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INVESTIGATION OF LEACHATE INFILTRATION ON GROUNDWATER USING GEO-RESISTIVITY AND NATURAL ELECTRIC FIELD METHOD AROUND OJOOU-OLAYANJU'S DUMPSITE, ADA, SOUTHWESTERN NIGERIA

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Abstract

The investigation of groundwater within the dumpsite environment is highly important in geophysical study. This is because the extent of interaction between the aquiferous medium and the contaminated zone could pose a serious threat to the end users especially humans when consumed. This research aimed at investigating leachate infiltration and its potential influence on groundwater at Ojoou Olayanju's Dumpsite using combining geo-resistivity and natural electric field (NEF) methods. In this study, five dipole-dipole and five NEF measurements were obtained using the Omega resistivity meters and PQWT-150 equipment respectively. The dipole-dipole method was deployed to obtain a 2D near-surface pseudo-section, and the NEF method was used to obtain the frequency curve and profile maps of electric potential difference. The dipole-dipole results revealed the lateral variation in the resistivity along the traverses, suggesting that the materials within this near-surface are heterogeneous, and the closely spaced contours' varying gradients indicate fracture, which would facilitate potential leachate filtration. The NEF results revealed curves, and a subsurface image with respect to depth and profile distance. The points of convergence signals on the frequency model correspond to a medium with low resistivity on the profile map. The conductive medium is seen as being saturated with leachate, which suggests that very large portion of the study area around the dumpsite has been contaminated by leachate. Conclusively, it was revealed that leachate filtration is evidence especially at the topsoil and due to the presence of fractured zones, the groundwater quality is at risk of contamination by continuous filtration of leachate.

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1.0 INTRODUCTION

Investigating the level of groundwater contamination has become increasingly important due to the fact that accessing clean water is a human right and a basic prerequisite for economic growth. In addition, [1] claimed that water is necessary for subsistence, development, and industrial expansion and its exploration in adequate amount is required when it does not easily exist on the surface. Also, [2] reported that groundwater is a vital relevance for domestic and industrial operations as well as the environment. Due to its growing importance, [3] and [4] have also highlighted the essential functions of groundwater, and reported that a good and balance quality water is essential for the subsistence of all living organism. However, [5] reported that human beings have carelessly contaminated the groundwater through dumping of refuse in non-controlled waste facilities in an attempt to dispose solid waste. Also, the growing amount of waste produced by population growth and development, [6] reported that municipal solid waste management has long posed an imminent threat to cities in developing nations. According to [7], when solid wastes are discharged, they gradually emit leachate and some of their degraded byproducts may settle at the bottom before infiltrating through the soil and reaching groundwater.

Furthermore, [8] reported that locations near dumpsites have a higher risk of groundwater contamination because leachate from the dumpsite might be harmful and act as a probable source of pollution. Likewise, [9] emphasized that the major source of groundwater pollution within or near dumpsite facilities is leachate from contaminants that permeate into the subsurface formations, particularly when the subsurface is fractured. To this regard, leachate is a term for a contaminated liquid that is frequently produced when water seeps through a solid waste disposal site. It includes components that are hazardous to the environment and have the potential to contaminate groundwater. Leachate as defined by [10] is a hazardous pollutant that arises from the liquid embodiment of solid waste and has an adverse effect on water bodies, human health, and groundwater.

According to [11], leachates from landfills vary widely in their constituents depending on how long the dumpsite has been in operation. Similarly, [12] reported that when the rainy season climax is reached, flood water swamps the dumpsites, which is a factor that facilitates leachate seepage into the subsurface (underlying aquifer) through the landfill. Studies by [13] and [14], revealed that groundwater contamination puts nearby users in grave risk and may endanger the ecology and ecosystem in the area, since the presence of a toxin in groundwater tends to promote high intensive threats and hazard. Also, [15] reported that about two million people every year, 90% of whom are children, perish as a result of inadequate environmental sanitation and drinking contaminated water, because the quality of drinking water as reported by [16], no longer complies with WHO standards in a number of nations. Consequently, the majority of the waste dumped in the environment of Ojoou Olayanju comes from residential and commercial activities, and to make rehabilitation and cleanup activities easier where they are required, the delineation and investigation of the leachate contamination plume and its infiltration pathway in the vicinity of the dumpsite is essential.

According to researchers such as [17], [18], and [19], geophysical investigation is essential and excellent choice for environmental impact assessment for investigating contaminated land, due to its major benefits, such as being non-invasive, non-destructive, and capable of providing continuous subsurface information for a profile in areas such as groundwater probing, delineating subsurface components, evaluation of topsoil hydrological characteristics. However, [20] reported that geophysical method provides a crucial profiling and investigation of leachate contamination caused by urban domestic dumpsite. As a result, it is always necessary to investigate the subsurface geophysical formation for groundwater quantity and quality, specifically in an environment with dumpsite facilities. According to [21], the method has been successful in mapping the distribution of leachate and monitoring its potential migratory pattern in the soil. In this regards, investigating level and extent of groundwater contamination becomes necessary, since [22] reported that diseases such as diarrhea, typhoid, cholera, dysentery and skin cancer occur world-wide causing over 4% of all deaths and 5% of health loss to disability.

Therefore, in this research, the geo-resistivity and the natural electric field method was combined using the Omega resistivity meter and the PQWT-150 equipment for such type of environment investigation due to the conductive tendency of most contaminants, with objectives to monitor and access the extent possible leachate infiltration on the groundwater quality of the study area. The aquifer units in a complicated geologic terrain were mapped by [23], utilizing natural electric field and electrical resistivity techniques applying the PQWT-TC150 model and the findings confirmed the presence of restricted aquifer units. Also, [24] mapped the routes of leachate in an active dumpsite by using geoelectrical sounding methods and frequency selection and concluded that leachate from dumpsite has negative effect on groundwater quality. Thus, to protect the people living close to the dumpsite facilities, it is necessary to periodically analyze and evaluate the leachate movement to groundwater systems in the study area environments.

1.1 Location and Geology of the Study Area

Adaland is a town in Osun State, Nigeria, located in the Boripe Local Government Area. It is situated between latitude 7^0 54’ 0” and longitude 4^0 43’ 0’’ as shown in Figure 1. The study area, Ada, has experienced a warm tropical climate, with an average annual temperature 26.1°C and daily maximum temperature between 25ºC and 29ºC as reported by [25]. Within the study area, two main different season are seen i.e. the rain and dry seasons. The annual rainfall distribution is around 1247mm, with variations between 1016mm and 1524mm.

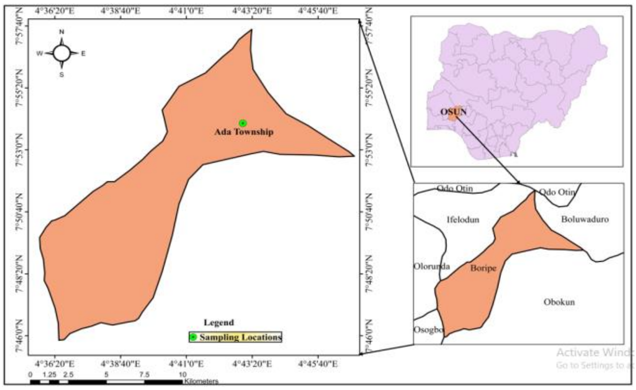

Figure 1: The location and Geological map the study area

According to reports by [26] and [27] and, the studied region is a confined portion of the basement complex rocks of Southwestern Nigeria as shown in Figure 2, and is underlain by vast outcrops of mostly banded gneiss and granite gneiss. With lithological shifts of coarse to fine-grained clastic, pelitic schists, phyllites, banded iron formation, carbonate rocks, amphibolites, younger metasediment rock, banded gneiss, and granite, the study area is situated in the Schist belt and Migmatite-Gneiss complex of the southwest basement complex.

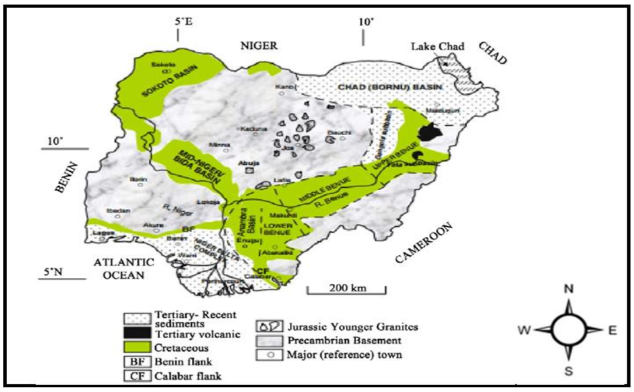

Figure 2: The Basement Pattern of the study area [26]

2.0 MATERIALS AND METHOD

2.1 Geo-resistivity Method

The study for the smooth apparent resistivity inversion that produced the 2D model of the predicted true subsurface resistivity employed the Ohm-mega resistivity meter. It features a setup that allows for the connection of electrodes and an external power supply as reported by [28].

2.1.1 Geo-resistivity field measurement

The dipole-dipole array was used for the field measurement as reported by [29] and as shown in Figure 3. In the illustration, the distance between the potential electrodes pair $P_1$and P_2 and the current electrode pair $C_1$and C_2 are denoted by spacing ‘r’. When the method is been repeated, it results in measurements with several spread (‘2r’ to ‘nr’).

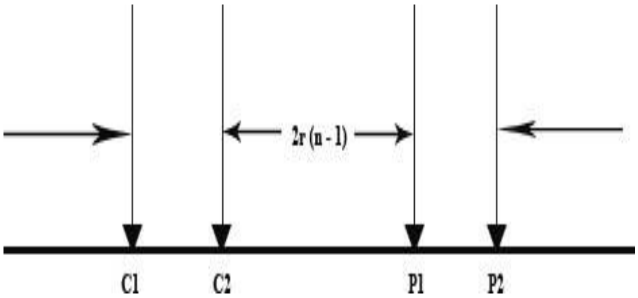

Figure 3: Sketch of Dipole-dipole surveys [29]

The potential electrodes of a dipole-dipole arrangem-ent are separated from the current electrodes, which are also near to one another. The dipole-dipole array was used for the 2D resistivity measurements because it allowed for a deeper level of analysis, high horizontal resolution, and data coverage.

2.1.2 Theoretical background

The potential is calculated after introducing the current, such that:

$$V = \frac{I\rho}{2\pi x} \quad (1)$$

If the potential at P_1 and P_2 are V_M and V_N, hence, the potential at M will be calculated as:

$$V_M = V_{r1} - V_{r2} \quad (2)$$

$$\text{Where,} V_{r1} = \frac{I\rho}{2\pi r_1}, V_{r2} = \frac{I\rho}{2\pi r_2} \quad (3)$$

$$\text{Therefore, } V_M = \frac{I\rho}{2\pi r_1} - \frac{I\rho}{2\pi r_2} = \frac{I\rho}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right) \quad (4)$$

Consequently, considering Equation 4 and Figure 3, when the current and potential electrodes are separated apart, and the dipoles are broadside rather than end on, this implies that:

$$r_1 = r_4 = 2nr, r_2 = r_3 = 2\sqrt{(nr)^2 + r^2} \approx 2nr\left(-\frac{1}{\frac{1}{2n^2}}\right) \quad (5)$$

$$\text{Then, } \rho_a = -4nn^2 r.\frac{\Delta V}{I} \quad (6)$$

Equation 6 is the apparent resistivity of dipole-dipole measurement. ‘n’ denote the number of electrode spacing; ‘r’ denote the electrode separation; ‘V’ denote the electrode potential and ‘I’ denote the current injected.

2.2 Natural Electric Field (NEF)

To determine the Earth's conductivity structure at depths ranging from a few tens of meters to several hundreds of kilometers, the NEF passive electromagnetic method (EM) measures fluctuations in the natural electric (E) and magnetic (B) fields of geomagnetic disturbances emanating primarily in the ionosphere in orthogonal directions at the surface of the Earth at 0–30 kHz [30]. The PQWT-equipment, according to [31] and [32], is a sensitive automated geophysical prospecting instrument that calculates the potential difference between any two ground-based locations, resistivity contrasts mapping of the groundwater and underground rocks carried by natural electric current of various frequency electric field components, based on their variations of anomalous changes in geological bodies.

The in-built algorithm within the PQWT is highly efficient; it has been tested severally and validated by groups of researchers in the Hunan Puqi Geologic Exploration Equipment Institute in China. The PQWT has been adopted in ground water exploration and environmental studies. Recently, it was applied successfully in groundwater exploration and in environmental study by [24, 33, 34]. Its in-built algorithm is reliable and the results from either ADMT or PQWT equipment have been found useful in real life application and in high-profiled research articles. Also, [35] reported that the PQWT uses three integrated geophysical approaches to detect subsurface water resources such as magnetotelluric, induced polarization, and nuclear magnetic resonance (NMR).

2.2.1 NEF field measurement

Five EM traverses were obtained using PQWT equipment. A PQWT machine that was used in this study is capable to probe up to 100 m depth. The range of the sounded points per traverse varied from 10 points (at traverse 5) to 28 points (at traverse 2). Figure 4 shows the sketch of the PQWT Survey.

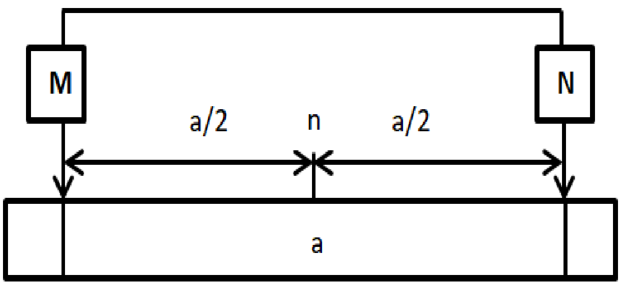

Figure 4: Sketch of the PQWT Survey

An inter-data point interval of 2m was used for the acquired EM data in this study. A two-probe M and N are placed on the ground at point 0 and 10 m [36] and [37], the probes were connected to the EM console via cable which reads the EM impulse generated by those points. The subsurface natural electric current is produced through electrochemical processes among various conductive minerals being in contact with one another, and the fluid contents in porous media within the subsurface [24]. The electric field (E-field) component of the Earth's EM field at various frequencies is measured in millivolt. This natural E-field is used to determine the resistivity contrast of various geologic bodies with respect to the lithological units of the near-surface as reported by [24].

2.2.2 Theoretical background

The PQWT device uses the time/frequency domain measurements of the horizontal ratio electric E_X and the magnetic field H_Y magnitudes to compute the resistivity structure of the earth, as shown in Equation 7.

$$\rho_m = 1(5f)^{-1}\left(\frac{E_X}{H_Y}\right)^2 \tag{7}$$

The resistivity of the medium under contact is represented by ρ_m,while the operating frequency is denoted by f respectively. Equation 7, as published by [38], is the result of inserting the electric and magnetic field components, as described by [39] in Cagniard's scalar resistivity formulas to obtain the apparent resistivity of the medium under interaction.

Consequently, the electric field component interacts with the ground perpendicularly, while the magnetic component of the field is assumed to remain constant. The geologic properties of the material under contact may be ascertained from the qualitative connection between the resistivity of the ground under interaction and the electric field component. Equation 8 indicates that the penetrating depth of electromagnetic waves in a medium is directly proportional to the resistivity of the medium at a constant frequency.

$$\delta = 503.3\sqrt{\frac{\rho}{f}} \tag{8}$$

Then, using Equation 8 and the Maxwell electromagnetic theory under the assumptions that the ground is homogeneous, isotropic, and horizontally layered, Equation 8 can be converted into a 1D depth inversion. The effects of the displacement current as reported by [40], where E_X and H_Y fall between the phase angles are likewise ignored, meaning that the data collection lines are perpendicular to the structure. The magnetic field is considered a constant function of the electric field response across a narrow region of measurement and is stable in most circumstances, which is the basis for the magnetotellurics process included in the

PQWT-TC150 operations as reported by [41]. According to [31], the electric components of the earth's electromagnetic field at different frequencies are measured in millivolts (mV) to estimate the resistivity contrast of the different geologic structures with regard to the lithological bodies under contact.

3.0 RESULTS AND DISCUSSION

3.1 Geo-resistivity Results

The geo-resistivity result sections are shown in Figures 5a – f. From the results, approximately 37.5m is the maximum depth at which the array's active depth of infiltration may disclose subsurface geology. The imaging-derived geoelectric layer characteristics provide an approximate representation of the distribution of subsurface electrical resistivity. The broad base and varying pseudo-depth of the 2D inverse model of the resistivity section was caused by short distance at which the current encountered the basement rocks because of the thin overburden.

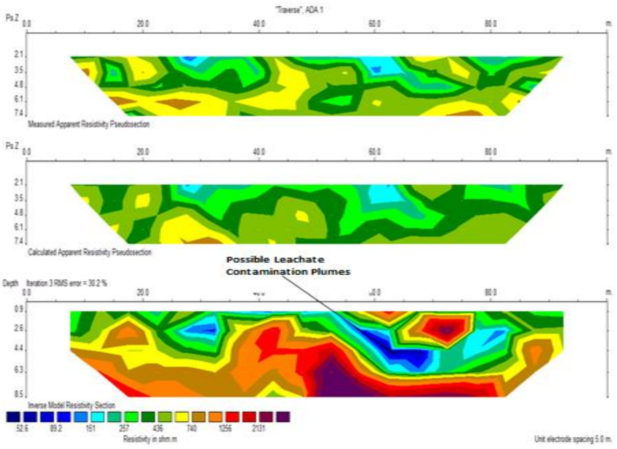

Figure 5a: 2D inverted resistivity structure along traverse 1

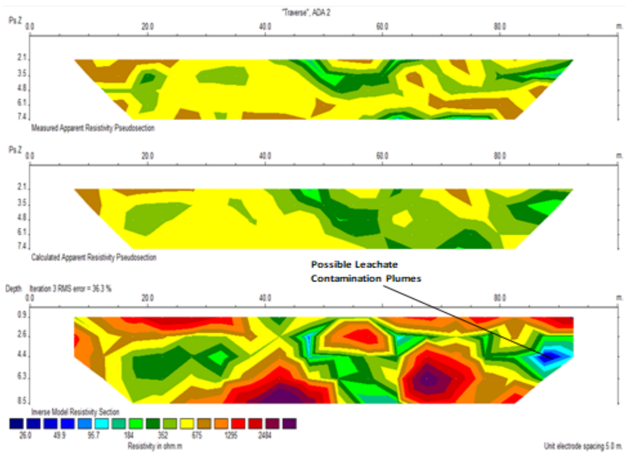

Figure 5b: 2D inverted resistivity structure along traverse 2

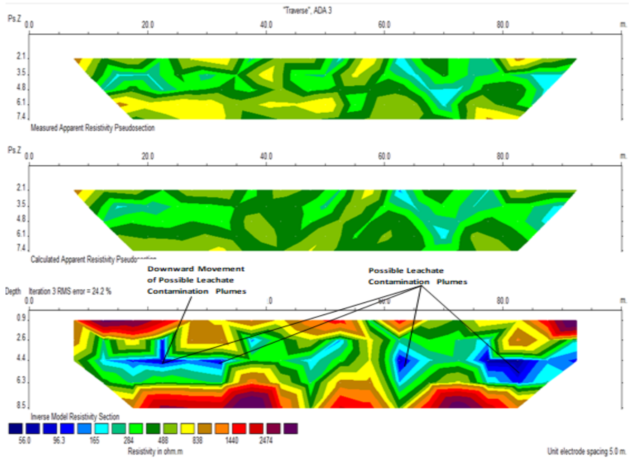

Figure 5c: 2D inverted resistivity structure along traverse 3

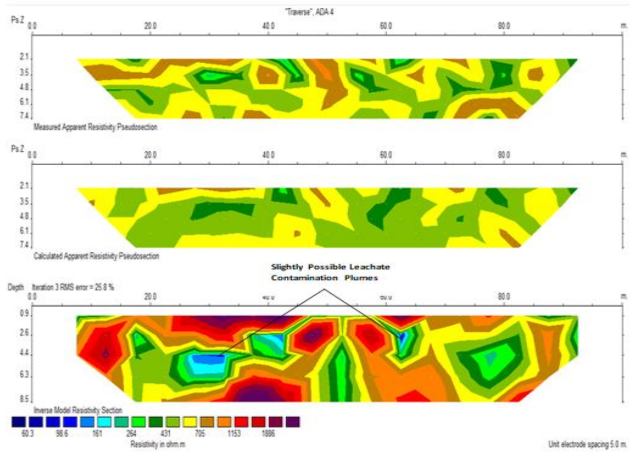

Figure 5d: 2D inverted resistivity structure along traverse 4

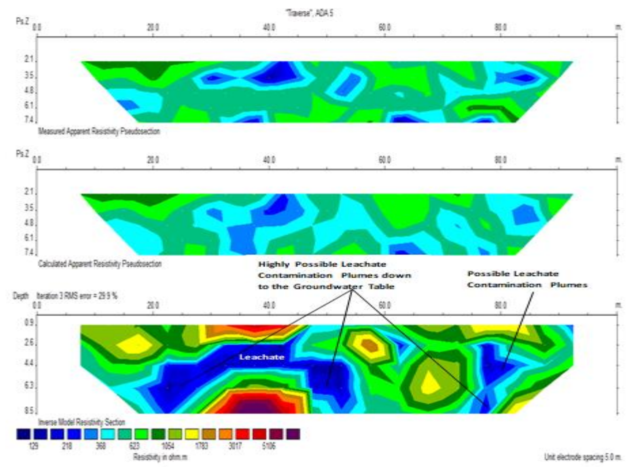

Figure 5e: 2D inverted resistivity structure along traverse 5

The subsurface resistivity response beneath the traverses can be divided into four zones such as low resistivity (Blue colour), moderate resistivity (Green colour), relatively high resistivity (Yellow and Red colour) and relatively very high resistivity (Purple colour). Across the profile, the Blue colour ranges between resistivity 26-368Ωm, distance 0-140m and depth 0-7m. These sections constitute a saturated near-surface material indicative of high impact leachate plumes. The green column constitutes the highly weathered basement typical of clayey sand/or sand materials and remain saturated at this depth extent with resistivity ranges between 0-1142Ωm, distance 0-320m and depth 0-37m. The yellow and red column overlies the fresh basement (B) as purple coloration with resistivity ranges between 675-3017Ωm, distance 30-85m. The column traverses across the entire traverse. This constitutes the partially weathered/fractured basement column. The purple column is suggestive of a fresh basement (B) and basal unit occurring dominantly between stations resistivity 1749-5106Ωm, 0-85m and depth 0-8.5m.

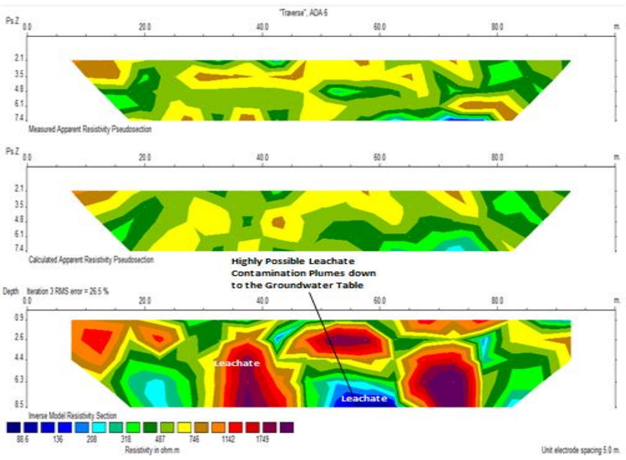

Figure 5f: 2D inverted resistivity structure along traverse 6

3.2 Natural Electric Field (NEF) Results

An internal algorithm in the PQWT instrument analyzed the collected natural electric field data, and the output was a frequency curve and a profile map showing the electric potential difference (EPD) per traverse. The frequency curve model is the electric potential difference curves, which are plotted against the profile distance while the profile map gives a subsurface image of the electric potential difference with respect to depth and profile distance. The points of convergence (C) or very low EPD signals on the frequency curve model correspond to a medium with low resistivity on the profile map as reported by [32]. The results of the NEF imaging revealed zones of weathered basement, weathered-soft (fractured) terrain, fresh basement, rock content, polluted aquifer, low/high yield aquifer, shallow/deep aquifer and leachates.

The significance of convergence points (C) on the 1D model and their corresponding features on the 2D model, particularly in relation to identifying fluid-filled mediums or layers with low resistivity, is from the relationship between the wavelength and the frequency as shown in Equation 9, such that.

$$f = \frac{c}{\lambda} \tag{9}$$

If the frequency of an EM wave is known (which was presented in frequency curve maps), the wavelength can be easily determined, since all EM waves travel at the speed of light, where f is frequency, lambda is wavelength, and c is the speed of light. Therefore, a point of convergence (which is represented as C) of electrical potential difference (in mV) curves at varying frequencies on 1D model corresponds to a porous medium filled with fluid or a weathered rock formation [24]. Meanwhile, a high divergence of electrical potential difference curves could indicate a highly resistive, highly compacted or hard rock terrain. In EM prospecting, the penetration depth is dependent on the electrical conductivity of the stratum and the frequency at which the EM field is propagating [24]. The amplitude of the EM field decreases exponentially as it penetrates the subsurface, which in turn increases the penetration depth as the EM frequency and the conductivity of the stratum decrease [24].

The result of NEF measurement along profile 1 (P1) trends from west to east orientation with a total length of 60m which matches 30 data points. The convergence (C) points were present on the frequency curve Figure 6a, with linear stream-line of electric potential difference curves towards the top. These two features correspond to a concentrated conductive medium being observed on the profile map Figure 6b varying from the surface to a depth of 12m.

The conductive media are interpreted as being saturated with leachates at the topsoil with depth ranging 5–10m across the profile. The layers beneath the leachates are interpreted as weathered terrain and fresh basement, respectively. Groundwater from hand-dug well (< 15m deep) around P1 is unfit for domestic usage, due to the depth of infiltration of leachate contaminants and borehole drilling is not visible due to the fresh basement as shown in Figure 6b.

The result of NEF measurement along profile 2 (P2) trends from north to south orientation. The P2 has a length of 112m with 56 data points. Several convergence (C) points are present with stream-lined curves on the frequency model as shown in Figure 7a.

It was observed that leachate contaminants have infiltrated to about 15m depth as shown in Figure 7b. Meanwhile, most of the identified zones for borehole developments are associated with low yields due to the very small pattern of the conductive media. At distance 16m corresponding to point 8 in Figure 7b, a rock contact was observed. The rock contact could have been the most viable spot for borehole drilling but the contact serves as a collecting trough for leachates, which has made the spot unsuitable for drilling.

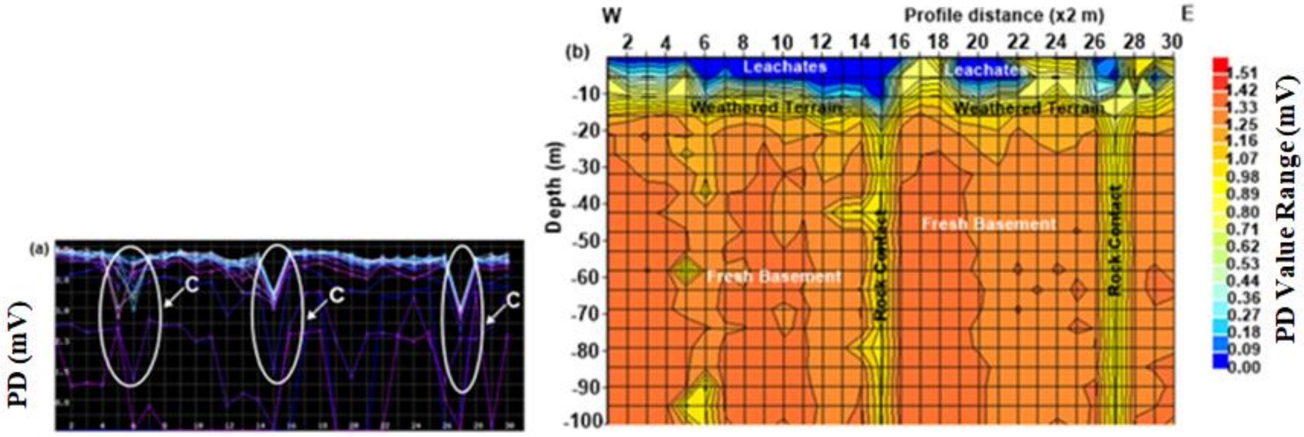

Figure 6: NEF (a) Frequency Curve (b) Profile map of P1

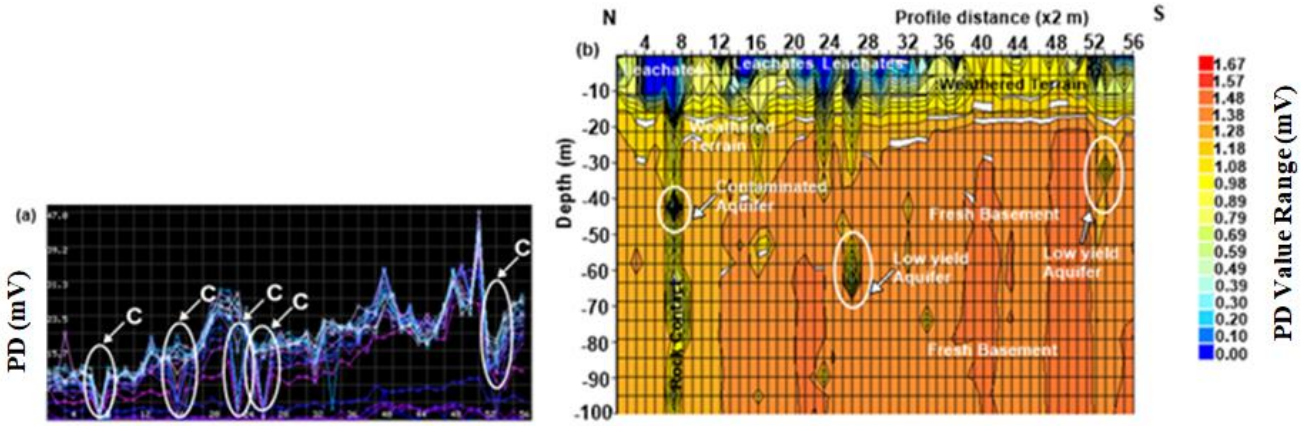

Figure 7: NEF (a) Frequency Curve (b) Profile map of P2

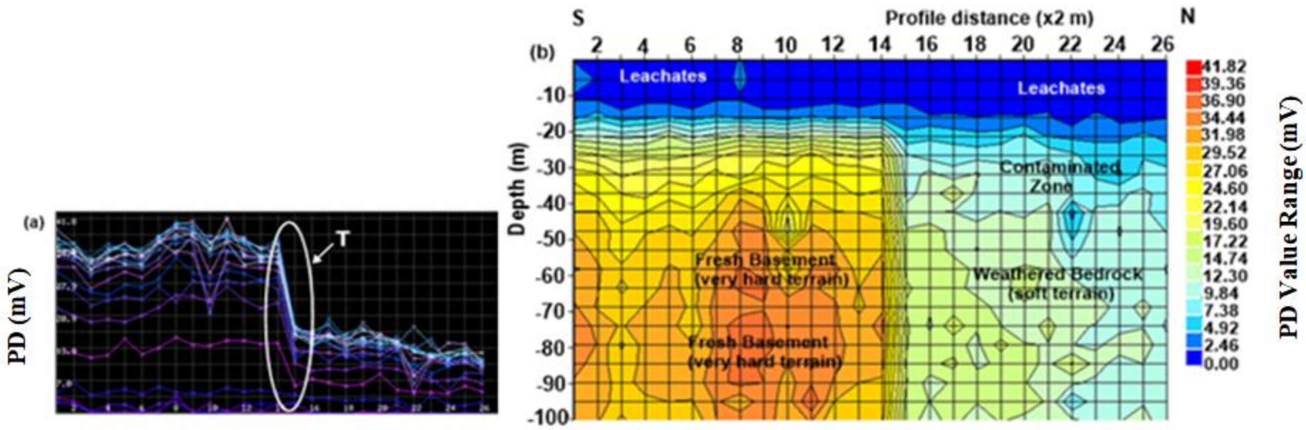

Figure 8: NEF (a) Frequency Curve (b) Profile map of P3

The NEF measurement result of profile 3 (P3) trends from south to north orientation. In this result, a total of 26 data points, culminating to a profile length of 52m was covered. A trench-like shape (T) was noticed at data point 15 i.e. profile distance 30m, which could be interpreted as a contact between two rocks according to Figure 8a. The conductive medium being interpreted as leachate is observed at the first layer in the P3. The leachate's depths varied from 20m (at the south) to a depth > 30 m at the north Figure 8b.

Also, the profile map also depicts the presence two bedrock types (hard and soft terrains) are present beneath the leachates. The soft terrain also known as fractured zone serves as a collecting trough for the contaminants, which justified the thick depth of leachate's infiltrating into the soft terrain along the northern part as revealed in Figure 8b. The result also revealed that there is no viable spot for borehole exploration.

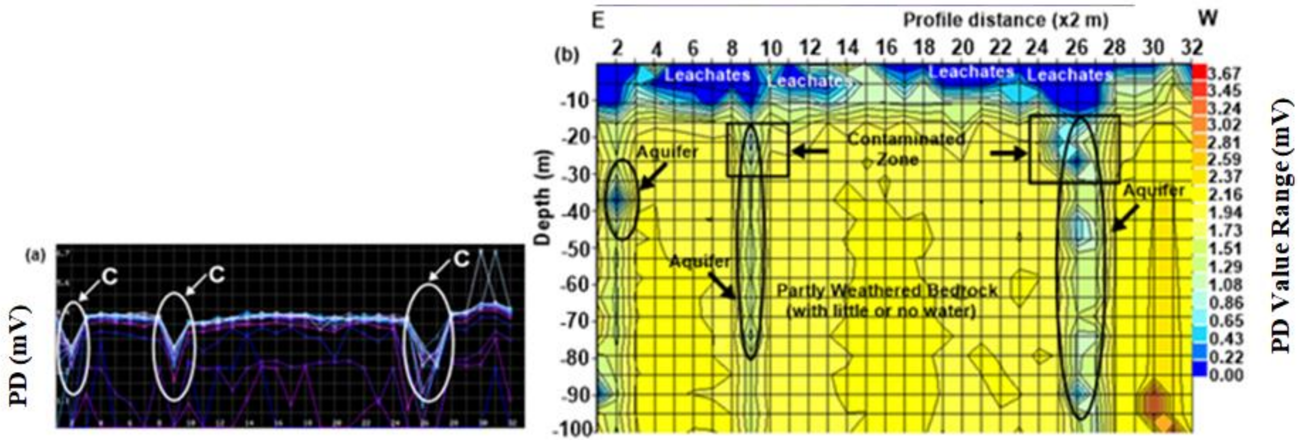

Figure 9: NEF (a) Frequency Curve (b) Profile map of P4

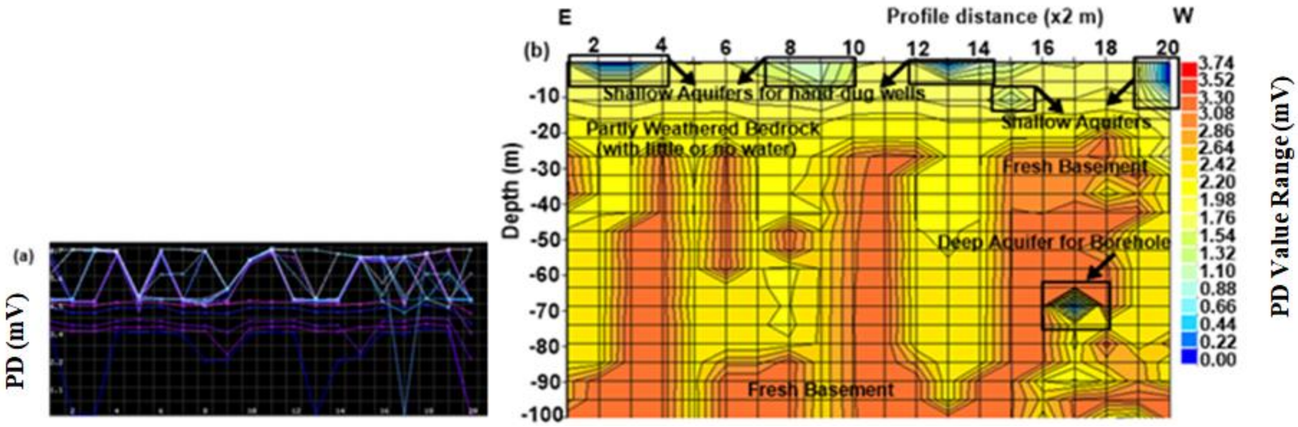

Figure 10: NEF (a) Frequency Curve (b) Profile map of P5 (control)

The NEF measurement result along Profile 4 (P4) trends from east to west direction. It has a total length of 64m corresponding to 32 data points. The convergence (C) points in Figure 9a correspond to conductive zones, which are interpreted as aquifer. In this result, the average extent of downward flow of leachates is about 15m from the surface as shown in Figure 9b.

However, to exploit viable aquifer with uncontaminated water in P4, it is advisable to drill to about 35m, 40-60m and 40-90m at distance 4m, 18m and 32m which correspond to data points 2, 9 and 26, respectively. Beneath the leachates medium lies the partly weathered bedrock, which could be interpreted as the granite gneiss being the major rock type found in the study area according to [42]. The result of P4 also revealed aquifer contamination zones depth 25m toward the east and west direction due to the distribution of leachates.

The NEF measurement along profile 5 (P5) trends from east to west direction, with a total length of 40m, corresponding to 20 points as shown in Figure 10a. The direction of P5 is located at about 500m away from the dumpsite to the south, which acted as the control profile. The signatures of the upper layer of P5 differ from other profiles, while the bedrock signatures are of the same trend. The shallow aquifers mapped in Figure 10b are <10m depth, which correspond to the range of water table (1.8-5.3m) in the study area.

A deep aquifer suitable for the development of sustainable borehole is present at distance 32m which corresponds to point 17 in Figure 10b, with approximate drilling depth of 70m. If this point is properly managed, it could be explored for a mini-community water project, since other profiles around the dumpsite have been contaminated with leachates according to [43] and [44].

3.3 Leachate Infiltration of the Study Area

It was revealed that the leachate infiltration was evenly distributed across the study area as shown in leachate infiltration base map Figure 11a. From Figure 11b, the result shows that 80% of the leachate infiltration was as a result of the un-controlled dumpsite facility around the study area, while the 20% non-leachate infiltration was because the area was farther from the dumpsite and acted as the control location. The results demonstrated that dumpsite facility have negative impact on groundwater quality due to its contamination activities of the hydraulic contact between the hazardous contents of the leachate plumes and groundwater.

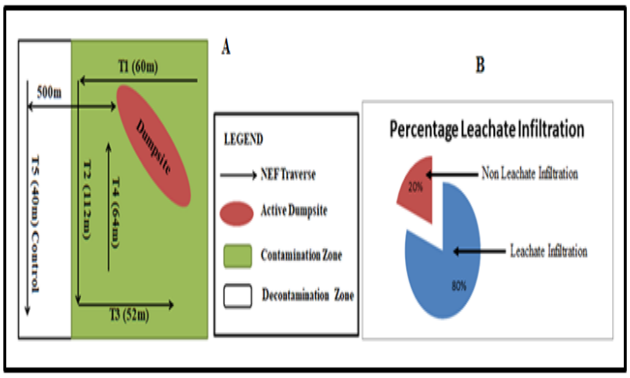

Figure 11: (a) Leachate infiltration base map (b) Percentage Leachate Infiltration

Consequently, the NEF results of traverse 1, 2, 3, and 4 suggested that groundwater quality is not suitable within the study area as shown in Table 1. This is due to the evidence of leachate infiltration from the dumpsite. However, NEF result of traverse 5, recommended the possibility of shallow and deep well exploration.

Table 1: The Summary of Groundwater Quality from the NEF Measurement

Profile	Groundwater Value	Observations
1	Not suitable	Leachate infiltration
2	Not suitable	Leachate infiltration
3	Not suitable	Leachate infiltration
4	Not suitable	Leachate infiltration
5	Recommended	Swallow and deep drilling at depth 5m and 70m respectively

Additionally, the presence of geological barriers may aid to prevent penetration into the deep aquifers, whereas fractures and partially weathered/soft terrain may serve as contamination conduits for the shallow aquifers surrounding the dumpsite. According to [45] a dumpsite needs to be appropriately designed, built, and maintained using engineering principles in order to reduce the influence of such leachate on groundwater quality and the ecosystem as a whole.

3.4 Discussion

The findings of this research revealed that the presence of leachates in the study areas is importance in groundwater environmental studies and these methods revealed that the groundwater development in the study area is of low yield and it's affected by leachate contamination. According to [46] and [47], reported that groundwater contamination from leachate is caused by high-conductivity routes passage through fractures and weathered rocks, which is experienced in the study from the topsoil to the water table. However, [48] and [49], drinking water from areas contaminated by leachate puts users' lives in danger because waste degradation can continue for years after it has been disposed.

Consequently, leachate plumes infiltration was significantly observed deeply at Figures 5e and 5f, down to the groundwater table. These zones of low resistivity with blue color codes from the observed dipole-dipole require special attention. As evidence in the NEF results, leachate migration were visible along profile one with depth 12m, along profile 2 depth 15m, along profile 3 depth 20m at the south and 30m at the north, and along profile 4 depth 15m. The downward movement of leachate within the dumpsite from the NEF results is consistent with the dipole-dipole results of the leachate contaminated zones as reported by [50].

The variation experience in NEF P5 and dipole-dipole 5d acts as the control and it is located 500m away from the dumpsite (to the south). Therefore, the findings from the two results revealed the presences of leachate infiltration from the dumpsite and its surroundings. Thus, due to the evidence of a fractured basements that encourage infiltration, the relative distribution of high conductivity values observed in the two models showed that the influence of leachates contamination may occur, which will have impact on the groundwater quality.

Furthermore, for electrical resistivity, low resistivity values in a crystalline basement complex correspond to aquiferous media [3]. Meanwhile, convergence of curves on 1D model always results to low electrical potential difference values being display as a 2D model. Low electrical potential difference values could be as a result of rock contacts, fracture or weathered rocks, which correspond to a viable zone for groundwater exploitation and borehole development [51].

Also, the key factors contributing to the broad base investigation within the study area are the fluid contents in porous media within the subsurface. The choice of the electrical resistivity (ER) array that was used in this study is to compare the model produced by the NEF to the one produced by the ER model, such that a meaningful conclusion can be made. However, the choice of adopting the dipole-dipole in this study is because of its high resolution to reveal the 2D imaging of the area of interest in the near-surface such as lithology [18].

In regards to this, the use and application of geophysical method(s) in environmental study is not to assess the quality of water (such as physical and chemical parameters of water) in the subsurface but to assess the extent or degree of interaction or communication between the aquiferous medium and the contaminated zone, since leachate's pathways to aquiferous media are chiefly governed by gravity [24]. Under the influence of rainfall, gravity permits leachates to flow vertically and laterally within the subsurface until it is able to reach or interact with the nearest aquifer along the flow path [52].

4.0 CONCLUSION

This research gave insight into the status of the illegal dumpsite in the study area using noble methods for the monitoring and accessing the leachate impact and extent on the groundwater quality of the Ojoou Olayanju's Dumpsite and its surroundings. The geo-resistivity and natural electric field (NEF) methods revealed a deeper understanding of groundwater contamination from leachate infiltration in the area. The contaminant's vertical infiltration from the dumpsite to the groundwater unit was discovered through analysis and processing of the collected data. The results come from the blue colour codes across the geo-resistivity and NEF methods, in which the subsurface structure shows the topsoil, the weathered layers, the hard and soft weathered terrain, rock contact and fresh basement and the broken subsurface which shows the aquifer layer in the study area. According to the geophysical analysis, the extremely soft terrain, also known as the fractured zone, makes it easier for the uncontrolled dumpsite facility, which is the cause of contamination, to swiftly reach the groundwater table and contaminate this natural resource. This implies that the groundwater quality might be at risk of contamination due to the continuous filtration of leachate. As a result, both findings conclude that:

- The nearby aquifer is seriously endangered by dumpsite leachate.
- It is possible to reduce the negative effects of such leachates on the ecosystem and groundwater quality by carefully planning, building, and operating dumpsite facilities using geophysical techniques.
- The study area is situated on a crystalline basement with thin overburden. Shallow aquifers exist within the weathered rocks while deep aquifers exist within fractured bedrocks.
- Hand-dug wells can be developed at the shallow aquifer zones, while borehole is strictly advised to be drilled at the deep aquifer zones.
- It is advisable to drill borehole for the use of the community dwellers because it will serve as a sustainable means for the dwellers in the dry season.
- Contaminant waste disposal sites should be situated far away from inhabited areas.
- For an extended duration, it is recommended to conduct routine groundwater monitoring in that area to confirm the impact of leachate pollutant concentrations.

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