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Preliminary Assessment of the Extent of Contamination of Selected Dumpsites' Soil in Port Harcourt Using Geophysical Method

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Abstract: **This article is focused on the application of geophysical method for the preliminary assessment of soils contamination around Igwuruta and Eliozu dumpsites in Port Harcourt city. An assembly of geophysical tools was installed in the study locations. Basic components of the assembly include set of geo-electrical cables, four metal electrodes and a resistivity meter. Others were DC source (or battery cell), tape and hammer. Streams of electric currents were sent into subsurface while the resistances were measured in return. The resultant data obtained were processed with the aid of proprietary software (RES2DINV) into 2-D imagery or tomogram. These tomograms were characterized by diverse colored segments ranging from bluish colored zones to reddish-purple colored zones. The significance of these colored zones formed the basis for ERT interpretation. Evidence of pollutants leached into the soil geological strata for the two dumpsites were confirmed in the ERT as low resistivity zones, while those for chemical or landfill gases zones were in the high resistivity zones. However, the nature and concentrations of the pollutants could not be established from the tomograms, hence the need for confirmatory test methods for the dumpsites soils.**

Keywords: **pollutant, dumpsite soil, leachate plume, electrical resistivity tomogram, solid waste.**

1. INTRODUCTION

Port Harcourt is a metropolitan city with high concentration of commercial and petroleum industry activities. The city has a population of about eight million people. The economic main stays of the populace are heterogeneous and diverse in nature. Some of them work in civil service, oil and gas industry, corporate private firms (such as banks, schools, hotels, hospitals etc) and small scale personal businesses. Large quantities of solid wastes are generated from all these sectors, collected and disposed off at dumpsites without any form of treatment. These disposal sites are presently located at the outskirts of the city especially at gateways; Eleme, Oyigbo, Igwuruta, Eagle Island, Eliozu and Choba. However, several of these dumpsites are now at the city centers due to urbanization. Human habitats are sited around the dumpsites.

Although, some of these dumpsites have been closed down, but a number of them are still operational such as Igwuruta and Eliozu dumpsites which are presently covered by this study. From these dumpsites, offensive air contaminants are continuously being released or emitted into the environment. The reasons are that the dumpsites are opened and lacked modern facilities for operating engineered landfill such as leachate (or gas) collection system and other treatment infrastructures [1]. Consequently, these dumpsites may constitute threats to ground water quality in Port Harcourt.

From previous reports, improper dumping of solid wastes has been seen as a major challenge to waste management. Other underlining factors affecting proper solid waste management includes over population, poverty and lack of technology to sufficiently manage the wastes [2}, [3] and [4]. Also, absence of inadequate legislation and public orientation may contribute to the deplorable solid waste management situation [5]

In Nigeria, there are laws for regulating solid waste management, for example, the management of hazardous and solid waste regulation acts S.1.15 of 1991 defines the requirements for groundwater protection, surface impoundment, land treatment, waste piles, landfills, incinerators etc as well as requirements and procedure for inspection, enforcement and penalty [6]. The challenge of poor implementation has been the bane to Nigeria's environmental issues [7], [5], and [8]. .

For a typical dumpsite, wastes disposed into it may produce both gaseous and liquid products. These gaseous products affect the general air quality of the environment, while the liquid products (or leachates) cause soil and water pollution. The amount and composition of these leachates can be affected by population growth rate, geographic location, local industry activities, quantity of rainfall, and hydrogeology of soil and social status of the inhabitants [9]. Aside soil pollution; possible ground water contamination can be induced by solid waste dumping as noted by [10].

Therefore, the focus of this paper is centered on the use of geophysical method to ascertain the existence of contaminants in dumpsite soils located in Port Harcourt city. This study used electrical resistivity tomogram (ERT) of the selected dumpsites for the preliminary analysis. This is because, possible inferences that would be drawn from the tomography will require further physicochemical verifications.

2. MATERIALS AND METHOD

Materials:

The main material employed for this investigation is set geophysical equipment, ABEM Terremetre SAS 2000B model. Other accessories include car battery (DC power source), four cables (two potential and two transmissions), four metal electrodes, an industrial tape, geological hammers, special software (RES2DINV) and printer.

Method:

The measurements were carried out in the dumpsite using an array of four electrodes. Two of the electrodes aided the potential difference (ΔV) distribution that arose when electric current (I) was transmitted into geological layers through two other electrodes. The industrial cable was used to mark the intervals of 5 m along a 100 m total distance to be covered around the dumpsite, while pegs were inserted as guides. The electrodes were planted at 0, 5, 10 and 15 m marks, and electric current was then injected through the outer pair electrodes (0 and 15 m marks). The resulting potential difference was recorded from the screen of the measuring device. This procedure was repeated with the electrodes planted at 5, 10, 15 and 20 m marks etc until the entire length was covered. Thereafter, the electrodes were planted at 0, 10, 20 and 30 m marks, and electric current was then injected through the outer pair electrodes (0 and 30 m marks) and the procedure repeated until the 100m length covered. The electrodes were moved from one end of the line to the other in a systematic manner depending on the prevailing spacing to achieve continuous horizontal resolution of the subsurface. The measured resistances R (Ω) along each traverse were converted to apparent resistivity ρ_a (Ωm) using the Ohms law derivation (R=ΔV/I). The measured data were processed using proprietary software (RES2DINV) to plot resistivity measurements against soil depth, thereby given tomography information on estimated resistivity for subsurface formations penetration in both vertical and horizontal orientation.

3. RESULTS AND DISCUSSION

The results obtained are presented in Figures 1 to 5 which represent electrical resistivity tomogram (ERT) for the investigated dumpsites in Port Harcourt as well as that of the control profiles (conducted 1 km away from the dumpsite). Figures 1 & 2 are the ERT for Igwuruta dumpsites, Figures 36 and 4 for Eliozu dump while Figures 5 is the control profile for Port Harcourt.

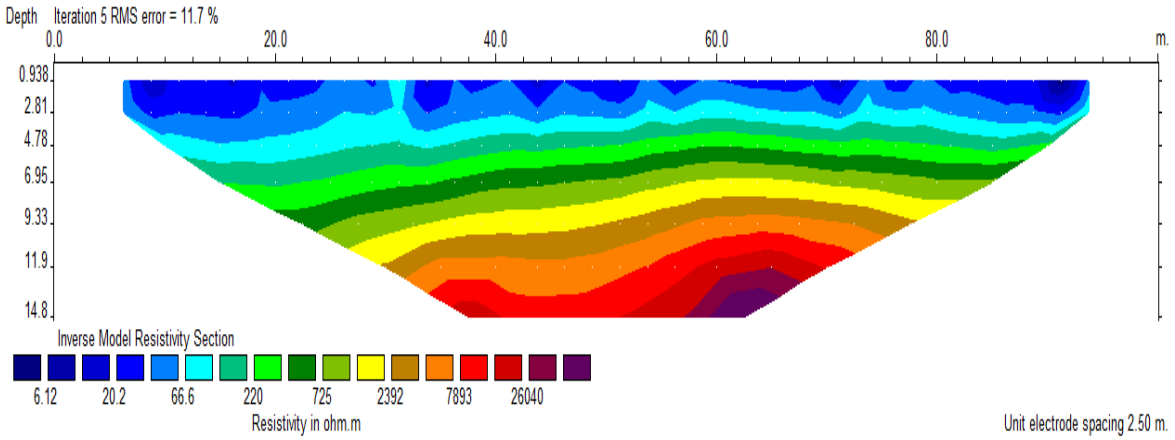

Figure 1: Igwuruta dumpsite Tomogram N-S

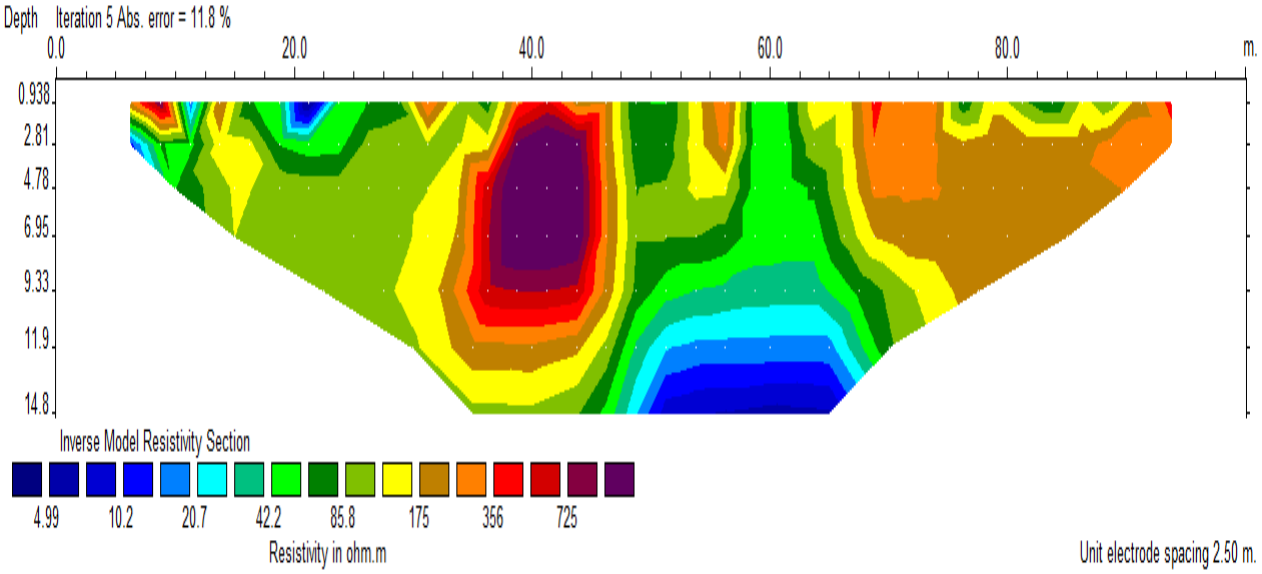

Figure 2: Igwuruta Dumpsite Tomogram 2 (E-W)

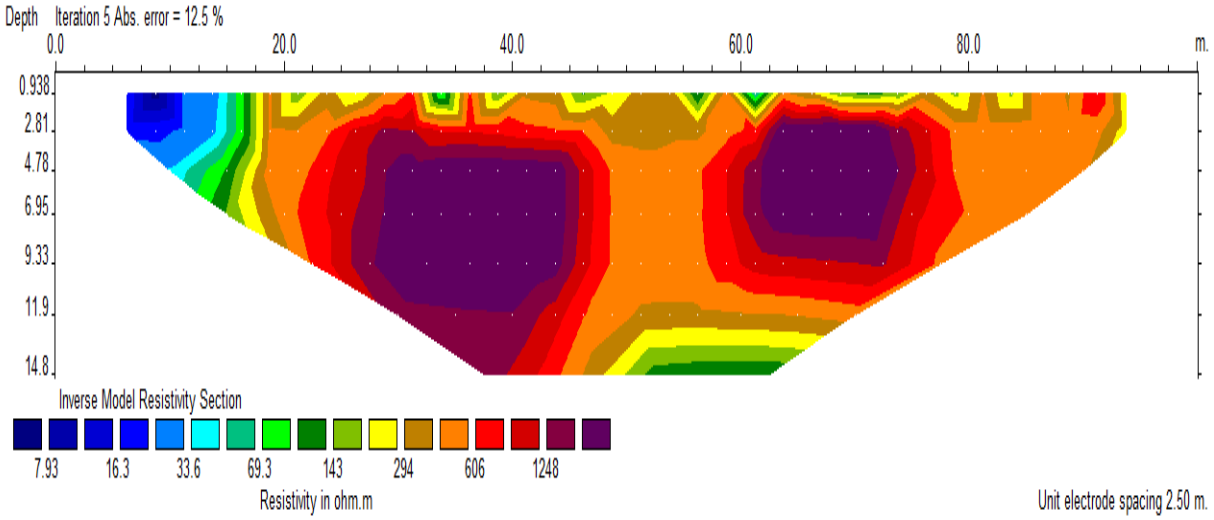

Figure 3: Eliozu dumpsite Tomogram 1 (N-S)

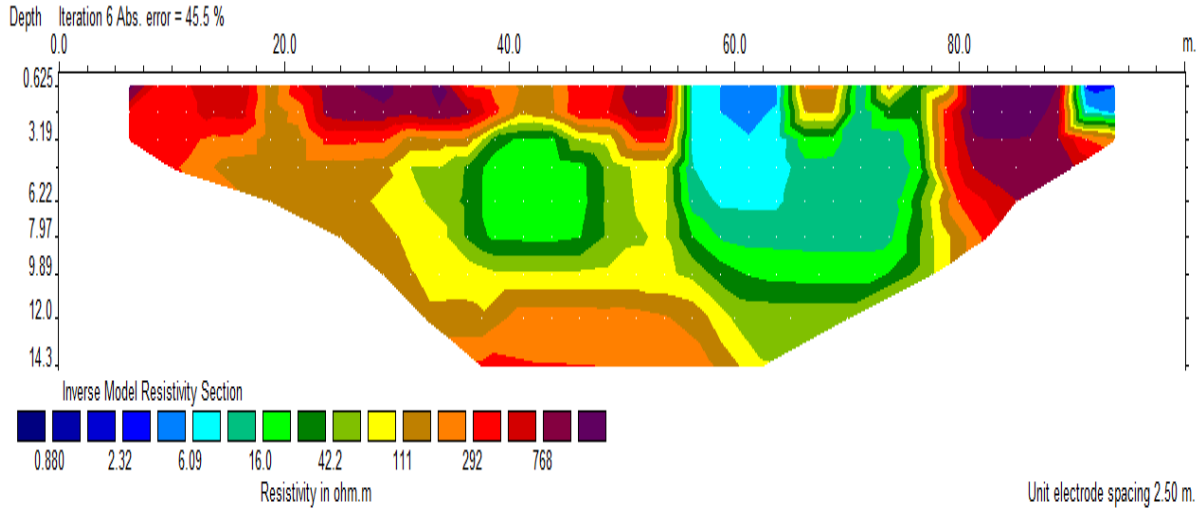

Figure 4: Eliozu dumpsite Tomogram 2 (E-W)

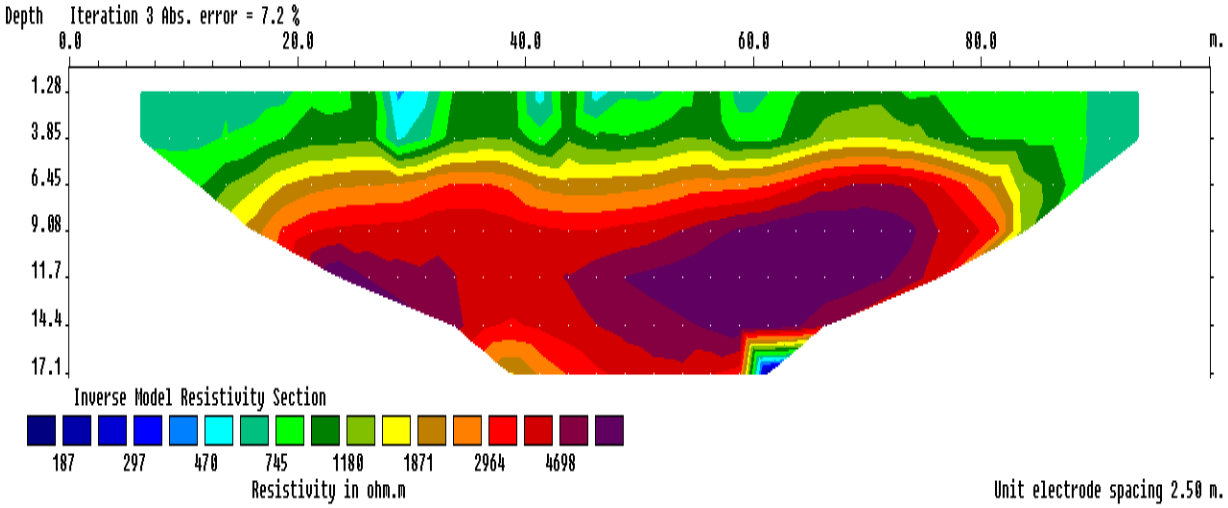

Figure 5: Port Harcourt Control Tomogram

DISCUSSION:

General Impression:

The electrical resistivity tomography **(**ERT) results (Figures 1 to 5) for the dumpsites under study were generated based on soil depth, horizontal distance and soil resistivity. The bluish portions of the tomograms are zones of low resistivity (interpreted as leachate plume), purple to brownish portion is zone of high resistivity (depicting landfill gas or chemical waste) while the yellow portion is zone of water bearing sands. Low values of resistivity in soils are strong indication of ground water contamination.

Igwuruta dumpsite:

The ERT for Igwuruta dumpsite profile 1 (Figure 1) showed the following profiles: low resistivity zones (<66.6 Ωm) at near surface depths of 0.94 - 4.6m, two isolated regions of high resistivities (>26040 Ωm) tending westward with depths > 12m downward and other zones sandwiched between the low and high resistivity zones characterized by decreasing resistivity with depth interpreted to be zones of probable contaminant leachate plume, chemical compounds that are probably landfill gaseous and sands of varying sizes, thicknesses with moisture respectively.

Similarly, Igwuruta *dumpsite profile 2 (*Figure 2) also showed isolated circular zones of moderate resistivity structures (>725Ωm) with depth between 0.938m to 11.9m delineated along the length 38m to 43m horizontally and characterized by chemical compounds (probably landfill gases) similar to profile 1. Low resistivity zone (<20.7Ωm) of depth 11.5m evident around the horizontal length between 45m to 60m, characterized by bluish spectrum were evidence plunges into the soil as evidence of contaminated fluid transport.

Eliozu Dumpsite:

The ERT for Eliozu dumpsite Profiles located NS and EW directions as depicted by Figures 3 and 4 are is transverse about 10m from the edge of the dumpsite. It is characterized by zones of very low resistivity structures (<33.6Ωm), depth between 0.938m to 5.1m delineated along the length 5m to 17m of the section. The observed bluish zones are indications of probable contaminant leachate plume mixed with decomposing waste capable of polluting surrounding soil. Beside the bluish sections there are two oval shaped purple-reddish sections of high resistivity (>1248 Ωm) identified as chemical compounds delineated in previous profiles. These chemical compound (or probably landfill gases) has in between it, some elements of water bearing soils or materials indicating possible ground water contamination.

Similarly, the ERT for Eliozu profile 2 as shown in the EW direction of the dumpsite showed transverse adjacent to profile 1 (Figure 4), while isolated zones of moderate resistivity structures (>758 Ωm) with depth between 0.625m to 5.1m delineated along the length 7.5m to 58m and 80m to 85m of the entire section are evident. These structures are interpreted to contain resistive chemical compounds (or probable landfill gases). Also, near surface low resistivity zones suspected to be leachate plume at length 60m to 63m indicates water bearing structures. This is also observed at the bottom of the profile.

Control ERT profile:

A control ERT for this study is shown in Figure 5. It is measured at 1km away from Eliozu dumpsite, and depicted isolated zones of high resistivity structures (>4698 Ωm) with depth between 6.45m to 14.4m were evident along the length 50m to about 78m of the segment. These profiles are interpreted to be probable landfill gases suspected to have migrated to the area. The residence around the profile also complained of foul odor in ground water which corroborates the inferences drawn from the study.

4. CONCLUSION

The preliminary assessment of Igwuruta and Eliozu dumpsites in Port Harcourt city using the ERT method has shown the existence of probable contamination of soils around the dumpsites. Thus, indicating the relevance of geophysical analysis in solid waste management, Inferences drawn from the 2-D resistivity imaging for these dumpsites has confirmed the evidences of probable leachate plume contamination of soil and groundwater in the environment. These findings corroborate a number of previous works especially those of [11] and [12] which reported that municipal solid waste leachates are characterized by high ion concentrations and low resistivity. However, confirmatory test methods are required to ascertain the validity of these inferences.

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