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Quality Assessment of Potable Water Supply System in Petroleum Training Institute Community, Effurun, Nigeria

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Abstract
Physico-chemical studies and bacteriological assay of ground water in petroleum training Institute, Effurun, Nigeria, were carried out to evaluate the quality of water supply system and to provide baseline data for future monitoring of contamination of the water. Water sample were collected from nine (Boys' hostel, Girls' hostel, Clinic area, Power house area, Church village, Conference center complex, Call duty quarters, Senior staff quarters Block 8 and Senior staff quarters Block 9) different sampling points for analysis using different standard analytical methods. The annual mean values of chemical parameters analysed in triplicates of the different water samples gave the following ranges: pH is 6.2-7.1, Conductivity is 25.0-120.1μS/cm, TDS is 13.0-58.3 mg/l, TSS is 0.01-0.21 mg/l, Alkalinity is 6.0-48.0 mg/l, Chloride is 17.71-71.00 mg/l, Total hardness is 1.6-54.0 mg/l, Sulphate is <0.01-31.04 mg/l, Nitrate is <0.01-9.00 mg/l and Total iron is 0.02-1.00 mg/l. The Lead and Turbidity analyses showed constant result values of <0.001 mg/l and <0.1NTU respectively. The microbial assay aspect of the work showed some growth loads of total viable count for bacteria with annual range of 0-5.0 x 10^2 cfu/100ml. This value though falls below WHO limit, could be attributed to leakages at few points on the supply lines that were observed. The coliform count assay showed no growth indicating the absence of faecal contamination. When compared with WHO Standards for drinking water, all the physico-chemical properties' values falls within the WHO limits with little deviation in pH excluding total Iron. The high level of Iron could be attributed to welding and fabrication activities which is one of the major operations in the Institute and its surrounding environment. We hope that good maintenance of the Water supply lines and constant monitoring will guarantee safe drinking water for the community.

Keywords: *Ground water, Quality, Deterioration, Sterilized, WHO Standards and Contamination*

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I. Introduction

Management and provision of good quality drinking water contributes to reducing diseases and water borne infections in developing countries (WHO, 2003; 2012; 2019). Ground water (which occurs at the depth of 20 meter to 45 meter in Warri-Effurun Area of the Niger Delta region) among other sources of potable water is an important source of water supply throughout the world. The increase in population, urbanization, industrialization and especially the oil/gas exploration and production activities has a resultant potential effect on the deteriorating quality of water. Drinking water needs to be from an improved water source which is located on premises, available when needed and free from faecal and priority chemical contamination (WHO, 2021).

The availability of water alone does not safeguard nutrition nor does it guarantee an access to healthy water. In different parts of the world, particularly rural areas, several research activities have been conducted to ascertain the quality of drinking water (Mulamattathil et al, 2015; Barakat et at, 2018; Raphael et al, 2018; Malek et al, 2019).

The quality of this source of potable water needs to be evaluated from time to time to ascertain its suitability for consumption and also to demonstrate the comparability of data obtained worldwide which forms the basis for appropriate decision making related to management of water resources. According to Amoo and Mojisola (2009), contaminated water kills more people than cancer, AIDS, war or accidents. It is imperative therefore to give highest priorities to safe drinking water and any water consumed by man should be free from disease-causing organisms and toxic chemical that can pose a threat to public health TWAS (2002). This research work therefore is geared toward the analysis of the most available borehole water outlets to the Petroleum Training Institute Community, Effurun, Nigeria. It has population of above 6,000 people which consisted of the Institute's workforce and their wards, students and oil/gas expatriates that use the ground (borehole) water system in the Institute for drinking, cooking and other domestic purposes.

II. Materials And Method

Study Area/Sampling Points

The study was conducted in Petroleum Training Institute, Effurun, Delta State, Nigeria, with an estimated population of over 6,000 people. Samples were collected from nine (9) geo-referenced sampling points (see table 2) that were randomly and carefully selected to ensure spatial distribution of the points within the Institute Community (Birma et al, 2018; Haider et al, 2020). The sampling include Boys Hostel (BH), Girls Hostel (GH), Clinic Area (CA), Power House Area (PH), Church village (CV), Conference Centre (CC), Call Duty Quarters (CD), Senior Staff Quarters 8 (SQ8), Senior Staff Quarters 9 (SQ9). The study area and the sampling points are represented in the map shown below in Figure 1.

Table 1: Showing sampling points and their coordinates

S/N	Name of Station	Station code	Coordinate (Deg Min Sec)	Coordinate (Decimal Degree)	Description of sampling points
1	Boys Hotel	BH	N 05° 34’13.437”	5.570399N	This is a hostel that accommodates the male students. It is near to a swamp area in the Institute.
			E 05° 47’44.724”	5.795757E	
2	Girls Hostel	GH	N 05° 34’13.107”	5.570307N	This is a hostel that accommodates all the female students. It is near to a swamp area in the Institute
			E 05° 47’48.444”	5.796790E	
3	Clinic Area	CA	N 05° 34’10.472”	5.569576N	This is occupational centre that receives all cases of medical and health issues.
			E 05° 47’39.474”	5.794298E	
4	Power House	PH	N 05° 34’6.032”	5.568342N	This is sampling point close to the water storage tank for the institute.
			E 05° 47’45.054”	5.795848E	
5	Church Village	CV	N 05° 34’22.340”	5.572872N	The church village houses a lot of worship centres for both students and external worshipers.
			E 05° 47’33.743”	5.792706E	
6	Conference centre	CC	N 05° 34’31.311”	5.575364N	The sampling point is from one of the business outfit of the Institute. The centre houses restaurant, lodge, reception venues and leisure points.
			E 05° 47’47.088”	5.796413E	
7	Call Duty Quarters	CD	N 05° 34’32.367”	5.575657N	The point is from residential area that accommodate majority of the young officers and their wards.
			E 05° 48’2.814”	5.800782E	
8	Senior staff Quarters8	SQ8	N 05° 34’10.005”	5.569446N	The station is a residential area for the Senior staff members and their families.
			E 05° 47’32.521”	5.792367E	
9	Senior staff Quarters9	SQ9	N 05° 34’13.149”	5.570319N	The sampling point is also within a residential area for the Senior staff members and their families.
			E 05° 47’29.910”	5.791642E	

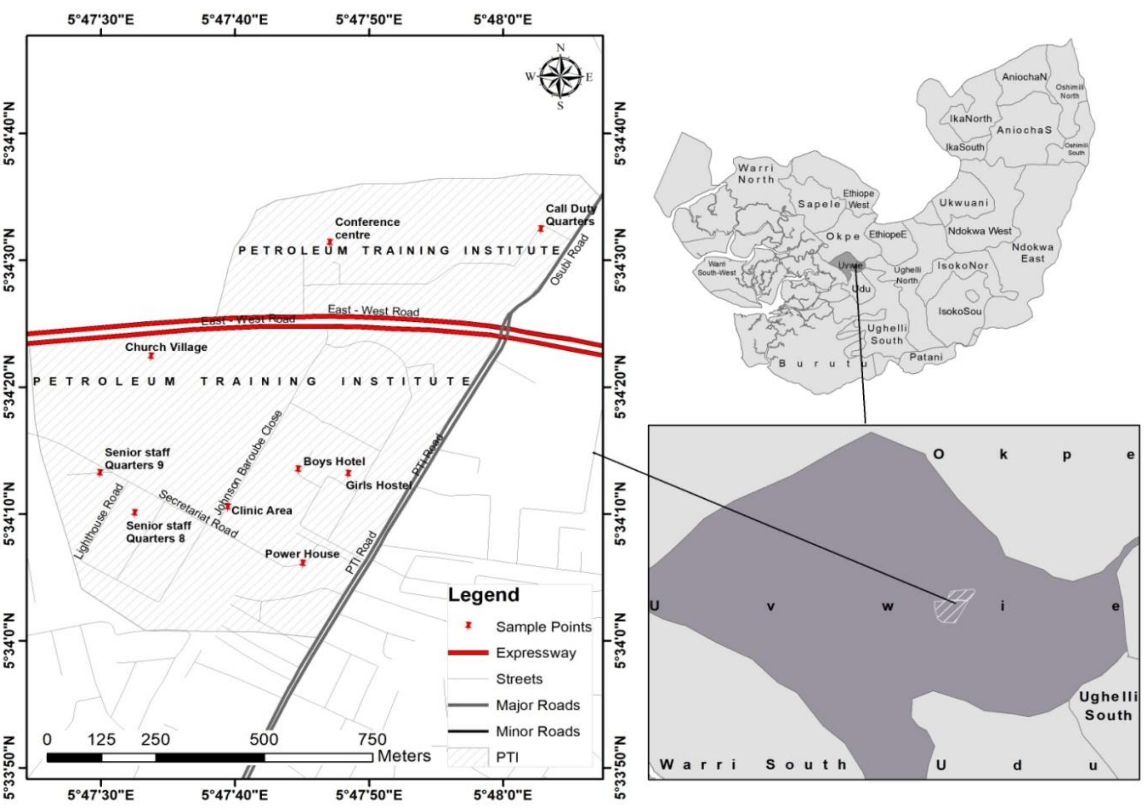


Figure 1: Map of the study area showing the sampling points

Sample collection

The procedure as prescribed by APHA (1981) was adopted for this sampling work. The samples were collected in cleaned low density polyethylene bottles for physicochemical analysis. Samples for heavy metals analyses were collected in separate clean polytetrafluoroethylene (PTFE) bottles and acidified with nitric acid to a pH of < 2.0 to minimize precipitation and adsorption on container walls.

Samples for bacteriological analysis were collected in cleaned glass bottles of 200ml sterilized in hot air oven at 170^{o}C with 0.25ml of 1.8% solution of sodium thiosulphate (Apampa et al, 2017 and Taiwo et al, 2020). The water taps were sterilized for a minute with a flame from cigarette lighter before samples were taken for the purpose (Barakat et at, 2018). All samples were collected, preserved and stored according to APHA 1060 A-C standard methods.

Analysis

All Samples were analysed using the American Public Health Association (APHA) Standard Methods for the Examination of Water and American Standard for Testing and Materials (ASTM) Part 31 for water as shown below

The pH and Conductivity was determined using Metler Toledo pH and conductivity meter probe respectively (Frank et al, 2018).

The Total Suspended Solids and Total Dissolved Solids were determined gravimetrically, while Sulphate and nitrate was measured at 425nm and 220nm nm respectively using UNICAM (uv-vis) spectrophotometer. Total iron and lead contents were determined using Atomic Absorption Spectrophotometer, model number UNICAM 969. Also total hardness, chloride and alkalinity were determined titrimetrically using 0.01M Ethylenediamine-

Tetraacetic Acid (EDTA) , 0.1M $AgNO_3$ and 0.02M HCl methods respectively according to (APHA, 1998).

The microbiological determination for Total viable bacterial count and coliform count were determined using pour plate method on macConkey agar (Frank et al, 2018). Table 2 below shows a comprehensive list of the parameters determined and the various test methods used.

Table 2: The list of parameters determined and test methods.

S/No	Parameter	Test Method
1	pH	Electrometric (SM4500-H^+B)
2	Conductivity	Electrometric (SM2540-B)
3	Turbidity	Nephelometric (SM 2130-B)
4	Alkalinity	Titrimetric (SM2320-B)
5	TSS	Gravimetric (SM 2540-D)
6	TDS	Gravimetric (SM 2540-C)
7	Hardness	Titrimetric (SM 2340-C)
8	Chloride	Titrimetric (SM 4500-Cl)
9	Sulphate	Spectrophotometric (SM 4500-SO_4^{2-})
10	Nitrate	Spectrophotometric (SM4500-NO_3^-)
11	Iron	AAS (ASTM D1068)
12	Lead	AAS (ASTM D3559)
13	Coliform count	Pour plate

III. Result And Discussion

The results of analysis of the collected water samples are presented in Tables 2and 3, which show the annual mean values of the physico-chemical properties and the microbiological analysis respectively of water from nine sampling points. All the water samples were clear and transparent with turbidity level of <0.1NTU as determined.

The result showed the annual pH value ranges from 6.2 to 7.1, with the Clinic Area and Senior staff quarters 8 recorded the the lowest and highest values respectively as shown in figure 2. The result of pH indicates that the water is acidic and few tend slightly toward neutrality, which confirms to most pH values of water from Niger Delta region (Ocheli et al, 2020; Ogbe et al, 2013). Osayande et al, (2015) reported that there was no potential risk arising from the consumption of either highly acidic or alkaline water but the fact remains that people with gastritis and gastrointestinal problems such as *Helicobacter pylori* are associated with persons that consume acidic water. The general low pH values also indicate acidity which means that the water has potentials to cause corrosion of metallic pipeline and general household materials. Most of the values fall within the WHO limit with the exception of pH values of samples from Boys Hotel and Clinic Area that fall a little bit below lower limit of the standard.

Table 2: Mean annual physico-chemical properties values of the water samples

S/N	Parameter	Unit	Result									WHO Limit
			BH	GH	CA	PH	CV	CC	CD	SQ8	SQ9	
1	pH		6.3	6.6	6.2	6.5	6.5	6.8	7.0	7.1	6.5	6.5-8.5
2	Turbidity	NTU	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	400
3	Conductivity	µS/cm	58.0	38.2	89.6	120.1	44.5	25.0	50.0	116.3	44.3	250
4	TDS	mg/l	29.0	19.1	45.2	60.2	22.4	13	24.0	58.3	21.9	500
5	TSS		0.13	0.21	0.03	0.01	0.04	0.05	0.07	0.02	0.05	NA
6	Alkalinity		48.0	18.0	61.0	15.0	30.5	7.9	7.3	6.0	11.0	500
7	Chloride		35.50	27.00	53.23	71.00	17.71	17.80	27.50	67.50	17.75	250
8	Hardness		54.0	18.0	13.0	24.0	9.0	2.5.0	6.0	1.6	3.0	500
9	Sulphate		4.6	31.04	9.02	0.04	<0.01	1.25	2.4	13.2	2.6	500
10	Nitrate		9.00	4.50	0.41	7.19	<0.01	0.64	4.87	3.08	2.90	50
11	Lead		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
12	Total iron		0.37	0.17	0.19	0.04	0.02	0.07	0.12	1.00	0.25	0.30

Table 3: Microbiological assay values of the water samples

S/N	Parameter	Unit	Result									WHO Limit
			BH	GH	CA	PH	CV	CC	CD	SQ8	SQ9	
1	TBC	cfu/100ml	**1.0 x 10^2**	**5.0 x 10^2**	**4.0 x 10^2**	**2.0 x 10^2**	**2.0 x 10^2**	**2.0 x 10^2**	**2.0 x 10^2**	**1.0 x 10^2**	**0**	**2.0 x 10^3**
2	Coliform Count		0	0	0	0	0	0	0	0	0	0

Figure 2: Shows annual mean values of pH from 9 sampling points

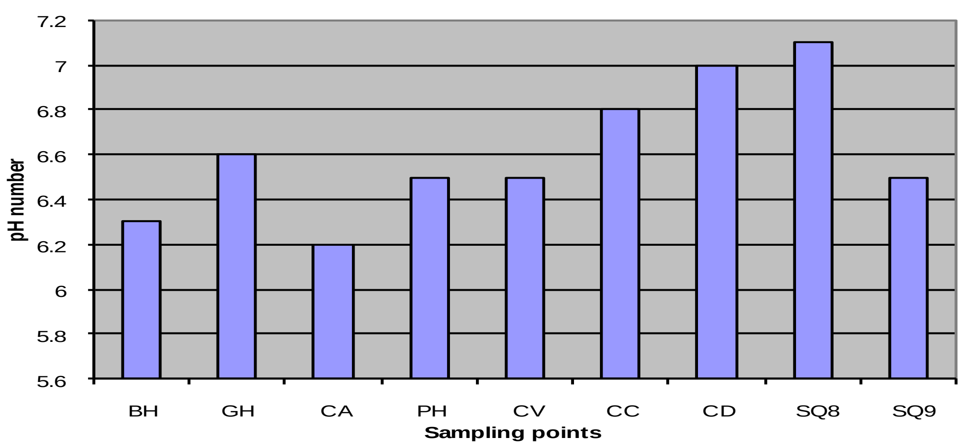


Figure 3: Shows annual mean values of TDS from 9 sampling points

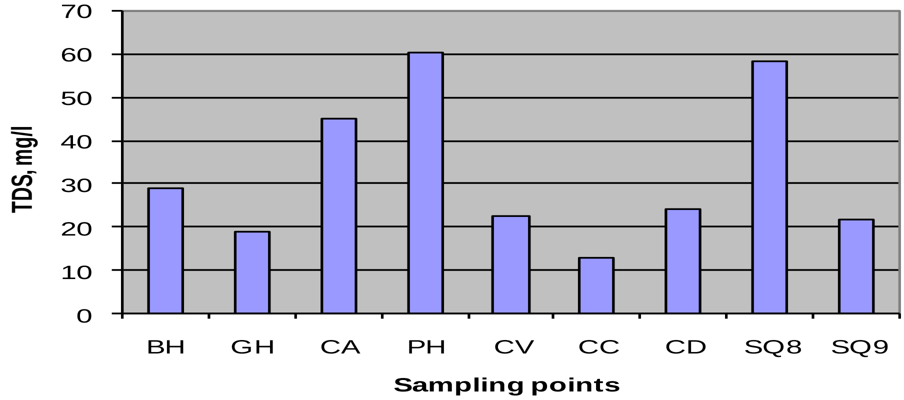


Figure 4: Shows annual mean values for Alkalinity, Chloride and Total hardness from 9 sampling points

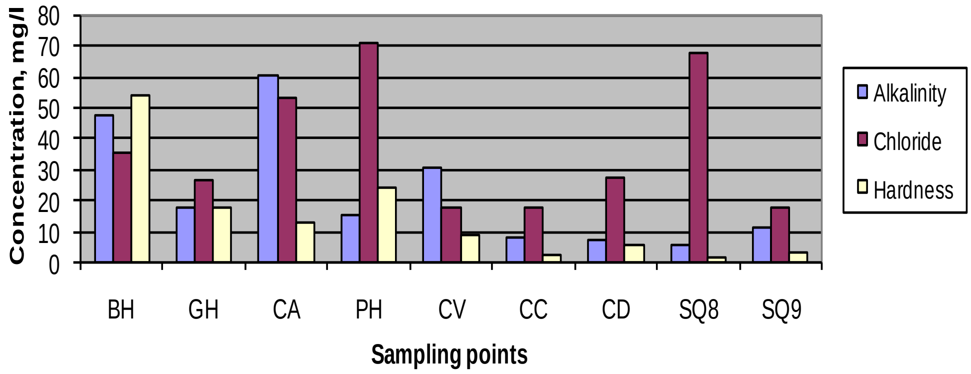
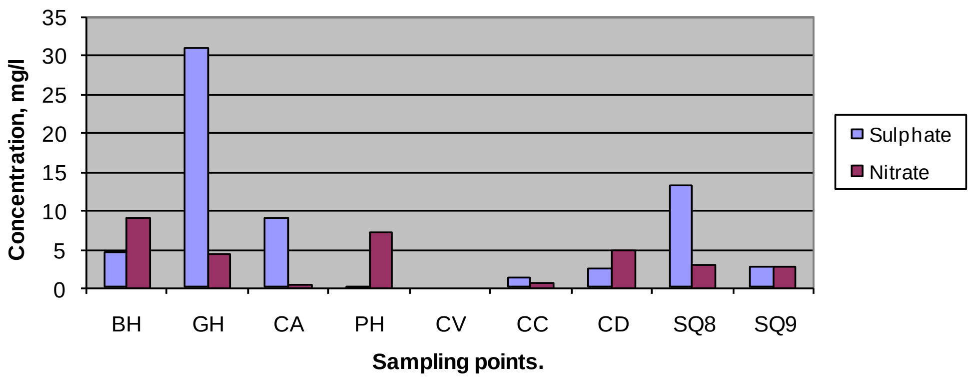


Figure 5 Shows annual mean values for Sulphate and Nitrate from 9 sampling points



The conductivity of water is related to the measure of its current and is directly related to the concentrations of the ions of total dissolved substances in the water (Jayalakshmi et al, 2011). The conductivity values ranges between 25.0 to 120.1µS/cm which are below the maximum desirable limit as prescribed (WHO, 2003). The Conductivity values shows significant correlation with some parameters such as pH value, alkalinity total dissolved solids etc in water as reported by (P*atil et al,* 2012). The values of TDS and TSS ranged 13.0-60.2mg/l and 0.01-0.21mg/l respectively. The TDS is below the WHO acceptable limit of 500mg/l for potable water. The values for total alkalinity, total hardness and chloride ranged 6.0-61.0, 1.6-54.0mg/l and 17.71-71.0mg/l respectively. These are far below 500mg/l, 500mg/l and 250mg/l standard limits respectively and these values are similar to other results obtained from previous research works carried in Niger Delta region (Ocheli et al, 2020; Ocheli et al, 2018).

The values are also similar to the ones obtained in similar work at Isuikwuato Local Area Council (Okoye and Okpara, 2010; Olanrewaju and Oyewole, 2017). The values of <0.01-9.00mg/l and <0.01-31.04mg/l are for nitrate sulphate respectively. These values are far below WHO limit of 50mg/l and 500mg/l for nitrate and sulphate respectively as recorded in a similar study (Ocheli et al, 2018). The concentrations of lead in all the water samples were below detection limit of 0.001mg/l for AAS. The values for the total Iron ranged 0.02-1.0mg/l. Some of the values are far above the WHO limit of 0.30mg/l. These high average values of total Iron could be attributed to the welding and fabrication activities which is one of the major operations within Niger Delta region because of oil exploration and exploitation in the area (Ezenwaji and Ezenweani, 2019).

The results of the microbiological assay are shown in Table 2 above. From the result, the coliform count assay recorded nil result in all the sampling points, however significant growth was recorded from total viable bacterial count. The values of total viable bacterial counts fall below the desirable limit of World Health Organisation (WHO) as reported by (Hassan et al, 2020 and Esharegoma et al, 2018).

IV. Conclusion

This research work has ascertained that water supply system in the Institute is very good. The water even though few of the values for pH and Iron fall slightly outside the WHO limit is consumable. It is recommended that more attention should be paid to parameters of concern (pH and Iron) in routine monitoring programmes as well as installing filter for quality improvement. Also high sanitary condition should be maintained around boreholes as well as general maintenance of boreholes at periodic intervals or as the need arises. Finally, the Institute authorities should put forward “Water Potability Awareness Programmes” (WAPAP) in radio, jingles, television stations etc to enlighten the Institute public on the need to drink good quality water.

References

[1]. Amoo, A. and Mojisola, A. A. (2007) ‘Physico-chemical analysis of well waters in Minna and its environs’. Niger State, Nigeria. *Journal of Chemical Society of Nigeria*, Vol.32(2), 122-127.

[2]. Apampa, S. A., Salisu, A. and Eze, S. (2017). Physicochemical Analysis of Underground Water in Zaria Metropolis, Kaduna State, Nigeria. *American Journal of Chemical Engineering*. 5(6), 158-162. doi: 10.11648/j.ajche.20170506.17.

[3]. APHA 1998. *Standard Methods for the Examination of Water and Waste Water*. American Public Health Association: Washington.

[4]. APHA-AWWA-WPCF (1981): Standard methods for the examination of water and waste water – related issues, Earth summit, Riode Janeriro, chapter 21.

[5]. Barakat, A., Meddah, R., Afdali, M. and Touhami, F. (2018). Physicochemical and microbial assessment of spring water quality for drinking supply in Piedmont of Béni-Mellal Atlas (Morocco). Physics and Chemistry of the Earth 104, 39–46.

[6]. Birma, G. J., Ukpebor E. E, and Issa,B. R. (2018) Assessment Of Environmental Noise Pollution In Warri And Effurun Metropolitan Cities. *Current World Environment*. 13(3). Available from: http://www.cwejournal.org?p=1093/

[7]. Esharegoma, O.S., Awujo, N.C., Jonathan, I. and Nkonye-asua, I.P., (2018). Microbiological and physicochemical analysis of orogodo river, agbor, delta state, Nigeria. *International Journal of Ecological Science and Environmental Engineering* 5 (2), pp34–42.

[8]. Ezenwaji, E. E. and Ezenweani, I. D. (2019). Spatial analysis of groundwater quality in Warri Urban, Nigeria. *J. Sustainable Water Resources Management.*. Available at https://www.springerprofessional.de/en/spatial-analysis-of-groundwater-quality-in-warri-urban-nigeria/15912688

[9]. Frank B. O., Vivian, E. B., Christian, A. and Robert, C. A. (2018). Physicochemical Properties and Microbial Quality of Water Used in Selected Poultry Farms in the Ashanti Region of Ghana. *The Open Microbiology Journal.* Vol. 13 pp121-127 DOI: 10.2174/1874285801913010121

[10]. Frank, E. T. F., Clarence, S. Y. and Bissong, M. E. A. (2018). Physico-Chemical Properties and Microbiological Quality of Borehole Water in Four Crowded Areas of Benin City, Nigeria, During Rainfalls. Shiraz E-Med J. Available at: doi: 10.5812/semj.68911.

[11]. Haider, A., Khan, M. Z., Begum, F., Nani, R. and Gurung, S. (2020). Physicochemical properties of irrigation water in western Himalayas, Pakistan. water supply. 20.8 pp3368-3379. Available at: http://iwaponline.com/ws/article-pdf/20/8/3368/814012/ws020083368.pdf

[12]. Hassan, A., Boubacar, I., Salack, S., Rabani, A., Safietou, S. and Stefan, L. (2020). Physico-chemical and bacteriological quality of groundwater in a rural area of Western Niger: a case study of Bonkoukou. *Journal of water and Health* 18.1. Available at: http://iwaponline.com/jwh/article- pdf/18/1/77/720568/jwh0180077.pdf. https://doi.org/10.1007/s10661-020-08302-5.

[13]. Jayalakshmi, V., Lakshmi, N. and SigaraCharya MA. (2011). Assessment of physicochemical parameters of water and waste waters in and around Vijayawada. *Int. J. Res. Pharm. Biomed. Sci.*, 2(3): 1040-1046.

[14]. Malek, A., Kaholu, M. and Bouguerra, H. (2019). Groundwater's physicochemical and bacteriological assessment: case study of well water in the region of Sedrata, North-East of Algeria. Journal of Water and Land Development 41, 91–100.

[15]. Mulamattathil, S. G., Bezuidenhout, C. and Mbewe, M. (2015). Analysis of physico-chemical and bacteriological quality of drinking water in Mafikeng, South Africa. Journal of Water and Health 13, 1143–1152.

[16]. Ocheli, A., Aigbadon, G. O. and Ogbe, O. B. (2018). Comparative analysis of zinc (Zn) and Lead (Pb) concentrations in sediment samples from the traditional hand-dug wells in Umukwata and its environs, Delta State Nigeria. Nigerian Journal of Applied Science, 36, 100–107.

[17]. Ocheli, A., Otuya, O. B and Umayah, S. T. (2020).Appraising the risk level of physicochemical and bacteriological twin contaminants of water resources in part of the western Niger Delta region. *Environ Monit Assess* 192: 324.

[18]. Ogbe, O. B., Opatola, O. A., Idjerhe, W., and Ocheli, A. (2013). Reservoir quality evaluation of sand bodies of K-field, onshore Niger Delta, using wireline logs. International Journal for Science and Emerging Technologies with Latest Trends, 13(1), 46–64.

[19]. Okoye, C. O. B and Okpara, C. G. (2010) Physico-chemical studies and bacteriological assay of groundwater resources in Isuikwuato local government area of Abia State, Nigeria. *Journal of Chemical Society of Nigeria*, Vol.32(1), pp182-189.

[20]. Olanrewaju, A. A. and Oyewole, J. A. (2017). Physico-chemical characteristics of water sample from Aiba Stream in Iwo, Nigeria and its distillate from a Double Slope Solar water distillation unit. Int. J. Biol. Chem. Sci. 11(5): 2421-2429,

[21]. Osayande, A. O., Emofurieta, W. O., Obayabona, O. N. and Anegbe, B. (2015). Physicochemical and bacteriological quality assessment of hand-dug well waters in Igarra tour Edo State. Nigerian Journal of Applied Science, 33, 1–13.

[22]. Patil. P.N, Sawant. D.V.and Deshmukh. R.N. (2012). Physico-chemical parameters for testing of water: A review. *International Journal of Environmental Sciences.* 3(3). Pp 1207. Available at: https://www.researchgate.net/publication/344323634

[23]. Raphael, O., John, O. O., Sandra, U. I. and Sunday, A. C. (2018). Assessment of borehole water quality consumed in Otukpo and its environs. International Journal of Ecological Science and Environmental Engineering 5 (3), 71–78.

[24]. Taiwo, A. A., Abayomi, T. O., Umar, B., Abubakar, N. M., Iduwo, A. A., Precious, Z. A., Niima, D. A. and Ibrahim, B. B. (2020). Assessment of bacteriological quality and physico-chemical parameters of domestic water sources in Samaru community, Zaria, Northwest Nigeria. Heliyon Available on: https://doi.org/10.1016/j.heliyon.2020.e04773

[25]. World Health Organisation (2003). Water supply, Sanitation and Hygiene Development and Health. Available at: http://www.who,int/water_sanitation/health.

[26]. World Health Organization (2012). *Guidelines for drinking-water quality*. Geneva, Switzerland.

[27]. World Health Organization (2019). Progress on drinking water, sanitation and hygiene: Special focus on inequalities. Geneva:[accessed 25 March 2021], Available at https://www.who.int/water_sanitation_health/publications/jmp-report-2019/en/.

[28]. World Health Organization (2021). Ending the neglect to attain the Sustainable Development Goals: a global strategy on water, sanitation and hygiene to combat neglected tropical diseases.[accessed 25 March 2021], Available at https://apps.who.int/iris/bitstream/handle/10665/340240/9789240022782-eng.pdf.

G. J. BIRMA, et. al. "Quality Assessment of Potable Water Supply System in Petroleum Training Institute Community, Effurun, Nigeria." *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 14(4), (2020): pp 33-39.