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Assessment of Water Quality Parameters of River Doma, Farinruwa and Mada in Nasarawa State, Nigeria

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Abstract
The study was carried out on assessment of water quality parameters of river Doma , Farinruwa and Mada in Nasarawa State, Nigeria. Water samples were collected from three sampling points of the three rivers in the month of February and analysed for trace metals,physiocochemical and microbiogical properties. The trace metals such as; Na, K, Cu, Mg, Fe, Ca, Zn, Ni, Cd, Pb, As, Se, Crand Mn were analysed using atomic absorption spectrophotometer method. Alkalinity, pH, temperature, turbidity, conductivity, total solids, total dissolved solids, suspended solids, and soluble anions such as phosphate, chloride, nitrate, bicarbonate, COD and BOD were the physiocochemical parameters analysed using standard techniques. Muellar Hinton and MacConkey agars were the media used to isolate the microorganisms. The results showed that Cd , As and Se were not at detectable range for all the river waters. While Cr was not detected in Doma river. Calcium was the most highly concentrated metal in these rivers followed magnesium. Most of the trace metals analysed were below the deleterious level in all the rivers except for Ni, Fe, Pb, Mn in all the rivers and Cr in Farinruwa and Mada rivers that were above the WHO standard while the physicochemical and microbiological properties of water were within the required standard limit set by WHO for drinking water except for Mada and Doma rivers where the microbiological properties determined were above the standard limit set by WHO for drinking water. Since most of the trace metals and microbiological properties determined were above the recommended limit for drinking water, it therefore means that the usability of such waters for domestic purposes is not in any case recommended. Such waters must be properly treated by conventional method before they are consumed or put to any reasonable domestic applications.
Keywords: River water, Trace metals, physiocochemical, microbiological ,parameters

INTRODUCTION

Poor drinking water quality has been identified as one of the major causes of health problems in developing countries like Nigeria. The physicochemical requirements for drinking water as stipulated by world Health organization (WHO) is about two litres of water per head per day and a daily supply of one hundred and fifty to two hundred litres cannot be met by majority of the developing countries like Nigeria (Ademoroti,1996). Indeed, WHO has estimated that approximately 80 percent of all illness in the world is attributed to bad water supply and poor sanitation. This percentage includes about 10-20 million children who die each year of diseases associated with diarrhea (Morrison, 1993).

Developing countries carry a heavy burden of water related diseases because most residence use unhygienic sources of water as their main sources for drinking and other related domestic uses. This has resulted into high case of water borne diseases such as onchocerciasis, typhoid fever, cholera, dysentery, gastroenteritis and other parasitic injections (Ademoroti, 1996). However, access to safe drinking water and sanitation is critical in terms of health especially for children. For instance, unsafe drinking water contributed to numerous health problems in developing countries such as the one billion or more incidents of diarrhea that occur annually (Mark *et al*., 2002). A study by Esrey*et al*,.(1985) suggests that improvement in waterquality is more likely to reduce the incidence of diarrhea than improvement in microbiological quality. Frequent examination of water for chemical and bacteriological contaminants should be a regular practice for any community (WHO,1984).

Consequent to the realization of the potential health hazards that may result from contaminated drinking water, contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases (Edema, 2001., Fapetu,2000). River Doma,Farinruwa and Mada in Nasarawa State,Nigeria had been in existence before the settlement of the present dwellers. Most rural dwellers depend largely on these rivers for their daily water needs and households requirement. The qualities of these sources are generally not guaranteed and cases abound where health problems have risen as a result of consumers drinking from such sources (Aremu *et al*., 2011).

In this study, the levels of some physicochemical and microbiological parameters of three major sources of natural flowing rivers in Nasarawa State have been studied. This is with view to ascertaining the safety levels and usability of these sources of water with regards to domestic, agricultural and other common purposes.

MATERIALS AND METHODS

Study Area

Nasarawa State is one of the 36 States in the Federal Republic of Nigeria. It is located in the North Central Geopolitical zone of Nigeria otherwise known as the Middle Belt Region. The State is made up of 13 local Government Areas. River Doma is found in Doma local Government Area . The local Government is located at latitude $08^0$66''-$08^0$72'' and longitude $07^0$64''-$07^0$69''. River Farinruwa is found in Wamba Local Government Area. The local Government is located at latitude 08^0 52''-$08^0$58''and longitude $07^0$53''-$07^0$57'' while River Mada is found in Akwanga LocalGovernment Area located at latitude 08^0 49''-08^0 52''and longitude $07^0$51''-$07^0$56''. These Local Government Areas share boundaries with Benue, plateau, and Kaduna States of Nigeria. The physical features of these areas are mountainous most of which are rocky and of undulating highlands of average heights. It has a typical climate of the tropical zone because of its locations. Its climate is quite pleasant with a maximum temperature of 95^0F and a minimum of 50^0F. Rainfall varies from 131.73 cm in some places to 145 cm in others (Obaje *et al*.,2005). The climate is characterized by two distinct seasons dry and wet. The dry season spans from October to March while the rainy season is from April to September. The months of December, January and February are cold due harmattan wind blowing across the local Government areas from the North-East of Nigeria. Mineral resources such as granite rock, and mica are found in the same areas. The sediments are generally comprised of sandstones, silt stones and forest soils which are rich in humus and very good for crop production. More than 80 percent of the inhabitants are predominantly farmers while few engage in fishing business. Most of the rural dwellers depend on these river waters as source of portable water.

SAMPLE COLLECTION, TREATMENT AND PRESERVATION

The water samples were collected in the month of February,2010 from three rivers of Nasarawa State,Nigeria namely; Doma, Farinruwa and Mada. Water samples were taken just below the surface water at three different locations of each river in pre-cleaned 1 L plastic containers then acidified with Analar grade of concentrated nitric acid (Aremu *et al.,*2011). The choice of plastic containers for sample collection is for the fact that the level of contamination from it to the water especially from trace metals is low (Odoh *et al*.,2013). They were then kept in coolers containing ice blocks and transported to the laboratory for preservation in a refrigerator before analysis was carried out on them.

PHYSICOCHEMICAL ANALYSES

Temperatures were measured using thermometer while pH was done using BOC pH meter. Conductivity was done using conductivity meter model NATOPPB5 while alkalinityand total hardness by titrimetry method (APHA,1992). Turbidity was done using digital direct reading turbidimeter. Chlorine was measured by chloride ion meter(KRK, Cl-5Z Japan). Phosphate (Molybdphosphoric blue colour method in H_2SO_4 system). Nitrate were estimated using a PYE UNICAM visible spectrophotometer. Total dissolved solids by gravimetric method. Bicarbonate, chemical oxygen demand (COD) and biological oxygen demand (BOD) by APHA method. All chemicals used were of analytical reagent grade and obtained from British Drug Houses (BDH,London).

MINERAL ANALYSIS

The elemental analysis(except Na and K) was done on the water samples using computer controlled Atomic Absorption Spectrometer(AAS 696 model, Japan) for trace metals while the Na and K were analysed using flame photometer perkins Elmer and Oak Brown Atomic Spectrophotometer(model 405, corning, UK). The instrument settings and operational conditions were in accordance with the manufacturer's specification.

MICROBIOLOGICAL ANALYSIS

The microbiological analyses carried out in order to the determine the presence of microorganisms using Muellar Hinton agar and Macconkey agar media as described by Edenam *et al.,*2001 .

The results of physicochemical analysis of water samples river Doma, Farinruwa, and Mada is shown in table 1. The pH values was 6.43 in Doma river , 6.40 in Farinruwa river and 6.68 in Mada river. The valve obtained fall within the WHO recommended valve for drinking water(FEPA,1991). Turbidity values 0.70 NTU in Doma river, 0.50 NTU in Farinruwa river and 0.40 NTU in Mada river. Turbidity is mainly a function of the suspended materials in the water which ranges from colloidal to coarse dispersion. Turbidity values recorded in this study for different water sources are close to the ones recorded for some rivers located in other parts of the country,Nigeria(Akhionbare,2004; Egboh and Emeshili,2007). Temperature values was 23^oc in Doma river, 24^oc in Farinruwariver and Mada river respectively. The temperatures obtained from these rivers were below the WHO recommended value of 25^oc. The total dissolved solid (TDS) and alkalinity values observed are within the recommended limit. The conductivity values was 0.58 $uscm^{-1}$ in Doma river,0.78$uscm^{-1}$in Farinruwa river and 0.64$uscm^{-1}$in Mada river. These values are below WHO recommended value of 10 $uscm^{-1}$.

The average soluble anions values in the rivers sources for chloride, nitrate and bicarbonate conform to

the recommended standard by WHO and FEPA. Chloride is present in nearly all natural waters at varying concentrations depending on the geochemical conditions. Chlorides are the stable components in water with concentration being unaffected by natural physicochemical and biological processes (Oludare *et al*.,2002). Phosphorus occurs in natural water and in waste water almost solely as phosphates. The record of present result showed that phosphate was not detected in the three river samples. The concentration of biochemical oxygen demand (BOD) was 2.35 mgL^{-1}in Doma river, 2.32 mgL^{-1}in Farinruwa river and 2.35 mgL^{-1} inMada river while the concentration of chemical oxygen demand(COD) was 3.44 mgL^{-1} in Doma river, 5.76 mgL^{-1} in Farinruwa river and 6.22 mgL^{-1} in Mada river. The results obtained from BOD and COD from these rivers showed that the water samples were not polluted because of high value of COD or BOD implies that such water will have objectionable odour, render the water unfit for domestic purpose and reduce oxygen available for aquatic organisms. The values of bicarbonate ions in the water samples was 11.9 mgL^{-1} in Doma river, 10.56 mgL^{-1} in Farinruwa river and 9.44 mgL^{-1} in Mada river. Water has been classified on the basis of hardness as follows: water having 0.75mg $CaCO3L^{-1}$ as soft, 75-150mg $CaCO3L^{-1}$ as hard and > 300mg $CaCO3L^{-1}$ as to total hardness(Aremu*et al*.,2011).

The levels various metals in the rivers Doma, Farinruwa, Mada is presented in Table1. Calcium has the highest concentration in all the three rivers ranging from 11.34 mgL^{-1}in Doma river, 14.05 mgL^{-1}in Farinruwa river and 8.47 mgL^{-1}in Mada river, followed by magnesium which also varied for the three rivers ranging from 8.65 mgL^{-1}in Doma river,9.95 mgL^{-1} in Farinruwa river and 5.99mgL^{-1}in Mada river. It is a well-known fact that mineral elements are necessary for life(Aremu *et al*.,2006). Magnesium functions as an essential constituent for bone structure of reproduction and for normal functioning of the nervous system. It is also a part of the enzyme system (Shills and Young,1988). Calcium plays an important role in blood clothing, in muscles contraction and in certain enzymes in metabolic processes. Calcium leads to be a kind of coordination among inorganic elements, if excessive amount of potassium, magnesium or sodium are present in the body, calcium is capable assuming a corrective role (Fleck,1976). The calcium and content of the water samples from Doma, Farinruwa and Mada rivers fall within the WHO/USEPA (1993) recommended range and could be said to be desirable for drinking without adverse effect. WHO recommended a maximum level of 200 mgL^{-1} as Ca(500 mgL^{-1} expresses as $CaC0_3$) above which deposition in water system can cause major problems while maximum permissible magnesium level of 150 mgL^{-1} was recommended provided the sulphate concentration is less than 250 mgL^{-1}. Nickel was not at detectable range in Mada river while in Doma and Farinruwa rivers, nickel showed a high concentration of 0.18 mgL^{-1} and 0.20 mgL^{-1} respectively which were slightly above the WHO recommended limit for drinking water Act. From this result, prolonged intake of these waters particularly river Doma and Farinruwa can cause decreased body weight, heart, liver damage and skin irritation. Even though a small amount of nickel is needed by the human body to produce red blood cells (Lenntech, 2008). The concentration of Copper in this study fall within WHO recommended standard of 1.00 mgL^{-1} . The concentration of iron was above WHO recommended maximum standards. The high iron content in water is not unusual, as it reflects what has been reported concerning its high concentration in Nigeria rivers(Aiyesanmi,2006; Kakulu and Osibanjo,1998; Aremu *et al*.,2008). Iron facilitates the oxidation of carbohydrate, protein and fats. It therefore contributes significantly to the prevention of anaemia which is widespread in developing countries such as Nigeria (Bender,1992). The concentration of iron in the present study, is above the WHO recommended limit of 0.3 mgL^{-1} and is not acceptable to the consumer,as it could give rise to iron depend bacteria which in turn can cause further deterioration in quality of water by prohibition of slimes or objectionable colour (Okedi and Oni,1997). The results obtained may be due to run-offs and geological formations of the Sample Rivers. The concentration of zinc was found to be below the WHO limit for drinking water standard of 5.0 mgL^{-1}. Lead was not at detectable concentration in Madariver while the concentratin of lead in Doma andFarinruwa rivers were 0.15 $mgL^{-1}$and 0.20 mgL^{-1}which was above the WHO standard. Lead is a known toxicant that has several deleterious effects even at minute concentration and has no known function in biochemical processes (Crossby,1977). Lead is commonly known to inhibit active transport mechanism involving ATP to depress the activity of the cholinesterase, to suppress cellular oxidation- reduction reaction and to inhibit protein synthesis(Waldren and Stofen,1974). Prolonged consumption of lead may also increase red cell fragility and kidney tubular cells and may become necrotic while chronic exposure may lead to intestinal nephrites. Prolonged consumption of lead may result to impairment of the hearing process (Fell,1954). The results obtained for lead in this study for some rivers(Doma and Farinruwa) were far above the WHO recommended standard of 0.005 mgL^{-1}. Cd, As and Se were not of detectable range in these rivers. Cr was not detected in Doma river while in Farinruwa and Mada rivers,the concentration of Cr was above the WHO standard of 0.05 mgL^{-1}. Therefore prolonged consumption of these water sources can cause kidney and liver damage, and damage the circulatory and nerve tissue (Lenntech,2008). The concentrations of Mn in these rivers were above the WHO standard 0.01 mgL^{-1}. In above all, some of the trace metals detected fall within the WHO/FEPA recommended range for drinking water without adverse effect in the rivers. But most of the trace metals such as Ni, Fe, Pb, and Mn were above the WHO recommended range for drinking water. This showed that metal concentration of the water from these rivers may

be hazardous on prolonged consumption.

Table 3 presents the result of microbiological analyses for isolating microorganisms using muellar Hinton Agar (MHA) and MacConkeyAgar(MCA) media. From microbial analyses only Farinruwa river has a growth below 100 counts MHA which shows that the water in the is within WHO Farinruwa river has a growth below 100 counts MHA which shows that the water in the is within WHO acceptable limit.Mada and Doma rivers had growth above 100 counts on MHA which showed that it is above acceptable limit of WHO standard. In Farinruwa river, there was no growth on MCA while in Doma river, the growth on MCA was less than 100 counts. Growth on MCA showed the possibility of enteric.

CONCLUSION

The study has presented data on the concentration of some trace metals, physicochemical and microbiological parameters of water samples collected from three rivers for pollution assessment. The result showed that most of the trace metals, physicochemical and microbiological parameters examined for water samples from the three rivers are within the World Health Organization limit for drinking water(WHO,2004) except for some trace metals such as Cr, Ni, Pb, Fe and Mn were above the WHO recommended standard. Also the examined in microbiological test were above the WHO recommended limits for drinking water at Doma and Mada rivers. Hence, the usability for such waters for domestic purposes is not in any case recommended. Such waters must properly treated by conventional method before they are consumed or put to any reasonable domestic application. Furthermore, the data generated in this study will serve as a baseline information with which future environmental impact assessment of anthropogenic activities could be progressively monitored in these areas.

REFERENCES

Ademoroti, C.M.A.(1996).Environmental chemistry and Toxicology, Foludex press Ltd; Ibadan, Nigeria, 20-30.

Akhionbare,S.M.O.(2004). Investigation of the chemical hydrology of Aga spring,Owan Area, Edo State, Nigeria. *International journal of Engineering science and Technology*, 1(3):27-35.

Aiyesanmi, A.F.(2006). Baseline concentration of heavy metals in water samples from rivers within Okitipupa, south East belt of Nigeria bitumen field. *Journal of chemical society of Nigeria*, 31(1 and 2):30-37.

American public Health Association(1992). *Standard methods for the examination of water and wase water*, 18 Edition, Washington D.C

Aremu, M.O., Olanisakin,A and Ahmed,S.A(2006). Assessment of heavy metal content in some selected agricultural products planted along some roads in Nasarawa State, Nigeria. *Journal of Engineering and Applied sciences*, 1(3):197-204.

Aremu, M.O.,Sangari, D.U., Musa, B.Z and Chaanda. M.S.(2008). Assessment of ground water and stream for trace metals and physicochemical contaminants in Toto Local Government Area of Nasarawa State , Nigeria. *International journal of chemical sciences*, 1(1): 8-19.

Aremu, M.O.,Gav, B.L., Opaluwa, O.D., Atolaiye,B.O., Madu,P.C. and Sangari, D.U. (2011). Assessment of physicochemical contaminants in waters and fishes from selected rivers in Nasarawa State, Nigeria. *Research journal of chemical sciences*, 1(4):6-17.

Bender, A.(1997). Meat and meat production in human nutrition in developing countries FAO, *Food Nutrition paper* 53, Rome Italy pp:46-47.

Crossby, N.F.(1977). Determination of metals in food. A review. Analyst 102:225-268.

Edenam, M.O., Omanu, A.M and Fapetu, O.M.(2001). Microbiology and physicochemical Analysesof different sources of drinking water in Abeokuta, Nigeria. Journal of microbiology 15(1):57-67.

Egboh,S.H.O and Emeshilli, E.M.(2007). Physicochemical characteristics of river Ethopia source in Umuaja, Delta State, Nigeria. Journal of chemical society of Nigeria, 32(2): 72-76.

Esrey,S.A.,Richard, G and Effachem, J.(1985). Intervention for the control of diarrhea disease among young chicken,improving water supplies and excreta disposal facilities. Bulletin of the world Health Organisation, 63: 757-772.

Fapetu, O.M.(200). Comparative Analysis of different sources of dinking water in Abeokuta, south L.G.A,Ogun State. *B .Sc Thesis* UNAAB,Abeokuta, pp:44.

Federal Environmental Protection Agency(FEPA).(2003). Guidelines and standards for Environmental pollution control in Nigeria,pp:328.

Fell, G.S.(1984). Lead toxicity problems of definition and laboratory evaluation. *Annual clinical Biochemistry,*21:453-460.

Fleck, H.(1976). *Introduction to Nurtrition* 3rd Edition. Macmillan publishing co. Inc. New York , pp:207-219.

Kakulu,S.E and Osibanjo, O.(1988). Trace metal pollution status in sediment on Niger Delta area, Nigeria, *Journal of chemical society of Nigeria*,13:9-15.

Lenntech.2008.http;//www.lenntech.com/heavy-metals.htm

Mark, W.R.,Ximing Cai and Sarah, A.C.(2002). World Water and Food to 2025; Dealing with security,

International food policy research Institute, NY. Washington, D.C, USA.

Marrison, A.(1983). " In third World villages. A sample recreation in natural streams" Transaction of the American society of civil Engineering, *Current World Environment*, 153-641.

Obaje, N.G.,Nzegbuna, A.I., Moumouni, A and Ukaonu, C.E.(2005). Geology and mineral resources of Nasarawa State. *Bulletin of Department of Geology and mining, Nasarawa State university,Keffi,* Nigeria,pp26-68.

Odoh, R., Oko, O.J., Kolawole, S.A and Oche, E.O (2013). A comparative study of the heavy metal content of Drinking water in different storage vessels. *International Journal of modern chemistry*, 5(3):166-180.

Okedi, C and Oni, O.O.(1997). Basic water Treatment operation. Edited by outreach department, published by *National water Resources Institute*, Kaduna, pp:1-90.

Oludare,A.C.,Adedepo, O.J., Balogun,O.(2002). Environmental safety, protection and policy for sustainable Development. *Environ. Rev* , 4(2):138-527. Shills,M.E.G.,Young,V.R.(1988). Modern Nutrition in Health and Disease Lea and febiger,philadelphia,USA.In: *Nutrition*. Eds. Nieman, D.C; Butterworth, D.E., Nieman,C.N. WmCBrown publishers,Dubuque, USA,PP:276-282.

US Environmental protection Agency .(1992). Interim guidance on interpretation and implementation of aquatic life criteria for metals. (USEPA,Health and Ecological Criteria Division, office of science and Technology).

Waldren,H.A.,Stofen, D.(1974). Sub-clinical lead poising. Acedemic press, New York,pp.84.

World Health Organisation(WHO),2004. Guidelines for drinking water quality, 3rd Edition, vol.1, Geneva.

World Health Organisation(1993). *Guidelines for drinking water quality,*WHO, Geneva.

TABLE 1: METAL CONCENTRATION (mgL^{-1}) OF AMBIENT WATER IN RIVER DOMA, FARIN RUWA AND MADA OF NASARAWA STATE, NIGERIA.

MINERALS	DR	FR	MR	WHO
Na	2.82 ± 1.20	2.89 ± 1.50	2.31 ± 1.10	na
Ki	2.01 ± 1.05	1.86 ± 1.50	2.09 ± 1.20	na
Ni	0.18 ± 1.20	0.20 ± 1.00	0.15 ± 2.10	0.05
Cu	0.49 ± 1.15	0.65 ± 1.50	0.78 ± 2. 50	1.00
Mg	8.45 ± 2.10	9.95 ± 1.50	8.65 ± 2.50	30
Fe	1.19 ± 1.50	1.94 ± 1.20	2.01 ± 1.50	0.3
Ca	11.34 ± 1. 00	14.05 ± 2. 50	13.15 ± 2.50	45
Zn	0.31 ± 0.01	0.32 ± 0.50	0.24 ± 1.50	5.0
Pb	0.15 ± 0.15	0.20 ± 150	0.09 ± 1.01	0.05
Cd	ND	ND	ND	0.005
As	ND	ND	ND	0.05
Se	ND	ND	ND	0.01
Cr	ND	0.11 ± 1.20	0.55 ± 2.10	0.05
Mn	0.12 ± 2.10	0.19 ± 0.50	0.19 ± 0.40	0.01

DR = Doma River; FR = Farinruwa River, MR = Mada River, ND = Not Deleted.

TABLE 2: PHYSICO CHEMICAL ANALYSIS WATER FROM THE THREE RIVERS OF NASARAWA STATE, NIGERIA.

PAREMETER	DR	FR	MR	WHO
PH	6.43 ± 1.50	6.40 ± 2.10	6.68 ± 1.20	65.8.5
Phosphate (MgL^{-1})	ND	ND	ND	45
Chloride (gL^{-1})	0.32 ± 1.00	0.57 ± 1.10	0.44 ± 2.10	200
Nitrate	ND	ND	ND	45
Bicarbonate (MgL^{-1})	11.90 ± 1.20	10.56 ± 1.01	9.44 ± 2.10	500
Turbidity	0.70 ±	0.5 ±	0.40 ± 0.10	Na
Conductivity (M/s)	0.58 ± 0.10	0.78 ± 2.00	0.64 ± 1.00	10
Alkalinity	2.21 ± 1.10	1.56 ± 2. 50	1.14 ± 1.50	200
TDS (MgL^{-1})	749 ± 8.10	568 ± 1.10	899 ± 5.05	2000
COD (MgL^{-1})	3.44± 1.50	5.76 ± 2.30	6.22 ± 1. 20	10
BOD (MgL^{-1})	2.35 ± 1.20	2.32 ± 2.20	2.33 ± 0.10	10
Temperature (^{0}c)	23 ± 2.00	24 ± 1.50	24. 1.00	<40
Total Hardness	7.44 ± 2.01	6.88 ± 0.20	2.99 ± 2.10	100
Total Solid	0.09 ± 0.10	0.14 ± 0.50	0.05 ± 1.10	500

DR = Doma River, FR = Farinruwa River, MR = Mada River, ND = Not Deleted.

TABLE 3: MICROBIOLOGICAL ANALYSIS FOR MUELLER HINTON AGAR AND MACCONKEY AGAR.

SAMPLE	MUELLER HINTON AGAR	MACCONKEY AGAR
Mada River	Greater than 100 counts	More than 100 counts
Farin ruwa River	Less than 100 counts	No growth
Doma River	Massive Growth, more than 100 counts	Less than 100 counts

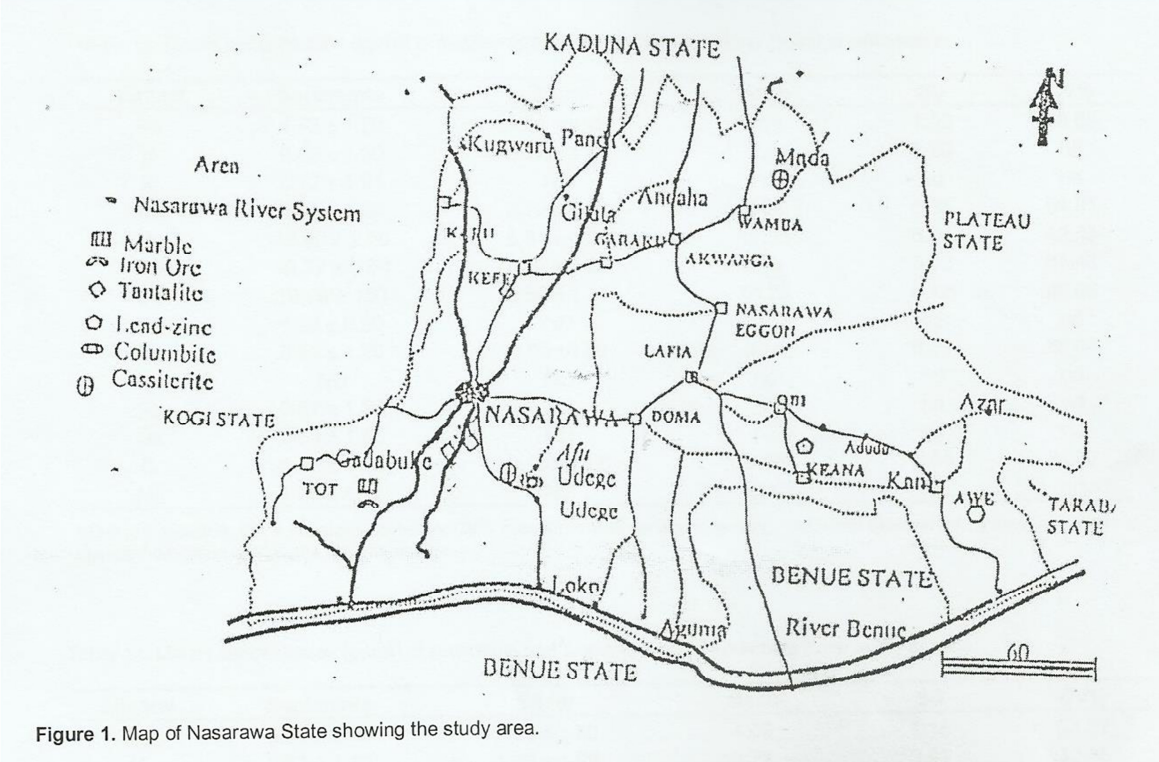

Figure 1. Map of Nasarawa State showing the study area.

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