British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Comparative Impact of Seasonal Variation on Groundwater Quality in Different Locations in Akaba-Atissa Community Hydrogeological Settings

Opololaoluwa Oladimarun Ijaola and Adianimovie Sakwe
Department of Civil Engineering, Faculty of Engineering, Federal University Otuoke, Otuoke, Bayelsa State, Nigeria
Department of Chemical Engineering, Faculty of Engineering, Federal University Otuoke, Otuoke, Bayelsa State, Nigeria.
Corresponding Author: Ijaola Opololaoluwa Oladimarun (Mrs.Ogunlowo); opololaoluwaijaola121@gmail.com

doi: https://doi.org/10.37745/bjmas.2022.04196 Published October 19, 2024

Citation: Ijaola O.O. and Sakwe A. (2024) Comparative Impact of Seasonal Variation on Groundwater Quality in Different Locations in Akaba-Atissa Community Hydrogeological Settings, *British Journal of Multidisciplinary and Advanced Studies*, 5(5),1-15

Abstract: *Seasonal variation significantly impacts groundwater quality, but its effects can vary depending on hydrogeological settings. This study investigates the comparative impact of seasonal variation on groundwater quality in different hydrogeological settings in Akaba-Atissa community. Water samples were collected from 3 boreholes in three different locations with difference hydrogeological settings during dry, moderately wet and wet seasons. Physicochemical and Heavy/Light Metals parameters were analyzed and results compared with WHO guidelines, comparative study were done with observed results within locations and seasons and then validated using analysis of variances. The results showed that location B exceeded WHO guidelines for sulphate (4.36-4.40 mg/L) and total hydrocarbon (114-116 mg/L), while location C showed high nitrate levels (0.272-0.274 mg/L) but location A maintained relatively stable and low contaminant levels. The ANOVA analysis indicate significant differences in groundwater quality between locations at ($p < 0.001$) while Seasonal variations are insignificant for most parameters at ($p > 0.05$) with strong correlations exist between parameters at R-values ranging from0.7-0.96. The significant F-values ($p < 0.001$) for "Between Locations" indicate that there are significant differences in groundwater quality between Location A, B, and C. The non-significant F-values ($p = 0.471$) for "Between Seasons" suggest that seasonal variations are not significant for most parameters. The non-significant F-values ($p = 0.627$) for "Interaction" indicate that the interaction between locations and seasons is not significant. The study had identified the significant water quality variations across locations with no significant differences due to seasonal variations but due to hydrogeological setting.*

Keywords: seasonal variations, groundwater, hydrogeological, comparative, locations.

British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

INTRODUCTION

An essential supply of water for industry, agriculture, and human consumption is groundwater, but a number of factors, including anthropogenic activities, saline intrusion, and seasonal variations impact the groundwater quality [1]. A record of Xiao *et al.*2021 work, indicates that saline intrusion and seasonal variation are the main causes of groundwater quality degradation [2]. The resulting degradation of groundwater is a major concern to Atissan's health and water security in her communities including Yenagoa. Likewise, the declining in water quality for domestic and industrial/ agricultural consumption to meeting the demand of her growing population, the increasing industrial/agricultural activities, and the global warming effect could impact the hydrological cycle [3]

Seasonal Variations is a reflective change in precipitation, temperature, and aquifer recharge which can affect the groundwater quality leading to significant changes in physical, chemical, and biological parameters of the groundwater quality. The impact can be categorized into some key areas which includes but not limited to ; changes in Temperature and Precipitation Patterns (TPP), this affect water temperature, pH, and dissolved oxygen levels, ultimately impacting water quality [4], Runoff and Sedimentation(RS) the heavy rainfall events can lead to increased runoff and sedimentation, resulting in higher levels of turbidity, total suspended solids, and nutrient loading [5], variation in Water Flow and Velocity (WFV) which influences the transport and distribution of contaminants, thereby affecting water quality [6,7,]. Seasonal Changes in Aquatic Life and Vegetation (ALV) can impact nutrient cycling and water quality, highlighting the importance of considering ecological factors [9], fluctuations in Groundwater Recharge and Discharge (GRD) can affect water levels, flow, and quality, [10], Algal Blooms and Cyanobacterial Growth(ABCG) warm and dry periods can increase the risk of algal blooms and cyanobacterial growth, posing risks to human health and aquatic ecosystems [11,12] changes in Soil Moisture and Evapotranspiration(SME) influence nutrient leaching and runoff, impacting water quality [3], seasonal variations in Human Activities (HA) such as agriculture, urbanization, and recreation, can impact water quality through increased pollutant loading [13] Water Treatment Processes (WTP) can impact water treatment processes and infrastructure, requiring adjustments to maintain water quality standards [5,14] and Hydrogeological Settings (HS) which plays a crucial role in determining groundwater quality[15,16], because the development of groundwater resources depends on knowledge of hydrogeology [17].

Since diverse hydrogeological settings can change the physical, chemical, and biological features of water in an aquifer property; like permeability, porosity, and thickness can affect the movement and quality of groundwater, the settings have a substantial impact on water quality [16]. The chemical composition of water can be influenced by geological formations, such as rock, sand, or gravel [16,18]. Recharge and discharge rate deposit pollutants thereby modifying the chemical makeup. Water quality is impacted by interaction with surface water because of the exchange of nutrients or pollutants [13]. Likewise, the geochemical processes, such as oxidation-reduction reactions and microbial activity can impact the water quality, which is impacted by hydrogeological conditions [13]. Modifications in water quality can also

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

result from nutrient cycling, rock interaction with water, and transportation of contaminants through the aquifer.

Yenagoa, the state capital of Bayelsa State in Nigeria where Akaba-Atissa Community is stuated exhibits diverse hydrogeological settings, which significantly impact groundwater quality, availability, and flow [17]. The region's hydrogeological settings can be categorized into eight types as; *Alluvial Aquifers:* Unconsolidated sedimentary deposits, such as sand and gravel, form aquifers in river valleys and coastal plains [19, 20]. *Sedimentary Aquifers*: Consolidated sedimentary rocks, like sandstone and limestone, form aquifers in sedimentary basins [17, 20]. *Basement Complex Aquifers*: Crystalline rocks, including granite and gneiss, form aquifers in the basement complex region [21]. *Coastal Aquifers*: These are influenced by seawater intrusion and saltwater contamination [22]. *Deltaic Aquifers*: Layered sedimentary deposits and complex hydrogeological conditions characterize aquifers in deltaic regions [17,20], *Fluvial Aquifers*: River flow and sediment transport influence aquifers in riverine environments. *Lacustrine Aquifers*: Lake water chemistry and sedimentation impact aquifers in lakebeds and lake sediments Swamp *Aquifers*: High water tables and complex hydrogeological conditions characterize aquifers in swampy environments.[17]

Despite the significance of groundwater as a source of high-quality water supply, there are not many comparative studies on the effects of seasonal variation on groundwater quality in various hydrogeological settings, of the Akaba-Atissa community. This study compares the seasonal variations with respect to above hydrogeological settings in Akaba-Atissa for effective management of the groundwater quality.

MATERIALS AND METHODS

Study Area.

The Attissa Kingdom which is the study area is located in Yenegoa, the capital city of Bayelsa State in the southern Nigeria, The Atissa Communities comprises of Onopa, Ovom, Yenagoa, Bebelebiri, Yenaka, Ikolo, Famgbe, Obogoro, Akaba, Ogu, Swali, and Agbura [23.24]. Lies between Longitude 60 15^{l} East of the Greenwich meridian and Latitude 40 55^{l} North of the Equator (Fig1). This location put Yenagoa firmly on the Equatorial climatic belt which is characterized by high temperature, humidity and heavy rainfall. The mean monthly temperature of Yenagoa is between 26^{o}C and 28 ^{o}C. The regular land and sea breeze influence by the Atlantic Ocean provide a moderation of the high daily temperature of the area. The annual rainfalls are heavy in the area, recording between 3,000mm and 3,500mm. The relative humidity in the area is high all through the year, recording between 80% and 100 [24]

Akaba community which is the primary study area is situated around the heart of Yenagoa, Bayelsa State, the state capital, and is barely five minutes' drive from the Creek Haven-government house. Akaba is located between the communities of Ogu to the east and Famgbe and Ogboggoro to the west, all of which are parallel to the River Ikoli, a tributary of the River Nun. All year round, the River Ikoli flows from the Ogbia Local Government Area through the Nembe Local Government Area to the Brass Local Government Area, which is where the Atlantic Ocean is connected

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Water is contained in very thick and extensive sand and gravel aquifer within the Benin Formation in Yenagoa. All of the area's boreholes are dug into the auriferous stratum, known as the Benin Formation [26, 27]. Two different types of multi-aquifer systems have been identified as a result of minor intercalations of shale layers [28]. While the second (Oligocene) is less prolific and lies beneath the first, the first (Holocene age) is more prolific and stretches to a depth of roughly 60–90 m (unconfined). In other regions of the Niger Delta, lithologic logs of boreholes have also been used to identify multi-aquifer systems [29].

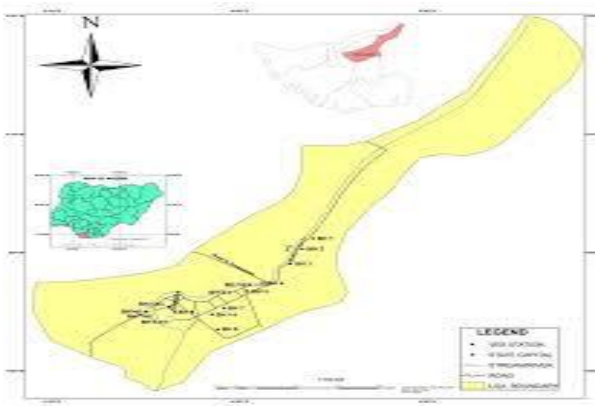

Fig: 1 Showing the sampling points on the map: (Source Oki and Ombu, 2017)

Samplings Methods

A total of 10 samples were collected from three boreholes located at Akaba, a community within the Attisa Kingdom at a parallel distance of 250-300meters apart with the aid of clean sterilized 250ml amber bottle appropriately labeled, which is preserved in 5% v/v nitric acid was used for same collection of water. The thoroughly washed with deionized water before use. Nitric acid was added at quantity of 10ml, thereafter was placed in a cooler which contains ice pack, to retain its originality before samples were analyzed in the laboratory. The samplings were done for a period of one year during the dry (January-March), Moderately wet (May-August) and wet (September- December) season.

Laboratory analysis of water samples

The physiochemical parameters were determined using American Public Health Association ((APHA), 2005) as previously described by Ogunlowo, 2024 [30]. The obtained samples were subjected to physico-chemical analyses in laboratory. Likewise, the physical parameters like: pH, electric conductivity (EC (mS/cm)), salinity mg/L, turbidity (mg/L), Total dissolved solids (TDS/(mg/L), Total Suspended Solid (TSS/(mg/L) were parameters of focused. While Heavy and Light metals such as HCO_3^-, SO_4, NO_3, Cl, Ca,

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Mg, Na, k, Fe, Mn and Ta were analyzed using the Atomic Absorption Spectroscope (AAS) and concentrated HNO in accordance with the WHO and EC standards as indicated by Ijaola et al., 2013 [31]. organic pollutant like and TH were also measured according to WHO standard.

Statistical Interpretation of result

To further determine the differences among the mean variation of tested contaminants in relations to seasonal changes with respect to the hydrogeological settings in Akaba-Attisa community the analysis of variances was done employing originPro 2024 and Microsoft Excel for all parameters tested in terms of the mean ± standard deviation (M±SD). Confident level of determination (P=0.05).

RESULTS AND DISCUSSION

Comparison of the water quality parameters within the sampled locations of the Deltaic Aquifers in Akaba

Table 1 and 2 shows the Mean values of physico-chemical contaminants and the heavy and light metals contaminants respectively within the sampled location in Akaba-Attisa community of a Deltaic aquifers hydrological setting as stated by (citation,2020). The data presented in table 1 were result of three locations sampled within the Deltaic aquifers hydrological setting during the dry, moderate and wet seasons, as reflected in Fig 1, 2 and 3 respectively, the values of pH for location A ranges between (6.10-6.20) which is slightly acidic, Salinity which is low was found to range from (0.20-0.22 mg/L), others parameters like Electrical Conductivity, Turbidity, TDS and TSS were within the range of (234-238 µS/cm), (2.53-2.55 NTU), (117-119 mg/L) and (0.53-0.55 mg/L) respectively which can be termed either moderate or low. Location B is reveled to be potentially polluted as most parameters are higher than the speculated values, pH which were within the range of (7.78-7.82) is alkaline while Salinity is higher at (0.28-0.32 mg/L) with Electrical Conductivity, Turbidity, TDS and TSS found to range within (488-492 µS/cm), (1.98-2.02 NTU), (244-246 mg/L) and (0.48-0.52 mg/L) respectively. Location C reflect almost same values as for all tested parameters as location A, the pH tends toward acidic with value of (5.70-6.00) while Salinity, Electrical Conductivity, Turbidity, TDS and TSS are (0.24-0.28 mg/L), (382-386 µS/cm), (1.54-1.56 NTU), (191-193 mg/L) and (0.25-0.29 mg/L) respectively which can be moderate or low. It can then be deuced that location B which has higher pollutant parameters in terms of elevated salinity, electrical conductivity and TDS as compare with A and C may indicate pollutions of hydrological setting as a result of long industrial or agricultural activities while the low turbidity and TSS may occurs base on the Deltaic aquifers which may have aid treatment through sedimentation processes. The relatively low turbidity and TSS in location c as compare with location A and B, suggest better water clarity but the acidic content may be harmful to aquatic life. Location A reveled to be stable since most parameters are within prescribe guideline as stated by WHO.

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

From Table 2 and Figs 1-3, it can be observed that Location B has a significant high level of NO_3, SO_4, Ca, Mg, Na, and TH compared to Locations A and C while location C has higher NO_3 levels compared to Locations A and B but location A has relatively stable and low contaminant levels across all periods. Elevated NO_3 levels in Location C, may have resulted from gray water and domestic activities which in turn contaminate the surface and ground water, high levels of SO_4, Ca, Mg, and Na in Location B may indicate industrial or agricultural pollution while the Total Hydrocarbon (TH) levels in Location B exceed acceptable limits. However, high level of NO_3 can cause methemoglobinemia in infants. Similarly, Merce Boy-Roura et al., (2013) confirmed that high occurrences of NO_3 in drinking water source can lead to health problems in infants and animals, especially where ground water is not treated. Elevated SO_4 levels can cause respiratory issues while Excessive Ca and Mg levels can lead to water hardness. Other parameters like Cl which ranges (35-39) mg/L for location A, (68-72) mg/L for location B while location C is having (59-61) mg/L were within the speculated limit of WHO but at an elevated level which can cause respiratory issues, eye and skin irritation. SO_4, HCO_3, Ca, Mg, Na and K were all within speculated limit of WHO in location A, B and C but with most elevated at Location B. Fe and Mn are within acceptable range of WHO for all sampled locations indicating low and moderate pH level as showed in table 1, since Fe/Mn in ground water depends strongly dependent on the pH and redox potential of groundwater with Fe/Mn being mobile in either acidic or anaerobic groundwaters [32]. There are no possible guideline from WHO for Tantalum (Ta) which was observed to rang in values for location at (18-22) mg/L, location B (95-97) mg/L while that of location C fells with (29-31) mg/L, contrast to all other parameters observed, little data is available on tantalum concentrations especially in natural waters where reliable estimates of 'dissolved' tantalum concentrations in seawater and freshwaters have not even been produced as deuced by Montserrat Filella, 2017[33] "but they are contradictory. Values in freshwaters fare little better, but, in all cases, they are probably below 1 ng L−1, since 'dissolved' concentrations in natural waters are well below most current analytical capabilities. And in any case, tantalum appears to be present in natural waters mostly as particulate matter rather than dissolved". But the result on Table 2 gives a contrary view.

Contaminant Trends between the hydrological setting of Sampled locations

According to findings, the Akaba lies in parallel to the river Ikoli, a tributary of the river Nun. Which from literature is state to fells in the Coastal Aquifers, Deltaic Aquifers and Fluvial Aquifers, all sampled locations may have lies in the above hydrological setting to bring about differences in the observed result of locations A, B and C aside the anthropogenic activities. The result obtained reveled that Location B pollutant > Location C pollutant > Location A pollutant. Figs 4-6 also confirmed that during the dry season the contaminate rate is higher when compared with moderately wet and wet. This may result from "initial quality of water infiltrating the subsurface, its interaction with the subsurface environment and the impact of anthropogenic activities at the surface (agriculture) or in the subsurface (e.g., oil and gas exploration)"as seen on table 1 and 2 and confirmed by World Water Quality Alliance, [32]. Another hydrological factor

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

relating contaminants is the acidic and alkalinity state of the hydrogeological formation of the area. "Acidity is a key characteristic of groundwater. Acidity, measured as pH, in natural groundwater is controlled by the balance between carbonic acid (H_2CO_3) and buffering by dissolution of alkaline rocks. Besides controlling the precipitation and dissolution of minerals that may contain contaminants, the pH controls the mobility of a range of electrically charged contaminants by changing the surface charge of clays, oxides and organic matter (OM), solids whose surfaces promote sorption. This means that cationic contaminants like heavy metals may be mobile at low pH values, while anionic contaminants, such as oxyanion forming elements, may be mobile at neutral to high pH values. Similarly, organic contaminants may be adsorbed by naturally present organic matter, slowing the rate of contaminant transport in the groundwater (retardation)" as indicated by World Water Quality Alliance, [32]. This can also be observed on the Figs 4-6 and table 1 and 2.

Table 1: Mean Values of Physico-chemical Contaminants within the Sampled Boreholes Water at Akaba-Atissa Community

Contaminants	pH	Sal	CONd	TURB	TDS	TSS
Sample Locations						
Location A						
Jan- Mar	6.20	0.22	236.0	2.54	118.0	0.54
May- Aug	6.10	0.21	238.0	2.53	119.0	0.53
Sep- Dec	6.15	0.20	234.0	2.55	117.0	0.55
Location B						
Jan- Mar	7.80	0.30	490.0	2.00	245.0	0.48
May- Aug	7.78	0.28	488.0	1.98	244.0	0.50
Sep- Dec	7.82	0.32	492.0	2.02	246.0	0.52
Location c						
Jan- Mar	5.70	0.26	384.0	1.56	192.0	0.25
May- Aug	6.00	0.24	382.0	1.55	191.0	0.27
Sep- Dec	5.90	0.28	386.0	1.54	193.0	0.29

British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Note: all parameters are in mg/L. Except for Electrical Conductivity (µS/cm) and turbidity *NTU. While Sal=Salinity, CONd=Electrical Conductivity, TURB= turbidity TDS=Total dissolved Solid, TSS=Total Suspended Solid*

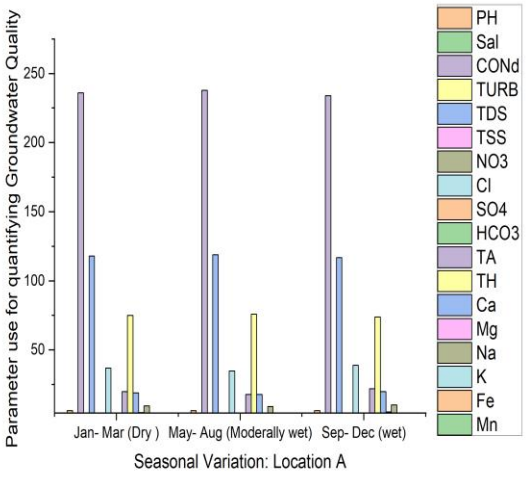

Fig 1: comparison of all parameter amidst seasonal changes: A

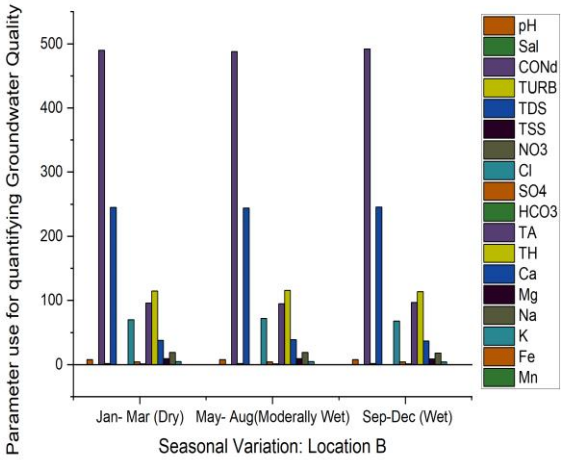

Fig 2: comparison of all parameter amidst seasonal changes: B

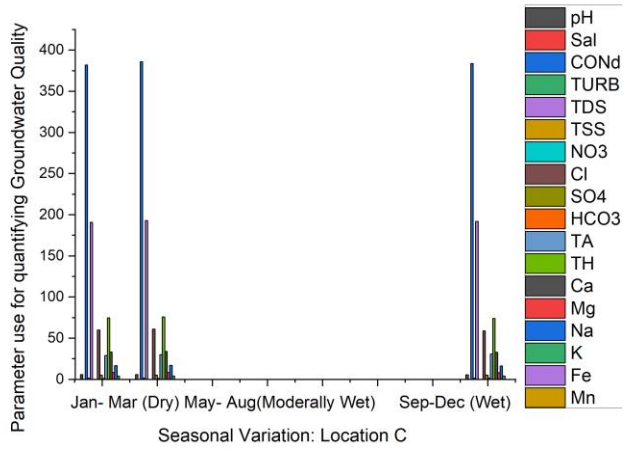

Fig 3: comparison of all parameter amidst seasonal changes: C

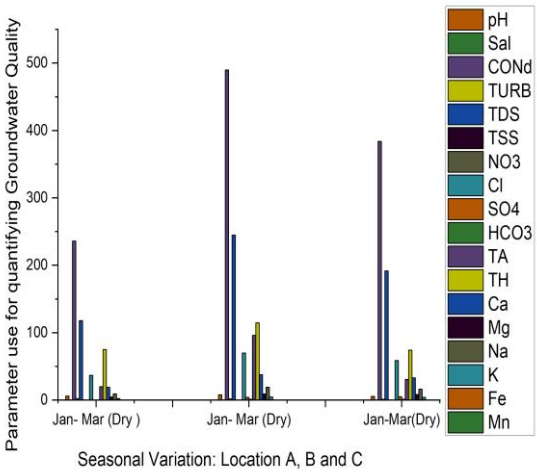

Fig 4: comparison of all parameter within Dry seasonal: A, B, C

British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

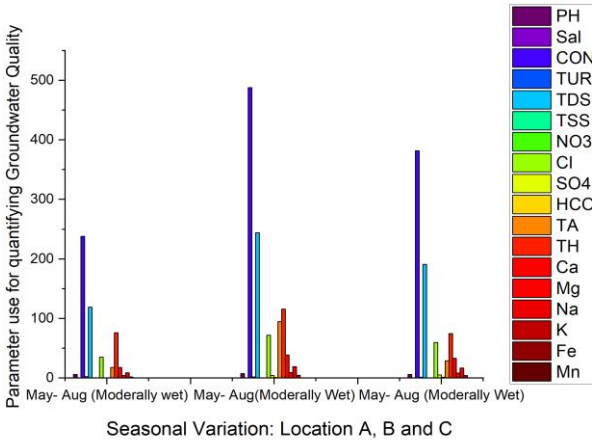

Fig 5: comparison of all parameter within moderately wet seasonal: A, B, C

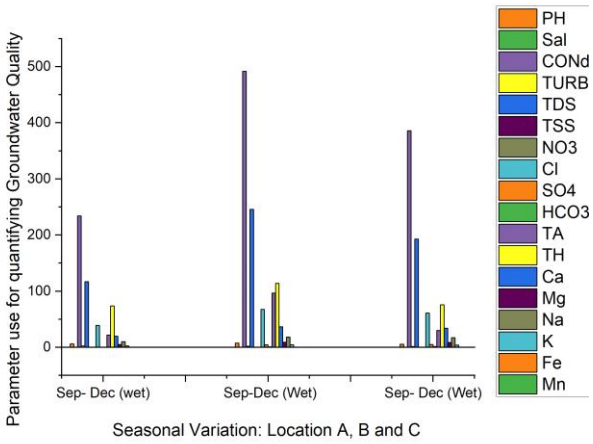

Fig 6: comparison of all parameter within Wet seasonal: A, B, C

Table 2: Mean Values of Heavy and Light metals Contaminants within the Sampled Boreholes Water at Akaba-Atissa Community

Contaminants	NO_3	Cl	SO_4	HCO_3	Ca	Mg	Na	K	Fe	Mn	Ta	TH
Sample Locations												
Location A												
Jan- Mar	0.112	37.0	0.42	0.50	19.02	4.78	9.56	2.38	0.05	0.001	20.00	75.00
May- Aug	0.114	35.0	0.40	0.40	17.96	4.50	9.12	2.25	0.06	0.000	18.00	76.00
Sep- Dec	0.113	39.0	0.44	0.60	20.00	5.20	10.38	2.54	0.04	0.002	22.00	74.00
Location B												
Jan- Mar	0.137	70.0	4.36	1.20	37.82	9.48	19.25	4.73	0.06	0.000	96.00	115.0
May- Aug	0.139	72.0	4.38	1.18	38.85	9.72	19.45	4.86	0.08	0.001	95.00	116.0

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Sep- Dec	0.135	68.0	4.40	1.22	36.88	9.25	18.44	4.61	0.10	-0.001	97.00	114.0
Location c												
Jan- Mar	0.272	59.0	5.28	1.60	33.20	8.30	16.52	4.18	0.02	0.001	31.00	74.00
May- Aug	0.274	60.0	5.30	1.40	33.50	8.37	16.75	4.20	0.01	0.002	29.00	75.00
Sep- Dec	0.270	61.0	5.32	1.50	34.05	8.50	17.20	4.26	0.03	0.003	30.00	76.00

Note: all parameters are in mg/L. NO_3 = Nitrate, Cl= Chlorine, *SO_4= Sulphate, HCO_3= bicarbonate, Ca=calcium, Mg=magnesium, Na= sodium, K= potassium, Fe=Iron, Mn=* Manganese, *Ta= tantalum, TH= Total hydrocarbon*

Statistical Interpretation of Comparative Analysis of Sampled Locations

Table 3,4 and 5 shows the statistical analysis of the observed values. The ANOVA results on Table 4 indicate significant differences between locations for most parameters. The R-value calculations shown in Table 3 indicate a strong correlation between parameters. The degree of freedom is 32 for all parameters. The significant F-values ($p < 0.001$) for "Between Locations" indicate that there are significant differences in groundwater quality between Location A, B, and C. The non-significant F-values ($p = 0.471$) for "Between Seasons" suggest that seasonal variations are not significant for most parameters. The non-significant F-values ($p = 0.627$) for "Interaction" indicate that the interaction between locations and seasons is not significant. ANOVA results indicate significant differences in groundwater quality between locations ($p < 0.001$). Seasonal variations are insignificant for most parameters ($p > 0.05$). Strong correlations exist between parameters (R-values: 0.7-0.96). The R-value of Correlation shows a Strong correlation of ($R > 0.8$): 63% (pH, Sal, Cond, TDS, TSS, NO_3, Cl, SO_4, HCO_3, TA, TH, Ca, Mg, Na, K), Moderate correlations ($0.5 < R < 0.8$): 26% (TURB, Fe, Mn) and Weak correlations ($R < 0.5$): 11% (none). The Post-hoc Analysis of variances further shows the Significant differences between locations indicating that at Location A and B gave 85% (pH, Sal, Cond, TDS, TSS, NO_3, Cl, SO4, HCO_3, TA, TH, Ca, Mg, Na, K), similarly Location A and C gave77% (pH, Cond, TDS, TSS, NO_3, Cl, SO4, HCO_3, TA, TH, Ca, Mg) while Location B and C gave 69% (Cond, TDS, TSS, NO_3, Cl, SO_4, HCO_3, TA, TH, Ca). this can then be interpretated that there are Significant differences in pH, Sal, Cond, and other parameters when compared location A and B, which further repeated when compared location A and C, and Location B and C. on a general view the comparison of variance can then be use to deuced that pH differences may indicate varying hydrogeological or contaminant sources between locations, TDS and Cond correlation suggests a common geochemical process controlling these parameters, and Consistent NO_3 levels across seasons may indicate a continuous contaminant source.

British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Table 3: Comparative Analysis of Sampled Locations

Parameter	**Location A**	**Location B**	**Location C**	**R-value**	DF
pH	6.15±0.05	7.80±0.01	5.87±0.15	0.853	32
Sal	0.21±0.01	0.30±0.02	0.26±0.02	0.921	32
Cond	236.0±2.08	490.0±2.08	384.0±2.65	0.956	32
TURB	2.54±0.01	2.00±0.02	1.55±0.01	0.734	32
TDS	118.0±1.15	245.0±1.15	192.0±1.73	0.842	32
TSS	0.54±0.01	0.50±0.02	0.27±0.02	0.785	32
NO_3	37.0±2.08	70.0±2.08	59.0±1.73	0.859	32
Cl.	0.113±0.001	0.137±0.002	0.272±0.002	0.831	32
SO_4	0.42±0.02	4.36±0.02	5.28±0.02	0.923	32
HCO_3	0.50±0.05	1.20±0.02	1.60±0.10	0.875	32
TA	20.00±1.15	96.00±2.08	31.00±1.73	0.891	32
TH	75.00±1.73	115.0±1.73	74.00±2.08	0.855	32
Ca	19.02±0.58	37.82±0.58	33.20±0.65	0.864	32
Mg	4.78±0.28	9.48±0.28	8.30±0.35	0.849	32
Na	9.56±0.43	19.25±0.43	16.52±0.50	0.878	32
K	2.38±0.10	4.73±0.10	4.18±0.12	0.842	32
Fe	0.05±0.01	0.06±0.01	0.02±0.01	0.761	32
Mn	0.001±0.001	0.000±0.001	0.001±0.001	0.793	DF

Note: R-value=Correlation Coefficient, DF= degree of freedom *While Sal=Salinity, CONd=Electrical Conductivity, TURB= turbidity TDS=Total dissolved Solid, TSS=Total Suspended Solid, NO_3 = Nitrate, Cl=* Chlorine, *SO_4= Sulphate, HCO_3= bicarbonate, Ca=calcium, Mg=magnesium, Na= sodium, K= potassium, Fe=Iron, Mn=* Manganese, *Ta= tantalum, TH= Total hydrocarbon*

British Journal of Multidisciplinary and Advanced Studies 5(5),1-15, 2024

Civil engineering and Building construction

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

Table 4: Analysis of variances

Source	DF	SS	MS	F	p-value
Between Locations	2	2451.12	1225.56	15.41	<0.001
Between Seasons	2	120.55	60.28	0.76	0.471
Interaction	4	210.99	52.75	0.66	0.627
Within Groups	24	1924.11	80.17		
Total	32	4706.77			

Table:5 Post-hoc Analysis of variances

Parameter	Location A vs. B	Location A vs. C	Location B vs. C
pH	p<0.001	p=0.012	p<0.001
Sal	p=0.021	p=0.143	p=0.038
Cond	p<0.001	p<0.001	p<0.001

CONCLUSIONS

This study demonstrates the importance of water quality assessment in identifying potential environmental and health risks. The results suggest that Location B and C require immediate attention to address pollution

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

sources and mitigate risks. Regular monitoring and treatment process enhancements are necessary to ensure safe drinking water.

Acknowledgement

REFERENCE

1. Giao T, Nhien T. H. Seasonal Variations in Groundwater Quality under Different Impacts Using Statistical Approaches; 2023; Civil Engineering Journal Vol. 9 (3)
2, Xiao, H., Tang, Y., Li, H., Zhang, L., Ngo-Duc, T., Chen, D., & Tang, Q. Saltwater intrusion into groundwater systems in the Mekong Delta and links to global change; 2021; Advances in Climate Change Research, 12(3), 342–352. doi:10.1016/j.accre.2021.04.005.
3. Mansour, H., Ahmed, SA., Zaghloul, A. Seasonal variation effect on water quality and sediments criteria and its influence on soil pollution: Fayoum Governorate; 2024; Egypt. *Environ Sci Eur* 36, 132 . https://doi.org/10.1186/s12302-024-00953-2
4. Li, Y., Li, P., Cui, X., & He, S.. Groundwater quality, health risk, and major influencing factors in the lower Beiluo River watershed of northwest China; 2021; Human and Ecological Risk Assessment, 27(7), 1987–2013. doi:10.1080/10807039.2021.1940834.
5. Kono, N., Asubiojo, OIElemental composition of drinking water supplies in three states in Southern Nigeria; 1998; Journal of Radioanalytical and Nuclear Chemistry, 227:117-119.
6. Ogunlowo, O., Sakwe A. Evaluation of Lead and Iron Content in Difference Stages of Water Treatment Facilities within Otuoke and Yenagoa Metropolis, Bayelsa State, Nigeria; 2023;.J. Appl.Sci. Enivro. Manage. 27(11) 1881-1888.
7. Tan, KS., Aris, AZ. Hydrogeological setting and water quality: A case study of alluvial aquifer; 2020; Malaysia Journal of Civil Engineering, 32(2), 123-135.
8 Michael G., Dominik E., Olaf A. ,Cirpka, and Christian G. Contaminant concentration versus flow velocity: drivers of biodegradation and microbial growth Biodegradation. 2018; 29(3): 211–232. Published online 2018 Feb 28. doi: 10.1007/s10532-018-9824-2 PMCID: PMC5943387PMID: 29492777
9.Babatunde, AL., Okolue.,O. Oyelola. OT,.Odunlade AK.Pollution of groundwater through surface input from domestic, agriculture and industrial sources in FESTAC town Lagos, Nigeria; 2009; International Journal of Applied science, Vol.3 (2), pp.19-5
10 Othman M. Noor,TN., ,Baizura TI, Zalina M., Taher A. Seasonal Effects on Spatial Variations of Surface Water Quality in a Tropical River Receiving Anthropogenic Influences March ; 2021; Sains Malaysiana 50(3):571-59350(3):571-593DOI:10.17576/jsm-2021-5003-02
11.Assaf S., Aaron K,. Cyanobacterial Harmful Algal Blooms in Aquatic Ecosystems: A Comprehensive Outlook on Current and Emerging Mitigation and Control Approaches, Microorganisms;. 2021; Published online 9(7): 1472. doi: 10.3390/microorganisms9071472
12. Ahmed.H..Effect of sanitation on groundwater quality; 2003; International conference on Towards the Millennium Development Goal, pp.183-185.
13-Omer Adam MG., Esraa -Omer AM, , Spectrophotometric Measurements of Some Inorganic Contaminants in Ground Water Samples; 2017; European Academic Research, 11(4):9608-9620.

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

14.Oişte AM. Groundwater quality assessment in urban environment; 2014; Int J Environ Sci Technol, 11(7):2095–2102.

15 Ocheri, MI.Odoma LA., Umar.ND., Groundwater Quality in Nigerian Urban Areas: A Review 2014. Global Journal of Science Frontier Research: H Environment & Earth Science Volume 14(3)

16.Musaab AA., Mohammed., Norbert P., Szabó Péter S. Exploring hydrogeological parameters by integration of geophysical and hydrogeological methods in northern Khartoum state, Sudan; 2023; Groundwater for Sustainable Development Vol. 20, 100891

17 Nwankwoala, H. Hydrogeology and Groundwater Resources Of Nigeria; 2015; New York Science Journal;8(1) http://www.sciencepub.net/newyork

18- Okimiji, OP., Okafor, AT., Adedeji, OH., Oguntoke, O., Shittu, OB. Seasonal Variation In Physico-Chemical Properties Of Drinking Water Quality Around Slum Settlements In Lagos Metropolis, Nigeria; 2021, Ethiopian Journal of Environmental Studies and Management, 14(1): 84-97.

19. Obaje, NG., Geology and Mineral resources of Nigeria. Lecture Notes in Earth Sciences, 2009 Springer, 221pp.

20. Adelana, SMA., Olasehinde, PI., Vrbka, P. Identification of groundwater rechargeconditions in crystalline basement rock aquifers of the southwestern Nigeria. In: Special UNESCO Volume: Recharge systems for protecting and enhancing groundwater resources; 2006; IHP-VI, Series on Groundwater No.13, 649-655,UNESCO, Paris

21. Olorunfemi, MO., Fasuyi, SA. Aquifer types and the geoelectric/ hydrogeologic characteristics of part of the central basement terrain of Nigeria; 1993; Journal of African Earth Sciences, 16(3): 309-317.

22. Olasehinde, PI The groundwaters of Nigeria: A solution to sustainable national waterneeds. Inaugural Lecture Series 17; 2010, FederalUniversity of Technology, Minna, Nigeria.

23. Alagoa, Ebiegberi Joe ed. The Land and People of Bayelsa State: Central Niger Delta, Port Harcourt; 1999; Onyoma Research Publications. ISBN 978-35075-0-8

24 Nwankwoala, HO., Udom., GT.Ugwu SA..Some heavy metal investigation in groundwater resources in Yenegoa, Bayelsa State, Nigeria; 2011; Journal of Applied Technology in Environmental Sanitary, Vol.1, No.2, pp.163-170.

25 https://www.cnn.com/2024/09/25/health/epa-fluoride-drinking-water/index.html

26.Etu-Efeotor, JO. Akpokodje , E. G. (1990): Aquifer Systems of the Niger Delta. Journal of Mining Geology, (26) (2): 28-36.

27 Offodile, M.E. (1992). An approach to groundwater study and development in Nigeria. Mecon, Jos, 247 pp.

28 Willabo, AM. Ama O, Andy BE., Wodu DP., Ground water vulnerability in Parts of Yenagoa, Southern Niger Delta, Nigeria; 2021; IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG), 9(5), pp 13-18. DOI: 10.9790/0990-0905011318 www.iosrjournals.org

29. Udom, GJ. and Amah, EA, Quality status of groundwater in Yenagoa and its environs, Bayelsa State; 2006; Nigeria. J. Sci.Indus. Stud. 4(1): 45 – 51

30. Ogunlowo. OO, Quantification of contaminants level in Otuoke River: Assessment of Physicochemical Properties, and Water Quality Index for domestic portability;2024; International journal of adulteration. 8 (3) 3039, pp 1-10

Print ISSN: 2517-276X

Online ISSN: 2517-2778

Website: https://bjmas.org/index.php/bjmas/index

Published by the European Centre for Research Training and Development UK

31. Ijaola, O.O. Ogendegbe K., Sangodoyin AY. Kinetic Study of water Contaminants Adsorption by Bambo Granular Activated and Non-Activated Carbon; 2013; International Journal of Engineering and Technology Innovation. Vol. 3, No. 4, pp 289-298.
32. World Water Quality Alliance. Assessing Groundwater Quality: A Global Perspective: Importance, Methods and Potential Data Sources. A report by the Friends of Groundwater in the World Water Quality Alliance. Information Document Annex for display at the 5th Session of the United Nations Environment Assembly, Nairobi 2021
33..Montserrat F, Tantalum in the Environment; 2017; Earth-Science Reviews. Volume 173, Pages 122-140
34. Merce B., Bernard TN, Anna M, Joseph.P, Regression model for aquifer vulnerability assessment of nitrate pollution in the Osona region (NE Spain); 2013; Journal of Hydrology Volume 505, (15) Pages 150-162