BACTERIOLOGICAL AND PHYSICO-CHEMICAL CHARACTERISTICS OF DIFFERENT WATER SOURCES IN BIDA TOWN, NIGER STATE

By

A. N. Amadi
Department of Geology
Federal University of Technology
P.M.B. 65, Minna, Niger State
akoamadi@yahoo.com

Abstract

The concern for quality of water supply all over the world most especially in developing countries has been on the increase after the Second World War. This concern is also important in ancient city like Bida, where brass, glass and blacksmith work is a popular industry next to agriculture in the area. The need to characterize the water quality in Bida town with respect to the aforementioned activities on groundwater leads to the present study. A total of 16 water samples were collected from different sources and relevant physico-chemical and bacteriological variables were analyzed. The study revealed that the concentrations of most physical and chemical parameters are within the maximum permissible limits for drinking water recommended the Nigerian Industrial Standard (NIS, 2007) and World Health Organization (WHO, 2006). However, in location 9, Dokodza areas where blacksmith and brass works are carried out; the value of Fe^{2} was found to be high when compared with NIS (2007) and WHO (2006). The local geology of the area and the dominant human activities in the area might be responsible for the high Fe^{2} in the area. At location 14, Cr^{6} has value higher than the recommended value by the NIS (2007) and WHO (2006). Hand-dug well at locations 3 and boreholes at locations 12 and 13 show high E.coli.and total coliform content as compared with NIS (2007) and WHO (2006). This suggests an indication of faecal contamination via animal or human means. The water in the area is of Calcium-Bicarbonate water type.

Keywords: Evaluation, water quality, Bida, Bacteriological, Physical and Chemical analyses.

Introduction

Water is one of the basic necessities of life indispensable to plants and animal life. It occurs in springs, rivers, streams and lakes in surface basin. It falls to the ground as rain, and occurs in the subsurface in porous, permeable rock formations as groundwater. Groundwater provides one of the best sources of potable water for domestic, agricultural, industrial and human development. The overlapping nature between groundwater and its host rock has made hydrogeology an indispensible tool in groundwater exploration, exploitation and management.

Bacteriologically polluted water is potentially dangerous to health because of possible outbreaks of typhoid, dysentery or cholera epidermis. Similarly, water of poor physio-chemical quality may have adverse health effects, causing avoidable economic and human losses. There is increasing demand for portable water in Nigeria and the inadequacy of water supply in most parts of Nigeria like Bida which makes it imperative that any available source is carefully protected and managed. Groundwater pollution is on the increase and this calls for setting up of a surveillance system to monitor and protect the resource. It is important to conduct a routine monitoring of water supplies in order to indentify pollution sources for corrective measures.

The study aims at characterizing microbial and physio-chemical parameters of different water sources in Bida town (Borehole, Hand-dug well, tap water and rivers) in order to determine their pollution status and make recommendation for proper monitoring, management and protection of the resources.

Study Area Description

Bida, the headquarters of Nupe kingdom is situated between longitude $06^0\ 00^1$E to $06^0\ 05^1$E and latitude $09^0 03^1$N to $09^0\ 08^1$N. The land area is about 58.6km^2 and majority of the people are farmers while some engage in brass, glass and blacksmith works. It has a good road network and is drained by river Kaduna and its tributaries. The area has a low to moderate relief with a few scattered laterite-capped coarse grained sandstone hills. It is accessible through Mokwa, Minna, Lanbata, Badegi and Doko roads.

Climate and Physiography of the Area

The annual rainfall ranges from 1100mm to 1500mm with a marked rainy season from April to October and dry season from November to March. The day light temperature varies from 23^0C at the peak of rainy season to about 36^0C at the climax of dry season (Minna Airport, 2007). The predominant vegetation consists of broad-leaved trees, shrubs and grasses. Along the river channels, the vegetation becomes more wooden and acquires some forest affinities.

General Geology of Bida Basin

The Bida Basin is located along the River Niger Valley (fig.1). It extends from Kontagora in the north to lokoja in the south, and is situated between the Sokoto and Anambra Basins. The Basin is a downwraped basin, filled with Campanian-Maastrichtian strata of marine to fluviatile and lacustrine origin (Adeleye, 1976). The iron ores located at the Niger-Benue confluence have been studied in details by many workers (Falconer, 1911; Du Preez, 1965; Jones, 1958). Three physiographical units are recognizable: the River Niger (its flood plains and tributaries) 20%; a Belt of Mesas 10% and the Plains 70% (Shekwolo, 1994). According to Adeleye, the epirogenesis responsible for the basin formation is closely connected with crustal movements of the Santonian orogeny of Southeastern Nigeria and the nearby Benue valley. The basin has been grouped among the West African Rift Basins (Ojo and Ajakaiye, 1976). The stratigraphic succession in the southern part of the basin comprises of the Agbaja-iron Formation, Patti Formation and Lokoja Formation. These units correlate with the Bida-Sakpe-ironstones, Enagi-siltstone and Batati-ironstone Formations in the northern part of the basin. The formations found in the southern Bida basin are given recognition because of their mappability and distinct lithofacies (Shekwolo, 1994). Sediments are of Cretaceous age and are composed of alternating series of weakly consolidated and friable sandstones, siltstones, claystone, conglomerates and their loose equivalents. These sediments are of fluviatile origin but oolitic and pisolithic ironstone which occur in places may have resulted from marine incursions where the base is exposed, they lie uncomfortably on the basement rocks. Whereas prevailing opinion suggest that the basin resulted from down warping, some authors believe some form of rifting as having influenced the Formation the basin. The total thickness of sediments is not exactly known but gravity studies by Ojo and Ajakaiye

(1976) indicates about 2000m but this is yet to be confirmed via borehole records. This is in agreement with the work of Udensi (2001).

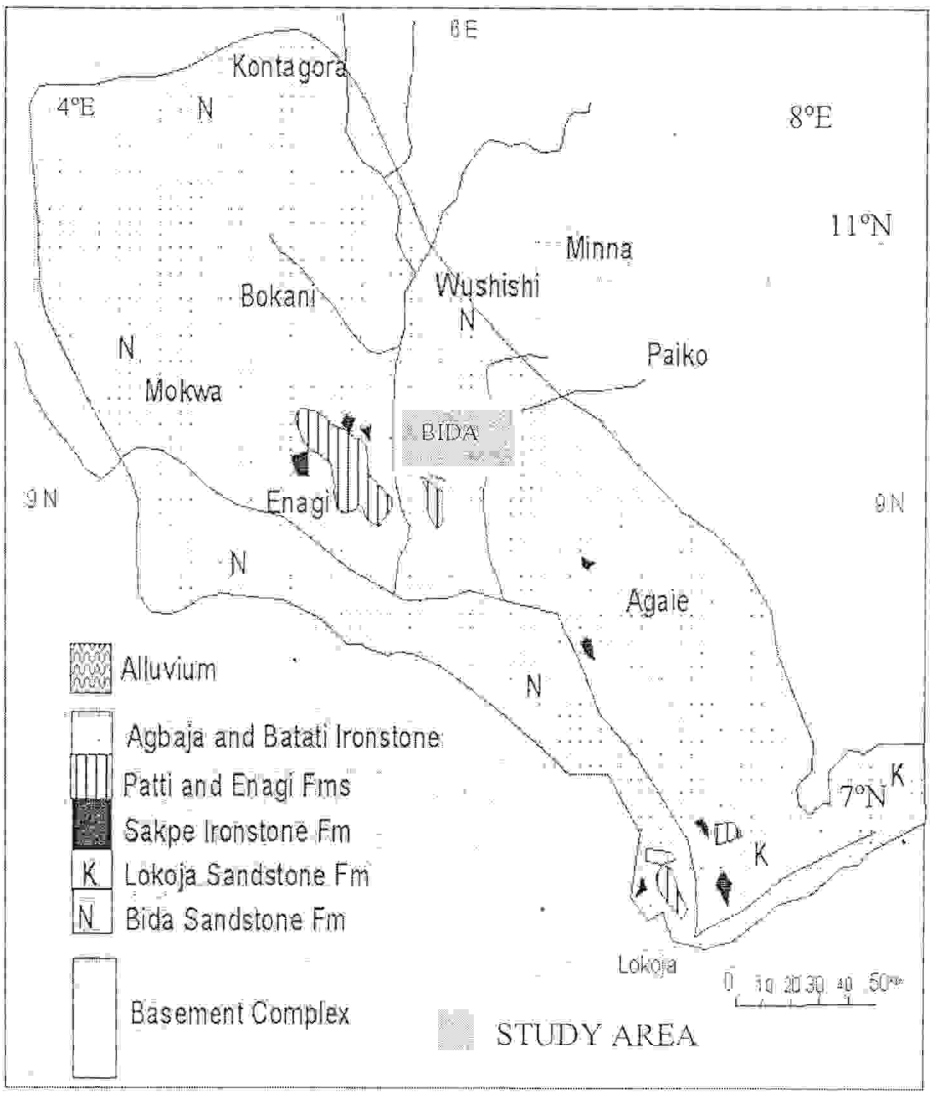

Fig. 1.Simplified Geological map of Bida Basin.

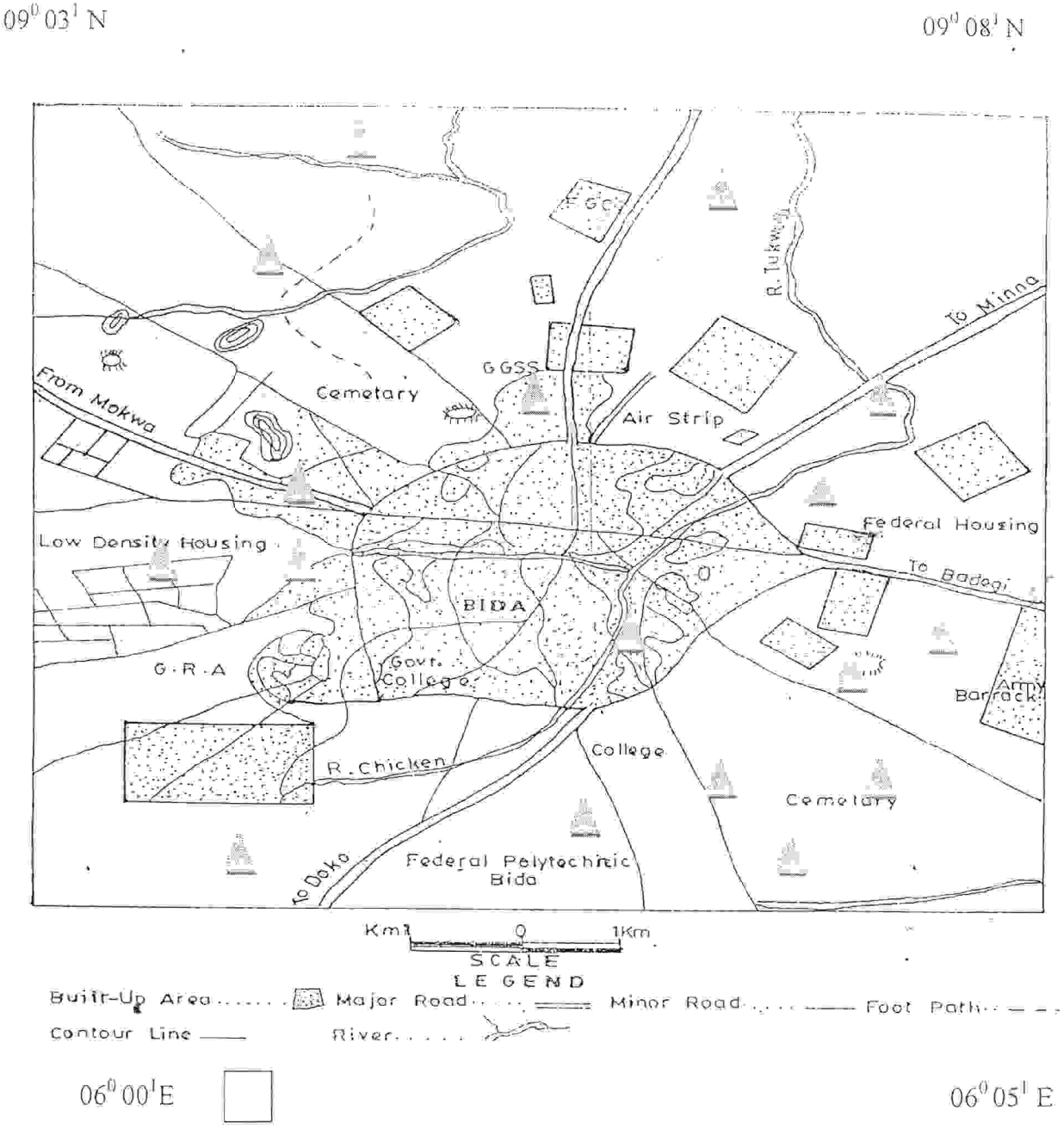

Fig. 2 Map of Study Area Showing Sample locations

Research Methodology

Hydro-geological investigation of the area was undertaken. A total of 16 water samples (Fig. 2) were collected in pairs using a glass and plastic container from different sources (boreholes, hand dug well, tap-water and rivers) in the area. The physical parameters (pH, conductivity, temperature and turbidity) were determined on the field using a calibrated pH metre, conductivity meter, thermometer and turbidometer

respectively. The chemical parameters (cations, anions and trace elements) were analyzed using Atomic Absorption Spectrometer (AAS) while Bacteriological determination of (coliform and E.coli) was carried out using presumptive count and differential count respectively.

Physical and Bacteriological Results

The results of the physical and bacteriological parameters are summarized in table 2. The pH values ranges from 6.4 to 7.4 with a mean value of 6.97. This shows neutral to slightly acidic water fairly good for drinking. The turbidity varies from 23.1NTU to 24.2NTU with an average value of 23.8NTU. The different water sources in the area show high turbidity values compared with (NIS, 2007) and (WHO, 2006) standards of 5NTU. The conductivity value is of the order of 22.0 to 279.0 with an average value of 72.2, which are within the limit for safe drinking water. The atmospheric temperature at sampling points varies from 23.2^{0}C to 24.3^{0}C with a mean value of 23.8^{0}C. The coliform value range from 0 to 94 with an average value of 26.1 while E.coli varies from 0 to 53 with a mean value of 3.5. The results of bacteriological tests in locations 3, 12 and 13 show that there are inadequacies in the bacteriological qualities of groundwater in these locations. This may be an attributed to faecal contamination via animal droppings on surface water and groundwater in contact with human faeces. The groundwater flow map of Bida town (figure 3) indicate a NE-SE flow direction (Amadi, 2007). The affected locations are concentrated at southeastern part of the study area.

Chemical Parameters.

Chemical analysis results (Table 3) show low concentration of cations and anions. Majority of the results of the analyzed trace metals compare favourably with the WHO recommended maximum permissible limits. But the values of Fe^{2+} at Dokodza area in location 9 is 1.07mg/l while the value of Cr^{6+} at location 14, opposite federal polytechnic gate is 1.0mg/l..Their values in these two locations are above the (WHO, 2006) and (NIS, 2007) recommended maximum permissible value. The high value of Fe^{2+} and Cr^{6+} can be linked to both natural and anthropogenic factors. The local geology of the area as well as human activities in the area might be responsible for the observed anomaly. The 8 major cations and anions were plotted in a trillinear diagram, which were used to classify the water in the area. The water in the area is of Calcium-Bicarbonate water type. This is in agreement with the slightly acidic nature of the water sources in the area. Piper diagram is an effective tool in separating analytical data for critical study with respect to sources of the dissolved constituents in water. The concentration of 8 major ions (Na^+ ,K^+, Mg^{2+}, Ca^{2+}, Cl , CO_3^{2-}, HCO $_3$ and SO_4^{2-}) are represented on a trilinear diagrams by grouping the (K^+ with Na^+) and the (CO_3^{2-} with HCO_3), thus reducing the number of parameters for plotting to 6. On the piper diagram, the relative percentages of the cations and anions are plotted in the lower triangles, and the resulting two points are extended into the central field to represent the total ion concentration. The degree of mixing between waters can also be shown on the piper diagram (Figure 4). It was used to classify the hydro-chemical facies of the water samples according to their dominant ions. The results show that water samples in study area are Calcium-Bicarbonate type of water.

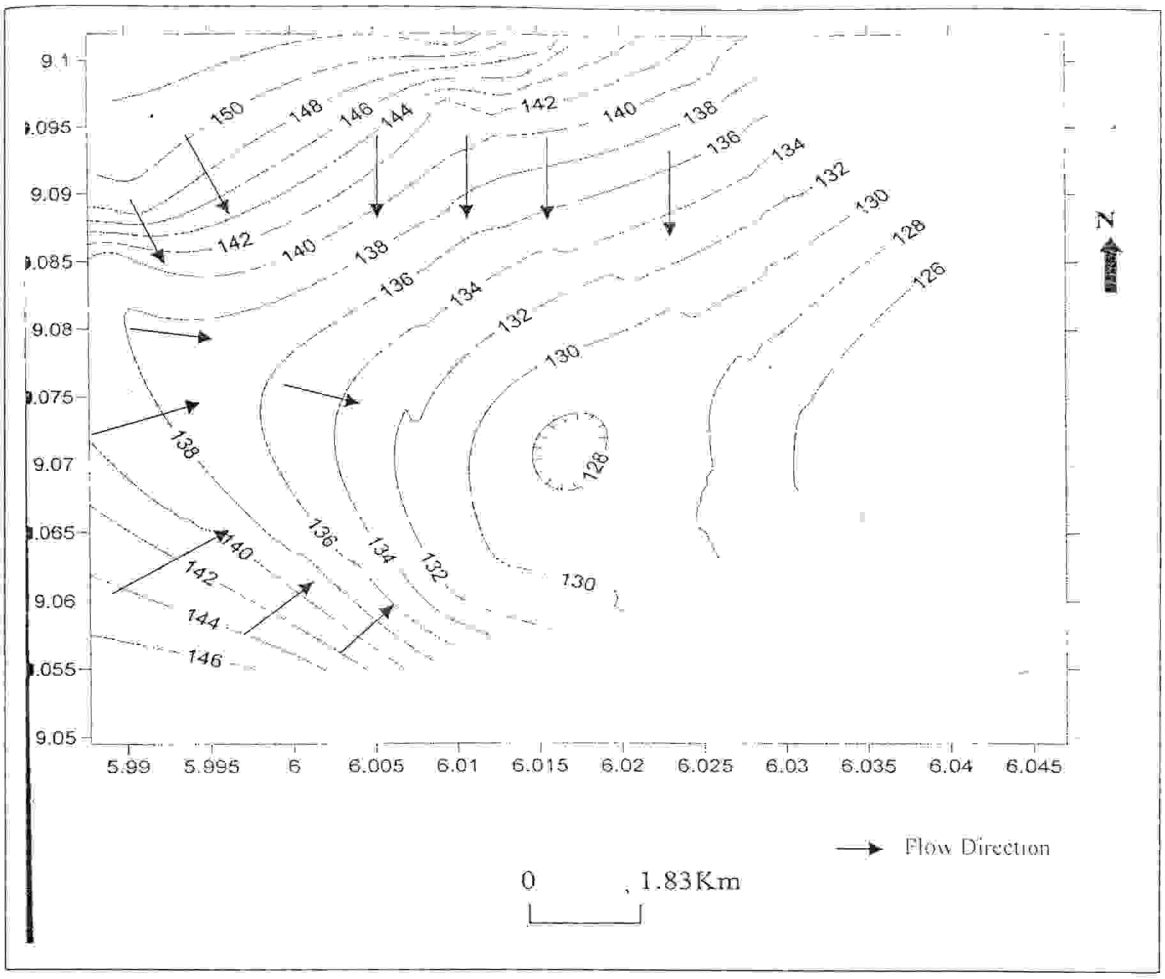

Fig. 3 Groundwater flow map for Bida town

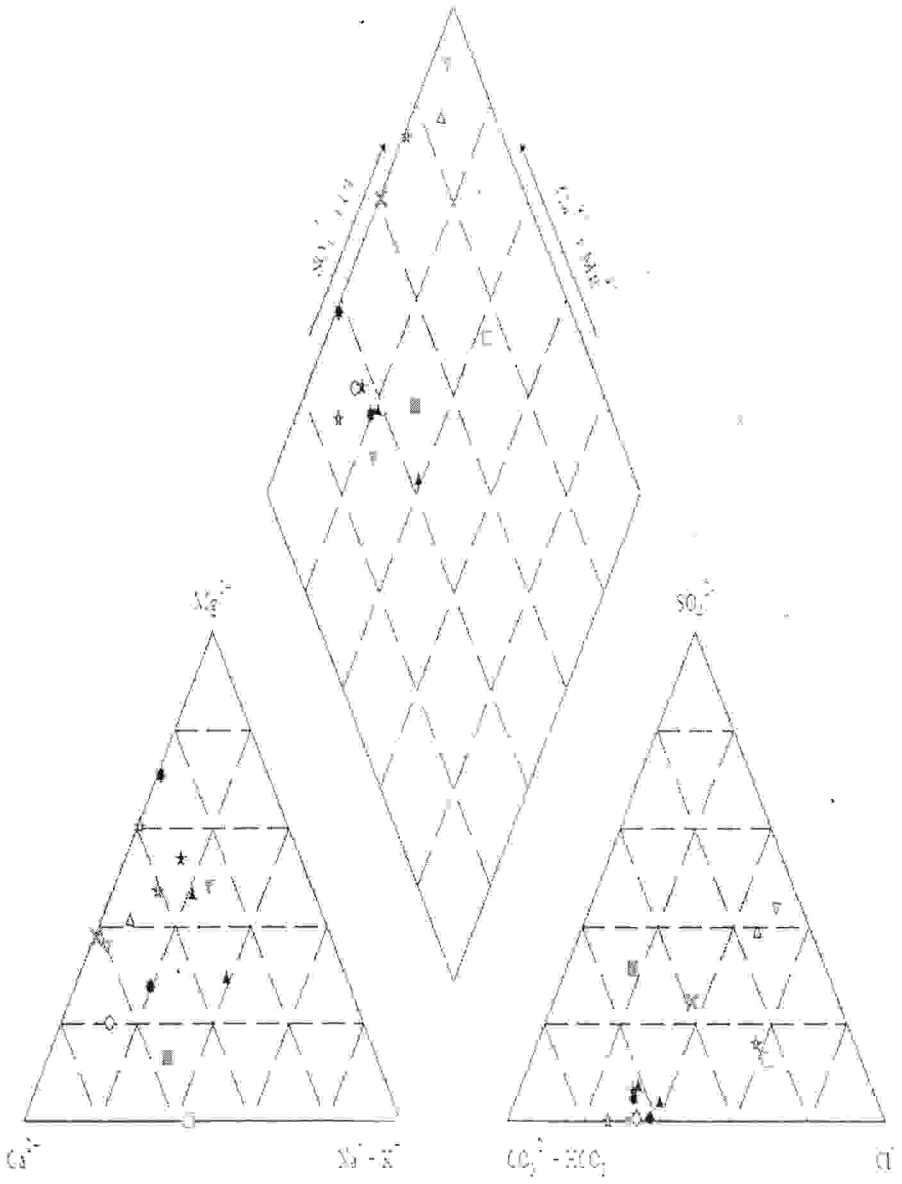

Fig.4 Summary of the Chemical Analyses of the Water Samples in Bida Town.

Discussion of Results

The microbial quality of water is based on the quantity of indicator bacteria it contains. The bacteriological quality of drinking water must meet WHO standards of less than 1-coliform per 100ml, for the water to be acceptable. The bacteriological test carried out suggests that locations 3, 12 and13 have higher E.coli. and coliform values than the WHO recommended maximum permissible limit which is an indication of anthropogenic contamination affecting the quality of water used for drinking purposes. Other chemical parameters have lower values except Fe^{2+} in location 9 and Cr^{6+} at location 14. The high concentration of Fe^{2+} and Cr^{6+} in these locations could be attributed to the infiltration from the oolitic and pisolithic ironstone into the water table or from leachate migration from

metal scrap used as raw material in blacksmith, brass and glass making. There is possible migration of the leachate in the area in accordance with the groundwater flow direction of the area thereby accumulating in these locations.

Conclusion

The water sources in Bida town have been investigated via the geology, hydrogeology, physical, chemical and bacteriological parameters. The water in the area is of Ca-HCO_3^- type of water. All the analyzed physical parameters in the area are far below the NIS, (2007) and WHO, (2006) maximum allowable limits. Similarly, most of the chemical parameters are within the tolerable limits except Cr^{6+} at location 14 and Fe^{2+} at location 9. The local geology of the area as well as human activities in the area are likely the main factors responsible for their high concentration. The blacksmith and brass work are done at Dokodza area point out to the fact that human activities might be responsible for the pollution.

Recommendation

Based on the findings above, shallow boreholes and hand-dug wells should be discouraged and groundwater should be sourced from dip-seated aquifers. Blacksmith work in the area should be relocated to remote area to minimize groundwater contamination. A forum should be organized to educate the people on the danger (health hazards) associated with groundwater pollution. Indiscriminate digging of wells should be discouraged and the need to drill deep boreholes that penetrate the confined aquifer should be emphasized. Hand dug well around the blacksmith area should be closed and a periodic monitoring of the groundwater quality in the areas should be carried out. Stakeholders in the water industry should come up with policies that will protect the groundwater system and ensure its proper management and utilization. Periodic checks of the chemical quality and bacteriological quality of selected hand-dug wells, boreholes and rivers are to be carried out in the area.

Acknowledgement

Many thanks to the Chief Technologist, Department of Plant Science and Biotechnology, University of Port-Harcourt, Rivers State and the Laboratory Manager, Regional Water Quality Laboratory, Minna, Niger state for carrying out the laboratory analyses. The author is grateful to Prof. P. I. Olasehinde for his mentoring and motivation.

REFERENCES

Adeleye, D. R., 1976. The Geology of the Middle Niger Basin: In the Geology of Nigeria, Ed. C A. Kogbe., Elizabeth Press, Lagos. Pp 283-287.

Amadi, A. N., 2007. Determination of E. Coli and total Coliform in the water sources of Bida area. In press, Water Resources, Journal of NAH.

Du Preez, J. D. and Barber, W., 1965. The Distribution and Chemical Quality of Groundwater in Nort hern Nigeria: Geol. Surv.Nig., Bulletin 36.

Falconer, J. D., 1911. The Geology and Geography of Northern Nigeria. MacMillan, London, pp 6-9.

Jones,H. A., 1958. Oolitic ironstones at the Agbaja Plateau Kabba Province. Records of Geol.Surv. Nigeria, pp 20-43.

Offodile, M.E., 2002. Groundwater Study and Development in Nigeria, 2nd Edition. Mecon Geology and Engineering Services Ltd, Jos, Nigeria, pp 239-244.

Ojo, S. B. and Ajakaiye, D, E., 1976. Preliminary interpretation of gravity measurement in the Middle Niger Basin area, Nigeria. In the geology of Nigeria, Ed. C. A. kogbe, Elizabethan Press, Lagos., 295-307.

Okuofu, A. C., Echafona, N. O. and Ayeni, O. G. 1990. Bacteriological and Physio-Chemical Examination of Well Waters in Ahmadu Bellow University (Main Campus) Zaira, Water resources. Journal of the NAH. Vol 2, No1, pp 111-115.

Nigeria Industrial Standard, 2007. Nigerian Standard for Drinking Water. NIS:554, pp13-14.

Piper, A. M., 1944. A graphical procedure in the geochemical interpretation of water analysis. Trans. Ameri. Geophyscis Union, Vol. 25, pp 914–9 23.

Shekwolo, P. D., 1994. Regional Hydrogeology of Bida Basin, Central Nigeria, unpublished Ph.D thesis, Ahmaud Bello University, Zaria.

Udensi, E. E., 2001. Interpretation of the total magnetic field over Nupe Basin, West Central Nigeria using aeromagnetic data. Unpublished Ph.D thesis, A.B.U. Zaria.

World Health Organisation, **2006.** International Standards for drinking water. 3rd edition, Geneva, pp 346-385.

Table 1. G.P.S. Reading and Elevation

S/N	Location of sample	Sample Source	Elevation (m)	Latitude	Longitude
1	Kure Crescent G.R.A	BH	177	$09^0 04'$	$005^0 59'$
2.	Bantwa, Cirico araea	RW	110	$09^0 05'$	$006^0 02'$
3.	Air Strip Gate, Esso	DW	146	$09^0 06'$	$006^0 01'$
4.	Opposite G.G.S.S	DW	145	$09^0 06'$	$006^0 02'$
5.	Tswanpa, Tswatamako	DW	147	$09^0 05'$	$006^0 00'$
6.	Opposite F.M.C gate	DW	147	$09^0 05'$	$006^0 00'$
7.	Pichi Road	DW	161	$09^0 04'$	$005^0 59'$
8.	Dokodza Junction	BH	156	$09^0 05'$	$005^0 59'$
9.	Dokodza Area	DW	127	$09^0 05'$	$005^0 59'$
10.	Dokodza Area	RW	134	$09^0 05'$	$005^0 59'$
11.	Wadata Behind NPF Barrack	DW	158	$09^0 05'$	$005^0 59'$
12.	Sauki Water	BH	161	$09^0 05'$	$005^0 59'$
13.	Polytechnic bida	BH	165	$09^0 03'$	$005^0 59'$
14.	Opp. Polytechnic Gate	DW	165	$09^0 03'$	$005^0 59'$
15.	F.G.G.C	BH	147	$09^0 00'$	$005^0 02'$
16.	Army barrack	TW	148	$09^0 05'$	$006^0 3'$

Table 3. Results of Chemical analyses

S/N	Location of sample	Sample source	Turbidity FTU	Ca mg/l	Na Mg/l	K Mg/l	Mg Mg/l	Fe Mg/l	Cu Mg/l	Mn Mg/l	Zn Mg/l	Pb Mg/l	Cr Mg/l	Cl Mg/l	SO_4 Mg/l	NO_3 Mg/l	HCO_3 Mg/l	CO_3^{2-} Mg/l
1	Kure Crescent G.R.A	BH	23.4	15.7	0.6	0.2	14.0	0.12	0.1	0.01	0.228	0.01	0.25	20.0	0.18	0.1	56.0	2.1
2.	Bantwa. Cirico araca	RW	24.0	36.0	7.9	0.01	6.4	0.36	0.7	0.03	2.1	0.0	0.0	17.0	0.2	0.1	56.1	3.2
3.	Air Strip Gate. Esso	DW	23.7	15.6	6.2	6.7	2.2	0.057	0.33	0.12	2.1	0.02	0.07	10.0	23.0	7.5	48.0	0.0
4.	Opposite G.G S.S	DW	23.2	17.2	15.1	16.0	9.5	0.171	0.75	0.11	1.7	0.01	0.0	32.0	4.0	8.0	82.0	0.0
5.	Tswanpa. Tswatamako	DW	23.5	26.1	4.6	0.06	12.6	0.1	1.03	0.02	1.64	0.01	0.36	40.0	14.0	14.5	20.0	0.4
6.	Opposite F.M.C gate	DW	23.5	3.6	2.2	2.7	3.9	0.029	1.0	0.08	0.0	0.0	0.0	7.0	0.0	14.0	25.0	0.0
7.	Pichi Road	DW	24.3	7.8	6.0	0.1	11.2	0.11	1.4	0.02	0.0	0.0	0.3	40.2	18.6	15.0	10.0	0.4
8.	Dokodza Junction	BH	24.2	7.6	1.7	4.0	7.8	0.043	0.08	0.1	2.1	0.0	0.014	14.0	4.0	0.92	51.0	0.0
9.	Dokodza Area 1	DW	24.2	12.0	1.8	3.7	8.3	1.07	1.09	0.09	0.0	0.0	0.0	14.0	0.0	16.3	64.0	0.0
10.	Dokodza Area 2	TW	24.2	0.0	0.4	2.7	0.0	0.029	0.63	0.09	2.0	0.0	0.0	9.5	1.0	0.32	0.0	0.0
11.	Wadata Behind NPF	BH	24.1	2.4	1.3	2.7	5.6	0.0	0.06	0.1	1.86	0.0	0.0	7.5	4.0	0.7	29.0	0.0
12.	Sauki Water	BH	23.7	9.2	1.3	4.7	2.9	0.19	0.0	0.13	2.01	0.0	0.02	10.0	2.0	0.7	35.0	0.0
13.	Polytechnic bida	BH	23.6	4.0	0.8	4.7	0	0.017	0.02	0.0	1.71	0.0	0.0	15.0	4.0	0.8	10.0	0.0
14.	Opp. Polytechnic Gate	DW	23.5	3.6	0.9	3.3	3.2	0.0	0.92	0.13	0.8	0.01	1.0	6.5	2.0	15.9	22.0	0.0
15	F.G.G.C	BH	23.7	16.0	0.4	0.01	12	0.1	0.01	0.0	1.2	0.0	0.0	22.1	8.0	12.0	17.0	0.2
16.	Army barrack	TW	24.1	11.3	0.1	0.01	4.14	0.03	0.61	0.0	1.0	0.0	0.0	16.11	14.3	1.11	29.0	0.2
		Min	23.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0.	0.0	0.0	6.5	0.0	0.1	0.0.0	0.0
		Max	24.2	36.0	15.1	16.0	14.0	1.07	1.4	0.13	2.1	0.02	1.0	40.2	23	16.3	82.0	3.2
		Mean	22.5	11.0	2.82	3.22	6.5	0.15	0.55	0.06	1.28	0.003	0.13	17.6	9.0	6.07	34.63	0.42
	WHO STD. 2006		5 NTU	75.0	150	75	150	0.3	2	0.1	5	0.01	0.05	150	100	50	100	200

DW: Hand dug-well | TW: Tap water | STD: Standard

BH: Borehole

Table 2 Results of Physical and Biological analyses of Water Samples

S/N	Location of sample	Sample type	pH	TDS	Turbidity FTU	Temp	E. coli (MPN/100ml)	Coliform (MPN/100ml)	Conductivity
1	Kure Crescent G.R.A	BH	7.4	101.0	23.4	23.4	0	43	22
2	Bantwa, Cirico araca	RW	6.6	45.0	24.0	24.0	0	31	41
3	Air Strip Gate, Esso	DW	6.4	110.6	23.7	23.7	1	94	165
4	Opposite G.G.S.S	DW	6.6	187	23.2	23.2	0	2	279
5	Tswanpa, Tswatamako	DW	7.2	140.0	23.5	23.5	0	20	54
6	Opposite F.M.C gate	DW	7.2	29.5	23.5	23.5	0	6	44
7	Prehi Road	DW	7.1	60.0	24.3	24.3	0	15	41
8	Dokodza Junction	BH	6.5	61.6	24.2	24.2	0	37	92
9	Dokodza Area1	DW	6.7	59	24.2	24.2	0	5	88
10	Dokodza Area2	RW	6.5	17.4	24.2	24.2	0	0	26
11	Wadata Behind NPF	DW	6.6	30.2	24.1	24.2	0	0	45
12	Sauki Water	BH	6.5	33.5	23.7	24.1	53	46	50
13.	Polytechnic Bida	BH	6.7	16.8	23.6	23.7	2	15	25
14.	Opp. Polytechnic Gate	DW	6.6	20.8	23.5	23.6	0	0	31
15	F G G C	BH	7.13	75.0	23.7	23,5	0	12	62
16	Army Barrack	TW	6.87	90.8	24.1	23.7	0	59	90
		Min	6.4	17.4	23.1	23.2	0	0	22
		Max	7.92	187	24.2	24.3	53	94	279
		Avg	6.97	67.4	22.5	23.8	3.5	26.1	72.2
	WHO STD (2006)		6.5 -8.5	1000mg/l	5 NTU	ambient	0	10	500