SCVJ
Volume 4, Issue 3, 2023
DOI: https://doi.org/10.55989/JUED2493
Science View Journal
ISSN (Online): 2734-2638

Assessment of Groundwater Quality in Owerri and Its Environments, Southeast Nigeria

P. I. Okeke[1], V. N. Nwugha[1], E. C. Nleonu[2], G. J. Okore[3], P. O. Okeke[4]

[1]Basic Science department, AlvanIkoku Federal University of Education Owerri, Imo State, Nigeria[1]
[2]Department of Chemistry, Federal Polytechnic Nekede, Imo State, Nigeria[2]
[3]Department of Chemistry, AlvanIkoku Federal University of Education Owerri, Imo State, Nigeria[3]
[4]Ministry of Works, Housing and Transport, Owerri, Imo State, Nigeria[4]

Email: okekepamelaify@gmail.com

Abstract:
Physico-Chemical and bacteriological characteristics of eleven boreholes located within Owerri city were examined. The bacteriological analyses were carried out using the method of inoculation and incubation of specimens and counted on colonies. Titration method was used to determine chlorides and nitrates while Cu2+, Zn2+ and Mn2+ used atomic absorption spectroscopy (AAS). Iron concentration was read off using benzylideneacetone (BDA) Lovibondcolour comparator while the total dissolved solids were determined gravimetrically. The water is usually clear at average temperature of 27˚C. The bacteriological parameters are within the acceptable World Health Organization (WHO) standard and safe for human consumption. The pH is 6.0 -7.5, total dissolved solids vary from 12.4mg/l to 49.4mg/l. The anions of chloride and nitrate are 67mg/L to 125mg/L and 0.003 mg/L to 23.1 mg/L respectively. Concentrations of cations include iron; 1.86mg/l, copper; 1.2mg/l, zinc; 2.1mg/l and manganese; 0.05mg/l. The results show that the groundwater within the city is suitable for drinking and other uses compared to the WHO standard. The environmental conditions of the borehole locations as well as the total drill depth should be emphasized. Government monitoring agency should ensure adequate drill depth to at least 200ft in the south- western area and north- eastern areas from 250ft to 300ft as this may reduce the injurious variations in the geochemical parameters in some boreholes.

Keywords: Bacteriological, Drill depth, Groundwater quality, Incubation, Inoculation, Physico-Chemical, Specimen.

I. INTRODUCTION

Water is one of the basic essentials of life. Owerri is surrounded by rivers Otamiri and Nwaorie. All sorts of things and refuse are thrown into them and people still use water for domestic purposes. The need for potable water supply necessitated the construction of water schemes by the government. This served the inhabitants as the reticulation was efficient until about late 1990s when the economy of the country started dwindling that the supply was not regular again. Individuals resorted to self-help which encouraged the drilling of private boreholes. This became a norm for every household except those who cannot afford it. In the recent past people were always complaining of fever and other related health issues that boarder on diseases that may be as a result of pollution and contamination of food items, water supply and dirty environment. This suggests that food items or even water consumed by people could be the cause of the endemic disease pestering residents.

When water is exposed to microorganism it leads to several disease conditions in both humans and animals. The potable water can be contaminated in several ways which include improper waste disposal at dumpsites, leaking septic tanks, and other unhygienic practices that can introduce microbes to our ground water (Bayode etal, 2012). These microbes are the agent of water borne from bacteria; heterotrophic bacteria, coli forms, fungi and viruses. Bacterial growth in water can cause diarrhea, typhoid fever, cholera, hepatitis etc (Sunday et al, 2014) and possible fungal growth as micro, fusarium, etc which is rare (Agbabiaka and Oyeyiola, 2012), hence, the need to investigate the groundwater in recent times.Groundwater quality is made up of the chemical, biological and physical qualities of the groundwater. Groundwater set aside for drinking purposes, should be non-toxic, free from living and non-living organisms, and certain quantities of minerals that could be dangerous to health (Ojoawo et al, 2016).Also, the presence of heavy metals and ions at certain amounts can pose serious threat to human health (Nwugha et al, 2021). Reports of relapsing and some other health related symptoms are reported from different boreholes within the Owerri city and environs. Generally, all over the world, soil environments are known to be contaminated (Akinlabi and Olaiya, 2021).

This is essential because it is the basic means of transmitting diseases (Hutchinson 1975).These diseases could be caused by bacteriological or physico –chemical agents at the shallow horizons. However, at deeper horizons all the natural heat eliminates micro-organisms that are there.

Life can hardly be sustained without water (Nwugha et al, 2016) According to World Health Organization (1976) about 1.5 billion people worldwide drink filthy water. This number is presumably increasing each year. The resultant effect is

SCVJ
Volume 4, Issue 3, 2023
DOI: https://doi.org/10.55989/JUED2493
Science View Journal
ISSN (Online): 2734-2638

illness and deaths from water-related infections. The potential degradation and contamination of groundwater sources in Owerri are concerns over quality and safety of the water supply for the population. Groundwater resource is the main stay of water supply especially in the South Eastern part of Nigeria yet their expatiations are not properly monitored and controlled as its pollution is occurring with increasing frequency and these points to the need to create a system that will monitor the existing boreholes. There is the need to assess and evaluate the current state of groundwater quality and if possible identify sources of contamination and determine the potential health and environmental risks associated with the consumption of contaminated groundwater, (Tariwari etal, 2015). The assessment is crucial to implement appropriate mitigation measures, ensure the availability of safe drinking water and protect the long term sustainability of groundwater sources in Owerri.

The subsurface is underlain by sands which are very permeable and this means that transmittance is easy. Microbes and their effects are not the only harmful factors that can be found in groundwater. The chemical parameters also play a role in the portability of groundwater. The major dissolved components of groundwater include the anions; bicarbonate, chloride and sulphate, and the cations; sodium, magnesium and potassium. The constituents are typically present at concentrations in the range of few mg/L to several hundred mg/L. Concentrations of iron and manganese in groundwater are often higher than these measured in surface water. The Aesthetic objective (AO) for iron in drinking water is less than or equal to 0.05mg/L, Weinberg (1981). Iron in rural groundwater supplies is common problem: its concentration level ranges from 0 to 50mg/L, NAS (1980) while WHO recommended level is <0.3mg/L. Iron occurs naturally in aquifer but the level in ground water can be increased by dissolution of ferrous borehole and hand pump components.
The common elements and compounds in ground water that cause toxic effects include arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, selenium and zinc. The concentrations vary from place to place and acceptable or consumable quantities by human beings have been specified by World Health Organization. Otherwise, it may be harmful to the body. This study aims at assessing the bacteriological and physico-chemical characteristic of eleven boreholes in some parts of Owerri city, GCDWQ, (2021).

II. Materials and Methods

LOCATION AND HYDROGEOLOGY OF THE AREA

The study area in Owerri city is located within latitudes 5˚24′N and 5˚30′N and Longitudes 6˚57′E and 7˚7′E in the south eastern Nigeria, Figure 1. It is underlain by Benin Formation coastal plain sands that yield fresh water. Groundwater is readily available (Shout and Stauble, 1967). The wet and dry sea seasons do not affect the flow as the volume is constant. Although, Benin Formation is a multi-aquifer system and most of the aquifers in these areas are unconfined and extends to great depths between 100m and 150m (Onyeagocha, 1980).

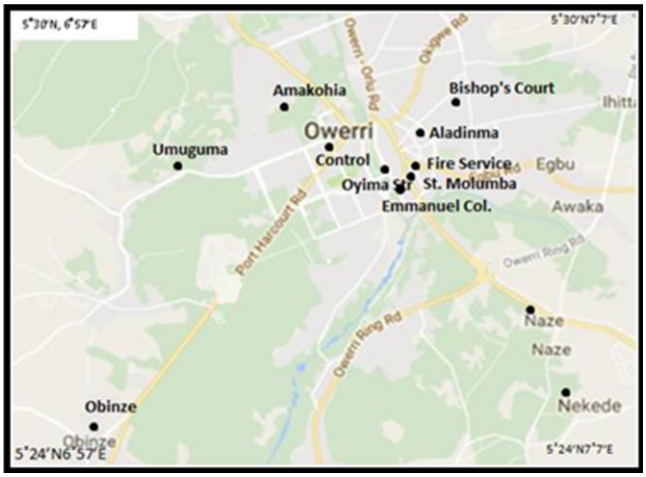

Figure 1: The Location Map of the study showing sample locations.

SAMPLING AND ANALYTICAL TECHNIQUES

Eleven water samples were collected using clean 500ml plastic bottles. The samples were taken at the well head each pumping borehole. The borehole was allowed to flow for more than five minutes before the samples were taken from the well head, to ensure stable condition of content. The sampling bottles were capped immediately to reduce oxygen intake into the samples. The samples were kept in ice-pack cooler to maintain the temperature of the samples. Then the samples were transported to the laboratory within 24 hours.

PHYSICO-CHEMICAL TESTS

Eleven each water sample in the glass bottles was acidified for later cation and anion analysis in the laboratory.

IRON: citric acid (2ml) was added to 50ml of water sample. Then 0.1mL thioglycolic acid and ammonia solution (2mL) were added. Distilled water was treated the same way to serve as standard. Both samples were allowed to stand for about 5minutess to develop colour if possible. Then, their concentrations were read off using BDA lovibond colour comparator.

TURBIDITY: The turbidity of water sample was measured by the turbid metric method in the unit of FormazinTurbidity Units (FTU) and compared with the WHO standard of 5 FTU.

ELECTROLYTIC CONDUCTIVITY: The conductivities of the samples were measured at the site due to the unstable nature using model MCT Mark V instruction manual. Conductivity shows presence of ionisable ions.

PH: Hydrogen ion concentration (pH) was measured colorimetrically on the field with a lovibond comparator and cross checked in the laboratory with a pH meter. The pH meter is (Bromthymol Blue pH kit of USA).

SCVJ
Volume 4, Issue 3, 2023
DOI: https://doi.org/10.55989/JUED2493
Science View Journal
ISSN (Online): 2734-2638

TEMPERATURE: The temperature of water samples were measured with the centigrade thermometer,˚C.
CHLORIDE AND NITRATE TEST: chloride Cl- concentration was determined by titration method and Nitrate concentration was by method given in APHA (1985). Chloride ions raise conductivity (Tebbutt, 1979).

COPPER, ZINC AND MANGANESE CATION TESTS: copper, Cu2+ and zinc Zn2+, were determined using the Atomic Absorption Spectroscopy (AAS) while the Manganese, Mg2+ and Sulphate SO42- were determined by Gravimetric method. They are the major aesthetic elements and compounds.

INOCULATION AND INCUBATION OF PLATES
Membrane filter were aseptically rolled onto the surface of appropriate media with Millipore forceps. All plates were wrapped and incubated for four hours at 35oCand 44.5oC for 24 hours and 48 hrs respectively. The total heterotrophic bacteria (THB), total fungi of the water samples were determined using pour plate method (Repper and Gerba, 2005), Benson (2002). Afterwards colonies were separated into yellow and red colonies as E. coli and streptococci.

III. Results and Discussion

The pH values are slightly acidic and slightly alkaline from 6.7 to 7.5, Figure 2. This could be as a result of some clay intercalation or varying drill depth at various locations. The nearness to the ground surface may introduce free carbon dioxide from the atmosphere introduced into aquifer system to increase the acidity.

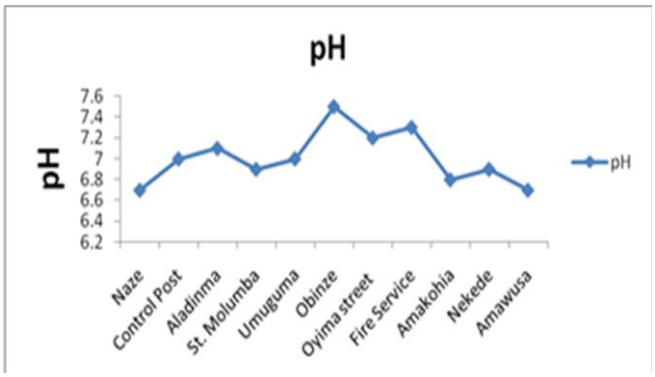

Figure 2: The pH values of samples within the study area

The electrical conductivity of the samples is in the range of 21.1NS/CM to 148NS/CM, Figure 3. High values mean that there are no sign of saline or mineralization and this makes it very good for human consumption.

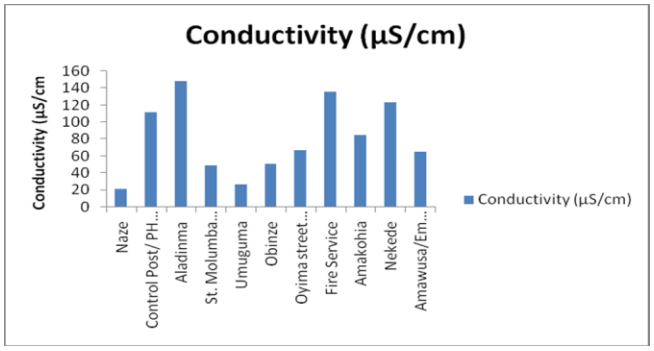

Figure 3: The electrical conductivity of the samples within the study area

The turbidity of the samples is low and in line with the clearness or the colour of the water. They vary from 0.0 to 1.5 Formazin Turbidity Units (FUT) with standard of 5 FTU, Figure 4. This means that less of oxidation of the ferrous ion is in the water.

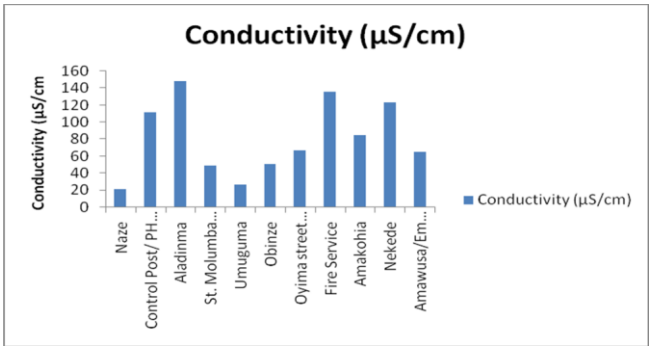

Figure 4: The turbidity of the samples within the study area.

IONIC CONTENT: The cations present in the groundwater are in the form of iron, Fe2+, Copper, Cu2+, Zinc, Zn2+ and Manganese, Mn2+.The anion concentrations identified are nitrate, NO2-, sulphate, SO22- and Chloride, Cl-. The Iron concentration varies from 18.6mg/L to 63.9mg/L, Figure 5. Manganese is 0.05mg/L, Copper is 0.7mg/L to 2.0mg/L at Amakohia, while Zn2+ ranges from0.89mg/L to 2.38mg/L at Emmanuel College/Douglas road. The concentrations at Nekede and Amakohia exceeded the acceptable limits while other locations have their values within the acceptable limits. The chloride ions range from 79ml at Aladinma to 125ml at Nekede. These values are within the admissible measures safe for human consumption. But, the sulphates measured are highest at Naze.

SCVJ
Volume 4, Issue 3, 2023
DOI: https://doi.org/10.55989/JUED2493
Science View Journal
ISSN (Online): 2734-2638

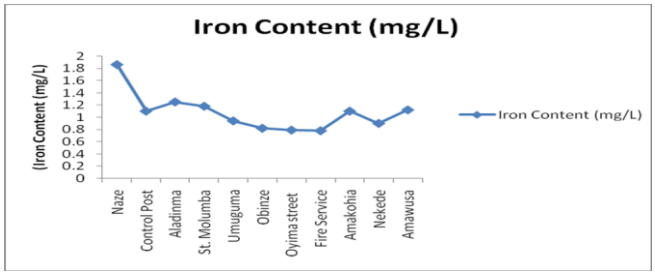

Figure 5: The Iron concentration of samples within the study area.

Total dissolved solids (TDS) vary between 12.4 mg/l to 49.4mg/L, Figure 6. Fresh water can be deduced from less amount of dissolved substance in it.

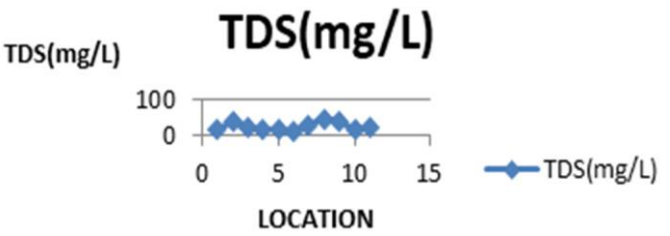

Figure 6: Total Dissolved Solids within the Study Area.

The temperature ranges from 26oC to 28oC with average of 27oC. The water always remained cool at the point of flow indicating constant physiogeographic condition of the area.

ENUMERATION OF MICROBIAL COUNTS

The total heterotrophic bacteria, (THB) vary between 0.1x102 and 1.13x102cfu/mL, feacal coliform 0.2x102 to 0.81x102 cfu/ml while streptococciis from 0.001x102 to 0.05x102cfu/mL. The average bacteria count is T0.45x102 mL, fungi is0.25x102 cfu/mL and feacal coliform is 0.03x102cfu/mL, Figure 7. These values are quite within the acceptable limits by the WHO standard and quite less the population that can be rated harmful in water samples. There is significant difference in the acceptance limit of the growths in the samples as the stipulated WHO standard of a count of less than 1/100mL for the water to be acceptable. THB –Total heterotrophic bacteria, TF –Total fungi, TFC – Total feacal coliform, STD –Standard, SON –Standard organization of Nigeria SON, 2007. The bacteria counts of THB vary between 0.1 x 102 cfu/ml, E. COLI ranges from 0.02 x 102 cfu/ml to 0.81 cfu/ml while the streptococci is from 0.005 x 102 to 0.07 x 102 cfu/ml.

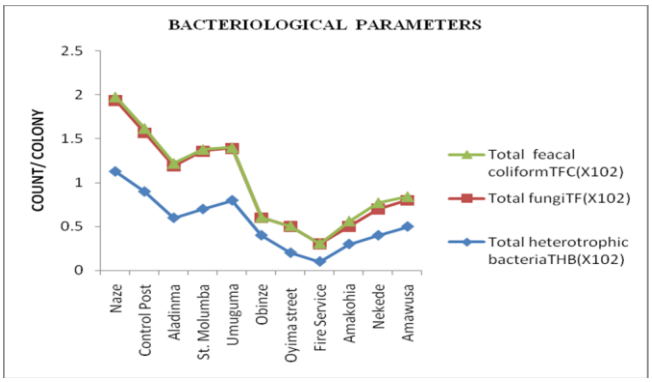

Figure 7: The total heterotrophic bacteria, fungi and feacal coliform counts.

IV. CONCLUSION

The water is clear and colourless with Fermazin turbidity unit of 1.5FTU. The pH values vary from 6.7 to 7.5. They are slightly acidic in areas such as Naze, St. Molumba on Wetheral road, Amakohia, Nekede and Emmanuel College areas and slightly alkaline in other places.

Other physic-chemical parameters such as electrical conductivity show normal concentrations are within the tolerable limits. The cations and anions are also within the range of allowable consumable concentrations.

The bacterial growths identified in water samples collected from various borehole locations are not much in population as to affect the health of the consumers. The average count of 0.45, 0.25 and 0.03 cfu/ml is within the acceptable limits of the WHO. From the foregoing, it is expedient that inspection/monitoring agency should be more agile in detecting pollutions. Strict guidelines should be drawn to control the construction and protection of wells in these areas. The inspection/monitoring agency should specify standard especially the total drill depth of particular areas as well as the distance between boreholes. The environment for location of the borehole is another controlling factor in determining the drill point, proposed sites near toilets, suck away pits, gutters and dumpsites or dustbins should be avoided. While existing and functional bole holes should be protected from such. The adherence to drill depth will reduce the occurrence of bacteriological investigation.

V. REFERENCES

Agbabiaka T. O. and Oyeyiola G. P. (2012). Microbial and physicochemical assessment of foma River, Hanmo, Ilorin metropolis. International Journal of plant, Animal and Environmental Sciences, 21(1) 209-216.

Akinlabi A. I. and Olaiya M. L. (2021). Geoelectrical and Physicochemical evaluation of soil corrosivity on metallic pipelines: A case study. Journal of Geography, Environment and earth science international Jgeesi.com DOI: 10.9734/jgeesi/2021/v25i530287 P.46-56, Issue 2021-Volume 25(issue5)

DOI: https://doi.org/10.55989/JUED2493

Akinlabi A. I. and Olaiya L. M. (2021). Geo- electrical and physicochemical evaluation of soil corrosivity on metallic pipelines: A case study. Journal of Geography, Environment and Earth Science International 25 (5) 46-56.

APHA (1975) Standard methods for the examination of water and waste water American Public Health Association Washington D.C. USA. 13THEdn. 635p

APHA, (1985) Standard methods for the examination of water and waste water American public Health Association (Revised) USA

Bayode S., Olurunfemi S. O. and Ojo J. S. (2012). Assessment of impact of some waste dumpsite on ground water quality in some parts of Akure metropolis southwestern Nigeria. Pacific journal of technology, 13(2)528-536

Guidelines for Canadian Drinking water Quality (2021): Guideline understanding drinking water chemical tests results. Environmental Public Health Alberta Health Services Health Link Advice 24/7

Hutchinson (1975). The national achieves of the united states, Federal register 40 (58) 13195-13292

National Academy of Sciences (1980) Recommended dietary allowances 9th edition. National Academy Press Washington D C

Nwugha V. N., Ezebunwa A. C., Okeke P. I. and Chinaka A. I. (2021) Environmental implications of leachates of sewage dumpsites in some parts of Owerri, Southeastern Nigeria The Pacicific Journal of Science and Technology. 22 (1) 254-261.

Nwugha V. N., Okeke P. I., Selemo A. O., Ibe C. G., Njoku P. C., Oluwaseun H. (2016) Effects of leaking septic tanks on underground water quality in Owerri Municipal Imo State Nigeria British Journal of Applied Science and Technology 12 (3) 1-10

Ojoawo A. I. and Seun G. A. (2016) Geophysical and hydro-physicochemical analysis of groundwater quality at Gbede mining site Ogbomoso South West Nigeria. International Journal of Scientific and Engineering Research 7 (8) 1156-1166

Onyeagocha A. C. (1980). Petrography and depositional environment of the Benin formation, Nig. Journal Mini beol. 17 (2) P. 147-151

Short K. C. and Stable A. J .(1967). Outline Geology of the Niger Delta. AAPG Bull 51; 761-779.

Sunday J. J, Spenser N. C. O., Kingsley O., Edet A. O. and Amaka D. D. (2014). Physico-chemical and microbiological properties of water sample used for domestic purposes in Okada town , Edo state, Nigeria. International Journal of current microbiology applied science, 3(6) 886-894.

Tariwari C. N, A., Izah C, S.,Cosboy M. E. and Bright Y. (2015) Microbial density of Groundwater in kolokum/opokuma local Government Area of Bayelsa State, Nigeria. FUNAI Journal of science Technology, 1(1) 1-9.

Tebbntt, T. H. Y. (1979) Principles of water Quality control. 2nd Pergamum press

Weinberg E. D. (1981) Iron and neoplasia Biol Trace Element Res., 3: 55

WHO (1976) International Standard for Drinking Water (3rd Ed), Geneva 9, Switzerland.