicates more dissolved solids in drinking water during the wet season,this could be due to the amount of dissolved elements in rain water which could be attributed to weathering intensity and the increased amount of ground recharge.

Water table ranges between 5.1m to 8.3m during the wet season and between 0.8m to 6.4m during the dry season showing high underground movement of water during the wet season. The ground water contour map for flow directions (fig. 6) further illustrates a semi anticlockwise movement of ground water for both wet and dry season. Pollutants from a particular source can easily be carried to other parts.

VI. CONCLUSIONS

The study reveals that the sources of drinking within the study area are more liable to interact with contaminants during the wet season than in the dry season. The water table map shows that pollutants could migrate from the mines and factoryto the surrounding environment.Based on the physico-chemical analyses carried out drinking water from boreholeswithin Obajana shows low contamination as

ISSN 2229-5518

compared to water from hand dug wells, dam and river channels. Water from boreholes around Obajanaare nontoxic hence, recommended for drinking.

REFERENCES

[1]. Aremu, M. O. Olaofe, O. Ikokoh, P. P &Yakubu, M. M. (2011) physicochemical characteristics of strem, well and borehole water soures in Eggon, Nasarawa State, Nigeria. Journal Chemical Society Nigeria, 36 (1), 131-136.

[2]. Edimeh, P. O., Eneji, I. S., Oketunde, O. F. &Sha'ato, R. (2011). Physico-chemical parameters and some Heavy metals content of Rivers Inachalo and Niger in Idah, Kogi State. Journal Chemical Society Nigeria 36 (1): 95-101.

[3]. Ejueyitsi, O. E., Ugwu, S.A. and Opara, A.I., (2015).Aeromagnetic Interpretation of KABBA (Sheet 246) KOGI State, Nigeria. International Journal for Research in Emerging Scince and Technology, Volume-2, Issue-8

[4]. Ekwueme, B. N., (2003). The Precambrian geology and evolution of the south western Nigerian Basesment Complex; University of Calabar press

[5]. Etu-efeotor, J. O., Akpokodje, E. G., Ike, E. C. and Njoku, C. O., (1989): Report of the multi- disciplinary Task Force on non-metallic mineral Raw material for Nigerian industries, pp290.

[6]. Ezepue, M. C. and Odigi, M. I., (1994): Journal of mining and geology, vol. 29 No.1 and vol. 30, No.1, pp1-9

[7]. NGSA, 2004 geology map of Obajana.

[8]. Odigi, M. I. and Ezepue, M. C., (1993): Journal of mining and geology, vol. 29 (1), pp41-50

[9]. Odigi, M. I., (2002). Journal of mining and geology, vol. 38 (2), pp81-89

[10]. Omada, J. I., Omatola, D. O. And Omali, A., (2011). Physico-Chemical Characteristics of Surface and Groundwater in Anyigba and lts Environs, Kogi State, Nigeria Journal of the Nigerian Association of Hydrogeologists, Vol 21, November,2011, pp 18 – 25.

[11]. Rahaman M.A., 1988, Recent advances in the study of the basement complex of Nigeria. In: Geological Survey of Nigeria (ed) Precambrian Geol Nigeria, pp 11–43

[12]. Rahaman, M. A., (1976) Review of basement geology of southwestern Nigeria: In geology of Nigeria (C. A. Kogbe, Ed.). Elizabethan publishing Co., Lagos.

[13]. WHO (2003) Iodine in drinking-water.Background document for preparation of WHO Guidelines for drinking-water quality.Geneva, World Health Organization (WHO/SDE/WSH/03.04/46).

Table 1.Physicochemical properties of surface water during the dry season

Sample ID	long	lat	Description	Location	Tempt oC	Conductivity (µs/cm)	TDS (Mg/L)	pH	Elevation (m)
J5	6.446	7.902	River channel	No1 market	28	5	500	7.7	156
J13	6.391	7.915	River channel	Iwa	27	1	100	6.3	175
J14	6.43	7.99	River channel	Chokochoko	27	1	100	6.4	274
J23	6.439	7.92	River channel	Iwa	27	7	700	5.3	263
J30	6.459	7.962	River channel	Oyo	28	2	200	7.6	184
J35	6.344	7.929	River channel	Iwa	28	5	500	6.1	359
J38	6.445	8.027	River channel	Jakura	25	5	500	7.1	169
J41	6.392	8.009	River channel	Jakura	27	4	400	6.2	152
J45	6.347	7.997	River channel	Jakura	28	3	300	7.2	349
J46	6.335	7.979	River channel	Jakura	28	2	200	5.1	317
J48	6.387	7.97	River channel	Jakura	29	5	500	5.2	256
J21	6.425	7.933	Dam	Iwa	26	6	600	5.5	345
J22	6.43	7.933	Downstream dam	Iwa	26	5	500	7.6	285
J26	6.437	7.936	River channel	Iwa	27	4	400	5.9	239
J37	6.347	7.949	River channel	Jakura	28	5	500	5.2	182
J33	6.349	7.891	River channel	Jakura	26	4	400	8.1	306
J34	6.353	7.915	River channel	Jakura	26	5	500	7.9	149
J36	6.335	7.928	River channel	Jakura	28	6	600	6.9	171

Table 2.Physicochemical properties of ground water during the dry season

Sample ID	long	lat	Location	Description	Tempt oC	Conductivity (µs/cm)	TDS (Mg/L)	pH	DSWL(m)	WTS (m)	TD (m)
J2	6.456	7.878	No1. Market	Hand dug well	28	3	300	7.4	1.2	3.2	10
J3	6.456	7.887	No1. Market	Hand dug well	27	3	300	6.9	0.7	4.1	8.6
J4	6.448	7.89	No1. Market	Hand dug well	26	4	400	7	1.8	3	9.7
J6	6.431	7.893	No1. Market	Hand dug well	26	3	300	6.1	1.1	0.5	8.8
J7	6.424	7.889	No1. Market	Hand dug well	27	3	300	6.1	2.3	4.1	8.6
J8	6.415	7.883	Chokochoko	Hand dug well	28	7	700	6.3	2.1	5.3	8.7
J9	6.398	7.878	Chokochoko	Hand dug well	27	4	400	6.3	1.4	4.6	9.4
J11	6.42	7.916	Iwa	Hand dug well	28	2	200	7.5	1.3	3.7	8.5
J12	6.399	7.925	Iwa	Hand dug well	27	1	100	7.2	1.5	3.9	8.6
J15	6.443	7.997	Chokochoko	Hand dug well	26	1	100	6.5	1.4	5.1	8.8
J16	6.406	7.955	Chokochoko	Hand dug well	28	2	200	6.2	1.1	6.4	10.6

ISSN 2229-5518

J17	6.443	7.999	Chokochoko	Hand dug well	29	2	200	6.6	1.7	4.5	10
J18	6.452	8.014	Chokochoko	Hand dug well	27	1	100	6.5	2.5	1.5	8.5
J19	6.379	7.951	Iwa	Hand dug well	26	1	100	6.4	1.4	3.4	10.8
J24	6.467	7.912	No1. Market	Hand dug well	28	6	600	6.8	2.5	3.1	10.7
J25	6.465	7.932	Iwa	Hand dug well	28	5	500	7.2	3.3	3.2	7.4
J27	6.436	7.945	Iwa	Hand dug well	28	2	200	5.8	3.5	1.9	8.7
J28	6.437	7.957	Iwa	Hand dug well	27	2	200	6.1	3.8	1.5	8.1
J29	6.44	7.97	Oyo	Hand dug well	27	5	500	5.5	4.2	1.6	7.8
J31	6.46	7.969	Oyo	Hand dug well	27	2	200	6.4	2.1	2	7.4
J32	6.465	7.982	Oyo	Hand dug well	26	3	300	5.5	2.6	2.3	8.3
J39	6.41	8.019	Jakura	Hand dug well	26	3	300	7.5	3.9	3.2	10.3
J40	6.4	8.036	Jakura	Hand dug well	26	4	400	7.2	3.4	1	7
J43	6.345	8.005	Jakura	Hand dug well	27	3	300	6.8	2.4	3.1	8.8
J44	6.344	7.999	Jakura	Hand dug well	28	4	400	7.4	1.4	1.2	8.7
J47	6.366	7.987	Jakura	Hand dug well	28	4	400	6.4	3.1	0.8	7.4
J49	6.4371	7.9647	Oyo	Hand dug well	20	4	400	7.4	3.5	2.5	8.2
J50	6.4375	7.9195	Iwa	Hand dug well	26	5	500	6.1	NA	NA	NA
J1	6.472	7.88	No1. Market	Borehole	20	2	200	7.1	NA	NA	NA
J10	6.422	7.904	No1. Market	Borehole	27	2	200	7	NA	NA	NA
J20	6.379	7.936	Iwa	Borehole	26	1	100	5.7	NA	NA	NA
J42	6.349	8.029	Jakura	Borehole	27	3	300	6.5	NA	NA	NA

Table 3. Physicochemical properties of surface water during the wet season

Sample ID	Long	Lat	Description	Location	Tempt oC	Conductivity (µs/cm)	TDS (Mg/L)	pH	Elevetion (m)
J5	6.446	7.902	River channel	No1 market	27	3	300	7.1	156
J13	6.391	7.915	River channel	Iwa	25	4	400	6.4	175
J14	6.349	7.891	River channel	Chokochoko	28	3	300	8.3	274
J23	6.439	7.92	River channel	Iwa	25	9	900	6.1	263
J35	6.406	7.955	River channel	Oyo	27	9	900	7.4	184
J30	6.459	7.962	River channel	Iwa	25	3	300	8.7	359
J38	6.445	8.027	River channel	Jakura	26	5	500	7.2	169
J41	6.392	8.009	River channel	Jakura	26	3	300	7.5	152
J45	6.347	7.997	River channel	Jakura	28	4	400	7.2	349

ISSN 2229-5518

J46	6.335	7.979	River channel	Jakura	26	4	400	6.3	317
J48	6.387	7.97	River channel	Jakura	25	4	400	8.9	256
J21	6.425	7.933	Dam	Iwa	26	8	800	8.2	345
J22	6.43	7.933	Downstream dam	Iwa	24	7	700	7.1	285
J26	6.437	7.936	River channel	Iwa	26	4	400	6.8	239
J37	6.452	8.014	River channel	Jakura	26	9	900	7.1	182
J33	6.43	7.99	River channel	Jakura	28	8	800	5.1	306
J34	6.443	7.997	River channel	Jakura	27	7	700	7.2	149
J36	6.443	7.999	River channel	Jakura	28	8	800	6.2	171

Table 4.Physicochemical properties of ground water during the wet season

Sample ID	Long	Lat	Description	Geology	Elevation (m)	Tempt oC	Conductivity (µs/cm)	TDS (Mg/L)	pH	DSWL(m)	WTS (m)	TD (m)
J2	6.456	7.878	Hand dug well	Not exposed	88	24	4	400	7.9	1.2	5.8	7
J3	6.456	7.887	Hand dug well	Not exposed	148	26	4	400	6.8	0.7	8.1	8.8
J4	6.448	7.89	Hand dug well	Not exposed	149	26	3	300	7.2	1.8	6	7.8
J6	6.431	7.893	Hand dug well	Not exposed	135	27	3	300	6	1.1	6.3	7.4
J7	6.424	7.889	Hand dug well	Not exposed	145	26	2	200	7.2	2.3	6.3	8.6
J8	6.415	7.883	Hand dug well	Not exposed	59	27	4	400	6.3	2.1	6.4	8.5
J9	6.398	7.878	Hand dug well	highly Weathered schist	70	26	3	300	7.4	1.4	6.5	7.9
J11	6.42	7.916	Hand dug well	Not exposed	128	25	2	200	5.3	1.3	6.8	8.1
J12	6.399	7.925	Hand dug well	Biotite gneiss	114	26	2	200	6.3	1.5	6.2	7.7
J15	6.353	7.915	Hand dug well	Not exposed	151	28	4	400	6	1.4	7.3	8.7
J16	6.344	7.929	Hand dug well	Not exposed	146	27	6	600	6.8	1.1	7.4	8.5
J17	6.335	7.928	Hand dug well	Not exposed	147	27	3	300	5.8	1.7	6	7.7
J18	6.347	7.949	Hand dug wall	Weathered schist	55	29	2	200	7.9	2.5	5.7	8.2
J19	6.379	7.951	Hand dug well	Not exposed	151	26	6	600	6.8	1.4	7.3	8.7
J24	6.467	7.912	Hand dug well	Not exposed	108	26	5	500	8.2	2.5	6.3	8.8
J25	6.465	7.932	Hand dug well	Not exposed	104	27	5	500	7.4	3.3	5.3	8.6
J27	6.436	7.945	Hand dug well	Not exposed	143	26	1	100	9.1	3.5	6.8	10.3
J28	6.437	7.957	Hand dug well	Not exposed	118	28	2	200	7.2	3.8	6.2	10
J29	6.44	7.97	Hand dug well	Not exposed	140	26	2	200	8.9	4.2	6.4	10.6
J31	6.46	7.969	Hand dug well	highly Weathered schist	96	27	3	300	6.4	2.1	6.5	8.6
J32	6.465	7.982	Hand dug well	highly Weathered schist	94	27	4	400	6.5	2.6	7.4	10
J39	6.41	8.019	Hand dug well	Not exposed	110	25	3	300	6.9	3.9	5.5	9.4
J40	6.4	8.036	Hand dug well	Quartz biotite gneiss	155	24	2	200	7.2	3.4	5.4	8.8
J43	6.345	8.005	Hand dug well	highly Weathered schist	73	26	4	400	6.2	2.4	5.8	8.2
J44	6.344	7.999	Hand dug well	Not exposed	126	26	1	100	6.6	1.4	6.1	7.5
J47	6.366	7.987	Hand dug well	Not exposed	101	26	5	500	6.5	3.1	8.3	11.4
J49	6.4371	7.9647	Hand dug well	Not exposed	117	26	3	300	6.2	3.5	5.2	8.7
J50	6.4375	7.9195	Borehole	Not exposed	145	26	2	200	9.3	NA	NA	NA
J1	6.472	7.88	Borehole	Not exposed	154	26	3	300	6.1	NA	NA	NA
J10	6.422	7.904	Borehole	Not exposed	155	26	2	200	6.2	NA	NA	NA
J20	6.379	7.936	Borehole	Highly weathered Gneiss	147	25	2	200	7.5	NA	NA	NA
J42	6.349	8.029	Borehole	Weathered schist	48	26	1	100	6.1	NA	NA	NA

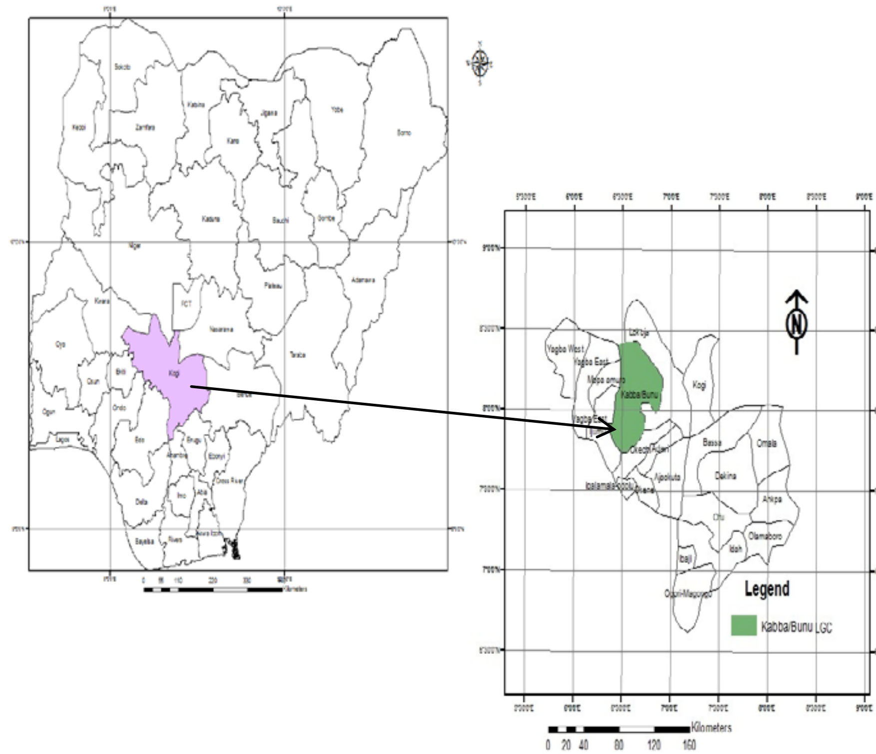

Fig 1: Map of Nigeria showing location of study area

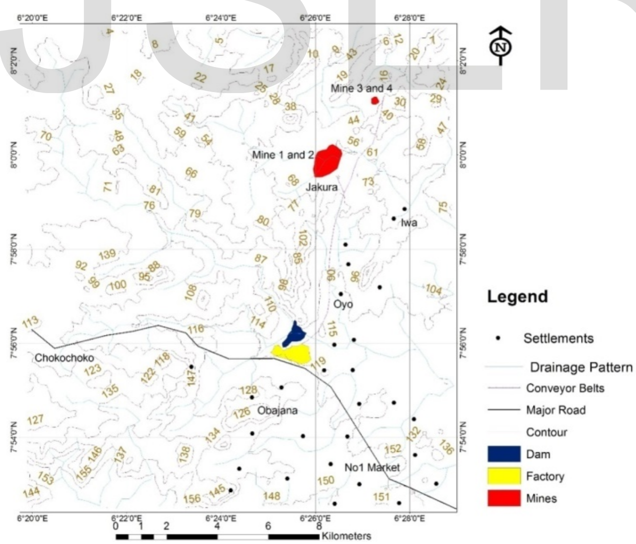

Fig 2. Topographic Map of Study Area Showing Major features Modified using ArcMap10.2.

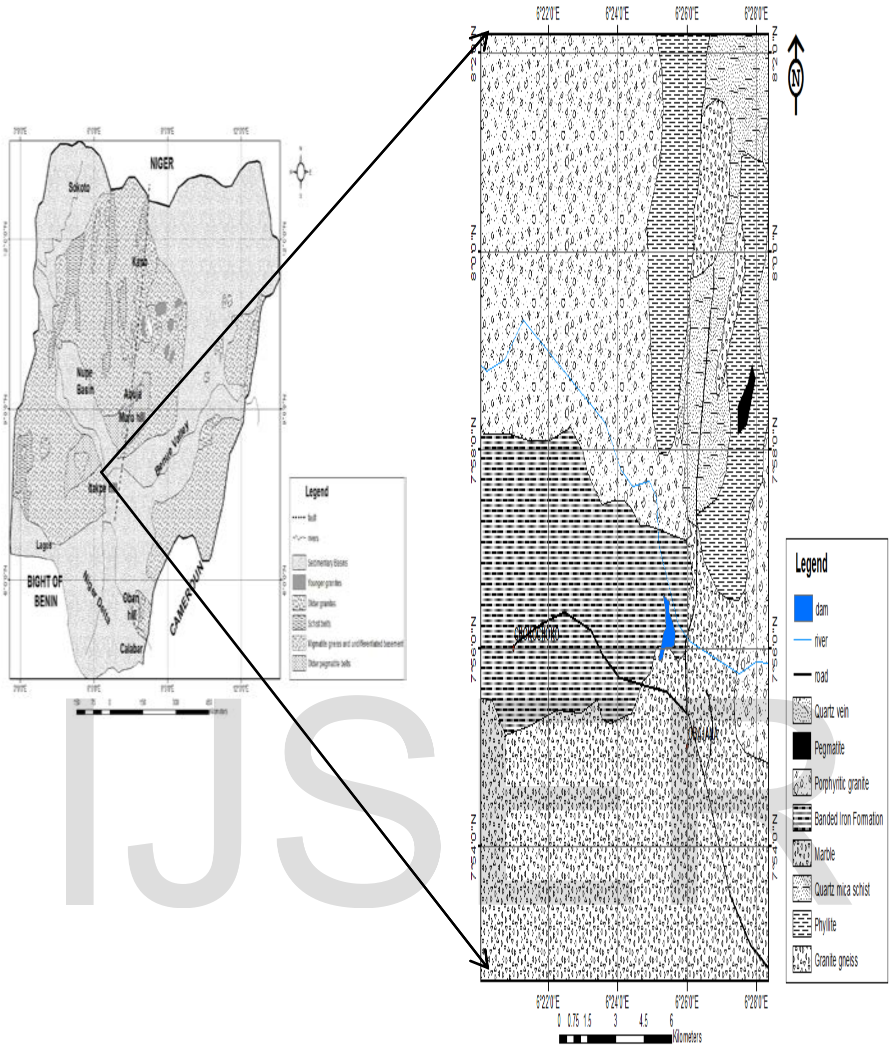

***Fig 3.**: Geological map of Nigeria showing the study area (modified from NGSA Map 2004)*

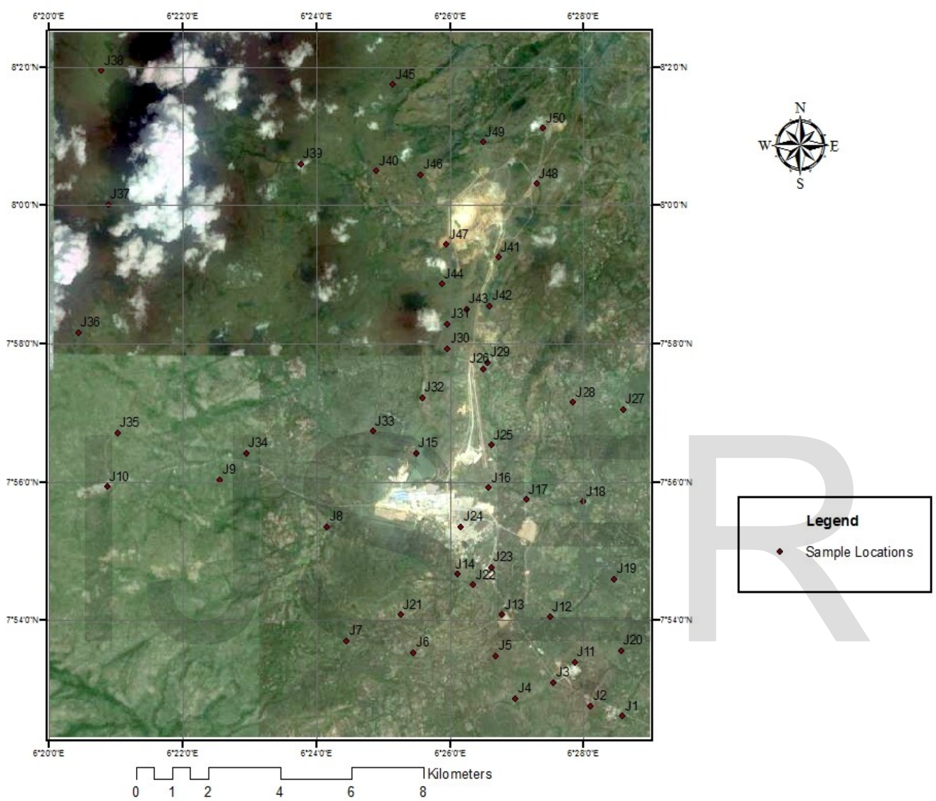

Fig4: Satellite image of study area showing location of samples collected

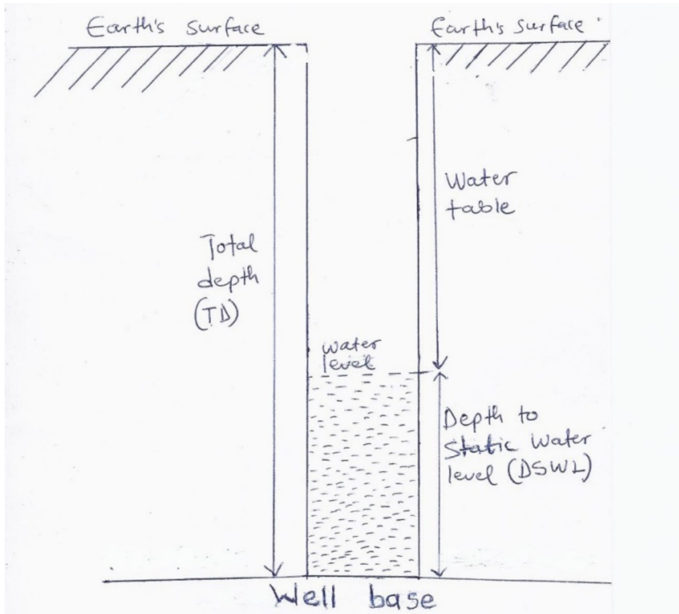

Fig 5. Cross section of the hand dug well

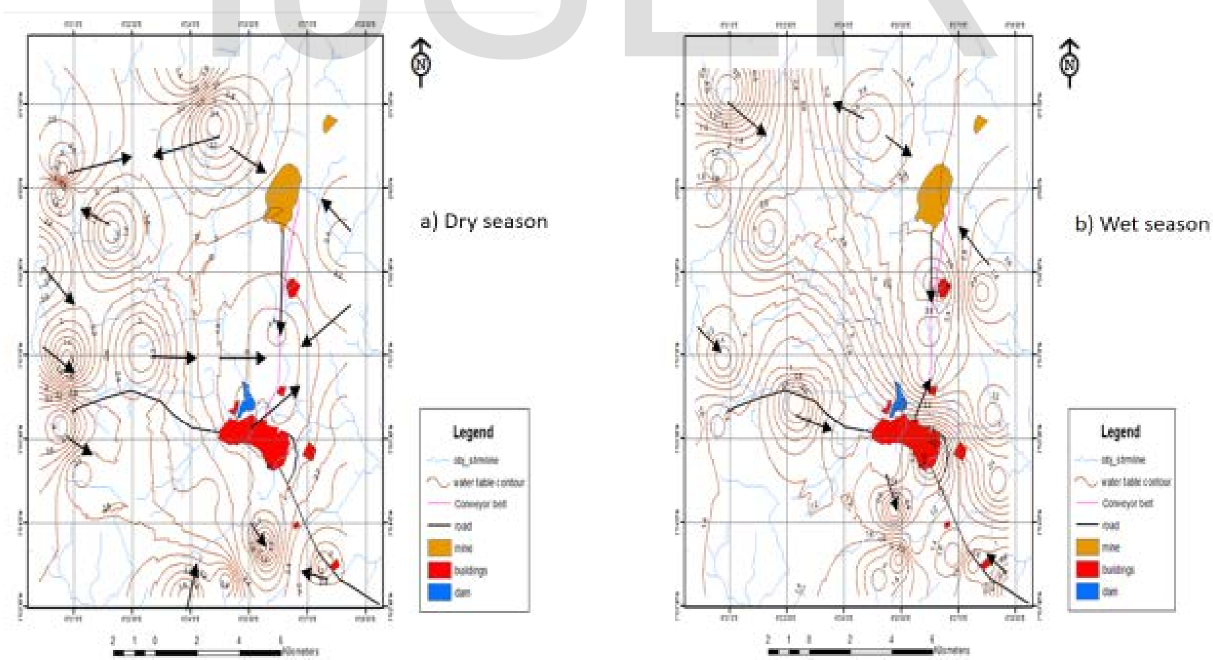

Fig 6. Ground water flow directions for a) dry season and b) raining season

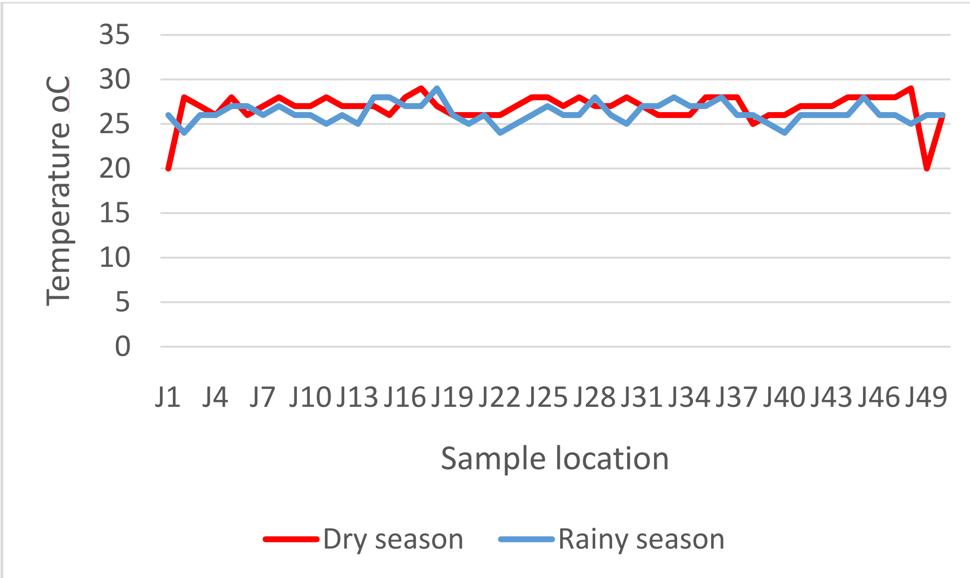

Fig 7. Relationship between temperatures for dry and wet seasons

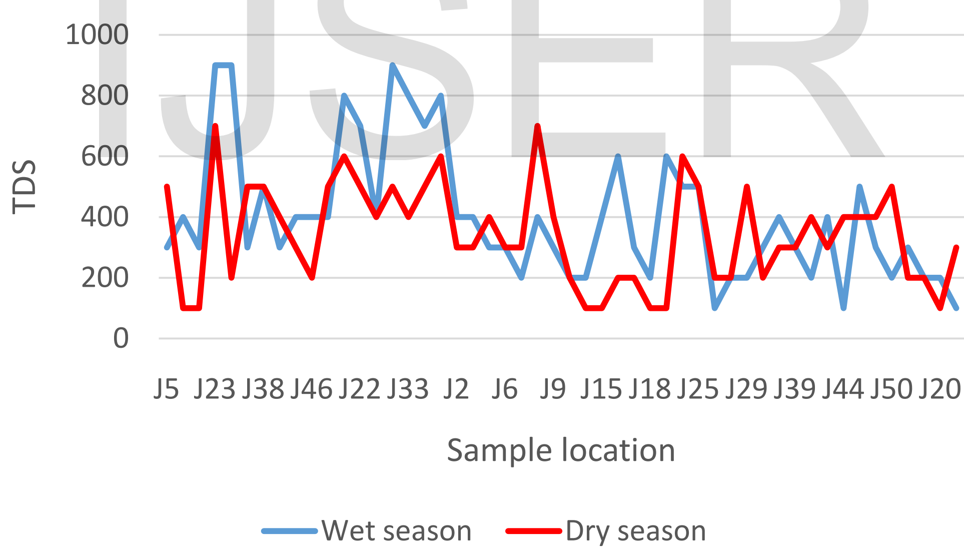

Fig 8. Relationship between TDS for dry and wet season

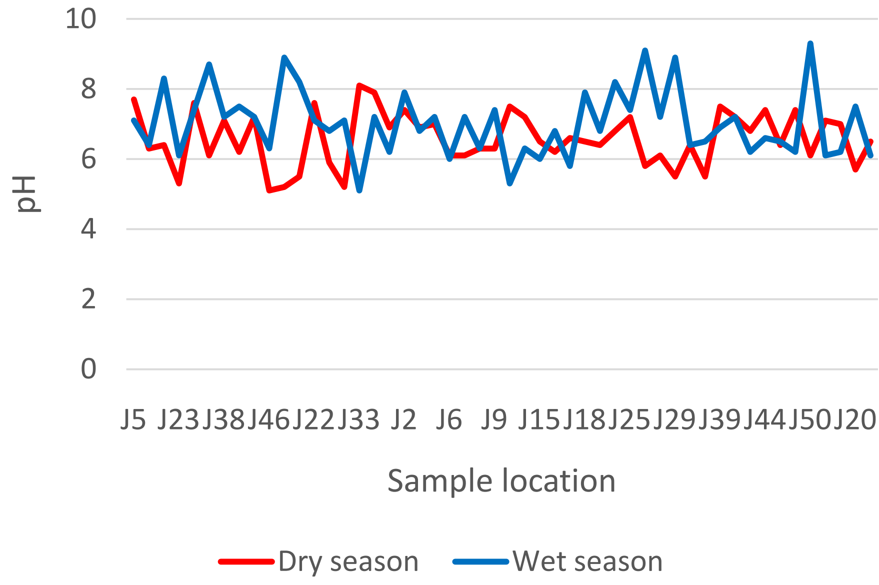

Fig 9. Relationship between pH values for dry and wet season