ISSN 2756-4444
E-ISSN 2756-4452

GEOPHYSICAL INVESTIGATION OF CONTAMINANT PLUME OF OFFA-GARAGE OPEN DUMPSITE, ILORIN SOUTH L.G.A., KWARA STATE, NIGERIA

BY

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Abstract
2-D Electrical Resistivity Profiling (2-D ERP) method was deployed to map the extent of leachate contamination in near-surface soil and rocks around Offa-Garage open dumpsite in Ilorin, Kwara State, North Central Nigeria. The ER profiles were carried out in the month of November (Dry season) and repeated in the month of September (Raining Season). Ilorin lies within the coordinates of 4^0 28.67' E, 8^0 27.2'N; 4^0 35.76' E, 8^0 27.2'N; 4^0 28.67' E, 8^0 35.2'N and 4^0 35.76' E, 8^0 27.2'N; 4^0 35.76'E, 8^0 35.2'N. Electrical Resistivity Profiling was established using DDC-8 resistivity meter by adopting Werner alpha configuration with half – currents electrode spacing that ranged from 1 to 100 m. A contaminant leachate plume was delineated in 2-D resistivity sections as low resistivity zones in the range 0.644Ωm -3.15Ωm for the month of September identified as raining season period and 0.649Ωm -2.89 Ωm for the month of November as dry season period of the year under study. The spread of leachate was observed in the range of range of 22.0 -27.0 m laterally and 1.35 -7.88m vertically in the study location for the months Under study. The result showed that location have been contaminated due to the migration of leachate. This was evident from the Low Resistivity values of the ERT. The Conclusion from this study was that leachate is present in the area.
Keywords: Leachate plume, health hazard, geophysical, resistivity

Introduction

Wastes are the unwanted or useless solid materials generated from the combined residential, industrial, and commercial activities of a given area. Solid wastes could be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper, etc.) or according to its hazard potential (toxic, non-toxin, flammable, radioactive, inflections, etc.). Municipal Solid Waste (MSW) are described as domestic as well as commercial waste that account for a relatively small part of the total solid waste stream in developing countries (Adefemi and Awokunmi, 2009)). Over the last couple of decades there has been an increase in the effect of environmental pollution on the health of the populace due to the improper disposal of waste. Improper waste disposal has become a major environmental issue affecting not only the health of the general public (health hazards) but also the surrounding environment (environmental hazards). The most prominent result of health hazards is the wide spread of communicable diseases like cholera (Agboola *et al.*,2018). Inappropriate disposal of solid waste may lead to contamination of surface and underground water through leachate, soil contamination through direct waste contact. Meanwhile, a contaminant is a substance or agent present in another substance, environment, or system, causing impurities, pollution, or undesired effects. They often have negative impacts on health and ecosystems, while it can arise from natural source or human activities. monitoring and managing contaminants are crucial for environmental and public health. (Aurangabadkar *et al.*,2001; Sunmonu *et al.*,2012).

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Dumpsites are areas where waste materials are disposed and are viewed as the oldest form of waste treatment. Most dumpsites are located within the vicinity of living communities and wetlands. Local dumpsites are often not lined nor basement prepared for selective absorption of toxic substances. Therefore, it is prone to release of pollutant to nearby water through leachates. The decomposed waste releases odour which affects the people living around such dumpsites, implies that the dumpsites have serious effect on people around its environment (Aurangabadkar *et al.*,2001; Singh and Mosley, 2005; WHO, 2002; Akinbiyi,1992). Like many cities or town in Nigeria, Offa-Garage (figure 1) is faced with the problems of improper collection, handling and disposal of domestic wastes. It is therefore imperative to provide necessary information on groundwater contamination that could support the government in finding lasting solution to the menace. There are a variety of methods that can be used to identify and monitor contaminants in the environment. Geophysical techniques, such as the electrical resistivity tomography, electromagnetic methods, and seismic methods, these methods can be used to detect the presence of contaminants and to map the extent of contamination (Akankpo and Igboekwe, 2011; Agboola *et al,* 2019) Among the available geophysical methods, electrical resistivity (ER) and electromagnetics (EM) have been reported as suitable in waste landfill characterization and delineation (Bernstone *et al*, 2000; Akpan, 2004)). In this study, the electrical resistivity (ER) method was applied to detect and delineate leachate plume from uncontrolled solid waste dumpsites in Offa-Garage, Ilorin South, Kwara State, Nigeria. However, this study is aimed at investigating possible Groundwater contaminant signature at Offa-Garage open dumpsite in Ilorin metropolis.

Methodology

The study covers Offa-Garage dumpsite (Figure 2) within Latitude 8° 30’ 10’’N to 8° 30’ 20” N and Longitude 4°33’ 20” to 4°33’ 21” E in Ilorin South Local Government areas of Kwara State, North Central Nigeria. The study area, being in Ilorin, it falls within the Guinea Savannah region of Nigeria with two major weather conditions viz; rain and dry season. The rain season commences around March and ends in October with annual rainfall estimate within 75mm to 112 mm, while dry season begins in November and ends in April. The humidity ranges between 60% to 89% and mean annual temperature is between 27 to 30°. They are within the Precambrian basement complex of south western Nigeria which consists of Granite Gneisses and Migmatities (Rahaman, 1976: Oluyide, 1979). According to Olasehinde, Virbka and Esan 1998, llorin is situated on the undifferentiated Precambrian Basement Complex rocks of granitic and metamorphic origin. These rocks represent the deeper, fractured aquifer which is partly overlain by a shallow, porous aquifer within the lateritic soil cover (Annor and Olasehinde, 1996)

ISSN 2756-4444
E-ISSN 2756-4452

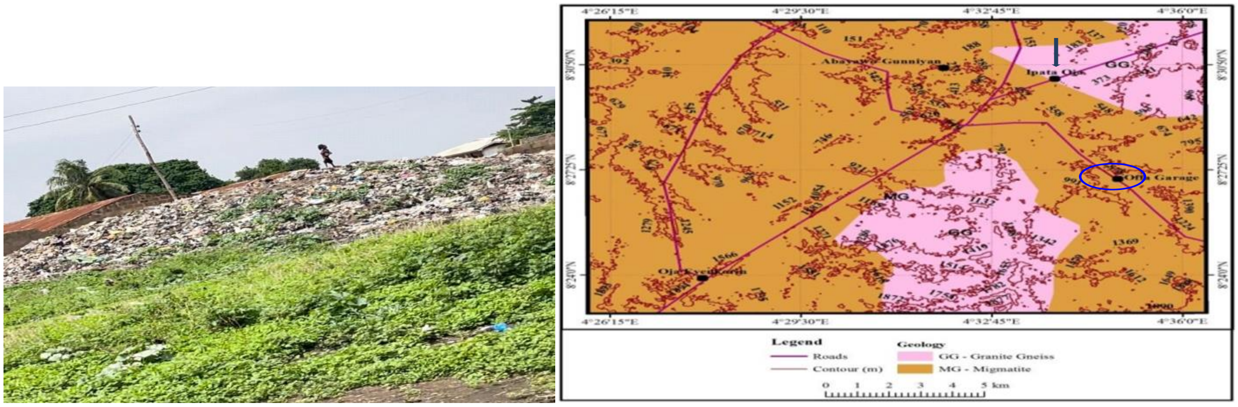


Figure 1: Geological map showing the study area

The following materials were used for data acquisition in this work:

(a) **Resistivity Meter (Terameter): -** The terameter used was a fully automated resistivity meter (DDC-8) with a composite unit made up of a transmitter and a receiver, usually powered by either direct current (DC) or low frequency alternating current (AC) source (Plate 1)

(b) **Electrodes: -** They are metal stakes through which electrical signals are transmitted and received to and from the ground respectively. They are made up of stainless steel with high strength and resistance to corrosion, about half a meter long and driven into the ground several centimeters for good electrical contact. Four electrodes were employed, two current and two potential electrodes (Plate 1)

(c) **Cables: -** Four reels of cables made up of multi-strand copper wires insulated with PVC were used, connecting each electrode to the terameter (Plate 1)

(d) **Hammer: -** They are used to drive the electrodes into the ground to ensure firm contact. (Plate 2)

(e) **Compass-** Clinometers: **-** Used in the bearing location.

(f) **DC Source: -** It is used to power the resistivity meter in order to send the current into the subsurface. (Plate 1)

(g) **Global Positioning System:** This is used to obtain the global coordinates and elevation of the sample VES points. Hand-dug well and Study Areas.

(h) **Cutlass: -** It was used for cutting down bush along the profiling and sounding area.

(i) 100m tape rule (Plate 2)

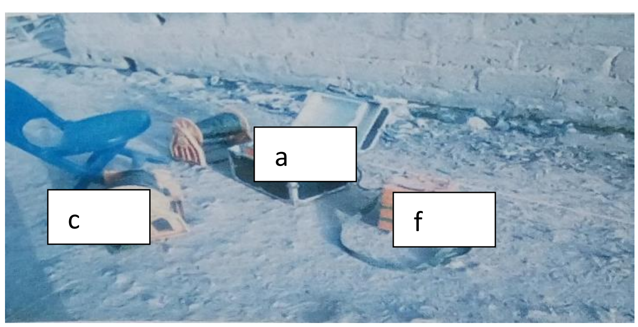
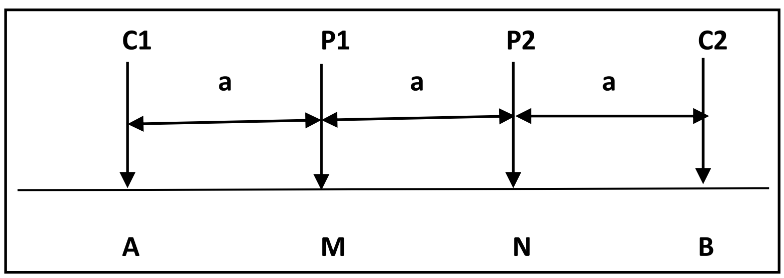


Plate 1: (a) Resistivity Meter (Terameter) (c) Cable (f) DC Supply

Plate 2: (b) Electrode (d) Hammer

In this study, Wenner alpha array electrode configuration was employed using Direct Data Capture (DDC-8) Resistivity Meter. Electric current (I) was introduced into the ground through a pair of electrodes A (Cl) and B (C2), while electrodes M (P1) and N (P2) measured the potential difference (ΔV) (Figure 3 and plate 3). Profiles were established on the dumpsites and outside the dumpsites area at the extent of 100m. This operation was repeated each time the electrode spacing (distance between A and B electrodes) was increased, which is associated with greater increase in the depth and volume of the ground. The electrode spacing (a) ranges from 1 to 20m which was considered satisfactory for the required information about the near-surface geo-electrical anomalies and possible environmental problems due to probable leakages in the study area. Values of apparent resistivity (ρ_a) were read and recorded directly from the resistivity meter. The field data collected were input on Microsoft Excel and notepad software, the raw data was processed by applying RES2DINV (Loke *et al*,1997) modelling software which automatically generates 2-D inverted electrical resistivity-depth model of the subsurface for the established profiles.



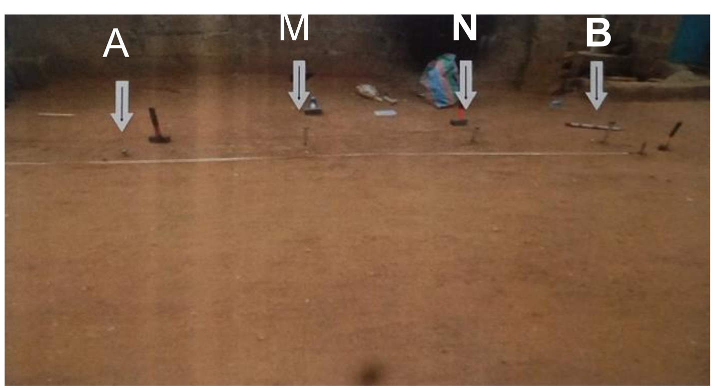


Plate 2: Conventional arrays of four electrodes to measures the subsurface resistivity.

Results

In the analysis of ERP results, color code is an integral part of the results presentation because they depict some features. However, in this result, the color code observed ranges from Red to Violet in the 2-D electrical resistivity tomogram. The blue color represents the area of low resistivity values along the ERP profiles while other colors like green, light green, yellow, brown, deep brown and black depicting places of high resistivity values which could be linked to the presence of Igneous and metamorphic rocks. Figure 4a and figure 4b represent the ERP results obtained from the dumpsite showing the area of blue color, spreads out laterally and vertically, representing the region of low electrical resistivity values. Figure represents the ERP control results obtained at 100m away from the dumpsite showing high resistivity values. According to the results, contaminant was delineated in 2-D resistivity sections for the studied location (Figures as low resistivity zones represented by the blue color .The results were interpreted in terms of the resistivity signature expected of contaminated soil and rocks (Karlik and Kaya, 2001; Porsani et *al*., 2004; Ramalho et *al*., 2013).As shown in the 2-D ERP profiles (Figures 4a and 4b), Offa-Garage Dumpsite was characterized by very low resistivity (or very high conductivity) in the range of 0.644Ωm -3.15Ωm for the month of September identified as raining season period and 0.649Ωm -2.89 Ωm for the month of November as dry season period of the year under study. These low resistivity values were interpreted as signatures of contaminant observed due to the waste materials dumped in the areas under investigation. The results depict traces of contaminant presence. Comparing the 2-D ERP profiles obtained on the dumpsite (Figures.4a and 4b) to the profiles 1000m away outside the dumpsite as control site (Figure 5), it was noted, generally, that rocks outside the dumpsite are more resistive than those within the dumpsite. This comparison shows that the present of contaminant in the investigated dumpsites is responsible for the low resistivity values measured in the area. This suggests the presence of leachate.

The results of ER Profiles from 2-D resistivity sections of the study location (Figures.4a and 4b) depicts the spread of leachate in the range of 22.0 -27.0 m laterally and 1.35 -7.88m vertically in the study location for the months of September and November in the year under study. The low resistivity values could not be interpreted as groundwater because the depth is too shallow and the resistivity values are too low.

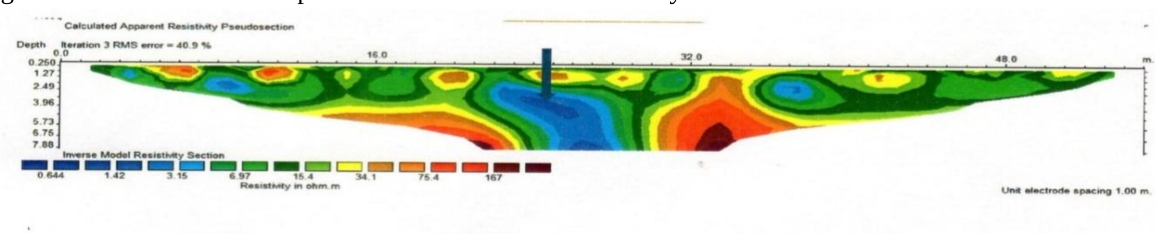


Figure 4a: 2-D Electrical resistivity tomograms for the ERP profiles E - W Direction of Offa-Garage for the month of September.

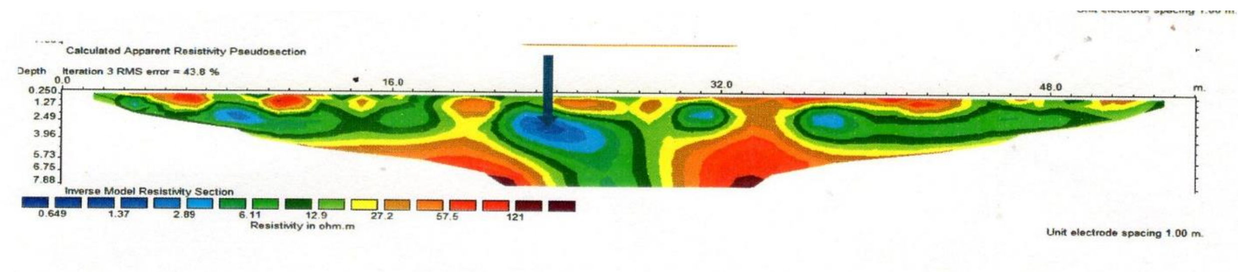


Figure 4b: 2-D Electrical Resistivity Tomograms for the ERP Profiles E - W Direction of Offa-Garage Dumpsite for the month of November

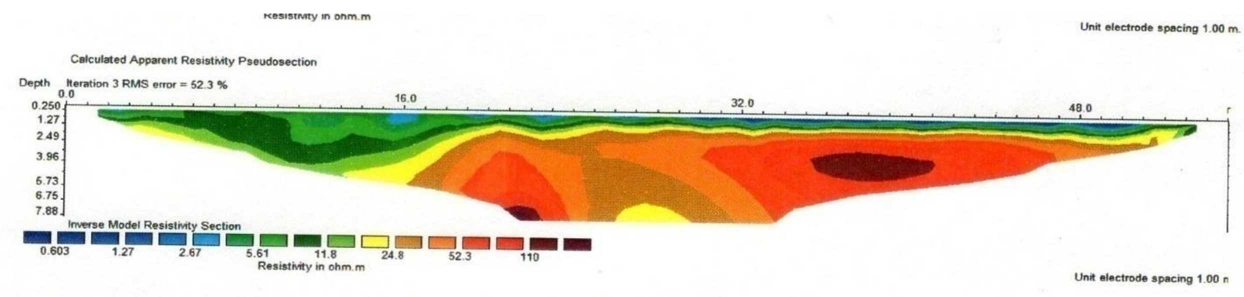


Figure 5: 2-D Electrical Resistivity Tomograms for the ERP Profiles E - W Direction of Offa-Garage Dumpsite Control.

Conclusion

The study revealed that, the dumpsite under investigation have been considerably contaminated due to infiltration of contaminant which could pose some health risks to the residents. This is evident from the Low Resistivity values obtained from the result of the ERT. The hydro geologic features of the study areas showed that contaminants derived from the waste disposal site infiltrate through vulnerable sandy formations and hence probable to the groundwater flow. The conclusion from this study was that contaminant is present in the area within the depth range of 1.35 -7.88m and spread in the range 22.0 -27.0 m.

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