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Seasonal Variation in Nitrate Levels in Hand Dug Wells in Makurdi Metropolis

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Abstract: Groundwater quality response to changes in season is documented in several studies. In this study, seasonal variation in nitrate levels in hand dug wells in Makurdi metropolis is examined. A total of 15 water samples were collected from hand dug wells and analyzed for nitrate level for both wet and dry seasons. The analysis was done according to standard method of water examination. The results of analyses show that 80% of the wells have nitrate levels above WHO guide limit for drinking water for the wet season as against 67% for the dry season. This implies that consumers of water from these hand dug wells especially children stands a very high of metheamogolineamia. Generally nitrate level in these hand dug wells were noted to be higher in wet season than in the dry season. Source of nitrate in these wells is attributed to use of chemical fertilizers on farms, improper disposal of animal and human wastes and influence of season. All land use activities capable of polluting water should be properly controlled. Water from these wells may be used for other domestic purposes other than drinking. Boiling of water from these should be encouraged to reduce the risk of contracting illness.

Key words: Nitrate, season, variation, hand dug wells, water quality

INTRODUCTION

A wide range of water problems faces nations and individuals around the world. These problems include international and regional disputes over water, water scarcity and contamination, unsustainable use of groundwater, ecological degradation and the threats to climate change. The failure to provide safe drinking water and adequate sanitation services to all is perhaps the greatest development failure of the 20th century. If no action is taken to address unmet basic needs for water, as many as 135 million will die from these diseases by 2020 (Gleick, 2002). Water-related diseases are a human tragedy, killing millions of people each year, preventing millions of people more from leading healthy lives and undermining development efforts (Nash, 1993). About 2.3 billion in the world suffer from diseases that are linked to water (Kristof, 1977; United Nations, 1997).

In Nigeria, urban dwellers faces serious threats to the quality of life and safety. With urbanization resulting into high degree of population densities and concentration of socio-economic activities, it has become increasingly difficult to meet all the water requirements both in quantity and quality. The public water supply is generally inadequate and in most cases inaccessible, the supply is intermittent and unreliable, thus resulting into high dependency on unsafe supplementary sources such as streams, hand dug wells and ponds (Kakulu and Osibanjo, 1992; Olajire and Imeppeoria, 2001; Nnodu and Ilo, 2002; Owuama and Uzoije, 2005; Ocheri, 2006). Concern over the quality of water harnessed especially from the hand dug wells have received wide attention among researchers (Ovrawah and Hymore, 2001; Ehinola and Coker, 2002; Nnodu and Ilo, 2002; Ogunbadewa, 2002; Omofonmwam and Eseigbe, 2009). Consistent in their findings is that water from hand dug wells are polluted through physical processes, geochemistry of the environment and anthropogenic activities. Consequently, consumers of such waters are exposed to series of health risks.

Health problems from nitrates in water sources are becoming a serious problem every here. In over 150 countries, nitrate from fertilizers seeped into wells, fouling the drinking water (Maywald *et al*., 1988) Nitrate is one of the most commonly identified groundwater contaminants (BGS, 2003). It is primarily regulated in drinking water because excessive levels can cause methaemoglobineamia (blue-baby syndrome). This is a condition whereby nitrate is reduced to nitrite in the stomach of infants thus inhibiting the transport of oxygen round the body. The consequence is shortness of breath (Cyanosis), blueness of skin and atimes death (BGS, 2003). Several studies on nitrate pollution of groundwater have been carried in different parts of Nigeria urban areas (Gbodi and Atawodi, 1986; Ezeonu, 1988; Adelana, 2006; Ogbu and Echebiri, 2003). None of these studies focused on the effect of seasons on the level of nitrate in groundwater. In this study therefore, attempt is made to assess the level of nitrate in hand dug wells among seasons in Makurdi urban area. Hand

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dug wells are well systems whereby groundwater is abstracted at shallow depths. They are generally more vulnerable to pollution than boreholes. Due to the general inadequacy and inaccessibility of public water supply in Makurdi use of water from the hand dug wells is common in the residential area.

The study area: The study area is Makurdi town, the capital city of Benue state in north central Nigeria. Makurdi lies between Lat. 7^{o} 44^{N} and Long. $8^{o}54^{N}$. It is located within the flood plain of lower River Benue valley. The physiographic characteristics span between 73-167 m above sea level. Due to the general low relief sizeable portions of Makurdi is water logged and flooded during heavy rainstorms. This is reflected in the general rise in the level of groundwater in wells during wet season. The drainage system is dominated by River Benue which traverse the town into Makurdi North and South banks.

Temperatures are generally high throughout the year due to constancy of insolation with the maximum of 32^{o}C and mean minimum of 26^{o}C. The hottest months are March and April. The rainfall here is convective, and occurs mostly between the months of April and October and is derived from the moist and unstable southwest trade wind from St. Helena Subtropical Anticyclones (STA). Mean annual rainfall total is 1190 mm and ranges from 775-1792 mm. Rainfall distribution is controlled by the annual movement and prevalence of Inter-Tropical Discontinuity (ITD).The mean monthly relative humidity varies from 43% in January to 81% in July-August period (Tyubee, 2009).

The geology is of cretaceous sediments of fluvio-deltaic origin with well-bedded sandstones of hydrogeological significance in terms of groundwater yield and exploitation (Kogbe *et al*., 1978). Makurdi town which started as a small river port in 1920 has grown to a population of 297,393 people (NPC, 2006).

MATERIALS AND METHODS

In this study, we relied on the analyses of water samples collected from hand dug wells across the residential area of Makurdi town. Two sets of water samples were collected from 15 hand dug wells in the months of September for wet season and January for dry season. The essence is to enable us ascertain the effect of seasons on the level of nitrate in these wells. To ensure quality assurance, adequate measures such as the use of sterilized containers in water sample collection, proper preservation and storage at temperature of 4^{o}C before laboratory analyses.

The analyses of the water samples collected was done according to standard methods of water examination using calorimetric techniques (APHA-AWWA-WPCF, 1985). The technique is based on the principle that the amount of energy absorbed is proportional to the concentration of nitrate ion present in the sample. The ion has its own characteristic absorption wavelength. Ultraviolet spectrophotometer UNICAM Sp 6-550 model was used to determine the ionic concentrations in water sample. Nitrate concentrations as it affects the quality of drinking water is based on the WHO 2006 prescribed limit.

RESULTS AND DISCUSSION

The results of analyses of nitrate level in hand dug wells for rainy and dry season are presented below for discussion.

From Table 1, 12 out of 15 wells (80%) have nitrate concentration levels above the WHO prescribed limit of 45 mg/l for drinking water for the rainy season. For the dry season, 10 out 15 wells (67%) have elevated nitrate concentration levels above the WHO limit. This shows that nitrate concentrations in hand dug wells in Makurdi during the rainy season are higher than in the dry season. For instance w7, w11, w14 and w15 have very high nitrate concentrations of 148, 120, 128 and 132 mg/l in rainy season as against 89, 98, 110 and 115 mg/l for the dry season. Nitrate concentrations in these well may be explained within the context of the season characteristics, hydrogeochemistry of the environment, well characteristics and associated land use activities. For instance, during rainy season groundwater is recharged through precipitation via percolation leading to general rise in the level of the water. This makes them highly susceptible to pollution and run off activities as elements in soils and rocks are easily released into the water. Beside, depths of the wells are important because contaminants generated through various land uses activities can easily get into them. Average well depth is 3 m and distance to latrines and soak ways is 3.5 m makes them highly vulnerable to pollution activities. The source of nitrate in these wells could be attributed to agricultural fertilization as urban farming is common in the wetland areas coupled with animal grazing. Use of chemical fertilizers on farms has been identified as one of the main causes of nitrate in ground waters (Calabresa, 1971; Laftouch *et al*., 2003; Kumar and Shah, 2004). Beside, indiscrimate disposal of human and animal wastes from grazing animal on land result in leaching of residual nitrate thereby causing high nitrate concentration in groundwater. According to Matthes (1976) Foster *et al*. (1982) use of chemical fertilizers, improper disposal of human and animal wastes are sources of nitrogen containing compounds that are converts to nitrate in soil.

Table 1: Nitrate level in hand dug well in Makurdi

Well code	Well depth (m)	Depth to water level (m)	Nitrate (mg/l) rainy season	Nitrate (mg/l) dry season
W1	2.30	1	50	39
W2	2.70	1.45	48	40
W3	2.70	1.45	46	47
W4	7.30	1.00	58	60
W5	5.20	1.65	62	53
W6	4.33	4.33	85	66
W7	5.80	3.43	148	89
W8	3.77	2.37	40	33
W9	1.87	1.87	49	35
W10	2.93	1.30	43	45
W11	3.70	3.50	120	98
W12	9.15	7.55	87	80
W13	2.90	2.00	86	40
W14	1.00	1.00	128	110
W15	1.00	1.00	132	115

Conclusion: The study has apparently demonstrated that hand dug wells in Makurdi urban area are highly polluted with nitrate. About 80% and 68% of the wells have nitrate concentrations above WHO prescribed limit in drinking water for both the wet and dry season. This implies that consumers of water from these wells especially children stands a very high risk of methaemoglobineamia (blue-baby syndrome). Nitrate level was noted to be higher in these wells in the wet season than in the dry season. The source of nitrate in these is attributed to the use of chemical fertilizers in urban farming, indiscriminate animal grazing, improper disposal of animal and human wastes and seasonal influence. To reduce the rate of contamination, there should be control of all land use activities capable of polluting well. Water from these wells may used for other purpose other than drinking. These water should be boiled for domestic uses.

REFERENCES

Adelana, S.M.A., 2006. Nitrate pollution of groundwater in Nigeria. In: Groundwater pollution in Africa, Xu, Y. and B. Usher (Eds.). Taylor and Francis Group, London, pp: 37-46.

APHA-AWWA-WPCF, 1985. Standard methods of, examination of water and wastes, Port City Press.

BGS, 2003. British Geological Survey, WaterAid fact sheet, London.

Calabresa, T.A.C., 1971. Nitrate and phosphate in rural Wisconsin, Ecosystem proceedings on farm animal wastes, Madison.

Ehinola, O.D. and J.J. Coker, 2002. Quality of groundwater and health hazards implication in Agbowo area of Ibadan metropolis, southweatern, Nigeria, Proceedings National Conference on Population, Enviroment and Sustainable development in Nigeria, University of Ado-Ekiti, Nigeria.

Ezeonu, F.C., 1988. Nitrate ingestation, intrastive metabolism, escretion and microbiology, Unpublished M.Sc. Thesis University of Ibadan.

Foster, S.S.D., A.C.A. Cripps and Smith-Carington, 1982. Nitrate leaching to groundwater. Philosohical Trans. Royal Soc. London, 2: 477-489.

Gbodi, T.A. and S.E. Atawodi, 1986. Nitrate content of wells, raw, treated and pipe-borne water, Vom Plateau state, Nigeria. J. Microbiol., Hum. Texicol., 29: 11-14.

Gleick, P.H., 2002. Dirty water: Estimated deaths from water-related diseases 2000-2020, Pacific Institute Research Report.

Kakulu, S.E. and O. Osibanjo, 1992. Pollution studies of Nigeria Rivers, Trace metals levels of surface waters in Nigeria. Int. J. Environ. Stud., 4: 27-92.

Kogbe, C.A., A. Torkashi, D. Osijuk and D.E. Wozney, 1978. Geology of Makurdi in the Middle Benue Valley Nigeria, Ocassional publication of Department of Geology, Ahmadu Bello University, Zaria.

Kristof, N., 1977. For third world, Water is still a deadly drink, New York Times, Jan. 9, pp: A1, A8.

Kumar, M.D. and T. Shah, 2004. Groundwater pollution and contamination in India. Emerging challenges, hindu survey of environment, Kasturi and sons.

Laftouch, N.E., M. Vanclooster, M. Jahal, O. Witam, M. Aboufirassi, M. Bashir and E. Persoons, 2003. Groundwater nitrate pollution in Estnonira basin, Morocco. Geoscience, 335: 307-317.

Matthes, G., 1976. Effects of man's activities on groundwater quality, Hydrological Science, XXI.

Maywald, A., B. Zeschmar-Lahl and U. Lahl, 1988. Water Fit to Drink? In: The Earth Report: Monitoring the Battle for Our Environment, Goldsmith, E. and N. Hildyard (Eds.). London Mitchell Beazley, pp: 79-88.

Nash, L., 1993. Water Quality and Health. In: Water Crisis, Gleick, P.H. (Ed). New York, Oxford University Press.

Nnodu, V.C. and C.I. Ilo, 2002. Bacteriological and Physico-chemical examination of well water in Enugu south, Local Government Area of Enugu state. Environ. Rev., 4: 411-419.

NPC, 2006. National Population Commission, census, 2006, Nigeria.

Ocheri, M.I., 2006. Analysis of water consumption pattern in Makurdi Metropolis. J. Geography Dev., 1: 71-83.

Ogbu, S.I. and V.C. Echebiri, 2003. Nitrate and nitrite content of wells in Enugu, S.E, Nigeria, Archives of environmental health.

Ogunbadewa, E.Y., 2002. Some physico-chemical-properties of water from hand dug wells in the basement of Southwestern Nigeria. J. Water Supply: Res. Technol., 51: 407-417.

Olajire, A.A. and F.E. Imeppeoria, 2001. Water quality of Osun River, Studies on inorganic nutrient. Environ. Monitoring Assessment, 69: 17-28.

Omofonmwam, S.I. and J.O. Eseigbe, 2009. Effects of solid wastes on the quality of undergroundwater in Benin Metropolis. J. Human Ecol., 26: 99-105.

Ovrawah, L. and F.K. Hymore, 2001. Quality of water from hand dug wells in the Warri Environ of Niger Delta Region. Afr. J. Environ. Stud., 2: 169-170.

Owuama, C. and A.P. Uzoije, 2005. Waste disposal and groundwater quality in Owerri, Nigeria. J. Environ. Syst., pp: 69-79.

Tyubee, B.T., 2009. The influence of ENSO and North Atlantic sea surface temperature anomaly (SSTA) on extreme rainfall events in Makurdi, Nigeria. J. Meteorol. Climate Sci., 7: 28-33.

United Nations, 1997. Commission for sustainable development. Comprehensive assessment of the fresh water resources of the world, New York.