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Geo-Implications of Seasonal Variation of Ilesha Water Quality, Nigeria.

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Abstract: *Ilesha is a town situated in the South – western part of Nigeria. It lies between latitude $7^{O}35'N$ and longitude $4^{O}38'E$. The Ilesha area lies within the schist belts which mainly occur within the Western half of the country. As industrialization and urbanization becomes the root of population increase, the rate of waste disposal is also a good match or perfect correlation. Thus, the basic water needed which is jeopardize is been looked at in terms of changes in climatic variation and the degree of contaminants. Water samples were collected from bore holes and wells for dry and wet seasons. Physico-chemical parameters, trace elements, and bacteriological analysis were determined to ascertaining the seasonal variation and the level of contaminants.The results showed that there are elevated values of the parameters analyzed, but mostly within the bearable limits of WHO's standard,and there exist slightly increase in mostphysico-chemical parameters tested for in dry than in wet season. Also, the bacteriological counts were more pronounced in well water samples than bore holes with a clear variation in seasons. The hydro-geochemical contour maps produced for the study areas do not reflect the bedrock geology but are more kin to population distribution pattern. Thus, there is a seasonal variationand human activity imprint on the hydro-geochemistry, especially, in the areas of high population density, which over-rides the influence of ambient geology.*

Keywords: *Seasonal variation, elevated values, physico-chemical, ambient geology*

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I. INTRODUCTION

The uncoordinated, indecent and indiscriminate waste discharged, constituting nuisance and dirtiness, resulting to increase and geometric rate of diseases spreading, and decline in water quality is one of the major environmental challenges of this resourceful nation, Nigeria. Ademoroti, 1996 revealed that; total water on Earth is enormous about 1.5 x 10^{18} metric tons, which is a quantity that is 300 times larger than the mass of the entire atmosphere. Incidentally, about 0.2% is accessible from surface water. Although, in Nigeria; the entire land mass is covered by about 300,000 square kilometers with water, it's inevitably clear that water which is not 100% pure carries traces of other substances - various organic compounds, particles, gasses, minerals and ions which impacts negatively to its physical, chemical and bacteriological characteristics.

The recent increase in urbanization and industrialization has led to a sudden increase in city population and spatial size (Sada, 1973); Ajeagbu, 1976; Abiodun, 1984; Onokerhoraye, 1984).

This phenomenon is more pronounced in the cities of Nigeria where Ilesha is typical example of this development in the South-Western part of the country.

The various components of the natural environment (e.g soil, water and air) are often adversely affected by anthropogenic factors. There are interactions among these components of the environment; land - water (interaction of water/moisture in soil), land- air (interaction of suspended solid in air) and water air (interaction of air dissolved in water) Ademoroti, 1996.

The major proportion of groundwater quality degradation is due to anthropogenic influences such as domestic and municipal waste, hazardous waste, sewage treatment plants, and incinerators, industrial and agricultural wastes.

The water quality entails its physical, chemical and biological characteristics, which is determined by comparing results of test and characteristics of the water with acceptable standards.

It is obvious that there is no master plan or good policy formulation to look into water supply sources in Ilesha area during wet and dry season in relation to seasonal variation. Also, there is no set standard to check the level of dissolved minerals and micro-organism content of the water from the boreholes, wells, and rivers before consumption.

Furthermore, there is no guideline on how and where to sink boreholes and wells. The focus of this study is that since many people have resorted to getting water through the sinking of boreholes and wells, the water (boreholes, wells, rivers and rain) from the area (Ilesha) have been studied and comparison been made for the possibility of it been contaminated by waste from refuse dumps, latrines and dissolved mineral from rocks in relation to seasonal variation.

Therefore, the study determines the degree of contaminants and also the vulnerability of the groundwater quality to contamination in relation to seasonal changes.

1.1 Objectives of study

The purposes of the investigations are:

- To study in detail environmental impact of human activities on water quality.
- To determine the possible sources/ causes of contaminants.
- To determine the type and concentrations of contaminants (if any) with seasonal variations.

1.2. Limitations of study

- Confidentiality of information from the host community.
- Accessibility restriction to sampling points within and around shrines and forbidden-bushes.

1.3 . Geological setting.

1.3.1. Location

Ilesha is a town situated in the South – western part of Nigeria. It lies between latitude $7^O35'$N and longitude $4^O38'$E. The area of study occupies the Southern part of Osun State, and is bounded by other towns like; Osogbo, Ile-Ife, Ibodi and Muroko in Atakumosa local government area. Ilesha lies in an altitude of about 301 meters above sea level, which covers an extent area of 113 square kilometers. It possessed an adoring beautiful landscape with projecting hills within the range of 365 to 396 meters above the sea level.

1.3.2 Climate

The Ilesha area lies within the rain forest. The climatic characteristic of the area is also similar to what obtains in other humid tropical environment. The major elements of the climate in the area are rainfall, temperature, wind (Speed and direction), relative humidity and sunshine.

Due to the fact that the area is situated in the tropical zone, tropical temperature and rainfall are obtained. The dry season begins towards the end of October and ends in March. The raining season begins in April and ends in October. Two main air masses dominate the climate of Ilesha area. These are the equatorial air mass and the tropical continental air mass. The equatorial maritime air mass originates from the Atlantic Ocean and it is popularly called the South – West Moonson. This air mass brings rainfall. The equatorial maritime air mass has more influence in Ilesha area than the tropical continental air mass.

The tropical continental air mass is dry and dusty. It originates from the Sahara desert and is popularly called harmattan. The effect of this wind (harmattan) is felt during December.

II. GEOLOGY OF THE STUDY AREA.

The Ilesha area lies within the schist belts which mainly occur within the Western half of the country, N-S trending, and which are of low-medium grade meta- sediments. The Ilesha schist belt lies within the basement complex of South Western Nigeria (fig.1). The Precambrian rocks of the region may be separated into three major tectono-stratigraphic divisions: the reactivated ancient basement complex of gneisses and migmatites; the schist belts, which predominantly comprise supracrustal rocks occurring within Northerly trending troughs in the basement complex; and the Pan African (ca. 600 Ma) Older Granite series, a suite of granites and related rocks which intrude the above successions. Contacts between the gneiss – migmatite complex and the schist belts are generally marked by major structural discordance (Elueze, 1992).

On the basis of field occurrence, petrology and geochemistry, the rocks of the Ilesha schist belt are grouped into three major units: the Ilesha amphibolite complex, the Ilesha metaclastics, and the Effonquartzitic sequence (EffonPsamite). The Ilesha amphibolite complex comprises mainly metabasalts and meta-ultramafites exposed as lenticular and ovoid bodies within the metaclastics. Petrochemical data show that they are of subcrustal origin and are largely tholeiitic and peridotitic in nature. The meta-sedimentary complex (the metaclastics and the Effon rocks) consists of sequences of supracrustals that have generally undergone low-medium grade metamorphism. The metaclastics include a variety of micaceousschists that are essentially of pelite to greywacke affinity and attained relatively low degree of chemical maturity.

For several decades, the Ilesha area had been known for gold production. Apart from the Iperindo auriferous quartz veins within granite gneiss, alluvial deposits have been worked form the meta-sediments / amphibolites in the area. Sulfide and oxide ore minerals are likewise disseminated in these rocks, which possibly constitute the ultimate source of the alluvial deposits. (Elueze, 1982)

III. MATERIALS AND METHODS: -

3.1 Reconnaissance Survey:-

Prior to embarking on detailed fieldwork, both literature review and preliminary reconnaissance survey were carried out. The reconnaissance survey involved two (2) days visit to field site, to familiarize with the target locations of the field, such as functional boreholes, open wells, dumpsite, industrial activities, and rivers, with reference to streets in Ilesha area of Osun State.

3.2 Detailed studies

3.2.1 Hydrological sampling:

Five (5) borehole water samples were collected in Ilesha area during wet and dry season. Four (4) open well water samples, two (2) river water samples were also collected in two different seasons respectively.

The observation involved measurement of some of the physical parameters of the water which include the well diameters, depth, depth to water surface, distance of each well to dumpsite (if any) and latrines.

All water samples were properly handled and fixed in-situ, depending on the type of analysis to be carried out on them. Since some determinations were likely to be affected by storage before analysis; parameters such as temperature, $_pH$, and electrical conductivity were determined in-situ because of their great possibility of changing on storage. Samples for heavy metals analysis were fixed separately; employing $_pH$ adjustment using concentrated H_2S0_4. Other sets of samples for bacteriological and physico-chemical analysis were left unfixed but kept in ice-cooled containers after collection into coolers and later transferred to the laboratory for analysis.

3.3 Determination of physico-chemical parameters.

i. Hydrogen ion Concentration ($_pH$)

The $_pH$ of each water sample was determined in-situ after collection. Pye model 291meter (UNICAM) was used. In the laboratory, they were further confirmed using a Phillips $_pH$ meter. (Model PW 19418).

ii. **Total Suspended Solids (TSS)**: - Suspended solid content was measured by filtering 500ml of water samples through a pre-weighed filtered paper which was subsequently dried in an oven at 150 ^{0}C for 15 minutes and re-weighed. The weighed differential was taken as the suspended solid content while the filtrate from this process was kept for the determination of dissolved solid content.

iii. Total Dissolved Solids (TDS):

Gravimetric method (APHA, 1989) : - The filtrate from TSS above was evaporated in a pre-dried and weighed porcelain dish in an oven at 180^{O}C until a constant weight was observed.

Calculation:

$$\text{Mg/l} \quad \text{TDS} = \frac{(A - B) \times 1000}{S}$$

Where:

A = Weight of dried residue plus dish, mg.
B = Weight of dish alone, mg
S = Sample volume, ml

iv. **Alkalinity:** This is the ability of water to neutralize acid and is due primarily to the presence of hydroxides of Calcium, Magnesium, Potassium, Sodium, Carbonates and Bicarbonates. The presence of Borates, Phosphate, Silicate, and other ionic constituents impacts additional alkalinity to water.

The alkalinity values were determined by titrating 50ml of the samples with 0.25N solution of sulphuric acid using phenolphthalein and methyl orange as indicator (APHA, 1985).

V. Total Hardness: - Hardness is one of the most important properly of water. Hardness is due to the presence of Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) in water, although other cations like iron (Fe), Manganese (Mn), Aluminum (Al), Zinc (Zn) and Strontium also react as hardness.

vi Dissolved Oxygen (DO):-The dissolved oxygen varies with depth, temperature, turbulence and salinity. Biological respiration, including decomposition processes reduces DO concentrations. DO presences in groundwater accelerate rates of metal corrosion through oxidation which also depends on temperature and $_pH$. Measurement of DO is a good indicator of degree of pollution by organic matter, destruction of organic substances and the level of self - purification of the water. Organic present in some aquifers rapidly deplete the dissolved oxygen. DO was determined by titration method (using Winkler method) involving the chemical fixation of the oxygen in a water sample collected in an airtight bottle.

vii Biochemical Oxygen Demand (BOD):

Modified Winkler's method (APHA, 1989). This method relies upon bacteria using oxygen dissolved in the water to oxidize the organic matter in a given sample. The amount of oxygen consumed during a fixed time period is related to the amount of organic sample.

Two sets of sterile bottles were filled each with water sample. One of these was analyzed immediately for its oxygen content using the Winkler's method and the result designated DO_0. The other bottle was wrapped with aluminum foil and incubated at 20^OC for five days.

Wrapping was necessary to prevent light penetration to avoid photosynthetic activities of phytoplankton, which may be present in the water sample. On the fifth day, the oxygen content of the second sets of the bottle was analyzed and results designated DO_5. The BOD was then calculated as the difference between DO_O and DO_5

Calculation:

$$BOD = (mg/l) \frac{DO_O - DO_5}{\text{Percentage dilution}}$$

Where: DO_o = initial value of DO

DO_5 = Final value of DO

viii Chemical Oxygen Demand (COD):

COD corresponds to the amount of oxygen required to oxidize the organic fraction of a sample, which is susceptible to

(i) Tetraoxo-manganate(vii) (Permanganate) or (ii) Heptaoxo-chromate (vi) (Dichromate) oxidation in an acid solution.

Chemical oxygen Demand (COD):- Closed Reflux – Titrimetric method Reagents:

Standard Dichromate Digestion solution (O.016M) :

To 300ml-distilled water, 4.91g, $k_2Cr_2O_7$ (dried at 103^OC for 2 hours) were added, 167ml of concentrated H_2SO4, were also added. These were dissolved and cooled to room temperature and diluted to 1000ml.

Sulphuric acid reagent

Silver sulphate, Ag_2SO_4, crystals or powders were added to concentrated H_2SO_4 at the rate of 3.5g Ag_2SO4/kg H_2SO_4. This was allowed to stand for one to two days to dissolve the Ag_2SO_4

Ferrion Indicator Solution.

About 1.485g orthophenanthroline monohydrate and 696mg $FeSO_4$. $7H_2O$ were dissolved in distilled water and diluted to 100ml.

Standard Ferrous Ammonium Sulphate (FAS) Titrant (0.01M)

About 39.2g $Fe (NH_4)_2 (SO_4)_2. 6H_2O$ were dissolved in distilled water and 20ml concentrated H_2SO_4 were added, cooled and diluted to 1000ml. This solution was standardized before use as follows: Reagents were added accordingly, to a culture tube containing the correct volume of distilled water substituted for sample. This was cooled to room temperature and 0.05 to 0.10ml (1 – 2 drops) ferrion indicator was added and titrated with FAS titrant.

Molarity of FAS solution is calculated as:

$$= \frac{\text{Vol. Of } 0.0167M\ k_2Cr_2O_7 \text{ solution titrated ml} \times 0.10}{\text{Vol. of FAS used for titration}}$$

Sulphuric acid required only when the interference of nitrates is to be eliminated.

Potassium Hydrogen Phtholate (KHP) standard

Crystals of KHP were lightly crushed and dried to constant weight at 120 ^OC and 4.25g of it were dissolved in distilled water and diluted to 1000ml. KHP has a theoretical COD of 1.176mg O_2/mg and this solution has a theoretical COD of 500mg O_2/mg.

Procedure:

Culture tubes were washed with 20% H_2SO_4 to prevent contamination.

The samples were measured into culture tubes and digestion solution was added. The sulphuric acid was carefully run down inside the vessel so that an acid layer was formed under the sample – digestion solution layer. The caps of each tube were carefully inverted several times to mix completely. Face shields and hand gloves were won throughout this experiment. Tubes were placed in block digesters or oven preheated to 150^OC and refluxed for 2 hours. These were cooled at room temperature. About 0.05ml to 0.10ml (1 to 2 drops) ferrion indicator was added and stirred rapidly on TFE covered magnetic stirrer while titrating with 0.10ml FAS titrant. The end point was a sharp colour, which changed from blue-green to reddish brown, although the blue-green colour may appear after titration. In the same manner, a blank containing the reagents and equal volume of distilled water (to that of the sample) was refluxed and titrated accordingly.

Calculation:

$$\text{COD as mg/1 } O_2 = \frac{(A-B) \times m \times 8000}{\text{ml sample}}$$

Where:

A = Vol. Of FAS used for blank, ml
B = Vol. Of FAS used for sample, ml
M = Molarity of FAS titrant

3.3.2 Determination of anions: -

PO_4, NO_3, SO_4^{2-} and Cl^- were determined calorimetrically using the Milton Roy spectronic 21D spectrophotometer. The concentrations of the Unknown samples (in mg/l) were extrapolated from their various standard curves.

3.3.3 Determination of cations: -

Sodium (Na) and Potassium (K) values were determined using conning flame photometer (iv); Lithium being the reference filter. Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using 0.1M solution of disodium salt of Ethylenediamine Tetra Acetic Acid (EDTA) Using Eriochrome Black T and Calcon as indicators.

3.3.3 Determination of heavy metals: -

Heavy metals are those having densities greater than $5g/cm^3$. The term is simply used to denote metals that are toxic that are found in groups III to V of the periodic table. The heavy metals after appropriate treatment were determined using a Perkin Elmer (2330) Atomic Absorption Spectrometer (AAS).

3.3.4 Microbial analysis: A significant fraction of all water borne disease outbreaks is associated with ground water. Several bacteria are found in the water, coliforms are the traditional indicator organisms for water contamination.

Examination of water samples for the presence of faecal bacteria is a sensitive technique indicating recent faecal contamination. In practice, use has been made of these tests to detect and enumerate indicator organisms. Absence or presence of Coliform group of bacteria has been the principal indicator of suitability or unsuitability of any kind of water for drinking. The presence of Coliform group of bacteria in a water body means that the water is polluted or contaminated by adopting indicator bacteria Escherichia Coli (E.Coli) with reference to standard(WHO,1985).

Laboratory Analysis:

Total viable counts of bacteria: A serial dilution of 10^{-1} to 10^{-4} of the water samples were made by dilution of 1ml portions to 9ml of sterile distilled water which was also indicated as diluents. The total bacteria load of each location was duplicated and determined by spreading 0.1ml of the dilutions on the surface of nutrient agar medium and spread with flame -sterilized glass rod. The dilutions of each water samples were inoculated as follows: 5 test tubes containing double strength Macconkey broth was inoculated with 10ml of water samples while 2 sets of 5 test tubes containing a single strength Macconkey broth were inoculated with 1ml and 0.1ml of water sample respectively. A control in which water sample was not inoculated was also set up. All tubes were incubated at 37^0C for 48 hours. Test tubes that show positive for acid and gas production at the end of incubation period were recorded, and the most probable number of coliforms was determined per 100ml of water sample with reference to Macradys probability table.

IV. RESULTS AND DISCUSSION

4.1. Results

The Physico-Chemical Data Obtained during Wet Season:

Hydrogen ion concentration ($_PH$)

The hydrogen ion concentration values obtained for borehole samples ranged from 6.37 to 6.92(Tab1). The borehole samples are therefore slightly acidic, with mean value of 6.58. The well water samples have $_PH$ range of 5.92 - 6.78. All the water samples are therefore slightly acidic in nature.

Turbidity

Turbidity result obtained for borehole water samples ranged between 0.58NTU to 1.12NTU. The values for well samples ranged between 0.48NTU to 1.43NTU.

Dissolved Oxygen (DO): The dissolved oxygen for borehole samples ranged between 5.62mg/l in $LSBH_1$ to 6.00mg/l in $LSBH_2$. Well samples varied between 5.96mg/l in $LSOW_3$ to 6.20mg/l in $LSOW_1$.

Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD)

The COD values are generally higher in all the samples than the BOD values, The borehole values are relatively lower compare with other samples. The COD values for borehole samples ranges from 1.98mg/l ($LSBH_3$) to 3.42mg/l ($LSBH_5$). BOD values ranges between 0.32mg/l ($LSBH_3$) to 0.44mg/l ($LSBH_5$) Well water samples have COD values ranged between 1.90mg/l in $LSOW_4$ to 3.58mg/l for $LSOW_1$ and Well BOD values ranges between 0.80mg/l in $LSOW_4$ to 0.99mg/l in $LSOW_1$

Total Dissolved Solids (TDS): Total Dissolved solid values ranged from 21.70mg/l - 26.72mg/l in borehole samples while the well values are between 38.00mg/l ($LSOW_2$) - 62.00mg/l ($LSOW_4$).

Total Suspended Solids (TSS): Total suspended solids values ranged from 1.65mg/l to 2.08mg/l for borehole samples. The well samples have between 6.28mg/l – 8.00mg/l (Tab1).

Conductivity: Conductivity values for boreholes ranged from 20.00Us/cm in $LSBH_4$ to 28.00Us/cm in $LSBH_{2.}$ Well samples have between 78.00Us/cm in $LSOW_2$ to 92.00Us/cm in $LSBH_4$

Total Alkalinity:

Values ranged from 12.96mg/l for$LSBH_2$ to 15.02mg/l for $LSBH_3$ in borehole samples, while the values ranged in wells between 3.20mg/l for $LSOW_2$ to 5.12mg/l for $LSOW_4$.

Sulphate : The values for sulphate in the borehole samples ranged from 4.72mg/l ($LSBH_1$) - 6.02mg/l ($LSBH_3$). However, the well sample values are generally lower. It ranged between 0.85mg/l for $LSOW_2$ to 1.24mg/l for $LSOW_4$.

Phosphate: The values for phosphate are slightly consistent in the boreholes, ranging from 0.04mg/l (equal values) for $LSBH_1$, $LSBH_4$ and $LSBH_5$ to 0.08mg/l for $LSBH_1$,while the well samples ranged between 0.06mg/l for $LSOW_3$ - 0.12mg/l for $LSOW_2$(Tab1).

Nitrate: Nitrate values ranged from 1.02mg/l ($LSBH_1$) to 20.60mg/l ($LSBH_2$) for borehole samples. The values for well samples ranged from 2.36mg/l ($LSOW_2$) to 18.20mg/l ($LSOW_3$.

Carbonate: Carbonate values for boreholes are fairly consistent. It ranged between 0.01mg/l to 0.18mg/l for borehole samples and Well samples have 5.96mg/l to 7.65.

Potassium: The Potassium (K^+) for boreholes samples ranged from 0.01mg/l in $LSBH_2$ to 0.05mg/l in $LSBH_5$. The well samples have values ranges from 0.03mg/l (equal values) for $LSOW_3$ and $LSOW_4$ to 0.12mg/l for $LSOW_2$.

Calcium: Calcium values for borehole samples ranged from 1.60mg/l in $LSBH_1$ to 3.67mg/l in $LSBH_5$. The well values ranged from 4.05mg/l in $LSOW_1$ to 6.21mg/l in $LSOW_3$.

Sodium: Sodium concentrations in boreholes samples ranged between 0.10mg/l ($LSBH_5$) -0.16mg/l ($LSBH_2$). Values for wells ranged between 0.10mg/l ($LSOW_4$) - 0.24mg/l ($LSOW_1$).

4.1.1 Heavy Metals.

The heavy metals in the samples include: Iron (Fe), Manganese (Mn), Cadmium (Cd), Lead (Pb), Chromium (Cr), Copper (Cu), and Zinc (Zn). The borehole water samples have the following values: Iron values ranges from 0.18mg/l to 0.42mg/l, Manganese (0.01mg/l - 0.08mg/l), Cadmium (<0.01mg/l), Lead (<0.04mg/l)and to (0.04mg/l)(Tab2). In all the borehole samples, Chromium values are less than 0.01mg/l. Copper values ranged between 0.02mg/l ($LSBH_4$) to 0.08mg/l ($LSBH_4$). Zinc values ranged between 0.01mg/l to 0.06mg/l. Well samples have the following values: Fe (0.03mg/l) to (0.24mg/l), Mn (0.02mg/l) to (0.06mg/l), Cd (<0.01mg/l)to (0.019mg/l), Pb (<0.01mg/l) to (0.05mg/l)$_,$ Cr (<0.01mg/l) equal values for $LSOW_1$, $LSOW_2$ and $LSOW_4$ - 0.01mg/l ($LSOW_3$), Cu (0.04mg/l to 0.09mg/l, and Zn (0.06mg/l) to 0.83mg/l. Therefore, concentrations ofheavy metals well water samples are depicted on Tab.3.

4.1.2 Presentation of Results of Bacteriological Analysis.

The borehole samples have the following count values: $LSBH_1$, $LSBH_5$ have nil count value (not detected), $LSBH_5$ (1.00/100ml), $LSBH_2$ (2.00/100ml) with highest number of coliform count(Tab.2). The degree of contamination varies with depth and distance to dumpsite.

4.1.3 The Physico-Chemical Data Obtained for Dry Season.

Hydrogen ion Concentration ($_P$H).

Hydrogen ion concentration values for boreholes samples ranged from 6.41 to 6.89 (Tab.1) .The $_P$H values for the boreholes are slightly acidic in nature with mean value of 6.59. The well water samples have $_P$H range from 6.32 - 6.82.

Turbidity: The turbidity values for boreholes samples ranged from 0.56NTU to 0.98NTU. The well values ranged between 0.48NTU to 0.69NTU.

Dissolved Oxygen: The dissolved oxygen for borehole samples ranged from 5.29mg/l to 5.42mg/l,and Well samples ranged from 5.92mg/l to 6.29mg/l .

Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD).

COD values are generally highest than the BOD in all the samples. Borehole COD values ranges from 1.82mg/l in $ILBH_1$ to 3.96mg/l in $ILBH_4$. BOD values for borehole samples ranged from 0.28mg/l in $ILBH_1$ to 0.36mg/l in $ILBH_3$. Well water samples have COD values between 1.94mg/l in $ILPW_3$ to 4.08mg/l in $ILPW_1$. BOD values ranged between 0.58mg/l in $ILPW_3$ to 0.72m/l in $ILPW_1$.

Total Dissolved Solids (TDS): The values for total dissolved solids in boreholes ranged from 22.10mg/l to 26.80mg/l,while Values for well samples ranged from 36.82mg/l to 44.20mg/l.

Total Suspended Solids (TSS): Total suspended solids values in boreholes ranges between 2.00mg/l to 2.16mg/l. Well samples have values between 5.00mg/l to 10.02mg/l.

Conductivity: Values for conductivity in boreholes ranged from 22.00Us/cm in $ILBH_3$ to 38.00Us/cm in $ILBH_1$. Well sample values ranges from 64.00Us/cm in ILPW4 to 72.00Us/cm in $ILPW_3$.

Total Alkalinity: The boreholes value ranged from 14.80mg/l to 17.36mg/l, while the values ranged in well samples from 3.60mg/l to 5.32mg/l.

Sulphate : Sulphate values in the boreholes ranges from 4.68mg/l to 5.58mg/l, and Well samples have values from 0.79mg/l to 1.22mg/l.

Nitrate: The nitrate values in the borehole ranged from 0.21mg/l to 1.12mg/l. Well water samples ranged from 0.32mg/l to 1.20mg/l.

Carbonate: Carbonate values in boreholes ranged between 0.03mg/l in $ILBH_1$ to 0.18mg/l in $ILBH_4$. The values for well samples ranged from 0.12mg/l in $ILPW_4$ to 0.28 in $ILPW_2$.

Potassium (K^+): Potassium concentrations in boreholes ranged from 0.02mg/l to 0.06mg/l. Values for well samples ranged from 0.02mg/l - 0.10mg/l (Tab1).

Calcium: The values of Calcium in boreholes ranged from 1.86mg/l in $ILBH_4$ to 4.12mg/l in $ILBH_5$. The well water samples have values from 5.64mg/l (ILPW4) - 7.15mg/l ($ILPW_3$).

4.1.4 Heavy Metals

The heavy metals determined in the samples are: Iron (Fe), Manganese (Mn), Cadmium (Cd), Lead (Pb), Chromium (Cr), Copper (Cu), and Zinc (Zn). The values for borehole water samples are depicted in Tab2. Iron values ranges from 0.22mg/l ($ILBH_4$) - 1.02mg/l ($ILBH_2$), Manganese (0.03mg/l) equal values in $ILBH_4$ and $ILBH_5$, Cadmium (<0.01mg/l) in all borehole samples, Lead (<0.01mg/l) in $ILBH_1$ and $ILBH_4$ to 0.04mg/l in $ILBH_5$. Chromium (<0.01mg/l)in all borehole samples. Copper (0.02mg/l)in $ILBH_2$ and $ILBH_3$ to 0.08mg/l ($ILBH_1$). Zinc (0.01mg/l) in $ILBH_2$ to 1.04mg/l in $ILBH_4$ .The well sample values are equally depicted in the Tab 3 and the bacteriological analysis in Tab1.

4.2. DISCUSSIONS.

The same techniques used in both dry and wet seasons determinations of the parameters investigated reveals, the PH-values in most of the samples were slightly higher in wet season than in dry season ,though all were both slightly acidic in nature,thus indicating some degree of contaminations. Similarly, the turbidity of wet season is relatively higher than that of dry season possibly due to surface discharge.

The total dissolved solids values in both seasons were all below regulatory criteria of WHO. Although,there is an elevated values of dry season more than the wet season.Equally depicting a perfect correlation with total suspended solids, thus, indicating the same direction of seasonal variations.Meanwhile,the dissolved oxygen shows wet season values more than dry season. Also,total suspended solids are a function of dissolved oxygen,as the TSS increases so is the DO decreases.

The concentrations of soluble salts (K, Na, Ca and Mg), in almost all thewater samples were consistently higher in dry season than in wet season.

Chloride, Sulphate, Nitrate, Phosphate, Carbonate and Bicarbonate are the common anions in soluble salts. Generally, chloride contents exhibits higher concentrations in wells than boreholes.

Chloride contents were higher during dry season than the wet season. The lower values of the raining season may be due to availability of fresh water, which causes reduced salt content through dilution. The nitrate in water is usually unrelated to geologic formation. High nitrate in water may be considered as an indication of pollution. Nitrate values as recorded in all samples during wet season were higher than dry season observed values.

Iron (Fe), from general observation was relatively higher in value as recorded than other metals.Higher concentrations were detected in well samples iron concentrations for dry season than in wet seasons.

Manganese resembling iron in all respect, both in chemical reaction and in effects it produces by water use. It occurrence is less common and usually less in concentration than iron. Manganese is objectionable in water in a similar way as iron. It occurs as soluble Manganous bicarbonate which change to insoluble Manganese hydroxide [Mn (OH)] when it react with oxygen in the air. The stains caused by Manganese are more annoying and harder to remove than those caused by iron.

Water Samples values within the study areas indicate an increase in concentrations due to degree of seasonal changes.

Cadmium and Lead values from wells indicated a fluctuated concentration throughout. The result obtained shows that the values were not seriously affected by seasonal variation. Close and surging values were observed between dry and wet seasons.

These high values of Lead and increase may be related to the plumb-solvent action of the water considering the acidic nature of the water samples. Apart from this, Lead is used as stabilizers in some plastic pipes and fittings and the possibility of it being leached out by the water is high (The 'WHO European Standards for Drinking Water', 1970).

Copper concentrations show no definite trend in the area. Values recorded in all samples indicated fluctuated concentrations throughout the seasons. Although, bacteriological content observed depicts the level of contamination which may be due to anthropogenic factors

From the data observed, seasonal variation also affects the degree of water contamination by coliform bacteria. The count values detected in dry season was a decreasing one when compared with wet season results.

The hydro-geochemical contour map of lead for wet and dry seasons (Fig.2and 3) shows fairly similar patterns of attributes. The contour appears to follow the population density of the areas. High values were found in the densely populated areas while low values were found in the sparsely populated parts of the study area, thus related to geographical position in the town rather than the geology.

V. CONCLUSIONS AND RECOMMENDATIONS

The contaminations of groundwaters system in a given environment depends on several factors; its distribution,anthropogenic factors and its ambient geology. The presence of these contaminants in water may constitute an environmental or health hazard depends on the degree of concentration level with respect to seasonal variations.

Physico-chemical parameters showed high level of hydrogen ion concentration making the water samples slightly acidic in nature. The chemical parameters of the water samples that include the test for Potassium (K), Sodium (Na), Calcium (Ca) and Magnesium (Mg) shows that these minerals are partly from dissolved elements from the bedrock. When analyzed, the result showed that these minerals are mostly within acceptable limit for water quality standard. Although, some of these elements at certain degree add nutrients to the soil yield and contributes positively to crop and plant produce.

High nitrate and fairly high chloride levels in some wells and boreholes are related to human activity especially, the highly populated areas. While, the micronutrients and most of the non-essential trace elements are known to have undesirable effects on human and animal health, if present in excess concentration in the water system.

The high values of iron may therefore be due to the nature of the geology of the area, and the complexing of the iron with some organic matter on the solubility of ferrous ion. The case of Lead can be attributed to the plumbo-solvent action of the acidic water, poorly cased boreholes, leaching from waste in the battery chargers and mechanic workshops as well as vehicular emissions from the exhaust pipes especially during wet season slightly greater than dry season.

The slightly elevated value of cadmium during raining season than dry season may probably due to leaching of heavy metal toxicant waste containing Cadmium.

The result obtained from the bacteriological analysis through the observed coliform bacteria count indicates that high contaminations (coliform count) were observed during wet season than the dry season. Thus, the presence of coliform bacteria in drinking water indicates that the water is contaminated and may constitute serious health hazard.

Therefore, different seasonal results indicates that the concentrations of some elements were actually affected by seasonal changes which may be due to ingress and regress of fresh water which affected their solubility and dilution.

RECOMMENDATIONS.

- Boreholes and well Locations as a matter of urgent and basic needs should not be determined, design and constructed by hydro-geological situations alone but also a set standard on how and where with respect to considerable distance from dumpsite, latrines and also the general gradient of the area.
- Hydro-geologic situation of underground infiltrations from leached substances should be considered in locating dumpsite and public latrines.
- Government should provide more boreholes in the areas to supply more hygienic water to the people.
- Health authority should carry out routine chemical, physico-chemical and microbial analysis seasonally to actually know the variations of contaminants and possible ways of addressing the deteriorating water quality.
- Government and private organizations should implement appropriate remedial, awareness, and rehabilitation programmes to safeguard health and the environment, to comply with legal and statutory body requirements including effective planning and hydraulic engineering designsto rescue the waste disposal and management system.
- A situation where government leaves supervision and design of millions of groundwater development program in the hands of partly non - professionals other than the suitably qualified and competent hands should be discouraged.
- Government must therefore and as a matter of urgency live up to her responsibility in terms of water storage, treatment facilities and total policy planning.

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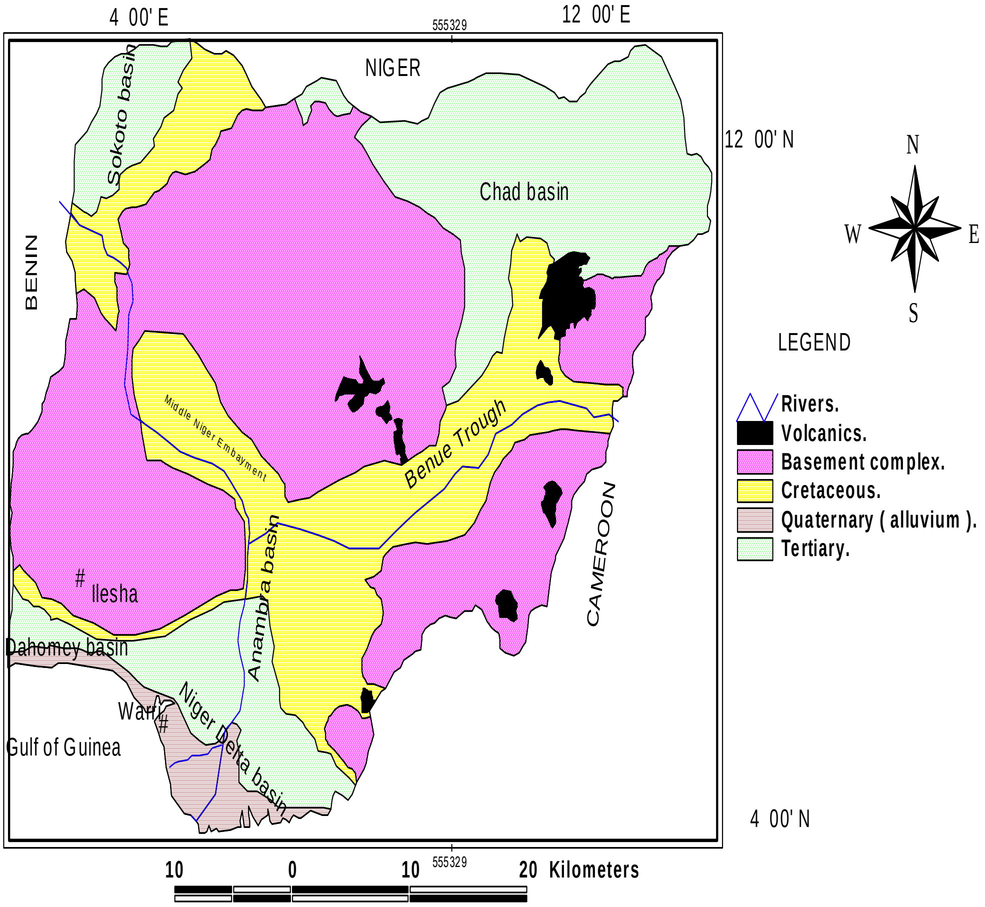


Figure 1: Geological map of Nigeria showing Basement and Sedimentary terrain.

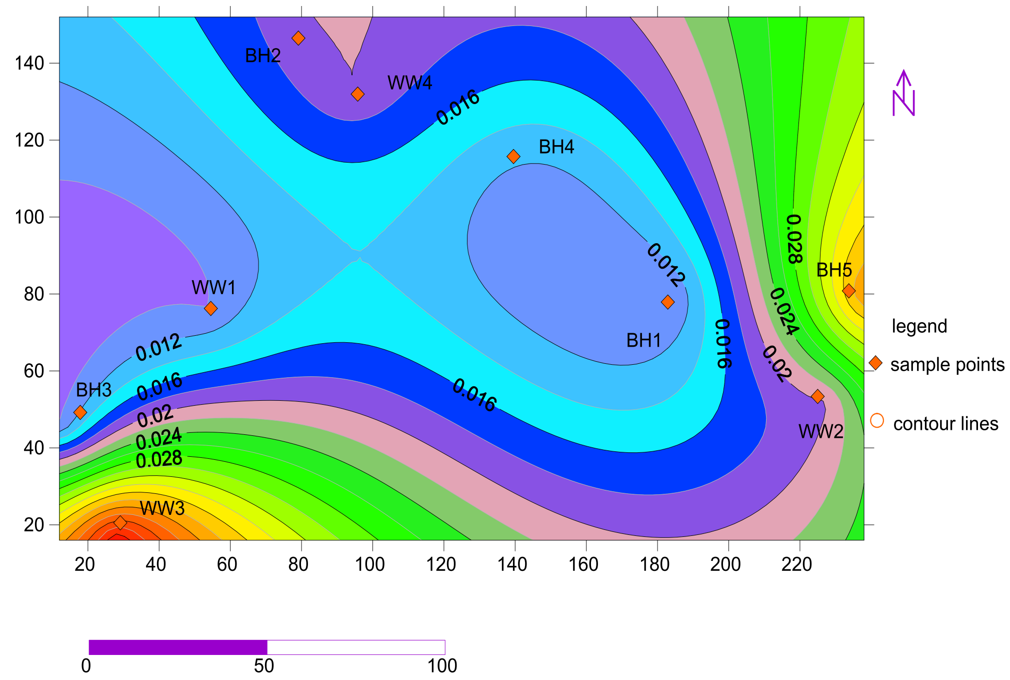


Figure 2:Hydrogeological contour map of lead(mg/l) at Ilesha during wet season

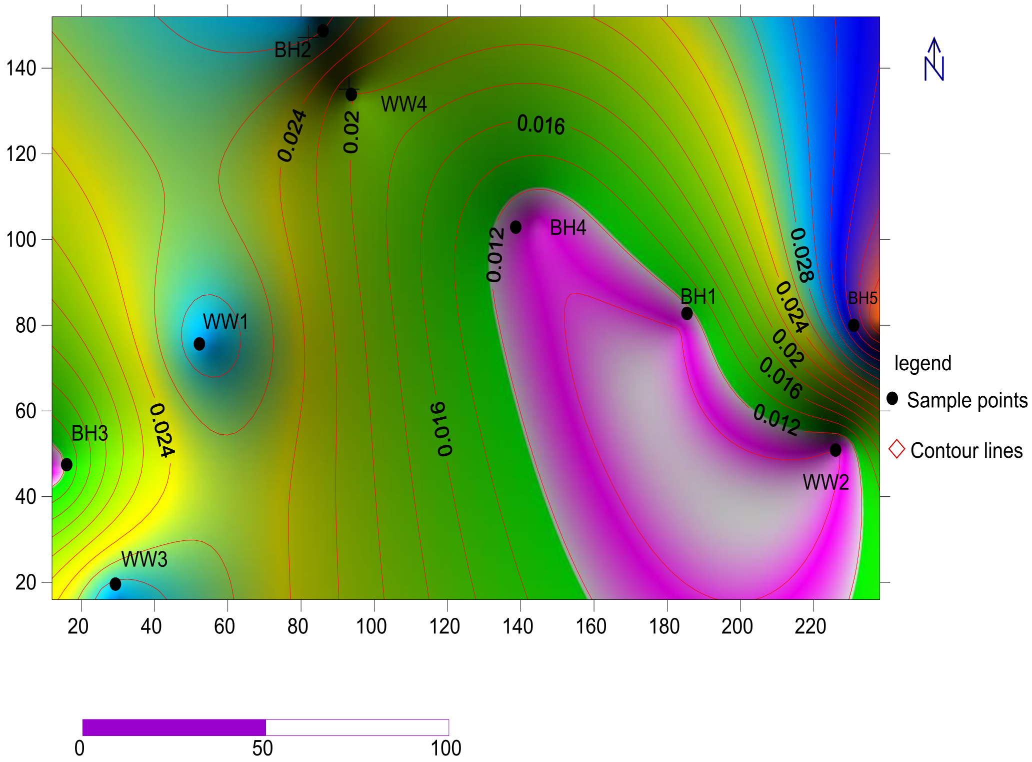
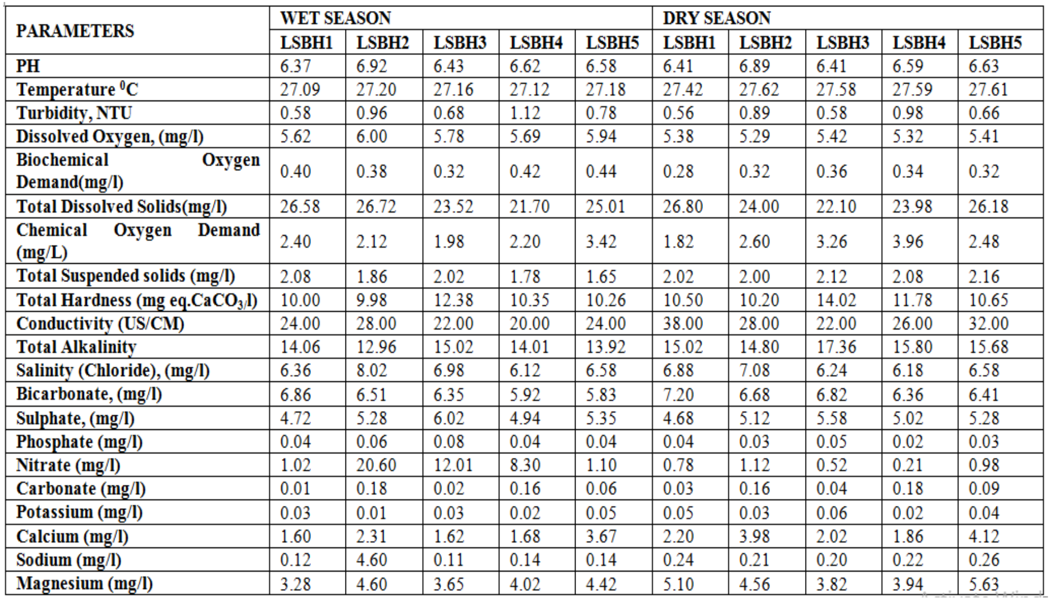


Figure3:Hydrogeochemical contour map of Lead(mg/l) at Ilesha during dry season.

TABLE 1: PHYSICO-CHEMICAL PARAMETERS OF WATER SAMPLES AT ILESHA.



PARAMETERS	WET SEASON					DRY SEASON				
	LSBH1	LSBH2	LSBH3	LSBH4	LSBH5	LSBH1	LSBH2	LSBH3	LSBH4	LSBH5
PH	6.37	6.92	6.43	6.62	6.58	6.41	6.89	6.41	6.59	6.63
Temperature ^{0}C	27.09	27.20	27.16	27.12	27.18	27.42	27.62	27.58	27.59	27.61
Turbidity, NTU	0.58	0.96	0.68	1.12	0.78	0.56	0.89	0.58	0.98	0.66
Dissolved Oxygen, (mg/l)	5.62	6.00	5.78	5.69	5.94	5.38	5.29	5.42	5.32	5.41
Biochemical Oxygen Demand(mg/l)	0.40	0.38	0.32	0.42	0.44	0.28	0.32	0.36	0.34	0.32
Total Dissolved Solids(mg/l)	26.58	26.72	23.52	21.70	25.01	26.80	24.00	22.10	23.98	26.18
Chemical Oxygen Demand (mg/L)	2.40	2.12	1.98	2.20	3.42	1.82	2.60	3.26	3.96	2.48
Total Suspended solids (mg/l)	2.08	1.86	2.02	1.78	1.65	2.02	2.00	2.12	2.08	2.16
Total Hardness (mg eq.$CaCO_{3/}$l)	10.00	9.98	12.38	10.35	10.26	10.50	10.20	14.02	11.78	10.65
Conductivity (US/CM)	24.00	28.00	22.00	20.00	24.00	38.00	28.00	22.00	26.00	32.00
Total Alkalinity	14.06	12.96	15.02	14.01	13.92	15.02	14.80	17.36	15.80	15.68
Salinity (Chloride), (mg/l)	6.36	8.02	6.98	6.12	6.58	6.88	7.08	6.24	6.18	6.58
Bicarbonate, (mg/l)	6.86	6.51	6.35	5.92	5.83	7.20	6.68	6.82	6.36	6.41
Sulphate, (mg/l)	4.72	5.28	6.02	4.94	5.35	4.68	5.12	5.58	5.02	5.28
Phosphate (mg/l)	0.04	0.06	0.08	0.04	0.04	0.04	0.03	0.05	0.02	0.03
Nitrate (mg/l)	1.02	20.60	12.01	8.30	1.10	0.78	1.12	0.52	0.21	0.98
Carbonate (mg/l)	0.01	0.18	0.02	0.16	0.06	0.03	0.16	0.04	0.18	0.09
Potassium (mg/l)	0.03	0.01	0.03	0.02	0.05	0.05	0.03	0.06	0.02	0.04
Calcium (mg/l)	1.60	2.31	1.62	1.68	3.67	2.20	3.98	2.02	1.86	4.12
Sodium (mg/l)	0.12	4.60	0.11	0.14	0.14	0.24	0.21	0.20	0.22	0.26
Magnesium (mg/l)	3.28	4.60	3.65	4.02	4.42	5.10	4.56	3.82	3.94	5.63

TABLE 2: HEAVY METALS AND COLIFORM COUNT ANALYSIS OF BOREHOLE WATER SAMPLES

HEAVY METALS(mg/l)	WET SEASON					DRY SEASON			
	LSBH1	LSBH 2	LSBH 3	LSBH 4	LSBH 5	LSBH 1	LSBH 2	LSBH 3	LSBH 4
Iron	0.18	0.42	0.26	0.21	0.29	0.06	0.14	0.27	0.08
Manganese	0.04	0,08	0.03	0.01	0.06	0.03	0.09	0.10	0.06
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01
Lead	<0.01	0.02	<0.01	<0.01	0.04	0.03	0.01	0.03	0.02
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.06	0.03	0.01	0.08	0.04	0.03	0.05	0.04	0.07
Zinc	0.06	0.01	0.02	1.02	0.03	0.04	0.13	0.78	0.07
COLIFORM COUNT/100 ml	WET SEASON					DRY SEASON			
	LSBH1	LSBH 2	LSBH 3	LSBH 4	LSBH 5	ILPW 1	ILPW 2	ILPW 3	ILPW 4
	Nil	2	Nil	1	Nil	2	5	6	3

TABLE 3: HEAVY METAL ANALYSIS OF WELL WATER SAMPLES.

Heavy Metals	WET SEASON				DRY SEASON			
	LSOW$_1$	LSOW$_2$	LSOW$_3$	LSOW$_4$	ILPW1	ILPW2	ILPW3	ILPW4
Iron (mg/g)	0.03	0.12	0.24	0.06	0.06	0.14	0.27	0.08
Magnesium (mg/l)	0.2	0.06	0.03	0.06	0.03	0.09	0.10	0.06
Cadmium, (mg/l)	0.018	<0.01	0.019	<0.01	0.01	0.01	0.01	0.01
Lead, (mg/l)	<0.01	<0.01	0.01	<0.01	0.03	0.01	0.03	0.02
Chromium (mg/l)	0.04	0.07	0.09	0.06	<0.01	<0.01	<0.01	<0.01
Copper, (mg/l)	0.04	0.07	0.09	0.06	0.03	0.05	0.04	0.07
Zinc, (mg/l)	0.06	0.11	0.83	0.09	0.04	0.13	0.78	0.07

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