Evaluation **of Hydrochemical Parameters of Okposi and Uburu Salt Lakes, Nigeria**

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Abstract- Some hydrochemical parameters of Okposi and Uburu lakes were analysed in the research. The results showed that the concentration of Cl-, Na+, total dissolved solids (TDS) and electrical conductivity (EC) were well above WHO Standard and the extreme cases of these constitutes are associated with the salt lakes. The result of the cations and anions showed that Na+ ranges from 16 to 27669, K+ (2 to 366), Mg2+ (13 to 111) and Ca2+ (3 to 774) while HCO32- (18 to 251), SO42- (0.27 to 90), Cl- (18 to 41654) and PO43- (0.07 to 7.0). The domination of Na+ and Cl- among the cations and anions respectively is a clear indication of the prevalent water type. The level of zinc is within WHO acceptable limit with values ranging from 0.005mg/l to 0.08mg/l, while values for lead obtained in the study area range between 0.001mg/l to 0.07mg/l. Other parameters such as Cu and Cd were also observed but within WHO standard. The concentration of Cu ranged from 0.008mg/l to 0.05mg/l and Cd from 0.001 to 0.008. Continual consumption of water from these sources may pose severe health implications in the near future.

Keywords: Hydrochemical parameters, trace metals, health implications, salt lakes, principal component, Okposi, Uburu

1 INTRODUCTION

The study evaluates the physicochemical characterization of the salt Lakes of the study area with a view of establishing their impact on water sources. The study areas include Okposi and Uburu towns in Ohaozara Local Government of Ebonyi State, Nigeria. It lies within latitude $7^{0}42'50''E$ to $7^{0}52'50''E$ and longitude $6^{0}00'$ to $6^{0}10'N$ fig 1. The area also form part of the Imo-Cross-River province but suffer severe water scarcity. This problem is exacerbated by the presence of several salt Lakes. The salt lakes support small scale traditional salt processing industries.

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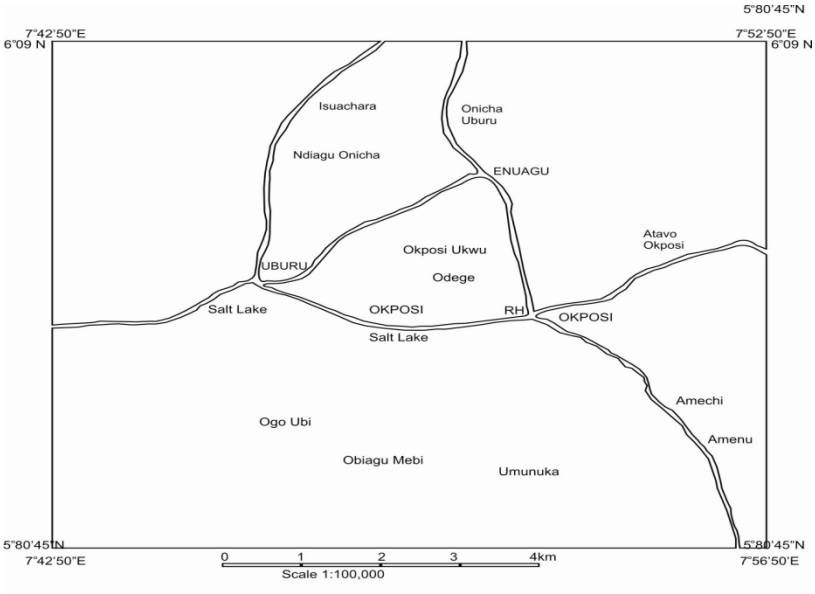

Fig. 1 Map of the study area showing sample locations

The area is made up of sedimentary rocks belonging to the Asu River Group of the Albian age. The lithology consists of an alternating succession of well-indurated argillaceous Sandstones, Siltstones and Shales [3]. The lithology in the vicinity of the Salt Lakes varies with location. While the Uburu Salt Lake consists of sandstone beds with intercalation of fine-grained bands of silts and shales, the lithology of Okposi salt Lake is a mud filled depression surrounded by sandstone exposures. The outlets of the waters of Okposi Salt Lake was observed to be along the fissured zone of a fault striking N470W and dipping southeast at the base of the lake. The topography of Okposi-Uburu is comparatively flat with irregular ridges and gentle sloping hills as controlled by the bedrock geology. The high concentration of heavy metals in the water resources of the area is attributed to the mineralized Pb-Zn veins significant in the geology of the study area [4], [3],[13]. Environmental media play major role in the distribution of the heavy metals [8]. The genetic classification of the saline water of the area with reference to element distribution was carried out by [7], [14]. The use of water of poor quality is associated with significant health implications and therefore, require adequate treatment before use [10], [2], [6], [9]. The presence of trace elements such as Lead and Zinc in the water sources that support the production of consumable salt may pose health threat if not properly managed. Salt harvesting by the rural women occurs during the dry season when the water levels in the host depressions have gone down increasing the salt concentration of the lakes. The presence of salt lakes and saline groundwater exacerbate the availability of potable water

supply for domestic, agricultural and industrial purposes. The research tends to evaluate the hydrochemical parameters of the water supply sources in the study area and their major sources.

2 MATERIALS AND METHODS

Water samples were collected from different water sources in the study area. Samples were collected in plastic bottles and taken to the laboratory in an ice packed cooler to minimize the effect of environmental conditions that may arise between the field and the laboratory. Consort PH/Conductivity meter 532 C was used to determine the values of EC and pH in the field. The major cations, anions and heavy metals were analysed in the Laboratory using Buck Scientific Atomic Absorption/Emission Spectrophotometer (AAS). Cl- and HCO32- were determined by titrimetry method. A Garmin GPS was used in obtaining the co-ordinates and elevation for the accurate location of the sampling points on a base map.

3 RESULT AND DISCUSSION

The result of the physico-chemical parameters of the salt Lakes and other water supply sources are presented in table 1 with concentrations in mg/l except EC that was presented in µs/cm.

Table 1 summary statistic of the analytical data of the water samples

Variable	Observations	Minimum	Maximum	Mean	Std. deviation
Ph	13	6.700	8.250	7.358	0.532
EC	13	120.000	47300.000	11940.462	18460.922
TDS	13	70.000	25140.000	3847.615	8622.423
HCO3	13	18.000	251.000	122.592	67.874
SO4	13	0.270	90.000	8.741	24.571
Cl	13	18.340	41654.000	8229.668	13708.025
Po4	13	0.000	6.910	1.175	1.808
Na	13	15.880	27669.000	3523.910	7940.189
K	13	2.070	366.430	85.375	134.886
Mg	13	1.300	110.660	28.035	31.640
Ca	13	3.130	774.070	149.312	227.014
Zn	13	0.011	0.045	0.027	0.011
Pb	13	0.002	0.211	0.042	0.211
Cu	13	0.003	0.050	0.017	0.018
Cd	13	0.002	0.007	0.003	0.002

The value of electrical conductivity ranges from 120 to 47300Uµs/cm. The high value of EC will result in saline soils if the water is used for irrigation purpose [15]. The high values of electrical conductivity are recorded from the salt Lakes of Okposi and Uburu. The pH values varied between 6.7 and 8.25. Although the water sources are slightly acidic they are

still within WHO standard. The result of the cations and anions showed that Na+ ranges from 15 to 27669mg/l, K+ (2 to 366), Mg2+ (13 to 111) and Ca2+ (3 to 774) while HCO32- (18 to 251), SO42- (0.27 to 90), Cl- (18 to 41654) and PO43- (0.07 to 7.0). The trend of the concentration of the anions was in the order of Cl->HCO43- > SO42- > PO43- while that of the cations was in the following order Na+ > Ca2+ > K+ > Mg2+. The value of the analysed heavy metals especially Pb and Zn ranged from 0.002mg/l to 0.211mg/l and 0.011mg/l to 0.045mg/l with a mean concentration of 0.042mg/l and 0.027mg/l respectively. Zn and Pb are well dispersed in the water supply sources of the area.

While zinc occurred within WHO acceptable limit, lead occurred in a concentration that is above toxic levels in some locations. Cu and Cd were also detected in the samples analysed but occurred within acceptable limit. Although the trace metals occurred below WHO recommended levels in some locations, their presence in water supply sources may pose health problem with time.

4 Correlation of Physico-chemical parameters of the water samples

Correlation analysis is usually used in hydrochemical analysis to establish the relationship between variables [1]. The correlation matrix of the physicochemical parameters is presented in table 2. Strong correlation was observed between EC and TDS with Cl, and Mg indicating input from the same source. EC correlated positively with Na and K. Cl correlated positively with K and Mg. A significant correlation pairs was also observed between Cl-K, Cl-Mg, and Mg–K.

Table 2 correlation matrix of the physicochemical parameters.

Variables	Ph	EC	TDS	HCO3	SO4	Cl	Po4	Na	K	Mg
Ph	1	0.537	0.728	-0.088	-0.156	0.463	0.492	0.062	0.417	0.534
EC		1	0.720	0.214	-0.228	0.947	0.539	0.613	0.941	0.924
TDS			1	0.134	-0.150	0.649	0.633	0.032	0.551	0.701
HCO3				1	-0.273	0.006	-0.402	0.287	0.043	-0.031
SO4					1	-0.215	-0.106	-0.158	-0.212	-0.128
Cl						1	0.724	0.526	0.977	0.981
Po4							1	-0.111	0.641	0.795
Na								1	0.557	0.410
K									1	0.959
Mg										1

The dominant cation and anion in the analysed samples were Na+ and Cl- respectively. The high concentration of these two parameters in objectional manner contributes to high level of NaCl making the water supply source not good for both domestic and industrial purposes. The high concentration of NaCl in the area is however been maximize to generate

income by the rural women through local salt production.

Factor analysis was also applied to futher explain the input sources of the physicochemical constituents. Factor analysis is multivariate statistical methods that shows the general relationship between measured chemical variables by showing multivariate patterns that may be helpful in classify the original data. It enables the geographical distribution of the resulting factors to be determined. The geological interpretation of factors yields insight into the main processes, which may govern the distribution of hydrochemical variables [11]. Factor analysis can identify several pollution factors reasonably but the interpretation of these factors in terms of actual controlling sources and processes is highly subjective [5].

In the present study, the variables used for the factor analysis are pH, EC, TDS, HCO3, SO4, Cl, PO4, Na, K and Mg. Three factors were extracted to statistically represent the contributions influencing chemical composition of the sample sources based on eigen value of > 1 using [16]. The significant factors explaining about 84% of the total variance was presented in table 3 while Fig.2 shows the scree plot of the eigen values.

Table 3. Factor loading of the variance

	F1	F2	F3
Ph	0.269	-0.230	-0.399
EC	0.408	0.175	0.040
TDS	0.330	-0.165	-0.406
HCO3	0.016	0.579	-0.408
SO4	-0.106	-0.266	0.530
Cl	0.414	0.047	0.167
Po4	0.316	-0.429	0.018
Na	0.193	0.533	0.366
K	0.400	0.104	0.214
Mg	0.416	-0.050	0.136
Eigenvalue	5.533	1.761	1.127
Variability (%)	55.333	17.610	11.265
Cumulative %	55.333	72.943	84.209

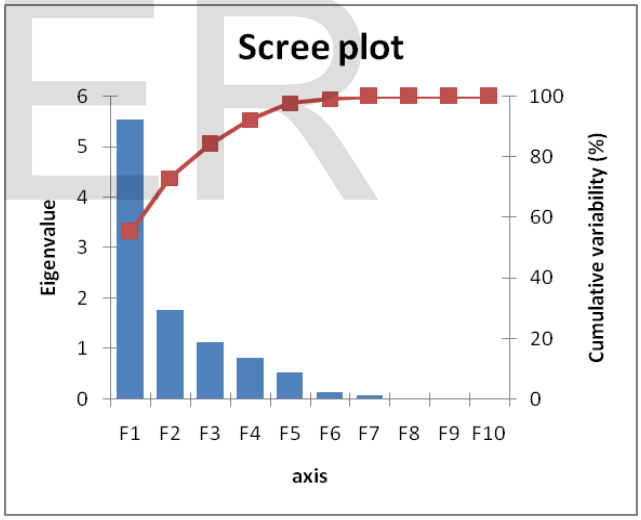

Fig 2 Scree plot of the eigen values

Factor 1 (55.33%) has a high load of EC, TDS, Cl, K, PO4, Na and Mg reflecting the signature of saline water. Factor 2 with a high loading of HCO3 and Na explains 17.61% of the variance. The HCO3 may be from the dissolution of carbonate minerals. Factor 3 explains 11.27% of the variance and is associated with SO4 indicating input from weathered soils and from fertilizers [12].

5 Conclusion

The study has successfully evaluated the physicochemical parameters of the salt lakes of Okposi and Uburu towns of Nigeria. The

interpretation reveals that the pH of the water supply sources of the study area is slightly acidic. The concentration of Cl-, Na+, TDS and EC were well above WHO Standard and the extreme cases of these constitutes are associated with the salt lakes. The trend of the abundance of the cations and anions are Na > Ca > K > Mg and Cl > HCO3 > SO4 > PO4 respectively. The domination of Na+ among the cations and Cl- among the anion reflects a significant NaCl water type. It could be inferred that the geology of the area is underlain by a salt dome few meters in the subsurface along the trend of groundwater flow that recharges most of the surface water.

Although the result of the hydrochemical parameters satisfy WHO standard with the exception of Na and Cl, the concentration of heavy metals such as Pb occurred above acceptable limit in some locations. The high concentration of Pb and the presence of Zn in all the samples are attributed to the mineralized Pb-Zn veins associated with the geology of the area. The prevalent unorganized mining of the Pb and Zn by the rural dwellers exacerbates the input of these heavy metals in the water resources of the area. However, the injection of water of high Pb and Zn concentration for a long period is associated with health implications. It is therefore recommended that a detailed hydrogeophysical study be carried out to determine the depth to potable watertable for the effective evaluation and utilization of groundwater resources as a reliable alternative source of water supply for the people.

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