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# Evaluation of Geophysical and Geochemical Characteristics of Soil and Groundwater Resources in Yenagoa Environs, Niger Delta, Nigeria

**Bunonyo, Y. Tekena[1], Ulori, Oritsebemigho[2] and Marere. Omamode[3]**

[1]Department of Physics, Niger Delta University, Bayelsa State, Nigeria

[2]Department of Physics with Electronics Fed Poly Ekowe Bayelsa State, Nigeria

[3]Department of Sci and Tech School of Marine Technology, Burutu, Delta State, Nigeria

**ABSTRACT**

*The problem of potable water has increased in recent time due to increase in population density, petroleum exploration activities and spillages along the creeks. Thus, three (3) Vertical Electrical Soundings (VES) were made using Schlumberger array in the study location to obtain geophysical data, using the ABEM SAS 1000 terrameter, in order to investigate the occurrence of groundwater in relation to the depth and thickness of viable aquifer. Six (6) surface water samples and six (6) subsoil samples were obtained from the study area. Both subsoil and surface water samples were analyzed to determine the concentration of contaminant. Analysis was performed using the Atomic Absorption Spectroscope (AAS) method which was compared with the World Health Organization Standard. Result and interpretation of analyses revealed high contaminant contents of lead (Pb) with values of subsoil samples at S2 (18 mg/l) and S6 (8.1302 mg/l), while Mn show very high concentration of contaminant values for all subsoil samples which exceeded the WHO permissible standard which indicates that aquifer may likely be polluted by intrusion. Cr for subsoil samples and Mn of surface water samples are likely within or slightly higher concentration value when compared with WHO limit. It is advisable to carry out proper water treatment from source and soil degradation, for potable drinking water and cultivation of agricultural product respectively.*

**Keywords:** Contaminant, Electrical, Concentration, Surface water, Sub soil.

## 1. INTRODUCTION

Water is essential part of human and plant existence on earth. Groundwater resources and soil are increasingly being contaminated due to man's exploitation of energy resources, especially fossil fuels with the consequent slick and spill of oil, in addition to gas flaring which are being released to the environment [1] Soil and groundwater are susceptible to contamination and pollution wherever exploitation of oil/gas is carried out [2]. Niger Delta region is a prolific oil producing area in Southern Nigeria. Researchers have employed several methods to study the impact of the degradation on the environment as a result of oil and gas exploitation activities in the region. Release of hydrocarbons into the environment whether accidentally or due to human activities is a main cause of water and soil pollution [3]. These pollutants usually caused disruptions of natural equilibrium between the living species and their natural environment. The aim of this study was to determine the concentrations level of heavy metals on water bearing; comprises Pb, Cd, Cr, Ni, Mn and Fe, in different water samples collected from the study location.

## 2. MATERIALS AND METHODS

The study area is located in Bayelsa State, Niger Delta. It lies between latitude $4^0$ 55'29"N and longitude $6^0$ 15' 51" E (Fig.1). The community host a manifold and oil pipelines crisscrossing residential areas, owned by one of the oil and gas companies operating in the country. River Niger is the major drainage system from which other discrete river systems originate. The region has a humid equatorial climate. The cloud cover is high, with relative humidity and average rainfall above 80% and 3000 mm [4]. Data sampling procedure involves water samples from the surface water and subsurface soil at different depths from the bottom of the spilled and non-spilled location. In order to determine the heavy metals concentrations; all collected samples were prepared using aqua regia to digest the soil samples. The concentrations of metals were determined by Atomic Absorption Spectrometry (AAS) which is a very reliable technique for detecting metals and metalloids in environmental samples [5]. Terrameter was used for the geo-electrical imaging with 5 m minimum electrode spacing, each covered a lateral distance of 120 m. IP12WIN software was applied to iterate the acquired data. Consequently, resistivity and the depths of the layers were estimated. Analysis measurements were carried out for the ground water collected and soil samples were collected from the survey area within the depth of 1-3 m, which were used for the determination of pollutant concentration.

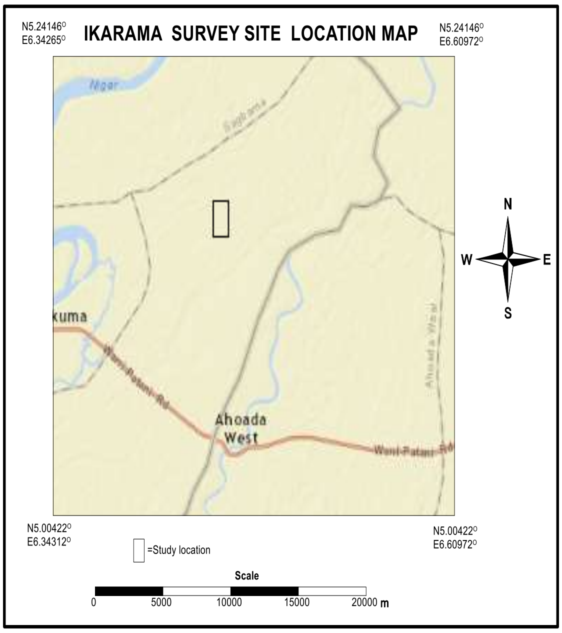


**Figure .1.: Study location map**

## 3. RESULTS AND DISCUSSION

The obtained results show that heavy metal concentrations were higher in soil samples comparative with water samples. The trace heavy metal concentrations parameters were assessed, as well. Trace heavy metals concentrations were determined by atomic absorption spectrometry (AAS). The relationships of the metal levels in samples collected from different stream and subsoil were assessed. The results of the geophysical analysis from the study area are presented in the figures 2, 3 and 4 below, while the heavy metal concentrations are also shown in table 1 for surface water and table 2 for subsoil samples. The geoelectric sounding results show that subsurface is characterized with soil material with resistivity ranging from 19.5 – 8563 Ωm for VES 1, 12.7 – 4475 Ωm for VES 2, and 4.42 – 1060 Ωm for VES 3 reflective of varying degree of conductivity.

**Table.1: Showing concentration level of Water samples**

| Water Samples(mg/l) | Pb(mg/l) | Cd(mg/l) | Cr(mg/l) | Mn(mg/l) | Ni(mg/l) | Fe(mg/l) |
|---|---|---|---|---|---|---|
| W1 | -0.0237 | 0.1174 | -0.1315 | 0.1697 | -0.5255 | -0.3926 |
| W2 | -0.0828 | 0.1164 | -0.1208 | 0.1887 | -0.5749 | 0.8248 |
| W3 | 0.0118 | 0.1156 | -0.1279 | 0.1756 | -0.5281 | -0.7167 |
| W4 | -0.0355 | 0.1169 | -0.1172 | 0.1922 | -0.5229 | -0.4084 |
| W5 | -0.1183 | 0.1169 | -0.1243 | 0.1768 | -0.5048 | -0.6140 |
| W6 | -0.0473 | 0.1182 | -0.1315 | 0.1792 | -0.5801 | -0.353 |
| WHO | 0.01 | 5.0 | 0.05 | 0.1 | 0.02 | 0.3 |



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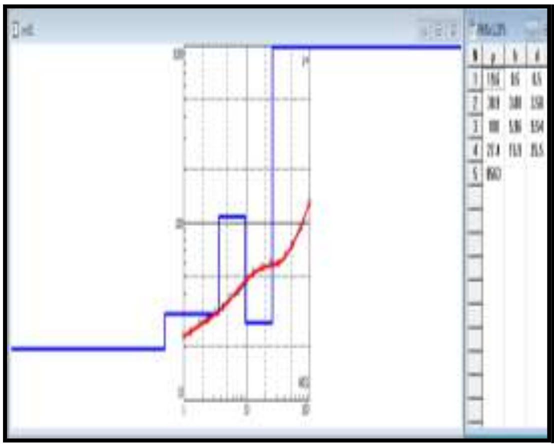
**Table.2: Showing concentration level of Soil Samples**

| Soil Samples(mg/l) | Pb(mg/l) | Cd(mg/l) | Cr(mg/l) | Mn(mg/l) | Ni(mg/l) | Fe(mg/l) |
|---|---|---|---|---|---|---|
| S1 | 0.7337 | 0.0879 | -0.0923 | 3.6688 | -0.2346 | -0.2346 |
| S2 | 18.000 | 0.1162 | 0.2849 | 6.6611 | 0.6121 | 0.6121 |
| S3 | 0.0947 | 0.1187 | 0.2564 | 4.9524 | -0.3671 | -0.3671 |
| S4 | 0.7574 | 0.1179 | 0.2671 | 6.5972 | -0.3463 | -0.3463 |
| S5 | 0.8521 | 0.1179 | 0.9147 | 3.0543 | -0.1801 | -0.1801 |
| S6 | 8.1302 | 0.1129 | 0.2386 | 7.7778 | -0.2918 | -0.2918 |
| WHO | 0.01 | 5.0 | 0.05 | 0.1 | 0.02 | 0.3 |



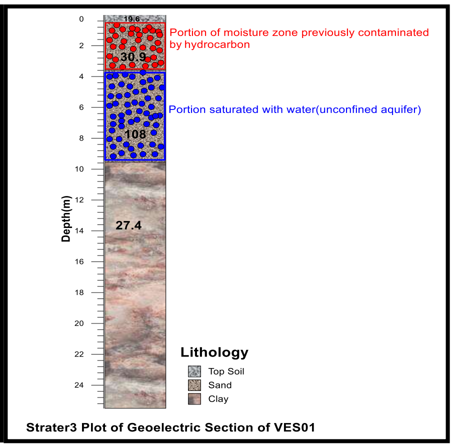
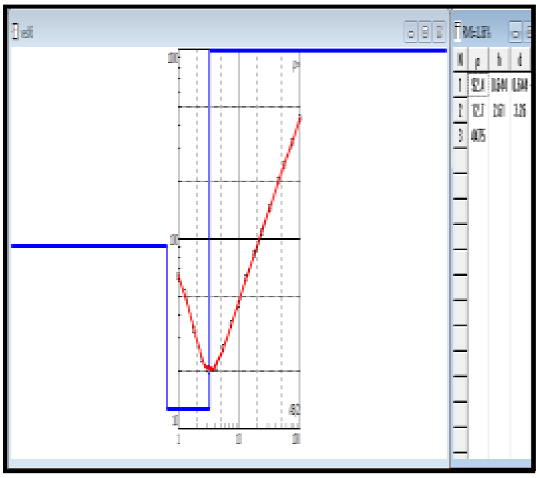



**Fig.2: Sounding curve for VES1**

**Fig.3. Litho log of VES1**



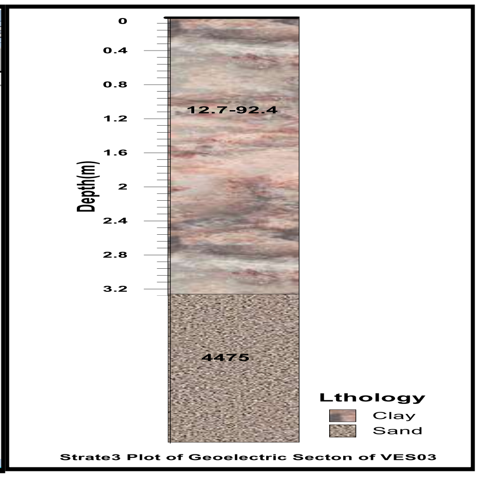



**Fig.4: Sound curve of VES 2**

**Fig.5: Litho log of VES 2**



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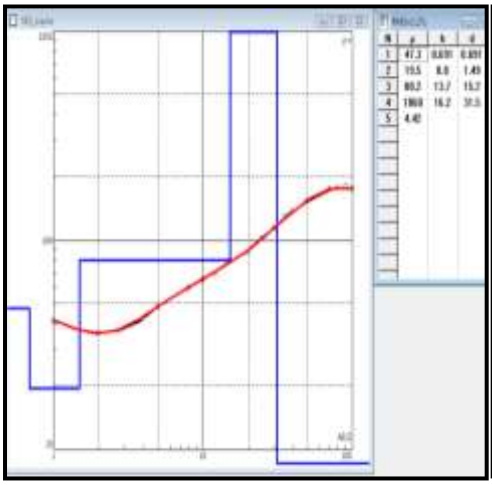

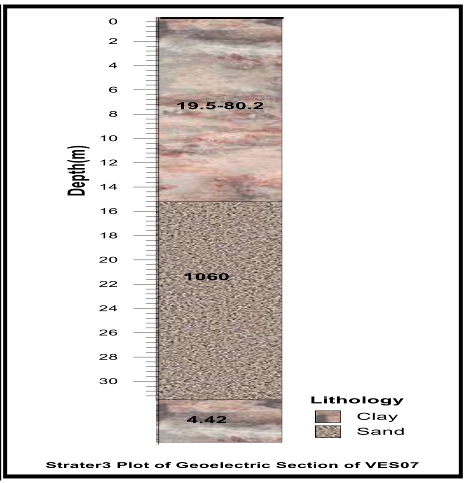


**Fig.6: Sounding curve for VES 3** **Fig.7: Litho log for VES 3**

The third geoelectric layer for VES 1 at resistivity and thickness 108 Ohm-m and 5.96 m respectively, most likely is within the aquifer unit, and could be characterized as conductive-water saturated sands due to released acid from biodegradation activity dissolving ions in the aquifer sediment. For VES 2, the curve bottom at a conductive unit with resistivity of 27.4 Ohm-m, interpreted to represent the clay unit in fig.2. The second layer is inferred to be sand formation, likely unsaturated with water, as shown by high resistivity in fig. 4. This occurs at depth of 3.26 m. For VES 3, the second layer in inferred to be sand formation, likely saturated with water, and is underlain and overlain by clay. This is confined aquifer, occurs at depth of 15.2 m and is16.2 m thick from fig 6. For samples analysis, Pb and Mn on soil samples were quite high in trace metal contaminant concentration which exceeds the WHO permissible standard limit.

## 4. CONCLUTION

The geophysical method is essentially conveniently helpful in providing quality information of subsurface geological. From the interpretation of geoelectric sounding the lithological interpretation revealed prominent groundwater pathways and AAS was used to analyse the sample collected to confirm the concentration of heavy mental contamination on the groundwater. However, the results for the chemical analysis shows that the water in the area is not conducive for domestic use with exceptions as the result findings revealed high concentration of lead, cobalt, chromium and Iron. It is worthy to note that all values for the chemical parameters for Lead (Pb) and Manganse(Mn) shows a high contamination concentration which trend even above the WHO permissible standard [6]. The Cr and Mn in concentration indicate a partial contamination of the surface and groundwater. This contamination is believed to have come mainly from the oil spilled that occurs as a result of vandalism of pipeline and leakage of the pipelines within the manifold. The water of the area still needs some treatment before it can be suitable for use.

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Corresponding email: tbunonyo@gmail.com, +2348030874256



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