Original Research Article

Electrical Conductivity for Selection of Viable Land for Agricultural Activities and a Suitable Sites for Borehole

ABSTRACT

An electrical Wenner-alpha and Schlumberger survey was carried out to select the viable regions for agricultural activities and to determine the most suitable regions for siting boreholes. The results of the Wenner-alpha data show the study area is highly conductive ranging from 1.1 mS/m to 9.8 mS/m, reflecting the soil water content of the terrain. Consequently, the soil water content of the terrain shows that the terrain is good enough for any agricultural activities operating within the limit of 0 - 4 m depth topsoil, based on the soil electrical conductivity survey data. Similarly, the results of the Schlumberger show that; 72% of the terrain is covered by deeper aquifers where the basement rock is weathered and fractured, while the shallow aquifer regions cover only 28% of the terrain.

Keywords: aquifer potential, agricultural viability, deeper aquifer, highly conductive, soil water content

1. Introduction

Among all natural resources and occupations, water and agriculture stand out and plays an all-important role because they touch all aspect of our lives most [1], [2]. Food insecurity is a global challenge emerging from the urgent needs of society and the growing population that requires urgent attention from agricultural sectors to safeguard the generations [3], [4], [5], [6]. Ensuring food security through agricultural sustainability requires proper understanding and adequate knowledge of environmental soil [3], [4], [5]. Hence, the integration of the environmental soil into agricultural policy is strategical for enhancing food security, because the soil is the only terrain where agricultural land use and environmental procedures meet [4], [6].

However, agriculture is currently facing serious challenges across the world. According to [1], [3], [4], geophysical applications have a great capacity to characterize and quantify these procedures. The greater parts of the agricultural challenge recede in Africa due to insufficient mechanized farming. Though; Nigeria is blessed with abundant soil and underground resources, it has not been transformed into food security as many Nigerians are still confronted with the challenge of hunger and many wallowing in abject poverty due to low agricultural crop yielding [7]. The situation of food security according to [7], has deteriorated rapidly in 2015 in most African and Asia countries, which has increased in 2016 and it has now become a global challenge, affecting over 815 million people. However, some authors argue that; the few Nigerians who ventured into farming to savage this situation, fail due to poor crop yields as a result of poor soil water content and transmissivity [1], [7], others believe that; most of the vast agricultural land has not been intensively put into use, [8]. [9], noted that the variation in crop productivity is not only the function of the changes in the soil's chemical properties but also a function of the physical properties of the soil. To enhance productivity, proper application of agricultural geophysics is essential, which could be guided by carrying out a soil electrical conductivity survey. Soil electrical resistivity helps us to measure the degree of~~, w much t~~ the soil ~~can~~ resistance ~~or retards~~to the flow of electricity or~~(~~ water~~fluid)~~ in the soil, while the soil electrical conductivity helps us to determine the degree of how much the soil can conduct electric current or transmits fluid in the ground [1], [3], [10], [11], [12], [13]. This implies that the soil water content (SWC) is a critical factor that determines crop productivity and groundwater contamination [1], [3], [4], [14], [15], [16]. Therefore, understanding the soil resistivity, conductivity and the degree of

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variation with depth in the soil is necessary to design the grounding system for agricultural activities, since SWC is a useful tool or measure in agriculture as a proxy measurement for moisture content [1], [13], [15], [17].

On the other hand, poor water supplies in quantities and qualities continue to threaten the existence of humanity in many parts of the world including Nigeria. According to [10] [11], many Nigerian communities still lack quality drinking water. Recently survey shows that; out of sixty-nine (69) boreholes drilled in the basement complex rocks of Kaduna State, sixteen (16) were unproductive, representing 30% failures, while the so-called productive ones were not encouraging due to low yield [11], [18~~2~~]. This high rate of unproductive boreholes according to [19~~8~~], is not unconnected to the fact that the boreholes were drilled at their various locations as pre-determined by their owners, instead of sitting the boreholes based on a good hydro-geological and geophysical investigation of the areas concerned. Most dug wells in the rural areas were located by 'common sense', or trial and error rather than by scientific methods due to the restricted availability of equipment and operators [12]. Consequently, these challenges and situations, therefore, make this type of investigation an important ~~prima facie~~ for ~~precise~~ sitting~~location of~~ productive boreholes and identifying viable land for maximum crop yielding ~~for precision farming~~ using the combined Schlumberger and Wenner alpha arrays configuration of an electrical resistivity survey. This is because [11], believed that while the government is largely responsible for the protection of properties and lives of her citizens, the academia and researchers are saddled with the responsibility of providing reliable information on subsurface properties underlain any environment as applicable to the study area to adequately advise government, organizations and individual who wish to exploit the earth's subsurface.

2. Site and Geology Description

The investigation was carried out at Baptist Theological Seminary farmland, Janruwa, Kaduna, as a case study with aim of evaluating ~~determining~~ the soil water content (SWC) through soil electrical conductivity to select a viable agricultural land as well as evaluating the subsurface aquifer parameters for sitting sustainable boreholes. The terrain lies within the geographical coordinates of latitude $10^0\ 27'986''$ N and longitude $07^0\ 28'84''$ E. It occupied a total landmass of 160,000 m^2 and with an average height of 612 m above sea level. The study area, according to [1], [10], [11], [1~~8~~9], is usually drained by both surface water and groundwater. The noticeable river close to the study area is the Kaduna River in the Northern part. The relief of the terrain is shown in Fig 1. The relief of the terrain is characterized by level ground (undulating plain) of laterite and sometimes clay, especially at the topsoil [1], [12], [19~~8~~]. Though, there was no noticeable rock outcrop in the study area except that it is bounded by a hill in some parts of Northwest and Southeast (Fig 1). The studies carried out around the study area within the distance of 8 km away by [1], [10], [11], [19~~8~~], [20~~19~~], [21~~0~~], provide an overview of the main aquifer unit of the area, which usually consists of either weathered/fractured unit or clay/silty unit.

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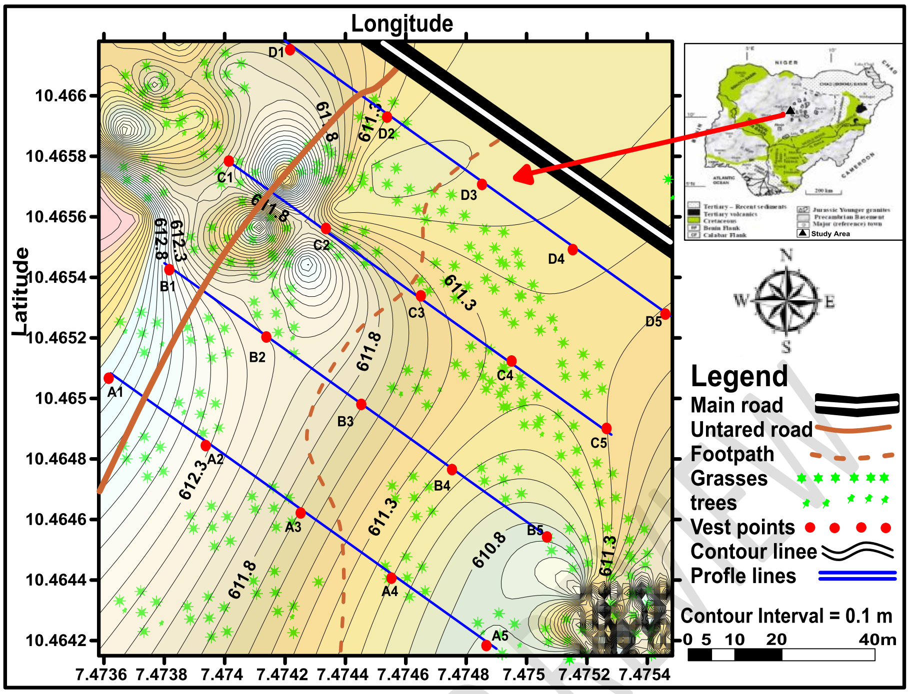

Fig 1: Map of Study AreaShowing the ~~with~~ Vertical Electrical Sounding (VES) Points and Profiles ~~and profiles and its Elevation~~

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3. Methods

The resistivity measurements are usually made by injecting current into the ground through two current electrodes (A and B), and determining the resulting voltage difference at two potential electrodes (C and D) (Fig 2) [10], [11], [20~~19~~], [2~~0~~1], [2~~1~~2]. From Ohm's law, the apparent resistivity (ρ_a) value can be estimated as:

$$\rho_a = K\frac{\Delta V}{I} \quad (1)$$

But the resistivity meters usually measure the resistance value which is defined as:

$$R = \frac{\Delta V}{I} \quad (2)$$

The natural fluctuations in electrical resistivity and conductivity can be influenced in the soil due to the presence of water [10], [11] and soil moisture can change during the dry season and the period of rainfall. Due to these fluctuations, the resistivity and conductivity measured are called apparent. While resistivity is the ability of soil to resist or retard current flow. Therefore, the apparent resistivity (ρ_a) can be defined as:

$$\rho_a = RK \quad (3)$$

Where k is the geometric factor that depends on the arrangement of the four electrodes (Fig 2a & 2b).

a. For Wenner-apha configuration

It can be defined from Fig. 2a, where, ($r_{AC} = r_{BD} = a$; and $r_{CB} = r_{AD} = 2a$), so that :

$$K = 2\pi\left[\left(\frac{1}{a} - \frac{1}{2a}\right) - \left(\frac{1}{2a} - \frac{1}{a}\right)\right]^{-1} \quad (4)$$

Further derivation shows that; equation (5) can be expressed as:

$$\cancel{\rho_a = 2a\pi \quad (5)}$$

$$K = 2a\pi \quad (5)$$

Equation (5) is used to calculate the geometric factor (K-factor) for the Wenner-alpha configuration.

b. For Schlumberger configuration

According to [12], [~~19~~20], [2~~0~~1], and [2~~1~~2], the four (4) Schlumberger electrodes can be defined from Fig. 2b, where, $\left(AC = BD = \left(\frac{L-a}{2}\right) \text{ and } CB = AD = \left(\frac{L+a}{2}\right)\right.$, so that, the K-factor for Schlumberger array, becomes:

$$K = 2\pi\cancel{\frac{V}{I}}\left[\left(\frac{2}{L-a} - \frac{2}{L+a}\right) - \left(\frac{2}{L+a} - \frac{2}{L-a}\right)\right]^{-1} \qquad (6)$$

Further derivation shows that; equation (6) can be expressed as:

$$K = \frac{\pi}{4}\left[\frac{L^2 - a^2}{a}\right] \qquad (7)$$

Consequently, equation (5) is used to calculate the geometric factor (K) for the Schlumberger configuration [1], [12], [21~~0~~], [2~~1~~2].

c. Agricultural geophysics

Agricultural geophysics according to [1], [4], [15], [23~~2~~], [2~~3~~4], focuses on the 2 m depth topsoil, which involves a wide range of scales and sometimes displays a significant variation both temporally and spatially in measurements. That is, the 0–2 m thickness of the region below the Earth's surface is the geophysical point of attraction for agricultural activities. The urgent demand for the near-surface geophysics observing technologies for studying a wide range of phenomena in the soil and environmental analysis of time-dependent change of water content in the field of agrogeophysics [4]. Agrogeophysics applies geophysical methods to characterize the soil that is of interest for agronomic management. Though; near-surface geophysical techniques are becoming increasingly powerful tools in the field of applied agricultural practices, with greater advantages in terms of their potential rapidity, spatial continuity and low cost when compared to conventional techniques of evaluating agricultural land [3], [4], [22~~3~~], [2~~3~~4]. This is done by obtaining information within the soil profile, which generally does not extend beyond 2 meters depth beneath the ground surface [1], [2~~3~~4]. The common geophysical techniques deployed for agriculture include electrical resistivity (ER), ground-penetrating radar (GPR) and electromagnetic induction (EI) [12], [15]. According to [12], GPR surveys provide more detailed images but are highly limited in-depth penetration and they should be used in conjunction with 2d ER, EI or seismic surveys as they can provide a piece of comprehensive and complementary information about the subsurface nature, especially for agricultural activities. These techniques are used for monitoring saltwater intrusion, soil water content, and conductivity which defines the plant root biomass and water–soil–root plant interactions [1], [4].

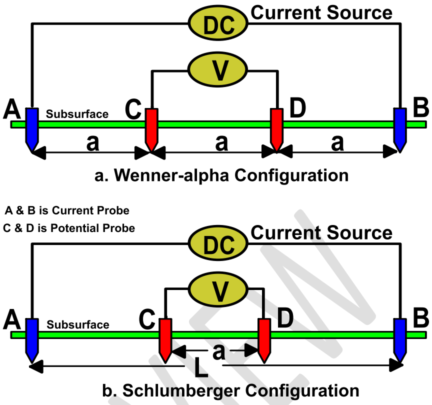

Fig. 2: Electrical Resistivity Configuration

d. Soil Electrical Conductivity

The soil electrical conductivity was evaluated from the apparent resistivity obtained from the terrain, thus, the conductivity obtained here is called apparent soil electrical conductivity (σ_a). It describes the capacity of soil to conduct an electrical current, which is a function of fluids transmitted vertically or horizontally within the soil [1], [3], [4], [10], [12]. It is measured in siemens per meter (S/m) and is commonly expressed as:

$$\Rightarrow \sigma_a = \frac{1}{\rho_a} \qquad (8)$$

According to [25~~4~~], the properties of soil can be differed spatially at different location because the soil inhomogeneous in terms of electrical resistivity measurement. Soil properties can be quantified through the geo-electrical properties, that is, the soil resistivity is an integral property that geoelectrical behaviour depend which describes how the soil nature reduces and increases the electric current flow through it [1], [~~]~~15], [25~~4~~]. The soil composition such solids, liquid, and gas phases are the major heterogeneous factors affecting soil properties [25~~4~~]. According to [2~~4~~5], electrical resistivity measurement has been conducted with the four-probe method in soil investigations since 1931 for evaluating soil moisture and its and salinity.

e. Aquifer Transverse Resistance

Transverse resistance (R_T) is one of the Dar Zarrouk parameters used to estimate the aquifer potential and protective capacity. In most cases, the transverse resistance reflects the nature of the terrain's aquifer transmissivity [10], which in turn defines the quantity of water that the aquifer can transmit horizontally. Transverse resistivity is the product of aquifer resistivity and its thickness (h_a) [10], and is expressed as:

$$R_T = h_a . \rho_a \qquad (9)$$

4. Data Processing

The data obtained across the terrain was processed using three major three software which includes Excel Microsoft, Res ID (1.00.07 Version Beta) and surfer (version 11). Excel Microsoft was used to convert and reduce the raw data. The processed Excel Microsoft data was input into Res 1D, where the subsurface layers were underlain in the study area was generated. Finally, the surfer software was used to produce the contour maps which were used for discussion and analysis as shown in Fig 5-7. Fig 3 represents a typical 1-D model used in the interpretation of the resistivity sounding database on the Schlumberger configuration for VES A2 along with the Profile A from the terrain.

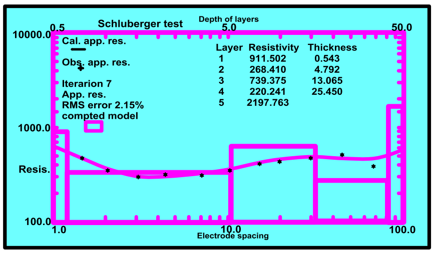

Fig 3: Resistivity curve for Profile A: VES A3

5. Results and Discussion

The results of the processed data focus on soil electrical physical properties to select the viable regions for agricultural activities and delineate the suitable zone for boreholes, based on their resistivity behaviour. The result and discussions of this work were explained in three phases as follows.

a. Soil Electrical Conductivity for Agricultural Applications.

The soil conductivity of the terrain was evaluated from the Wenner-alpha resistivity survey taken at 2 m and 4 m depth as shown in table 1 and table 2 respectively.

Table 1: The summary of the soil electrical conductivity (in mS/m) taken across all the profiles at a 2 m depth

S/N	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5
1	2.4	2.5	2.1	1.9	2.6
2	2.7	2.5	1.9	2.4	2.5
3	3.3	2.1	2.3	2.2	3.2
4	4.1	2.2	2.4	3.2	3.8
5	5.8	2.4	3.6	3.2	5.0
6	9.8	2.8	3.6	3.6	6.6
7	9.1	3.2	3.6	4.0	7.0
8	5.3	3.1	3.0	3.8	7.0
9	6.1	3.3	3.6	3.2	5.2
10	8.6	3.0	3.1	3.8	4.6
11	9.4	3.3	0.0	3.1	3.8
12	8.2	3.2	3.0	3.3	3.6
13	4.3	3.3	3.6	3.2	3.8

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Table 2: The summary of the soil electrical conductivity (in mS/m) taken across all the profiles at a 4 m depth

S/N	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5
1	3.8	2.4	3.3	3.4	3.0

2	4.1	2.8	3.2	3.3	3.8
3	7.8	3.0	3.0	3.6	5.3
4	8.0	3.4	3.3	2.8	5.0
5	5.4	3.2	3.1	4.1	4.0

Fig 4 is a conductivity map distribution of the terrain that varies from 1.0 mS/m to 9.8 mS/m. This implies that the terrain is highly conductive at 2 m depth, especially at profile lines 1 and 5, since according to [1], [16], agricultural geophysics interest is within the 2m depth topsoil which is the heart of agricultural activities, thus, the soil conductivity obtained at 2 m depth satisfied the condition the implementation of precision farming. The variation in conductivity suggests that the land is viable for agricultural activities. According to [1], [10], [13], [14], [16], the soil conductivity is predominantly controlled by the amount of moisture, soil water content, and dissolved minerals within the soil, which is a function of the porosity and permeability. The conductive nature of this terrain presented in Fig 4, is a function of soil water content, which is a measurement of its water holding capacity. High soil electrical conductivity (SEC) represent high soil water content (SWC) according [1], [4], [16]. Consequently, the high SEC noted across all the profiles except in small parts of the western region, indicates a high SWC of the terrain, which shows that the terrain is good enough and highly viable for agricultural practices. That is, the groundwater movement limiting factor is very low and this is very good for agricultural activities, since [2~~5~~6], is of the view that, soil fertility does not only depends on chemical and biological factors; but also depends on SWC, as no soil can produce well when its SWC is poor.

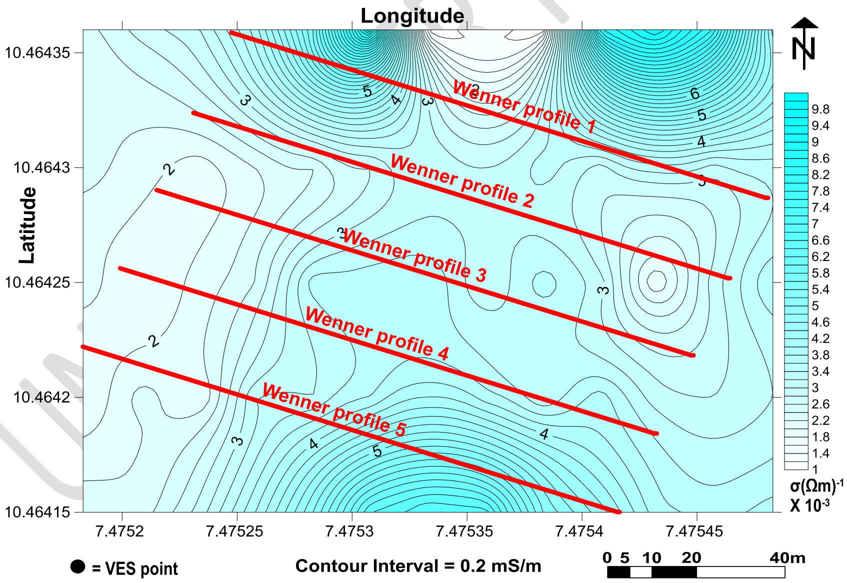

Fig 4: Conductivity Map of the Terrain at 2m Depth

Fig 5 is another conductivity map distribution of the study area taken at 4 m depth and it varies from 2.2 mS/m to 7.8 mS/m. Though; agricultural geophysics focuses on 2 m depth topsoil, the conductivity obtained at 4 m depth plays an important role in crop yields, because; a high soil water content at this depth supports the 2m depth topsoil. This implies that; the roots of the plants that grow on the land can penetrate deep the soil beyond the usual 2 m depth, and thus, more crops yield. However, the conductive nature of the study area at 4 m depth, suggests that the study area is viable for agricultural practice, and this agreed with [1], [4], [16], that the crop productivity varies with soil water-holding capacity which is the major factor affecting crop yield. However, the high electrical conductivity noted in the northern and southern parts of the terrain indicates that the subsoil of the terrain is generally conductive and it implies that, the less degree of soil consolidation, high soil moisture, and organics matters, are predominant in the terrain, which could enhance the crop productivity for precision farming. The agronomic soil information delineated shows that; the integration of electrical soil conductivity maps gives an overview of soil water content, important underpins and distributed soil information to manage agricultural systems and activities

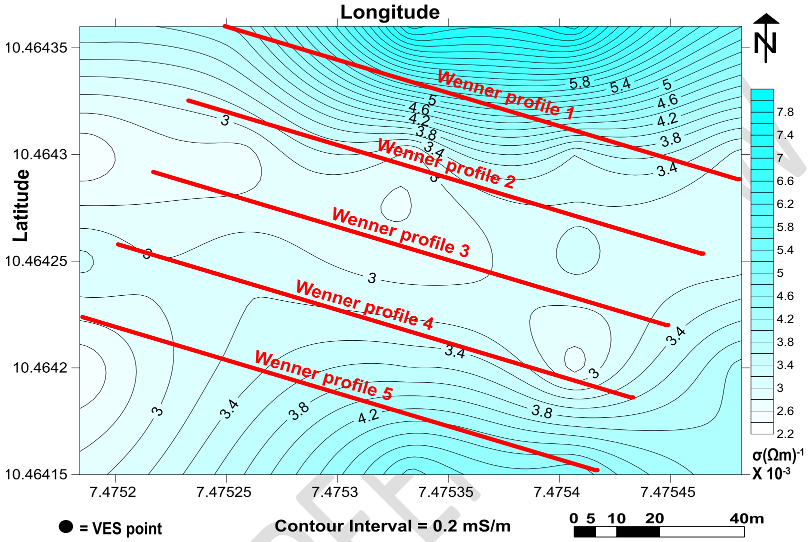

Fig 5: Conductivity Map of the Area at 4m Depth

6. Soil Profile Depth Section of the Terrain

Fig 6 shows the soil depth section of the study area. According to [12], [17], [120~~9~~], the soil depth section can be described as the subsurface of the earth's geo-electrical properties and the sequence of layered rock formation, which is also known as the geo-electric/geologic section. The depth section reveals the variations in resistivity with depth and layer thickness within~~n~~ ~~a~~ the terrain. Generally, the sections revealed that; the terrain is underlain by four to five subsurface layers, which consist of topsoil, clay/silty/sand layer, weathered/fractured layer and the fresh basement as shown in Fig. 6. This section was constructed using the result of the work after [1], [10], [11], [12], [17], [20~~19~~], [2~~6~~7], [2~~7~~8], [2~~8~~9]. The first layer which is also known as topsoil; varies from 0.9 m – 4.7 m in thickness and 240 Ωm – 1601 Ωm in resistivity. The weathered/fractured basement resistivities and thickness varies from 111 Ωm – 955 Ωm and 9 m – 43 m respectively. This layer forms the aquifer unit of the Terrain. This indicates that; the terrain is generally good for groundwater development, most especially the first profile, which consists of A1, A2, A3, A4 and A5, due to the fractured basement found in the region. The highly fractured profile can be considered suitable for siting boreholes. The last layer, with an infinite thickness, is found to have high resistivity values, ranging from 1112Ωm to 3351 Ωm, which is believed to be the fresh basement. According to [10], [11], [12], [1~~8~~9], [27~~6~~], [2~~7~~8], when the basement rock's resistivity is less than 1500Ωm, it suggests slight fracturing and weathering and it should be recommended for a sitting borehole due to its water content or holding capacity.

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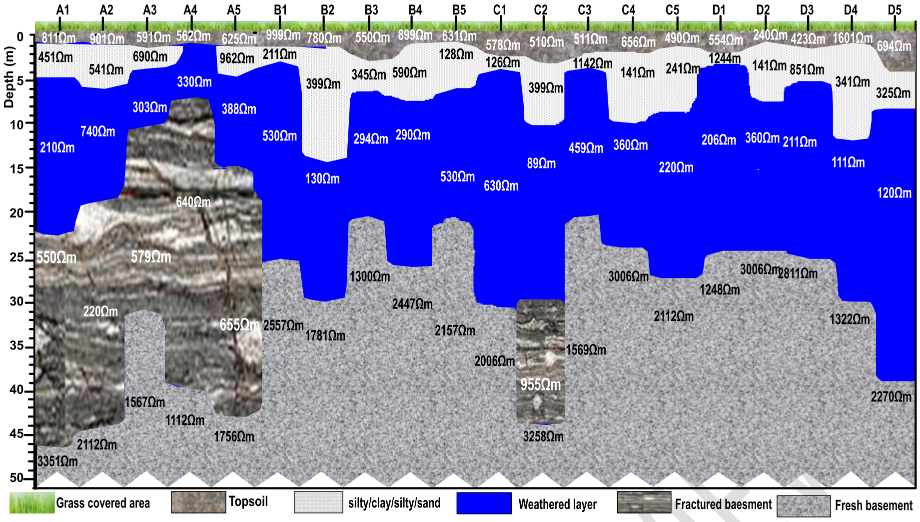

Fig 6: Geoelectric/geologic section of profile all the Profiles

7. Aquifer Transverse Resistance (R_T)

Table 3 shows the transverse resistance of the study area estimated from aquifer resistivity and its thickness.

Table 3: Estimation of Study Area Aquifer Parameters

SN	VES Points	Aquifer Resistivity $\rho(\Omega m)$	Aquifer Thickness d (m)	Transverse Resistance R_T (Ωm^2)
1	A1	542	42	22764
2	A2	450	40	18000
3	A3	420	28	11760
4	A4	432	36	15552
5	A5	498	40	19920
6	B1	330	19	6270
7	B2	130	12	1560
8	B3	294	12	3528
9	B4	290	10	2900
10	B5	431	11	4741
11	C1	501	25	12525
12	C2	511	32	16352
13	C3	458	11	5038
15	C4	360	9	3240
14	C5	220	11	2420
16	D1	206	19	3914
17	D2	360	17	6120
18	D3	211	19	4009
19	D4	111	18	1998
20	D5	120	25	3000

Fig~~ures~~ 7a and 7b show the weathered/fractured layer (aquifer unit)

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resistivity and its thickness maps of the study area respectively. Both figures closely agree with each other. It was noted that high weathered/fractured resistivities reflect high aquifer thickness and vice versa. That is, the fractured zones are found in deeper regions. From fig 7a & 7b, the deeper aquifers are found mostly in the Southwest region (all the VES stations in profile A), in the Northwest (at VES C1, C2, D1, D2) and finally in the Northeast. All these regions are highly suitable for siting boreholes.

On the other hand, the regions in Fig 7a & 7b, depicted with deep blue colour indicate high aquifer potential. This is, Fig 7a and Fig 7a are proportional to each other. The relatively high resistance noted in Fig 7a, indicates fractured, which according to [1], [7], [1~~9~~8], [2~~6~~7], [2~~8~~9], such zones are the most suitable regions for siting boreholes.

Finally, the deep blue coloured regions noted in Fig 7a coincide with the deep blue coloured regions observed in Fig 7b, and this occurs in most parts of the terrain. Consequently, the zones are therefore suggested as the best zones for groundwater development, while the regions depicted with light blue may be prone to contamination from near-surface sources and it should be avoided for borehole siting.

Fig 8 shows the transverse resistance ($\boldsymbol{R_T}$) of the study area, it presents us with additional information to evaluate the aquifer potential. According to [10], [11], [2~~6~~7], the high R_T, reflects deeper aquifers, and this is found mostly in the Northwest and Southwest of the study area, which corresponds to the aquifer parameters shown in Fig 7a and Fig 7b.

This implies that; all the aquifer characteristics presented in Fig 7-9, have a direct relationship with each other, and the regions with the highest transverse resistance values (profile A, VES C1 and C2), reflect most likely the highest Transmissivity, hence, it is therefore recommended for boreholes siting due to its high hydraulic conductivity.

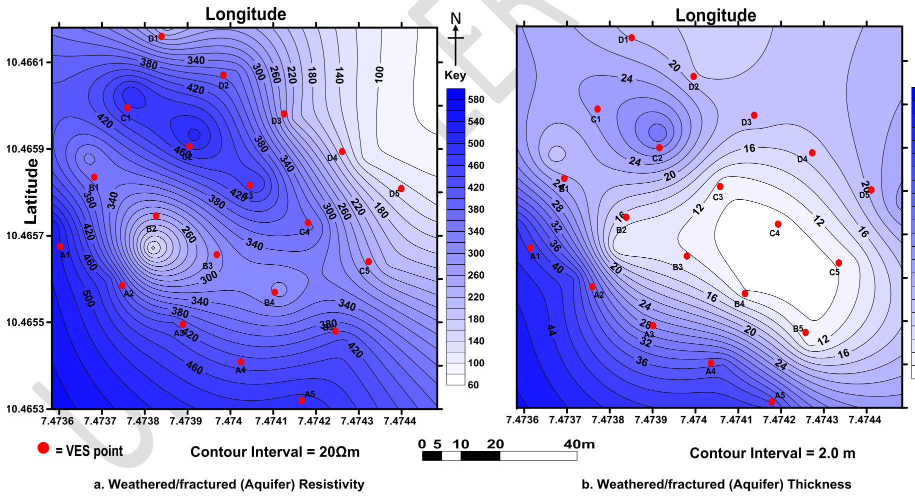

Fig 7: Weathered/fractured (Aquifer) Parameters

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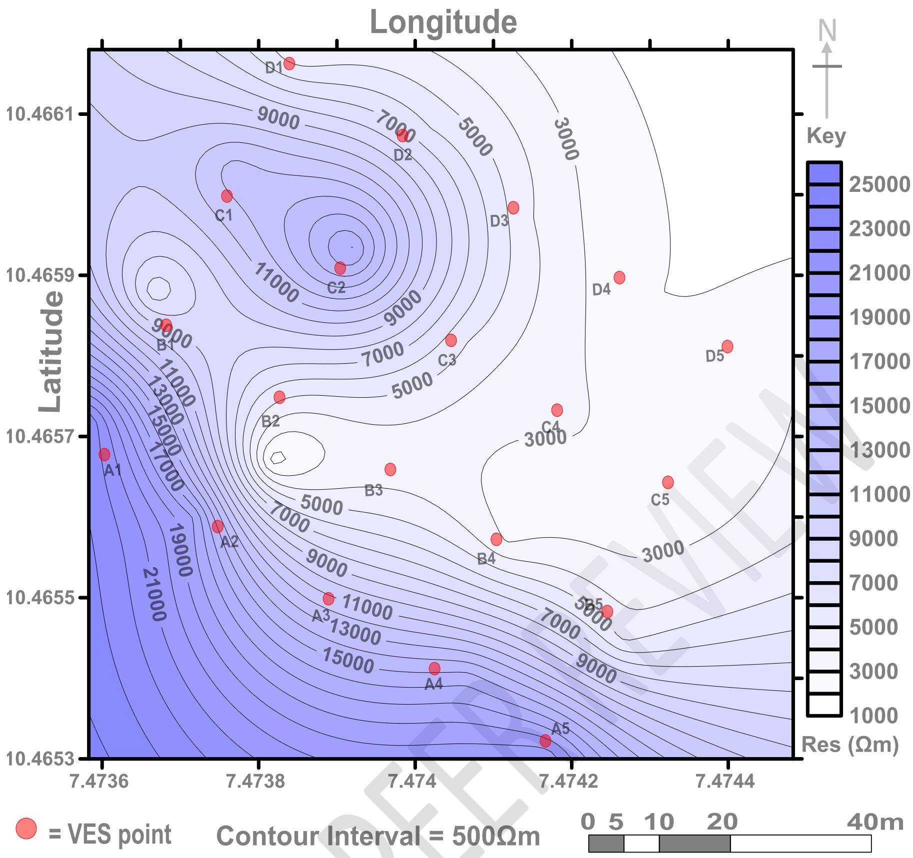

Fig 8: Transverse Resistance Map of the Study Area

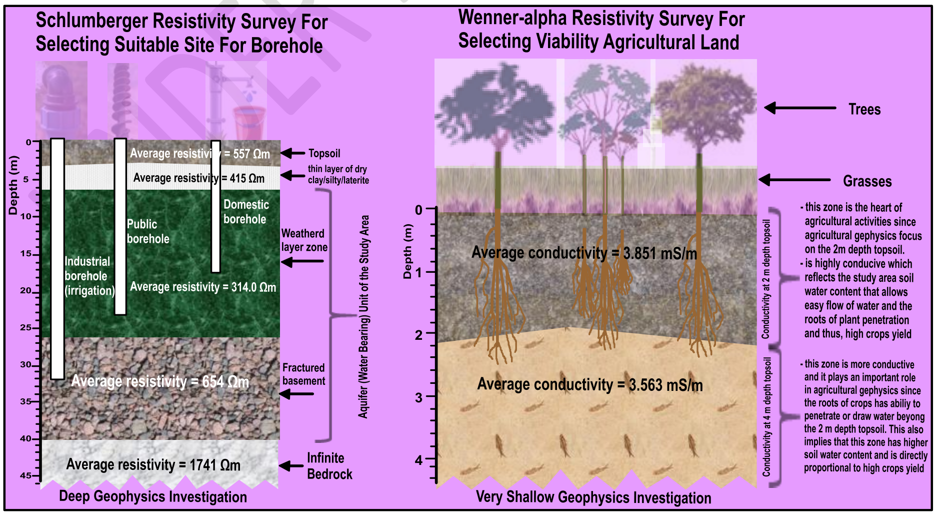

Fig 9: Graphical Illustration of the Results

8. Summary

- An electrical Wenner-alpha survey was carried out across five profiles at 2 m and 4 m depth to select viable land for agricultural activities.
- The Wenner-alpha survey was taken at 2m depth topsoil; since agricultural geophysics interest and focus are usually targeted at 2 m depth topsoil.
- The Wenner survey was extended to 4 m depth, which allows us to further evaluate a viable agricultural land; since the roots of some plants and crops can penetrate down the soil beyond 2 m.
- The Wenner-alpha survey reveals that the study area is highly conductive and is good enough for agricultural activities and development, especially in the region of profile A and profile D presented in Fig 4 & 5.
- The conductivity map at 2 m and 4 m depth shows much resemblance.
- On the other hand, the Electrical Schlumberger survey was carried out across ~~F~~four profiles with each profile containing 5 VES stations for delineating groundwater potential.
- The Schlumberger survey interpreted and processed data presented aquifer parameters in table 1 and Fig 4, 5~~,~~ & 6, all agreed that the deeper aquifer which is considered the major water-bearing unit of the study area is found in the Northwest, Southwest and some parts of Northeast.
- The light and shallow aquifer areas are majorly found in the eastern antral parts of the study area.
- The regions of a deeper aquifer are recommended for groundwater development (siting boreholes), while the shallow aquifer regions are discouraged for siting boreholes because the regions are considered less productive and are usually prone to surface contamination.

Highlights

- Agrogeophysics bridges the gap in the characterization of soil structure through soil electric properties which reflects the soil pores, transport, soil air-water content, limiting factors mechanism and penetration of roots
- Soil conductivity data helps to characterize large areas in selecting viable land for agricultural precision.
- Geophysical characterization gives an overview procedures driving the soil–plant–atmosphere continuum.
- Improving our understanding of the links between soil electrical conductivity, soil water content and penetration of roots as well as crop yields to sustain establish food security.
- Less degree of soil consolidation and high soil moisture enhance crop productivity for precision farming.
- Agrogeophysics is a powerful tools for sustainable groundwater development and viable agronomic.
- DC-resistivity surveys at sufficient spatial resolutions identify zones affected by soil compaction.

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9. Conclusion

The Schlumberger data has revealed that the study area is underlain by four to five subsurface layers consisting of topsoil, silty/clay/sand/laterite, weathered/fractured and fresh basement (Fig~~.~~ 4). The weathered basement layer which is presumably clay/silt/sand and fractured zone constituted the aquifer (water-bearing) units of the study area. The deeper aquifer was found in the Northwest, Southwest and in some parts of the Northeast which covers 72 % of the study area, leaving the shallow aquifer with 28 % as in Fig 7, 8 & 9. These deeper aquifer regions have been successfully identified as potential aquifer zone targets for groundwater exploitation and it is large enough to meet any substantial demand of water demand that may be arising in future, while the shallow regions are to be avoided because they like prone to the surface pollutants.

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Similarly, the Wenner-alpha survey data shows that the study of soil electrical conductivity has the potential to accommodate agricultural activities. The area shows higher soil electrical conductivity which is directly proportional to higher crop yield because the high soil electrical conductivity allows easy flow of water in the soil which is the major factor that affects crops yield. Consequently, the Schlumberger and Wenner-alpha survey has proved very successful in identifying and delineation the high aquifer potential and a viable land for agricultural activities respectively.

Declaration of Conflict Interest

In compliance, the authors declare that there is no conflict of interest in this research work. All information provided in this work has been duly acknowledged in the text and the references provided. No part of the work has been previously published in any journal.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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