TRACE METAL DETERMINATION IN UKE, AUTA-BALEFI AND KARU (HEADQUARTER) IN KARU LOCAL GOVERNMENT AREA OF NASARAWA.

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Abstracts: Water samples collected from nine sampling points of three different sources (Bore-holes, stream sand wells) within Karu Local Government Area of Nasarawa State, Nigeria were analyses for trace metals. The trace metals Na, K, Mg, Fe, Ca, Zn, Pb, Cd As, Ni, Cr and Hg were analyzed using atomic absorption spectrophotometric method. The results showed that Ni and Hg were not at detectable range for all the water samples. The trace metals analyzed were found within the required standard limit set by World Health Organization (WHO) for drinking water. All findings have been discussed and appropriate recommendations made.

Keywords: Trace metals, Cadmium Streams and Groundwater.

INTRODUCTION

Water is the most abundant chemical substance on earth. It covers over 70% of the earth's surface and water vapor is present in the atmosphere. Without water life cannot survive, [14]. Humans obtain water from rivers, stream or springs. In areas were these resources are not available, boreholes and well are needed to tap underground water trapped in layers of absorbent rocks between non-porous layers [14]. Mankind, in the new millennium, is faced with a number of challenges including the need for sustainable use of water resources. This need stem in the indiscriminate utilization of the water resources which may not only reduces the quantity of water but also the quality of water available for human and other uses. Water is often being referred to as the universal solvent. Yet man's assessment of the value of water is very low until he finds himself without it [8]. The largest available sources of fresh water lies underground and is referred to as ground-water, [10]. The chemical composition of surface and ground water varies considerably depending on the nature of the water body and its locations [17]. The quality required of ground water supply depends on its purpose [11, 43]. Water is a renewable resource, it cannot be used up and the total balance of water on earth has been constant for millions of years. Safe water drinking is a human birth right as much as clean air. However, much of the world population lacks access to safe drinking water. Of the six billions people on earth, more than one billion lack access to adequate and safe drinking water [44]. The basic purposes for which water is domestically required includes drinking, bathing, cooking, sediment, fishing and general sanitation such as laundry, flushing of closets and other household chores [13, 35]. It is a well know fact that adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth; yet it has been observed that millions of people are deprived of this, particularly in the developing countries including Nigeria. The neglect of rural areas in most developing countries in term of basic infrastructures such as pipes born water and sanitation facilities, expose the communities to a variety of health related problems such as water borne diseases.[41]. 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[20,23] The World Health Organization [50]. Estimate that up to 80% of all sickness and disease in the world is caused by inadequate sanitation, polluted water or unavailability of water. A report also indicates that about 61% of people in developing countries are estimated to have access to good domestic water supply, and 36% to sanitation facilities, greater in urban than rural areas [5]. In Ethiopia, over 60% of communicable diseases are due purely to environmental health conditions arising from unsafe and inadequate water supply and poor hygienic sanitation practices [1]. Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on fresh water bodies due to the introduction of various pollutants such as organic compound, heavy metals, agricultural wastes etc. [4, 28]. Metals are introduced also into aquatic systems as a result of the weathering of rocks and soils, for example, volcanic eruptions and also from several human activities involving the mining, processing and uses of metals, and industrial materials that contain metals contaminants [26,31]. The increased use of metal containing fertilizers due to the agricultural revolution could lead to a continued rise of the concentration of metal pollutants in fresh water reservoirs due to water run-off [3, 21]. Vehicle emissions, and tire and engines wear contribute sizeable concentrations of all metals, particularly zinc and copper. Thus, significant correlations are found between traffics volumes and metals concentrations [2,9]. Heavy metal contaminations of surface water have been reported by several research workers [5,30,42].

Studies have confirmed that heavy metals can directly influence behavior by impairing mental and neurological function and alter metabolic processes. they could induce impairment and dysfunctional in blood and cardiovascular, endocrine, immune, nervous, urinary and reproductive systems[19,33] Portable water supply to communities in Nasarawa State is the responsibility of the government which in most cases has been characteristics by low productivity, small coverage and inefficient service delivery. Uke, Auta-Balefi, karu (headquarter) all in Karu Local Government Area is one of the areas that do not enjoy portable water supply. Most rural dweller therefore depends on various available water sources. 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. The provision of good quality water to the ever growing population (Due to the recent demolition of houses in the Federal Capital Territory) in the study area cannot be over emphased. Hence assessing its suitability for domestic uses. This research work aims at investigating the trace metals of waters from wells, boreholes and streams which are the main sources of portable water for the inhabitants of Uke, Auta-balefi and karu (headquarter) all in Karu Local Government area.

MATERIALS AND METHOD

Karu Local Government is the most populated in Nasarawa State due to its boundaries with Federal Capital Territory (F.C.T) Abuja of Nigeria. The Local Government is made up of different ethnic group each with distinct heritage; Among the major tribes are: Gbagyi, gwandara, Koro, Gade, Yeskwa; while minor tribes such as Hausa, Igbo, Yoruba etc. The physical features of the area are largely mountainous, most of which are rocky and of undulating highland of average height. It has a typical climate of the tropical zone because of its location. Its climate is quite pleasant with a maximum temperature of 95^0F and a minimum of 50^0F. Rainfall varies from 130.72cm in some places to 145cm in other [34]. Mineral resources such as marble deposits, granite rocks, iron ore and mica are found in some areas. The climate is characterized by two distinct seasons, dry and wet. The dry seasons spans from October to March while the rainy season is from April to September. The months of December, January and February are cold due to harmattan wind across the Local Government blowing across the Local Government Area from the North- East of Nigeria. Karu(Headquarters), Auta-Balafi and Uke are towns located about 12Km apart from each other in the LGA. Samples of water were collected from well, boreholes and streams located in these three towns.

Sample Collection, Treatment and preservation

Water samples from streams was collected between February, March, June and August, 2012 on a monthly basis. This was done in order to cover both wet and dry seasons. The boreholes samples were collected from five different sources bimonthly for two month in dry and wet season (February and March) and June and August respectively. For the well sample, the grab method was used [2]. Sampling and preservation of samples were carried out as prescribed by APHA (1995) methods. The sampling was done using well-labeled plastic bottles which were washed with detergent and rinsed with distilled water and acidified(1.5) with Analar grade concentrated nitric acid. The samples were subsequently kept in ice bags and transferred to the laboratory.

Mineral Analysis

The elemental analysis (Na and K in exception) was done in the water samples using Perkin-Elmer and Oak Brown atomic absorption spectrophotometer. Sodium and Potassium were determined by using a Flame Photometer.

DISCUSSIONS

Statistical Analysis The result obtained were subjected to statistical evaluation and presented in Table 1- 4. The parameter evaluated were grand means and standard deviation. In Table 1: presents the result of trace metals in the located at Uke, Auta-Balefi and Karu (Headquarter) towns. Calcium is the most highly concentrated mineral in the stream water sample ranging from 25..61 MgL^{-1} in Auta-Balefi, to 104.3mgL^{-1} in Karu; followed by magnesium which ranged from 9.44 MgL^{-1} in Karu to 12.54 MgL^{-1} in Uke. The concentration of Cadmium is the least ranged from 0.002mgL^{-1} in Uke to 0.006mgL^{-1} in Karu town. Mercury and Nickel were not at detected in any of the wells. The lead content is higher than the permissible limit of World Health Organisation(WHO). The result of trace metals analyzed for the three well water is shown in Table 2. The concentration of calcium is the high in well water varied from 34.01mgL^{-1} in Uke to 56.10mgL^{-1} in Auta-Balefi; followed by magnesium from 11.35mgL^{-1} in Auta-Balefi to 17.78mgL^{-1} in Uke, the least concentrated metal was Cadmium varied from 0.001 mgL^{-1} in Uke to 0.005 mgL^{-1} in Karu. In all the three water samples from the borehole, mercury and Nickel was not detected. Table 3 shows result of trace metals in the three Borehole; Uke, Auta-Balefi and Karu.

The highest concentrated mineral was calcium which ranged from 41.21mgL^{-1} in Uke to 56.25mgL^{-1} in Karu while that of Magnesium ranged from 12.11 mgL^{-1} to 13.43mgL^{-1} while the least was found on Cadmium ranging from 0.001 mgL^{-1} in Uke to 0.004 mgL^{-1} in Karu. Nickel and Mercury were not at detectable range for any of the streams. A summary of the levels of various metals in the stream, well and boreholes is presented in Table 4. Calcium showed the highest concentration in all the three different type of waters ranging from 44.71mgL^{-1} in the well to 54.0mgL^{-1} in the streams water sample; followed by magnesium which varied from 11.10mgL^{-1} in the stream to 12.93mgL^{-1} in well. It is a well known fact that minerals elements are necessary for life[16,29,38] Magnesium functions as an essential constituent for bone structure, for reproduction and for normal functioning of the nervous system[40]. Calcium play an important role in blood clotting, in muscles contraction and in certain enzymes in metabolic processes.

The calcium and magnesium content of the water samples from Streams, wells and borehole falls within the recommended range[50] that is, is good for drinking without adverse effect. The value(104.3mgL^{-1}) of water sample from Karu was exceptionally high (Table 1) compared with the values of other water samples. This being that the level of calcium in natural waters depends upon the type of rock through which the water has passed. Calcium is usually present as carbonated or bicarbonates, sulphate, chloride and nitrite in high saline waters[49]. There is no health objections to a high calcium content in water; the limitation being made on the ground of excessive scale formation [50]. Sodium concentrated values ranged from 5.52mgL^{-1} in the borehole water sample to 6.74mgL^{-1} in the stream while potassium values ranged from 3.74mgL^{-1} in the well to 4.40mgL^{-1} in the stream water sample. Potassium is primarily an intracellular cation, mostly cation is bound to protein in the body with sodium influencing osmotic pressure and contributions to normal pH equilibrium[25]. The sodium content in water is important for a healthy person, except when combined with excessive concentrations of sulphate. This combination can cause gastrointestinal initiation (laxative effect) for person placed on low sodium diet because of heart, kidney or circulatory ailment. The usual low sodium diet allowed in drinking water is 20mgL^{-1} [2]. The values recorded for both sodium and potassium in the present study fall under WHO guidelines and thereby the waters from different sources are good for consumption without any adverse effect. The high iron content and its wide distribution throughout the sampling points (Table 3) reflect what has been reported regarding its presence at high concentration in Nigeria soils [12, 27]. Iron is one of the essential components of haemoglobin which is responsible for the transport of oxygen in the body. Iron also facilitates the oxidation of carbohydrates, proteins and fats.

It therefore contributes significantly to the prevention of anaemia, which is spreading wide especially in developing countries like Nigeria [15]. The iron contents in all the water sample are higher than WHO\ USEPA guideline value (0.30mgL^{-1}) for drinking water [45 ,50]. This is not acceptable to the consumers, but could give rise to iron-dependent bacteria which in turn can cause further deterioration in the quality of water by the production of slimes or objectionable colour. The result obtained may be due to run-offs geological formation of sample area. Some methods of aeration can remove or reduce iron level through simple chemical reaction [36]. The highest concentration of Lead was found in the stream water sample to be 0.072 mgL^{-1}. Lead is a well-known toxicant that has several deleterious effects even at low concentrations, and has no known function in biochemical processes. The source been the use of leaded gasoline [39]. Other Sources of lead include storage batteries, type of metals and anti-knock compounds in petrol [18]. An onset of lead pollution of surface waters in Nigeria had been reported [32,37]. Lead known to inhibit active transport mechanisms involving ATP, to depress the activity of the enzymes cholinesterase, to suppress cellular oxidation- reduction reactions and to inhibit protein synthesis [47]. Prolonged consumption of lead may result to impairment of the learning processes [24]. However, lead, content values in the present study are lower than WHO\ USEPA guidelines recommended value of 0.05mgL^{-1}. Comparison of the mean concentration of the metals in well, borehole and stream water samples with WHO\USEPA guidelines value for drinking water shows compliance with Cu, Zn, Cd, As, Ni, Cr and Hg (Table 4). However, because a metal concentration in the aquatic environment is low and considered to be naturally occurring or background; does not mean that the concentration could not cause adverse ecological effects [46]. The presence of one metal can significantly affect the impact that another metal may have on an organism. The effect can be synergistic, additive or antagonistic [22].

CONCLUSION

The essence of trace metals analysis in the study area is to offer greater understanding of our environment and resources and their best uses both physically and chemically. Of prime importance is the wise use of water and its resources for sustainable development. The study has presented data on the concentrations of some trace metals in water samples from streams, wells and boreholes. The results showed that the heavy metals from the three sources are within the World Health Organisation (WHO) limit for drinking water (WHO, 2004). Indiscriminate dumping of waste into the drainages which later find it way to the stream should be discourage. The environmental protection agency should see that sanitary materials is sufficiently available. The environmental impact assessment of anthropogenic activities should be continuously monitored in the area.

RESULTS

Table I: Metal Concentration (MgL^{-1}) of three Streams in and around Karu Local Government Area of Nasarawa State, Nigeria.

Trace Metal	Uke	Auta-Balefi	Karu	$\dot{X}$	S.D
Na	5.89	6.22	8.11	6.74	0.99
K	4.21	3.98	5.02	4.40	0.45
Cu	0.72	0.65	0.78	0.72	0.05
Mg	12.54	11.34	9.44	11.10	1.28
Fe	1.45	0.81	1.46	1.24	0.30
Ca	32.33	25.61	104.3	54.0	35.62
Zn	0.14	0.17	0.19	0.17	0.02
Pb	0.042	0.061	0.072	0.058	0.012
Cd	0.002	0.003	0.006	0.004	0.002
As	0.08	0.05	0.09	0.07	0.017
Cr	0.35	0.17	0.46	0.33	0.120
Hg	ND	ND	ND	Na	Na
Ni	ND	ND	ND	Na	Na

$\dot{X}$ = Grand meams; SD = Standard deviation; ND = Not Detected; na = not available

Table II: Metal Concentration (MgL^{-1}) of three Boreholes in and around Karu Local Government Area of Nasarawa State, Nigeria.

Trace Metal	Uke	Auta-Balefi	Karu	$\dot{X}$	S.D
Na	5.41	5.78	6.34	5.84	0.38
K	3.78	2.45	4.98	3.74	1.03
Cu	1.45	1.78	1.91	1.71	0.19
Mg	13.78	11.35	13.67	12.93	1.23
Fe	1.56	0.93	1.01	1.17	0.28
Ca	34.01	56.10	44.02	44.71	9.03
Zn	1.17	1.25	1.36	1.26	0.08
Pb	0.02	0.004	0.007	0.04	0.02
Cd	0.001	0.004	0.005	0.003	0.002
As	0.06	0.04	0.07	0.06	0.012
Cr	0.31	0.14	0.37	0.27	0.010
Hg	ND	ND	ND	Na	Na
Ni	ND	ND	ND	Na	Na

$\dot{X}$ = Grand meams; SD = Standard deviation; ND = Not Detected; na = not available

Table III: Metal Concentration (MgL^{-1}) of three Streams in and around Karu Local Government Area Of Nasarawa State, Nigeria.

Trace metal	Uke	Auta-Balefi	Karu	$\dot{X}$	S.D
Na	4.99	5.56	6.01	5.52	0.42
K	4.50	3.10	4.96	4.20	0.79
Cu	1.42	1.67	1.89	1.66	0.19
Mg	12.11	12.78	13.43	12.77	0.54
Fe	2.54	1.94	2.14	2.20	0.26
Ca	41.21	49.20	56.25	48.89	6.14
Zn	1.01	1.25	1.39	1.23	0.16
Pb	0.03	0.05	0.06	0.05	0.01
Cd	0.001	0.002	0.003	0.002	0.0008
As	0.021	0.032	0.042	0.032	0.009
Cr	0.25	0.12	0.31	0.23	0.079
Hg	ND	ND	ND	Na	Na
Ni	ND	ND	ND	Na	Na

$\dot{X}$ = Grand meams; SD = Standard deviation; ND = Not Detected; na = not available

Table IV: Level of Metal Concentration(MgL^{-1}) in the Wells, Boreholes and Streams Water Sample Compared

Trace metal	Streams	Wells	Boreholes	USEPA in MgL^{-1}
Na	6.74	5.84	5.52	na
K	4.40	3.74	0.79	na
Cu	0.70	1.71	0.19	1.0
Mg	11.10	12.93	0.54	na
Fe	1.24	1.17	0.26	0.30
Ca	54.0	44.71	0.14	na
Zn	0.17	1.26	0.16	2.0
Pb	0.01	0.04	0.01	0.017
Cd	0.004	0.003	0.0008	0.005
As	0.07	0.06	0.009	0.05
Cr	0.33	0.27	0.079	0.10
Hg	ND	ND	ND	0.02
Ni	ND	ND	ND	0.03

$\dot{X}$ = Grand meams; SD = Standard deviation; ND = Not Detected; na = not available

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REFERENCES

Abede, I.S (1986). Hygienic Water quality, its Relationship and Testing Aspect in TropicalConditions. Department of Civil Engineering Tempere University Finland. Pp 22-27.

Ademorati, C.M. A.(1996). Standard Methods for Water and effluent Analysis Foludex press Ltd: Ibadan 20-30.

Adeyeye, E. I 1997. Water quality criteria and the relationship between the distribution and concentration of some mineral elements in soil sediments, ambient water and the body parts of *Claris gariepinus* fish in a freshwater point. *Ghana j. Chem.*, 3(2): 42- 50.

Adeyeye, E. I.; Akinyugha, N.J.; Fesobi, M.F.; TENABE, V.O. 1996. Determination of some metals in *Claris gariepinus* (Cuvier and Vallenciennes), *Cyprinus carpio (L) and Oreochromis niloticus* (L) fishes in a polyculture fresh water pond and their environmens. 47(6): 471-477.

Ahmed, A.; Alam, M. 2003. Physicochemical and toxicological studies of industrial effluents in and around Delhi and ground water quality of some areas of Delhi city. *Chemical Environ.* Res., 12: 13-15.

American Public Health Association(APHA), 1992.*Standard Method for the Examination of water and wastewater* 18th ed. Washington D.C

American Water Works Association and water pollution control federation, 1995. *Standard Method for the Examination of water and wastewater* 19th edn. American Public Health Association (APHA) New York..

Aremu, M.O. 2008. Environmental pollution by toxic heavy metals and its possible abatement for developing a healthy ecosystem. In: *Environment, Health and Nutrition*: aGlobal perspective, APH Publishing Inc. New Delhi, India, Eds, Basu, S.K and Datta Banik(in press).

Aremu M.O; Olonisakin, A; Ahmed, S.A. (2006). Assessment of heavy metal content in some selected agricultural products planted along roads in Nasarawa State, Nigeria *j. Eng & Appl. Sci.,*1(3); 199-2004.

Ariyo, S. O.; Adeyemi, G.O.; Odukoya, A. M. 2005.Geochemical characterization of aquifers in the basement complex sediment transition zone around Ishara, southwestern Nigeria. *Water Res. J. Nigeria Assoc. Hydrogeologists.,* 16: 31- 38.

Asuquo, F. E. 1999.Physiocochemical Characteristics and anthropogenic pollution of the surface water of Calabar River, Nigeria. *J. Pure & Apple . Sci* 5(4): 595-600.

Ayejuyo, O.O.; Oluwu, R. A.; Megwa, K. C.; Denloye, A. A. B.; Owodehinde, F.G. 2003. Trace metals in *Clarias lazera,* water and sediments from Majidun River, Ikorodu, Nigeria. *Res. Commun. Fisheries,* 1: 27-31.

Anzene, S.J.; Aremu, M.O 2007. Quality and antiseptic properties assessment of indigenous black soap produced in Nasarawa State, Nigeria. *j. Eng. & Appl. Sci* 2(8): 1297-1300.

Bajah, S.T (1993). Chemistry for Senior Secondary Schools. 3rd Edn., Heinemann Educational Books, Ibadan, pp 74.

Bender, A. 1992. Meat and meat products in human nutrition in developing countries. FAO Food and Nutrition Paper 53, Rome, Italy, pp 46- 47.

Buss, D ;Robertson, J. 1976. *Manual of Nutrition.* Her Majesty stationary office, London, UK, 8th edn. Pp 32-40.

Cheesbrough, M.(2004). District Laboratory Practice in Tropical Countries. Pp 108

Crossby, N.T.1997.Determination of metals in foods: A review. *Analyst* **102:** 225-268

Davis, B. L.; Jixiang, G. 2000. Airborne particles study in five cities of China atmosphere. *Environ.,* 34: 703- 2711.

Edema, M. O.; Omemu, A. M and Fapetu, O. M. 2001. Microbiology and Physicochemical Analysis of different sources of drinking water in Abeokute, Nigeria. Nigeria Journal of Microbiology **15(1):** 57- 61

Edet, A. E; Offiong, E. E.(2003). Evaluation of water quality pollution indices for heavy metal contamination monitoring. A study case from Akpabuyo Odukpani area, Lower Cross River Basin (Southern Nigeria). *Geojournal,* 10: 1-10.

Eisler, R. 1993.Zinc harzard to fish, wildlife and invertebrates': A Synoptic Review. U.S. Fish and wildlife service, biological report 10. Publication unit USFWS. Washington. D.C 20240.

Fapetu, O. M. 2000. Comparative Analysis of different Sources of drinking water in Abeokuta South LGA, Ogun State. B.Sc Thesis UNAAB, Abeokuta pp 44.

Fell, G.S. 1984. Lead toxicity problems of definition and laboratory evaluation. *Ann. Clin. Biochem.,* **21:** 453- 460.

Fleck, H. 1976. *Introduction to Nutrition.* Macmillian, New York,USA, 3rd edn. pp. 207-219.

Gutenmann, W. H.; Bache, C. A.; Mccahan, J. B.; List, D. I 1988. Heavy metals and chlorinated hydrocarbons in marine fish products. *Nutr. Rep. Int.,* 38:1157-1161.

Kakulu, S. E.; Osibanjo, O. 1988. Trace heavy metal pollutional status in sediment of the Niger DeltaArea of Nigeria. *J. Chem. Soc. Nig.,* 13: 9-15

Manahan, S. F 1994. Environmental Chemistry , Lewis Boca Baton, Pp 76.

Mertz, W. 1981. Recommended dietary allowances up to date trace minerals. *J. Am. Dietet.* Assoc., 64(2): 163- 167.

Mohan, S.V.; Nithila, P.; Reddy, S. J 1996. Estimation of heavy metal in drinking water and development of heavy metal pollution index. *J. Environ . sci and Health*, A31 (2): 283- 286.

Marr, I. I.; Creaser, M. S. 1983. Environment Chemical Analysis. Pub. Blackie and sons Ltd, London. Pp 104.

Mombershora, C. O.; Osibanjo, O. Ajayi S. O. 1983.Pollution studies on Nigeria rivers; the onset of lead pollution in Ibadan. Environ. Int,. 9: 81-84.

Nriagu, J. O.; Pacyna, J. M. 1980. Quantitative assessment of worldwide contamination of air, water and soil with trace metals. Nature, 333: 134-139.

Obaje, N.G.; Nzegbuna, A.I.; Moumouni, A.; Ukaonu. C.E. 2005. Geology and mineral resources of Nassarawa State. Bulletin of Department of geology and Mining, Nasarawa State University, Keffi, Nigeria.

Ogunawo, C. O. 2004. Coping with domestic water supply problems in Nigeria Urban Centres, The Ijebu-Ode City experience. *Int. J. Env. Issues,* 7(1&2): 21-25.

Okedi, C.; Oni, O.O 1997. Basic Water Treatment Operations, edited by outreach depertment, Published by National Water Resources Istitute, Kaduna, pp. 190.

Okoye, B. C.O. 1991. Heavy metals and organisms in the Lagos Lagoon. Int. J. Environ. Stud., **37:** 285 – 292.

Olaofe, O.; Sanni, C.O; 1988. Mineral contents of agriculture products. *Food Chem,.* 30: 73-77.

Osibanjo, O.; Ajayi S. O. 1980. Trace metals levels in the tree barks as an indication of pollution. *Environ.* Int., **4:** 236-244

Shill, 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.

Sridha, M. K. C. (2000). Ground Waters in Nigerian Urban Centres; Problems and Options. Schriftenr Ver Wasser Boden Lofty, 105, 393-397.

Tareq, S. M,; Rahman, S. H. 2002. Portable water quality of Jahangirnagar University Campus , Savar. Banglandesh U. J. Sci., 25: 147- 152

Todd, D.K 1984. Groundwater Hydrology. 2nd. *John Wiley and Sons,* New York. Pp 267-312.

TWAS (2002). Safe Drinking Water the Need, the Problem, Solution and Action Plan. Third World Academic of Sciences Italy, Pp 8-12.

US Environmental protection Agency, 2002. Current drinking water standards (Office of groundwater drinking water. Government printing office; Washington DC).

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

Waldren, H. A.; Stofen, D. 1974. Sub-clinical lead poisoning. Academic Press, New York, pp. 84.

Wright, R.F; Norton, S.A; Brake, D.F; Frogner, T. 1988.Experimental verification of episodic acidificationof fresh water by seasalts.Nature, **334:** 422- 424.

World Health Organisation (WHO), 1997. Standard Parameters for potable water. Geneva.

World Health Organisation, (WHO), 1993. Guidelines for Drinking Water Quality, 3rd Edition, vol. 1, Geneva.

World Health Organisation, (WHO), 2004. Guidelines for Drinking Water Quality, 3rd Edition, vol. 1, Geneva.

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