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Hydrogeophysical Survey and Vulnerability Assessment of some Communities in Okigwe Local Government Area, South-east Nigeria

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Abstract

Detailed hydrogeophysical and vulnerability studies of the aquifer systems in Okigwe area with focus on communities such as Aku, Agbobu, Ihube and Umulolo was carried out using the vertical electrical sounding (VES) method and the DRASTIC model. A total of twelve (12) vertical electrical sounding (VES) were acquired using the digital Omega Terrameter 0198. The Schlumberger configuration with a maximum current electrode spacing (AB) of 800meters was used to acquire the data. Computer Iteration was carried out using IPI2 win computer software. Layer parameters were obtained and used to estimate Aquifer Hydraulic parameters Lithologs were generated for the VES locations from which cross-sectional profiles were analysed. Results reveal the presence of four geoelectric layers with the resistivity of the first layer ranging from 18.45Ωm-773Ωm and thickness of 0.9m-0.29m representing the top soil. The second Geoelectric layer representing laterite has resistivity range of between 3.17Ωm and 5299Ωm and thickness of 0.78m to 588m. The third layer representing clay/shale has resistivity range between 2.8Ωm to 5475Ωm and thickness of 4.56m to 55.6m. Depth to the water table range from 43.6m to 59.5m. Aquifer thickness of the study area varies from 25.2m to 61.3m with a mean value of 43.7m. Transmissivity value ranges from 1679.4m^2/day to 4755.2m^2/day. Estimates of aquifer vulnerability rating indicates that about 46.5% of the study area has low groundwater vulnerability index to contaminants while 53.55% of the area indicated moderate aquifer vulnerability using the DRASTIC model

1. Introduction

Groundwater is one of the major sources of replenishable water on the earth. Over the years, the demand for groundwater has increased because the availability of surface water resources are inadequate to meet the water needs of the study area. Groundwater is reliable and safe when compared to other water resources. Naturally, groundwater is stored in pore spaces and between unconsolidated formations within soil compartments. In view of the fact that the study area is a residentially developing area, where water will be required for drinking, agricultural and industrial purposes, it became important to embark on this study.

Records available in the Imo State Water Board and the Imo State Water Development Agency (IWADA,2002) show that a number of isolated pre-drilling geophysical investigations have been carried out for citing boreholes in some parts of the area (Nwosu et al; 2014). The Anambra-Imo River Basin Development Authority report of the pre-drilling geophysical study for water borehole project at Ihube-Okigwe, one of the communities under survey show that clay and shale members of Ajali Formation are predominant which makes groundwater exploitation difficult. Nwosu *et al*., (2014) used pumping test analysis and results of vertical electrical sounding (ves) to evaluate the groundwater of Imo North, Southeast Nigeria. Their results show that the Southern part of the region recorded the highest values of groundwater yield of about 8292m^2/ day.

Igboekwe and Akpan., (2012) used the resistivity method to determine the aquifer potentials of Abia State University, Uturu and its environs. The average Hydraulic Conductivity (K) and Transmitting (Tr) for the study area were found to be 8.12m/day and 1154.2m^2/day respectively. Their results show that potential aquifer zones lie between Ugba junction (Uturu) and 200m south eastward along Isiukwuato-ABSU road.

Results of Vertical Electric Sounding and Pumping Test analysis were used by Nwosu *et al.,* (2014) to map out the groundwater flow pattern in Imo North. Southeastern Nigeria. Their results show that groundwater flows from the Northern part of the region towards the Southern part. The transmissivity values ranged from 992.04 to 10263.65m^2/day while the storativity values determined from the area range from 1.59×10^{-4} to 7.80×10^{-3}.

Amos – Uhegbu *et al*., (2012) carried out a research on the hydrogeophysical and hydrogeochemical characterization of the aquifer systems in Umuahia – South area, Southeast, Nigeria. They used the eletrical resistivity method to delineate the aquifer systems and the hydrogeochemical facies of the study area. The electrical resistivity method was used in this research. The developmental growth and increasing population of these communities in the Okigwe area prompted this research work to delineate the hydrogeological potential and the vulnerability assessment of the area.

II. Location and Geology

The study area is Okigwe area with focus on communities such as Aku, Agbobu, Ihube and Umulolo. It is bounded by latitudes 5°40′N to 6°55′N and longitude 7°14′E to 7°16′E. These communities are located in Okigwe Local Government Area in the Northern Zone of Imo State, Southeast, Nigeria. They can be assessed through Enugu-PortHarcout express way, Okigwe-Owerri express roads with other secondary and minor roads.

The study area geologically lies within the Anambara Sedimentary Basin which constitutes a major depocenter of clastic sediments in the Southern portion of the lower Benue Trough (Nwajide and Reijers 1996). The geological formations of Anambra Basin are Nkporo formation, Mamu formation, Ajali formation, Nsukka formation, Imo Shale, Ameki formation and Ogwashi Asaba formation. Soils of the area are identified to originate from the false bedded sandstones of the Ajali formation. The Nsukka formation is underlain by the Ajali formation. The Ajali formation overlies the Mamu formation.

The study area is largely drained by the Imo river. The drainage path is mainly dentritic. Its topography is slightly undulating and punctuated by low hills with evidences of sandstone and siltstone deposits.(Ofoegbu,1985) The climate of the area is tropical with a mean annual temperature range of 27° - 28°C (IWADA,2002).

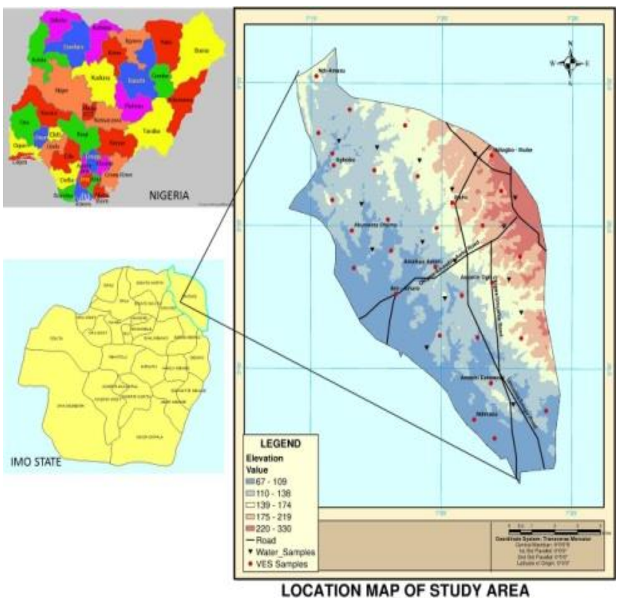

Fig 1: LOCATION MAP OF THE STUDY AREA

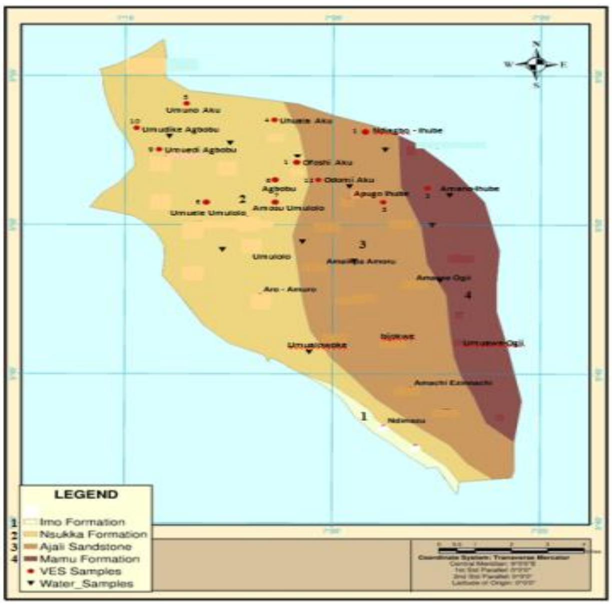

Fig 2: GEOLOGIC MAP OF THE STUDY AREA

III. Material and Method:

Geophysical investigation was carried out in the field using Vertical Electrical Sounding Method. The instrument used is the Omega Terrameter with model number 0198. A total of twelve (12) vertical electrical sounding profiles ware carried out within the survey area using the Schlumberger array with a maximum current electrode separation of 800m. The Terrameter reads directly the resistance of the subsurface which is a measure of the voltage (V) to the imposed current (I). The resistance measured is used to compute the corresponding apparent resistivity by multiplying the geometric factor values.

$$P_a = \pi R \left\{ \frac{\left|\frac{AB}{2}\right|^2 - \left|\frac{MN}{2}\right|^2}{MN} \right\} \quad (1)$$

Where AB is the current electrode separation

MN is the potential electrode separation.

$\pi\left\{\frac{\left|\frac{AB}{2}\right|^2-\left|\frac{MN}{2}\right|^2}{MN}\right\}$ is the geometric factor

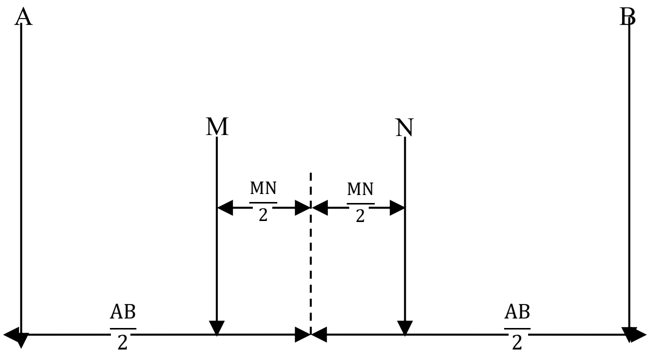

Fig 3: Schlumberger electrode configuration

The resistivity is constant in a homogenous and isotropic ground irrespective of surface location and electrode spread. However, in the presence of subsurface inhomogeneities, the resistivity varies with the relative positions of electrodes. The computed value in this case is called apparent resistivity. With the aid of IPI2 win computer software, computer iterations were carried out. Results of the final interpretation were used to generate lithologic cross sectional profiles.

Aquifer Parameters from Geo-Electric Data

The transmissivity *(T)* and hydraulic conductivity (*K*) of the aquifer, has a direct relationship to the resistivity and thickness of the aquiferous medium. The integration of these parameters give an indication of the groundwater potential of an area (Maillet, 1947). For the assessment and evaluation of the aquifer hydraulic properties of an area, the concept of Dar-Zarrouk parameters: Transverse resistance R and Longitudinal conductance S are applied [9-10].

$$R = h\rho (2)$$

$$S = \frac{h}{\rho} .(3)$$

Where ρ and h are resistivity and thickness of each layer respectively.

The relationship between transmissivity and hydraulic conductivity is:

$$T = kh \quad (4)$$

From equation 3, $h = s\rho = \frac{s}{\sigma}$ (5)

Where σ is layer conductivity

From equation 4, $h = \frac{T}{k}$ (6)

Therefore, equation 5, is equal to equation 6

$$\frac{S}{\sigma} = \frac{T}{k}$$

$$T = \frac{KS}{\sigma} = kh = \frac{KR}{\rho} = K\sigma R \quad (7)$$

In areas of similar geologic setting and water quality, the product Kσ remains fairly constant. (Niwas and Singhal, 1981). Transmissivity values and its variation from one VES point to another can be determined by using parameters 'R' and 'S' in areas where borehole data is unavailable (Igbokwe et al; 2006).

Estimation of Aquifer Vulnerability from DRASTIC model

The most commonly used aquifer sensitivity assessment method is the DRASTIC model. This model is based on the fact that the hydrogeological setting is defined as a composite description of all major geologic and hydrogeologic factors that affect and control groundwater movement in, through and out of an area (Aller et al; 1987). The aquifer parameters used for DRASTIC index assessment are: depth to water table (*D*), net volume of recharge (*R*), Aquifer media (*A*), Soil media (*S*), Topography (*T*), Impact of Vadose zone (*I*) and hydraulic conductivity (*C*). The acronym DRASTIC therefore corresponds to the initials of these seven parameters. Weights and ratings are assigned to each aquifer parameter on a range of 1 to 5 and 1 to 10 respectively. Vulnerability assessment is therefore based on the product of weights and ratings assigned to each parameter

Table 1: Rating and weighting values for DRASTIC Parameters. (Igbokwe *et al*; 2006).

Depth to water (meter)		Net Recharge (Inches)		Aquifer material		Soil type		Topography (%)		Impact of vadose zone		Hydraulic conductivity (mho)	
Range	Rating	Range	Rating	Range	Rating	Range	Rating	Range	Rating	Range	Rating	Range	Rating
>100	1	0 – 2	1	Shale	1	Clay/Organic soil	1	>18	1	Clay	1	Clay 1 - 100	1
75 -100	2	2 – 4	3	Till	3	Loamy Clay	4	16-18	2	Shale	2	Silted Shale 100-200	2
50 – 75	3	4 – 7	6	Silt	3	Clayey Loam	5	14-16	3	Silt	3	Sandstone 300-700	4
30 – 50	5	7 – 10	8	Schist	4	Loam	7	12-14	4	Schist	4	Sand 700-1000	6
15 – 30	7	>10	9	Sand Stone	5	Sandy loam	8	10-12	5	Till	4	Sand and gravel 1000-2000	8
5 – 15	9			Lime Stone	6	Loamy Sand	9	8-10	6	Green rocks	5		
<5	10			Green rock	6	Sand/gravel	10	6-8	7	Sand Stone	5		
				Sand	8			4-6	8	Lime Stone	6		
				Sand and Gravel	9			2-4	9	Sand	8		
				Gravel	10			0-2	10	Sand and gravel	9		
										Gravel	10		

The DRASTIC Vulnerability index is calculated by the formula given below:

DRASTIC index = $D_rD_w + R_rR_w + A_rA_w + S_rS_w + T_rT_w + I_rI_w + C_rC_w$

Where

D_r = Rating for the depth to water table

D_w = Weight assigned to the depth to water table

R_r = Rating for aquifer recharge

R_w = Weight for aquifer recharge

A_r = Rating assigned to aquifer media

A_w = Weight assigned to aquifer media

S_r = Rating for the soil media

S_w = Weight for the soil media

T_r = Rating for topography (slope)

T_w = Weight assigned to topography

I_r = Rating assigned to impact of vadose zone

I_w = Weight assigned to impact of vadose zone

C_r = Rating for rates of hydraulic conductivity

C_w = Weight given to hydraulic conductivity

DRASTIC Vulnerability classification is displayed in Table 2 below.

Table 2: Classification of Vulnerability of DRASTIC modelling(Igbokwe *et al*; 2006).

Vulnerability Class	Low	Moderate	High	Very high
DRASTIC index	<101	100 – 140	141 -200	>200

IV. Results

The IPI2 win computer software was used to analyze the VES data obtained. Subsurface layers were delineated as well as the resistivity values, layer thickness and depths. Sample field curves at sounding stations across the study area are shown in Fig 4. A summary of layer parameters interpreted from the study area is shown in table 3.

An average conductivity (K) value of 62.9m/day for existing boreholes in the area (Maduagwu, 1990) was used to calculate the transmissivity values of the VES locations. Using the concept of Dar-Zarrouk parameters, the hydraulic characteristics of the aquifers within the study were established. A table of aquifer hydraulic parameters are presented in table 4. Three cross sectional profiles were traced across the study area in order to determine the subsurface characteristics of the area under investigation. (Fig 5) These profiles are the A-A′ treading N-S in figure 6.

The B-B′ profile trending NW-SE direction n in figure 7 and C-C′ profile trending SW-NE direction in figure 8. The subsurface VES profiles were analysed using the Geoelectric section from the 10m depth to beyond the 60m depth, based on the field resistivity data acquired. This was to provide in-depth understanding on the stratigraphic layers available and the sequence in which they occurred. It was also to help us determine any anomaly that could aid or abate groundwater pollution within the study area. This is because pollutant migration has a strong link with soil characteristics (permeability and porosity).

V. Discussion

Cross Sectional Profile AA′

Three (3) different VES stations make up this profile. They include VES 4 (Uhuala – Aku), VES 8 (Agbobu), VES 7 (AmosuUmulolo) as shown in figure 6. Six (6) different layers were delineated in the Geoelectric section generated from computer iteration of data obtained in this section. They are Top soil, laterite, sand stone, clay,siltstone and silt. The resistivity of this profile ranges from 8.56Ωm to 12163Ωm such that the highest tresistivity is identified as possible sandstone (Table 3). At VES 4, the lithology shows that aquifer zones lies within the fourth and fifth layer (i.e. sand) with thickness about 61.3m. At VES 7, the aquifer is at the sixth layer (i.e sand) with a depth of about 40m and a thickness of 43.6m. At VES 8, the aquifer lies at the fifth layer (i.e siltstone) with a depth of about 35m and thickness of 25.3m.

Cross sectional profile BB′

The profile runs across three (3) communities. They are VES 5 (Umuno-Aku), VES 11 (Ofoshi- aku) and VES 12 (Odomi Aku) Fig 7

The Geoelectric section of the layers delineated consist of sand, silt, shale, clay, literite and top soil in thee younging direction (Table 3). The resistivity of this profile ranges from 0.5Ωm to 86249Ωm at VES 5.

At VES 5, the depth to the aquifer is about 46m (Table 3) and fig 4. It lies at the fifth layer. Its thickness is about 63.1m.

At VES 11, the aquifer lies at the fifth layer (i.e sand stone) Depth to the aquifer is about 59.5m and the thickness is 36.9m.

At VES 12, the depth to aquifer is about 35m (fig 7). It lies within the sixth layer. It has thickness of about 47.4m

Cross sectional profile CC′

Four (4) different VES stations make this profile. They are VES 6 (UmueleUmulolo), VES 8 (Abgobu) VES 11(Ofoishi – Aku) and VES 1 (NdiagboIhube) Fig 8. A maximum of five (5);lithologic layers have been delineated for this section. They consist of shale, sandstone, siltstone, laterite and top soil in the younging direction. From table 3, the lowest resistivity of this profile is 1.80Ωm at VES 11 and highest resistivity is 8360Ωm at VES 1. At VES 6, the aquifer lies within the fifth layer (i.e sandstone) , The depth to the aquifer is about 59.5m and the thickness is 36.9m. At VES 8, the aquifer lies within the fifth layer, the depth is about 34.8m from the ground surface. Its thickness is 25.2m. At VES 11, the depth to the aquifer is about 60m. It lies within the fifth layer and consist of sandstone. Its thickness is 36.9m. At VES 1 the aquifer lies within the sixth layer (i.e sandstone). It has a depth of about 44.6m from the ground surface. Its thickness is 33.4m.

The thickness aquifer, about 61.3m is located at VES 4, (Uhuala-Aku) at the North of the Study area (fig 5). Depth to the aquifer is about 69.97m. The transmissivity value is 4755.2m^2/day. Thick aquifers are also found in communities such as VES 5 (Umuno-Aku) Northwest and VES 7 (Amosu-Umulolo) South, with corresponding transmissivity values of 2748.7m^2/clay and 2314m^2/day. High values of transmissivity imply high potential for aquifer productivity which reflects the geological setting if thick sandy formation.

Aquifer Vulnerability Assessment and Interpretation using DRASTIC index

Table 5 is the result of DRASTIC vulnerability index generated from the study area.

From table 4, the low vulnerability zones contribute to about 46.55% of the study area with a DRASTIC index range of 65 at VES 8 to 87 at VES 10. The low vulnerability index in these areas could be attributed to deep water. About 53.5% of the study area falls within the moderate vulnerability zones with DRASTIC index values ranging from 103 at VES 12 to 138 at VES 1.

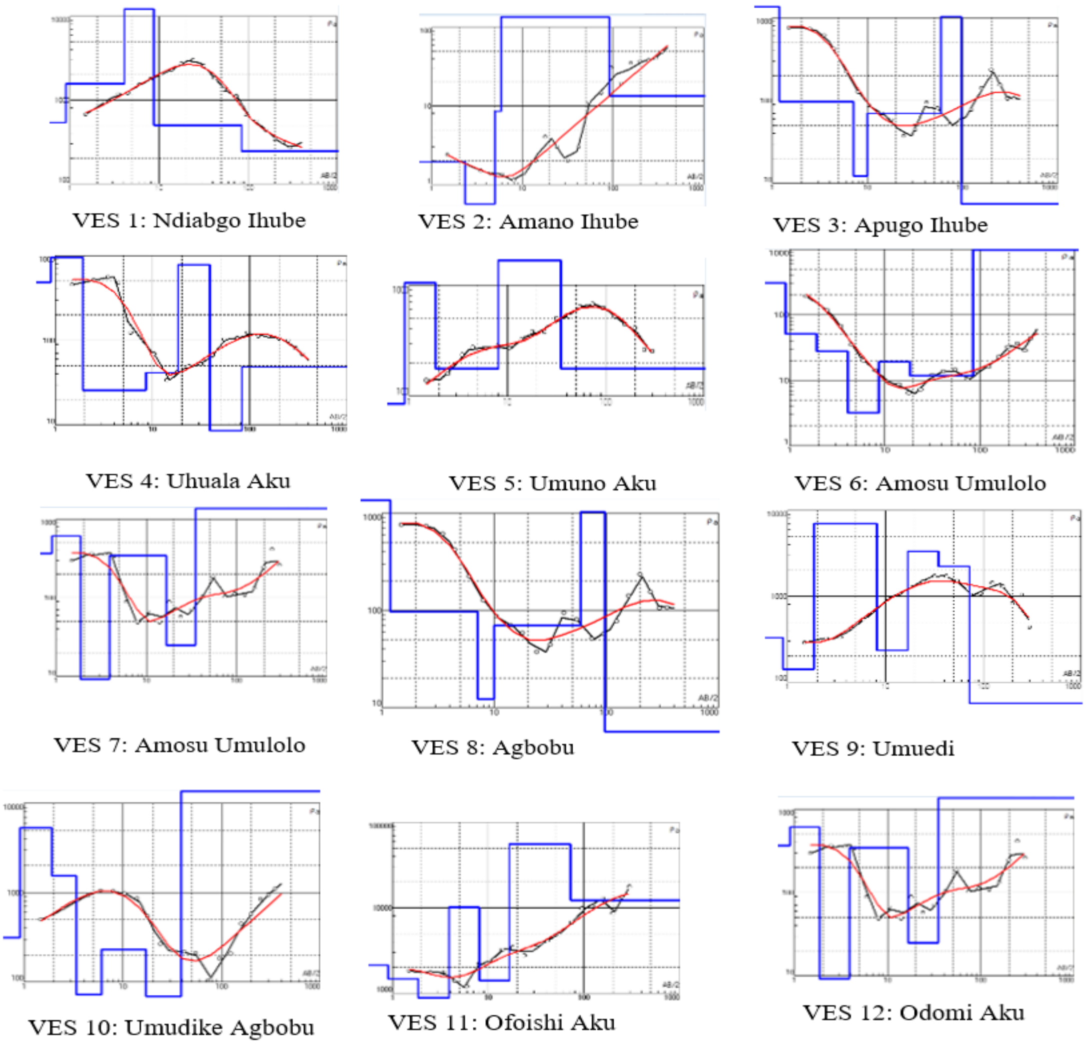

Fig 4: Interpreted VES Curves

Table 3: Results Of Interpreted Layer Parameters

VES	VES STATION NAME	ELEVATION(m)	LATITUDE	LONGITUDE	LAYERS	RESISTIVITY(Ω m)	THICKNESS(M m)	DEPTH(m)	LITHOLOY
1	Ndi-agbo Ihube	254	5°52.502′	7°22.506′	1	773	0.9	0.9	Top soil
					2	106	0.97	1.87	Laterite
					3	8360	2.01	3.88	Laterite
					4	311	4.18	8.06	Laterite
					5	7568	36.5	44.56	Sand
					6	1552	37.4	81.96	Sandstone
					7	2.8	-	-	Sandstone
2	Amano-Ihube	282	5°52′10.604″	7°22′35.251″	1	2148	0.9	0.9	Top soil
					2	1463	0.97	1.87	Laterite
					3	88.4	2.01	3.88	Laterite
					4	10145	4.18	8.76	Clay Laterite
					5	1414	8.68	17.44	Silt Stone
					6	55475	55.6	73.04	Sand Stone
					7	12297	-	-	
3	Apugo-Ihube	231	5°52′45.642″	7°21′54396″	1	366	0.9	0.9	Top soil
					2	608	0.97	1.87	Laterite
					3	9.27	2.01	3.88	Laterite
					4	345	12.9	16.78	Sand: Laterite
					5	249	18.0	34.78	Sand
					6	4439	37.4	72.18	Sand Stone
					7	19521	-	-	
4	Uhuala-Aku	225	5°53′.966″	7°20.422′	1	538	0.9	0.9	Top soil
					2	1561	3.21	4.11	Laterite
					3	12163	4.56	8.67	Sand Stone
					4	498	75.6	84.27	Sand: Shaly
					5	246	-		Sand: Shaly
5	Umuno-Aku	86	5°42.462′	7°17.729′	1	18.4	0.29	0.29	Top soil
					2	19.4	2.03	2.32	Laterite
					3	0.5	2.66	4.98	Shale
					4	8.6	0.05	5.03	Shale
					5	209	6.71	11.74	Shale
					6	958	11.7	23.44	Shale
					7	86249	22.6	46.04	Shale
					8	214	43.7	39.74	Shale
					9	13.4	-	-	
6	Umuele Umulolo	144	5°49′26.574″	7°20′3.435″	1	466	0.41	0.41	Top soil
					2	1777	0.78	1.19	Laterite
					3	96.3	588	7.07	Laterite
					4	12.3	2.93	10.00	Clay: Laterite
					5	70.0	49.5	59.50	Silt stone
					6	1035	36.4	95.90	Sand Stone
					7	1.88	-	-	
7	Amosu Umulolo	116	5°48.479′	007°19.294′	1	484	0.9	0.9	Top soil
					2	954	1.01	1.91	Laterite
					3	25.5	6.72	8.63	Siltstone
					4	41.7	9.67	18.30	Clay e.g Siltstone
					5	785	20.5	38.80	Sandstone
					6	856	43.6	82.40	Sand
					7	48.7	-	-	Shale
8	Agbobu	112	05°51.717	007°15.628"	1	85.5	0.9	0.9	Top soil
					2	1043	0.97	1.87	Laterite
					3	177	6.22	8.09	Laterite
					4	1656	26.7	34.79	Siltstone
					5	178	-		Siltstone
9	Umuedi Agbobu	121	05°49.797"	07°16.052"	1	309	0.9	0.9	Top Soil
					2	50.6	1.01	1.91	Laterite
					3	27.6	2.15	4.06	Laterite
					4	3.17	4.56	8.62	Laterite
					5	19.1	9.67	18.29	Shale
					6	11.8	66.9	85.19	SaltStone
					7	5151	-	-	
10	Umudike Agbobu	108	5°.86750"	007°.25989"	1	315	0.92	0.92	Top soil
					2	5299	0.99	1.91	Laterite
					3	1548	1.49	3.40	Laterite
					4	72.8	2.68	6.08	Laterite
					5	229	11.2	17.28	Clay
					6	68.8	21.8	39.08	Shale
					7	39796	-		
11	Ofoishi Aku	144	5°49"25.574"	7⁰20'3.425'	1	460	0.41	0.41	Top soil
					2	1775	0.78	1.19	Laterite
					3	46.1	5.88	7.07	Laterite
					4	12.3	2.93	10.00	Clay:Laterite
					5	70.0	49.5	54.50	SiltStone
					6	1038	36.4	95.90	Sand Stone
					7	1.80	-	-	
12	Odomi Aku	178	05°50.593"	07°19.182"	1	131	0.9	0.9	Top Soil
					2	141	0.97	1.87	Laterite
					3	702	6.31	8.18	SandStone: Laterite
					4	238	8.68	16.86	Sand Stone
					5	33.52	18.0	34.86	Silt Stone
					6	2220	37.4	72.26	SandStone
					7	4.67	-	-	

Table 4: Results Of Aquifer Hydraulic Parameters

VES	VES STATION NAME	TRANSVERSE RESISTANCE (Ω)	LONGITUDINAL CONDUCTANCE(mΩ)	TRANSMISSIVITY m^2/day	LAYER CONDUCTIVITY (Ωm)	AQUIFER THICKNESS (m)
1	Ndi-agbo Ihube	58044.8	0.0241	2352.5	0.0006	374
2	Amano-Ihube	3084410	0.0010	3497.2	0.0010	55.6
3	Apugo-Ihube	166018.6	0.0084	23525	0.0002	37.4
4	Uhuala-Aku	37648.8	0.1518	4755.2	0.0020	86.3
5	Umuno-Aku	9351.8	0.0204	2748.7	0.0047	63.1
6	Umuele Umulolo	38195.5	0.0360	2321.0	0.0010	36.9
7	Amosu Umulolo	84.3	16.070	2314.7	0.4367	43.6
8	Agbobu	44215.2	0.0161	1679.4	0.0006	25.2
9	Umuedi Agbobu	15313.5	0.0274	1289.5	0.0013	66.9
10	Umudike Agbobu	867552.8	0.0005	1371.2	0.0003	21.8
11	Ofoishi Aku	38195.5	0.0360	2321.0	0.4367	36.9
12	Odomi Aku	83028	0.0168	2352.5	0.0005	37.4

Table 5: Drastic Index Result

		DEPTH TO WATER TABLE			NET RECHARGE			AQUIFER MEDIA			SOIL MEDIA			TOPOGRAPHY			IMPACT OF VADOSE ZONE			HYDRAULIC CONDUCTIVITY			DRASTIC INDEX	VULNERABILITY INDEX
		D			R			A			S			T			I			C				
VES	LOCATION	D_r	D_w	D_rD_w	R_r	R_w	R_rR_w	A_r	A_w	A_rA_w	S_r	S_w	S_rS_w	T_r	T_w	T_rT_w	I_r	I_w	I_rI_w	C_r	C_w	C_rC_w		
1	Ndiagbo-Ihube	5	5	25	6	4	24	5	3	15	8	2	16	6	1	6	8	5	40	4	3	12	138	Moderate
2	Amano-Ihube	2	5	10	3	4	12	5	3	15	1	2	2	6	1	6	3	5	15	4	3	12	72	Low
3	Apugo-Ihube	3	5	15	6	4	24	5	3	15	8	2	16	5	1	5	8	5	40	4	3	12	127	Moderate
4	Uhuala-Aku	3	5	15	3	4	12	8	3	24	8	2	16	5	1	5	3	5	15	6	3	18	105	Moderate
5	Umuno-Aku	2	5	10	3	4	12	5	3	15	1	2	2	5	1	5	2	5	10	4	3	12	66	Low
6	Umuele-Umulolo	2	5	10	3	4	12	5	3	15	7	2	14	5	1	5	3	5	15	4	3	12	83	Low
7	Amosu-Umulolo	5	5	25	3	4	12	8	3	24	7	2	14	5	1	5	5	5	25	6	3	18	123	Moderate
8	Agbobu	3	5	15	3	4	12	3	3	9	1	2	2	6	1	6	3	5	15	2	3	6	65	Low
9	Umuedi-Agbobu	2	5	10	6	4	24	3	3	9	5	2	10	6	1	6	3	5	15	2	3	6	80	Low
10	Umudike-Agbobu	5	5	25	6	4	24	3	3	9	4	2	8	5	1	5	2	5	10	2	3	6	87	Low
11	Ofoshi-Aku	2	5	10	3	4	12	5	3	15	7	2	14	5	1	5	3	5	15	4	3	12	83	Low
12	Odomi-Aku	3	5	15	6	4	24	5	3	15	8	2	16	6	1	6	3	5	15	4	3	12	103	Moderate

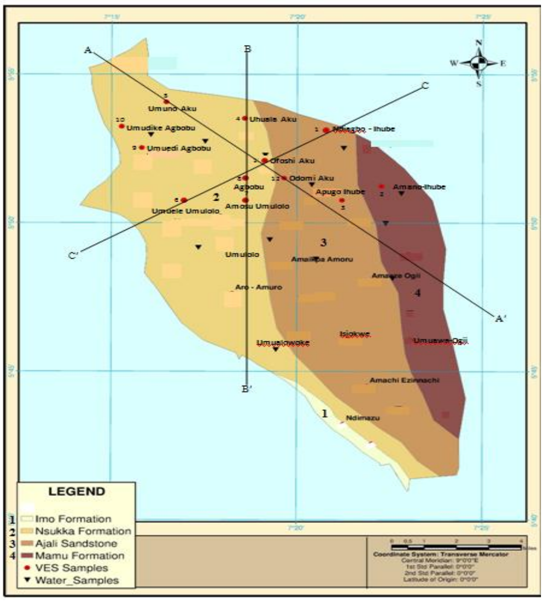

Fig 5: VES Profile Map of Study Area

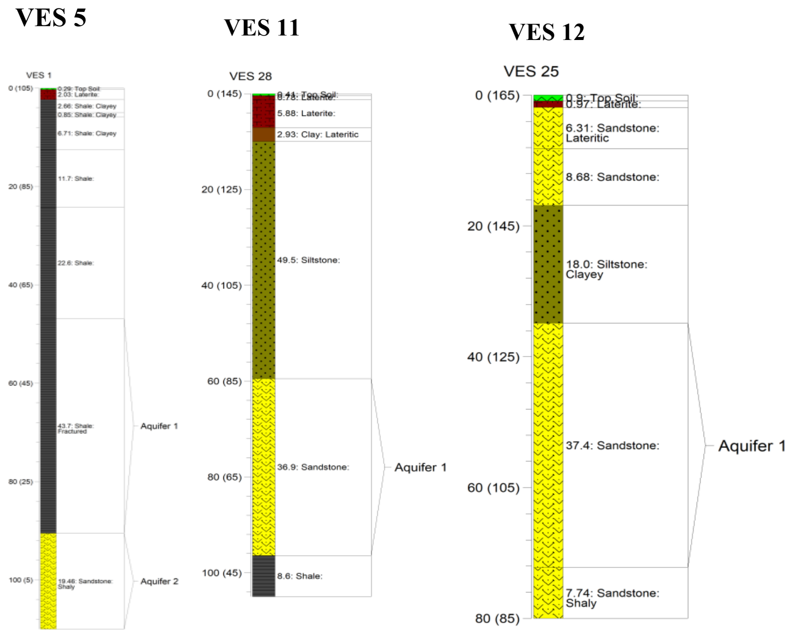

Fig 7: Geoelectric cross section B-B′

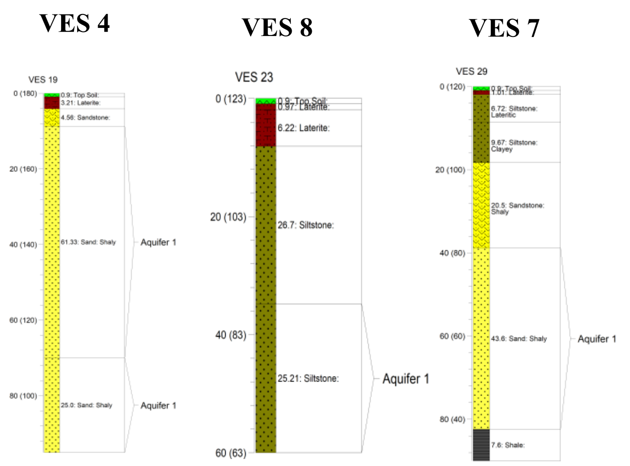

Fig 6: Geoelectric cross section A-A′

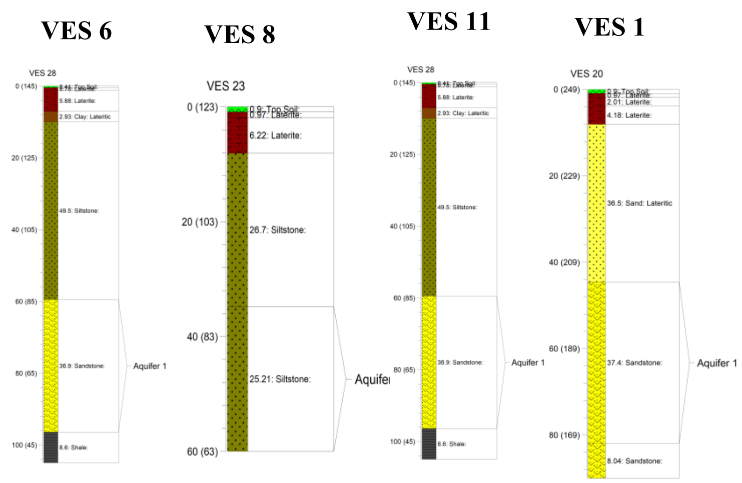

Fig 8: Geoelectric cross section C-C′

VI. Conclusion

The electrical resistivity sounding method was used to evaluate the hydrogeophysical parameters and vulnerability assessment of groundwater in some communities in Okigwe hydrogeological area. With the help of the concept of Dar-Zarrouk parameters, the hydraulic character of the aquifer in the area where evaluated. The highest aquifer thickness of 61.3m was recorded at VES 4, (Uhuala-aku), North of the study area with transmissivity value of 4755.2m^2/day. The lowest aquifer thickness of 25.2, was recorded at VES 8(Agbobu) the central part of the study area. Transmissivity value here is 1679.4m^2/day. Hence, it can be concluded the communities such as Uhuala-Aku (VES4), Umunno-Aku (VES 5) and Amosu-Umulolo (VES 7) are most profilic and attractive to the exploration of groundwaterResults of the aquifer vulnerability assessment using the DRASTIC model shows that the area has low and moderate vulnerability to groundwater contamination (Table 5). This indicates that aquifers and other underground resources are protected from the effects of pollution.

VII. References

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