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HEAVY METALS RISK ASSESSMENT OF SELECTED SHALLOW WELLS WATER QUALITY IN MAIDUGURI METROPOLITAN, BORNO STATE

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Abstract*: Heavy metals (HMs) have become a source of concern in the last few decades as a result of people's consciousness and concern for safe drinking water. The study aims to identify the common heavy metals found in the vicinity of the MMC, particularly in areas where shallow wells are located near some disposal facilities which are not properly designed or constructed. In order to identify the sources of these heavy metals, water samples were collected from various shallow wells in close proximity to disposal facilities. A statistical technique of multivariate analysis was used to undertake the principal component analysis(PCA) and cluster analysis .it was determined that few heavy metals have exceeded the allowable drinking water quality standards for Nigeria as provided by WHO, NESREA and the NSDWQ. Water samples were obtained for five (5) shallow wells that were examined for the research. It was found that the detected heavy metals presence was attributable to the siting of the shallow wells near waste disposal facilities. There is an urgent need for regulatory agencies to curtail the proliferation of uncontrolled disposal facilities as well as shallow wells constructions near solid waste disposal facilities.*

Keywords: *Heavy metals, water quality, pollution standards, solid waste****Keyword****: Zinc Oxide Nanoparticle, Nanocomposite of BBZincs, Biochar, Absorbance, Transmittance, Energy bandgap, Electromagnetic spectrum.*

INTRODUCTION

The contamination of the human environment components such as water, soil, and sediments, and their presence in sources and the ecosystem as a result of heavy metals have been established by several researchers in many parts of the globe and the MMC cannot be an exception. Besides, these heavy metals are proven to be toxic to human health when they exceed the permissible limit set by regulatory agencies.

The sources of environmental anthropogenic pollution by heavy metals includes among others a variety of establishments such as agriculture the soil and inevitably the food chain resulting in severe consequences to human. The ever-increasing presence of heavy metals in the environment has attracted global attention. In Nigeria, an increase in the rate of

population, a corollary effect of an increase in the level of urbanization, and industrial and agricultural activities are perceived to pose serious pollution threats with all its concomitant health hazards on groundwater quality especially in urban and peri-urban areas (Kehinde *et al.,* 1989; Adelana *et al.,* 2008). Groundwater in some climes contains specific ions (such as fluoride) and toxic elements (such as arsenic, lead and selenium) in quantities that are harmful to health, while others contain elements or compounds that cause other types of problems (such as the staining of sanitary fixtures by iron and manganese). Groundwater is used for agricultural, industrial and domestic purposes. It accounts for about 50% of livestock and irrigation usage and just under 40% of water supplies, whilst in periurban areas, 98% of domestic water use is from groundwater (Todd, 1980; Stigter *et al.,* 2006). Groundwater can be put to different uses such as domestic, agricultural and industrial activities. These activities put a demand on groundwater thereby attenuating the remaining portion of available groundwater reserves (Sangodoyin and Agbawhe, 1992). Activities such as these not only put pressure on global groundwater reserves but also affect the quality of groundwater (Oluwande, 1983; MacDonald *et al.*, 2005; Stigter *et al.*, 2006; Akoteyeon, 2013). Groundwater quality comprises the physical, chemical and biological qualities which can be analysed using appropriate approved techniques so as to ascertain them.

STUDY AREA

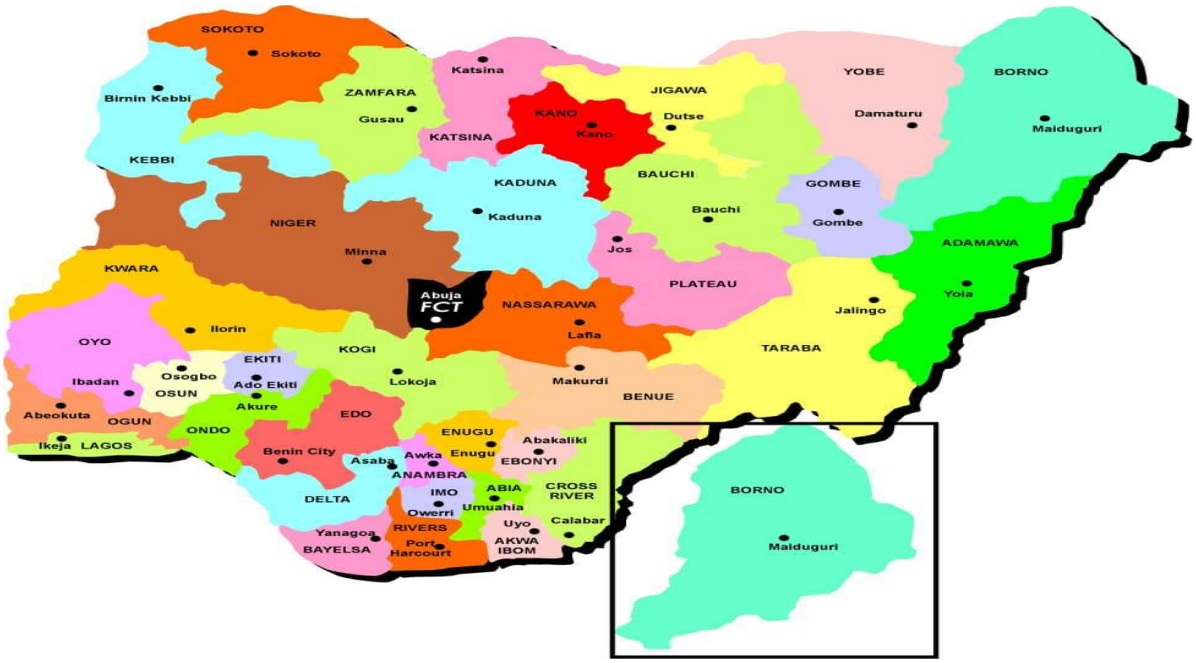

Fig.1.0. MAP OF NIGERIA SHOWING THE STUDY AREA

Table 1.0 SAMPLING LOCATION CODES

SAMPLING LOCATION CODES
AJD-001-005,AJD -001-010,AJD-001-O15,AJD-001-020 & AJD-001-025
BLD-002-005,BLD-002-010,BLD-002-015,BLD-002-020 & BLD-002-025
BLKM-003-010,BLKM-003-015,BLKM-003-020 & BLKM-003-025
GWGD-004-010,GWGD-0-4-010,GWGD-004-015,GWGD-004-020 & GWGD-00-4-025
MMD-005-010,MMD-005-015,MMD-005-020 & MMD-005-025

METHODOLOGY

MATERIALS AND METHODS

SAMPLING AND PHYSICOCHEMICAL ANALYSIS OF WATER

Groundwater is the major source of potable water supply in the study area and its contamination at any scale is a source of great concern to human health and the environment. The improper disposal of municipal solid waste management is a major environmental problem in the metropolis due to the absence of engineered landfills which results in adverse risks to both the groundwater and surface water at the open dumpsite vicinity. Most wells across the study area are shallow and are particularly sited in close proximity to the dumpsites and several other workshops such as mechanic, auto wielding and auto painting in addition to several tannery workstations. Impurities of great concern found their way from the dumpsites and workshops into the soil profile and contaminated the aquifer level resulting in groundwater pollution due to their shallowness

It is quite clear from the preliminaries as regards the tastes and appearances of the sampled water that most of the wells within the study area are shallow and hence susceptible to contamination

Groundwater samples were obtained from wells at different locations. The scale of this threat depends on the concentration and the toxicity level of the contaminants in the Water, the type and permeability of the geologic strata, the water table depth and the direction of the groundwater flow.

Field survey was carried out before the sample collection. This was necessary in order to examine the general characteristics of the area and determine the most feasible routes and points(wells) for sample collection. These areas were identified during the course of reconnaissance and it was gathered that their source of ground which is mostly from wells is not too palatable for drinking

The samples for the chemical analysis of the groundwater samples were collected from the five different wells that are located about 25 to 100m from the dumpsites. Samples were collected and preserved before being transported to the NAFDAC zonal office using the International Organisation for Standardization (ISO)standards for water quality giving guidance and sampling as contained in ISO5667-1,2006 sampling –part 1. Guidance on the design of sampling programmes and sampling techniques, ISO 5667.3.2009 ,sampling .part 3 Guidance on the preservation and handling of groundwater samples ,ISO 5667.11.2009 Sampling .part 11.Guidance on sampling of groundwater ,ISO13530.2009 ,guidance on

analytical quality control for chemical and physiochemical water analysis and ISO 17381.2003 Selection and application of ready-to-0use kits ,kits methods in water analysis.

RESULTS AND DISCUSSIONS

The groundwater samples for the five (5) wells coded here as W1, W2, W3, W4, and W5 were collected and stored in a distilled and thoroughly washed container according to APHA standards methods of sample collection and storage and were transported to the Maiduguri NAFDAC office for analysis. accordingly, Various tests were conducted as stipulated in the above table and compared with the WHO, NSWDQ, Federal Ministry of Environment standard and the NESREA standard The WHO produces international water quality and human health in the form of guidelines that are used as the basis for regulation and standard setting worldwide. the guidelines for drinking water quality (GWQ) promotes the protection of public health by advocating for the development of locally relevant standards and regulations (health-based targets) adoption of preventive risk management approaches and covering catchments to consumer (water safety plans) and independent surveillance to ensure that water safety plans are being implemented and effective and that international standards are met.

The results indicate that there is a source of concern about some of the levels of concentration of the chemical parameters such as Lead(Pb) Zinc(Zn), Iron (Fe)), and chromium(Cr) as they are above the Federal ministry of environment WHO (World Health Organization), NSDWQ(Nigerian standard for Drinking water quality, and NESREA(National Environmental standards enforcement Agency) standards whereas chloride(Cl)and Sulphate (SO4) are of no consequences far away from the prescribed permissible limits of all the known regulatory agencies, both locally and internationally.

Table 2.2 Water Quality Standards for Domestic Use as Specified in Schedule (11) of Regulation (9) in Nesrea's Nigerian Domestic Water Usage Guidelines.

PARAMETERS		MAX.ALLOWABLE LIMIT
PH		6.5-8.0
SUSPENDED SOLIDS		30mg/L
NITRATES NO3		10mg/L
AMMONIA NH3		10mg/L
NITRITES NO2		30mg/L
TDS		1200mg/L
ECOL		NIL/100ML
FLOURIDE		1.5mg/L
PHENOLS		NIL/mg/L
ARCERNIC		0.01mg/L
CADMUIM		0.01mg/L/L
LEAD		0.05mg/L
SELEMIUM		0.01mg/L
COPPER		0.05mg/L
ZINC		1.5mg/L
CADMUIM(Cd)		0.005mg/L
CHLORID(cl)		250mg/L
CHROMUIM(Cr)		0.10mg/L

NIL means less than the limit for detection using prescribed sampling and analytical methods and equipment as determined by the agency from time to time and any other parameters.

Table 2 Comparative Analysis of the five wells water quality

CHEMICAL PARAMETERS	W1	W2	W1	W4	W5	WHO	NSDWQ	NESREA	FEDMINENV
Chloride Mg/L	0.10	0.09	0.04	0.09	0.08	50	50	250	250
Sulphate Mg/L	100	180	165	123	118	250	250	0.50	0.50
Nitrates Mg/L	26	20	24	32	30	250	100	30	10
Lead Mg/L	1.02	1.05	0.98	0.86	1.01	0.05	0.05	0.05	0.05
Chromium Mg/L	0.34	0.25	0.29	0.19	0.18	0.1	0.10	0.10	0.10
Iron Mg/L	2.5	2.9	1.8	2.0	0.41	0.1	0.3	0.3	1.0
Zinc Mg/L	3.5	4.0	3.25	3.0	2.95	5	5	1.5	1.0

Table 2.4 Groundwater Quality Matrix for Some Selected Shallow Wells in the MMC, Borno, State (Red: High Risk, Yellow: Medium Risk, Blue: $N^{+}O$ Risks)

	ꝑH mg/L	EC mg/L	TDS mg/L	CL Mg/L	NO3 Mg/L	SO4 Mg/L	Fe Mg/L	Pb Mg/L	Cr Mg/L
STREET									
A									
B	Yellow				Blue			Red	
C									
D									

The above shows the water quality of some shallow wells in various months of the year indicating the effects of seasonal variations on water quality from shallow wells

CONCLUSIONS

The study focussed on determining the quality of shallow wells water in some areas of the metropolis and took a comparative analysis with WHO and NSDWQ limits relative to the physicochemical characteristics of the shallow wells water samples. it was determined that the presence of pit latrines indiscriminate siting of septic tanks and uncontrolled proliferation of waste disposal facilities are the likely causes of the poor state of shallow wells water quality in some selected areas of the MMC.

It was determined statistically that seasonal variations and proximity to waste disposal facilities are important factors that have a great influence on some of the parameters examined. Consequent upon these, shallow wells water from some of these areas should be treated properly so as to avoid contaminations and affects human and animal health. Besides, it's necessary to undertake an awareness campaign so as to enlighten the public about the environmental consequences of siting pit latrines and septic tanks indiscriminately in their areas.

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