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# 2D and 3D Subsurface Geo-electrical Resistivity Imaging of Contaminant Plume from Cassava Processing Mill in Uzebba Area of Edo North, Edo State, Nigeria

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**ABSTRACT**: Electrical Resistivity Tomography (ERT) was used to map and detect the subsurface contaminant plumes from the cassava effluents in the various cassavas processing mill in the study area. The result from the 3D resistivity images showed clearly the distribution of the plumes from all the profile lines in the surveyed area. From the results it is evident that at a depth of 2.5m-21.9m with resistivity values between 6.2Ωm-13.1Ωm the plumes were observed. The results thus point out the need for environmental Education and proper management/location of cassava processing mill by the relevant agencies of Government.

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As observed by Begun *et al*. (2009), large quantities of pollutants have continuously been introduced into ecosystems as a consequence of urbanization and industrial processes. These pollutants can be biomagnified in the food chains, becoming increasingly dangerous to human beings and wildlife. Soil is one of the repositories for anthropogenic waste. Biochemical processes can mobilize them to pollute water supplies and impact food chains. Heavy metals such as Cn, Cr, Cd, Ni, and Pb are potential soil and water pollutants. Globally, the problem of environmental pollution has begun to cause concern in most large cities since this may lead to geoaccumulation, bioaccumulation and biomagnifications in ecosystems. Contaminants in the environment are eventually deposited in soils in some form of a low solubility compound, such as pyrite (Huerta-Diaz and Morse, 1992) or sobbed on surface-reactive phases, such as Fe and Mn oxides (Cooper *et al*.., 2005; Hamilton-Taylor *et al*., 2005). Lead is the most common environmental contaminant found in soils. Unlike other metals, Pb has no biological role, and is potentially toxic to microorganisms (Sobolev and Begonia, 2008). Its excessive accumulation in living organisms is always detrimental. Furthermore, Pb exposure can cause seizures, mental retardation, and behavioral disorders in human beings. Heavy metal exposure to human beings occurs through three primary routes namely inhalation, ingestion and skin absorption. All these occur in myriads of places including auto-mechanic workshops. Generally, toxic metals cause enzyme inactivation, damage cells by acting as anti-metabolites or form precipitates or chelates with essential metabolites. According to USDA (2000), acute (immediate) poisoning from heavy metals is rare through ingestion or dermal contact, but it is possible. Chronic problems associated with long-term heavy metal exposures are mental lapse (lead); toxicological effects on kidney, liver and gastrointestinal tract (cadmium); skin poisoning and harmful effects on kidney sand the central nervous system (arsenic). There is a link between long term exposure to copper and decline of intelligence in young adolescents (Lenntech, 2009).

Leachate plumes generated from cassava effluents can be inorganic chemicals similar to those inorganic contaminations from landfills, open wastes disposal sites, salt brines, acid spills and natural salt-water intrusions. Inorganic contaminations from cassava effluents, cemeteries, open waste disposal sites as well as salt brines, acids spills and natural salt-water intrusion are detectable by electrical methods because of their high values of specific conductance, the application of electrical resistivity tomography in tracking the plume from cassava effluents emanating from the processing of cassava which serves as Environmental pollution and contamination to ground water supply has led to this research work.The aim of this research is to establish the reliability of using geophysical method in mapping contaminant plume of

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cassava processing mill location in Uzebba Area of Edo North.

## MATERIALS AND METHODS

***Location of the Study Area***: The study was carried out in Uzebba community were cassava is processed in the Northern part of Edo state, Nigeria.

**Fig 1:** Aerial View of Uzebba Town (Source Google Earth)

*Experimental*: Electrical Resistivity Tomography (ERT) survey was carried out using the Wenner array to obtain the apparent resistivity of the various survey site because of its relativity sensitivity to vertical variations in the subsurface resistivity, moderate depths of investigation and general strong signal strength which is a preferred choice for the survey in a noisy site. A minimum electrode separation of (5m) and inter-lines spacing 10 m was used. In each site of investigation, the field survey was in a square grid format, such that the parallel lines are all the same of 100 m each. The 2D apparent resistivity data for each of the Wenner arrays were collated to 3D data and inverted using a full 3D inversion code RES3DINV. After inversion with RES3DINV the 3D inverted data was extracted and volume rendering image processing technology Voxler 3D software was used to transforms the inverted data into understandable visual models. With Voxler's extensive 3D modeling tools, it is easy to visualize multi-component data for geologic and geophysical models, contaminant plumes, borehole models, or ore body deposit models. Also from the 3D block model, the flow chart/pattern of the contaminant leachate plumes were modeled out in layers.

## RESULTS AND DISCUSSION

The 2D images of all the profiles taken obtained from Uzebba Community in Owan-West Local Government Area are presented in figure 2–9. The images obtained from the Profile lines shows that the depth of investigation is 13.8 m with a horizontal spread of 100 m with resistivity values ranging between 1 Ωm – 455 Ωm

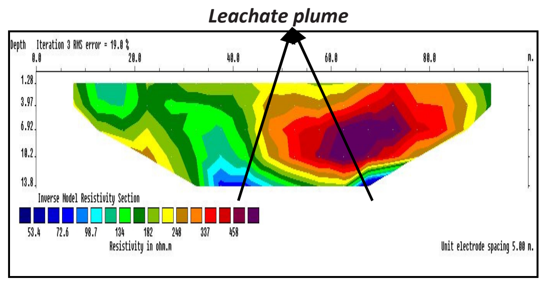


**Fig 2**: Inverted resistivity imaging obtained from Uzebba community profile one.

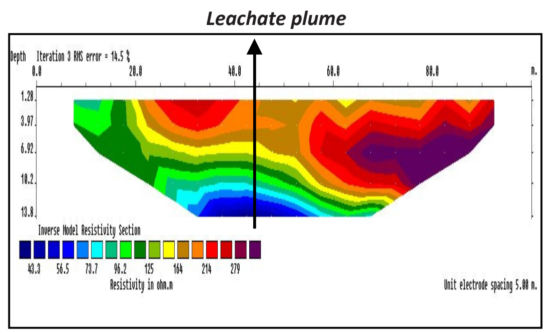


**Fig 3**: Inverted resistivity imaging obtained from Uzebba community profile two.

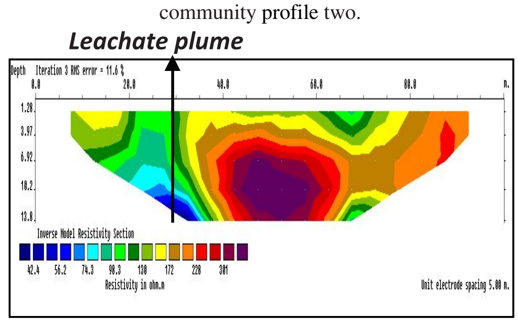


**Fig 4**: Inverted resistivity imaging obtained from Uzebba community profile three

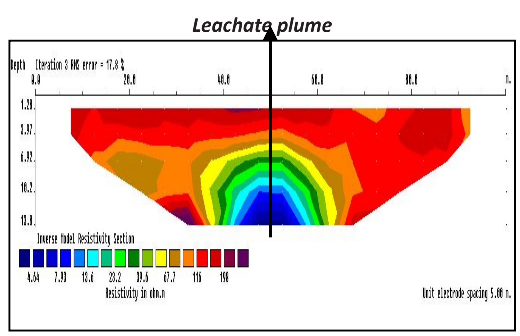


**Fig 5**: Inverted resistivity imaging obtained from Uzebba community profile four.

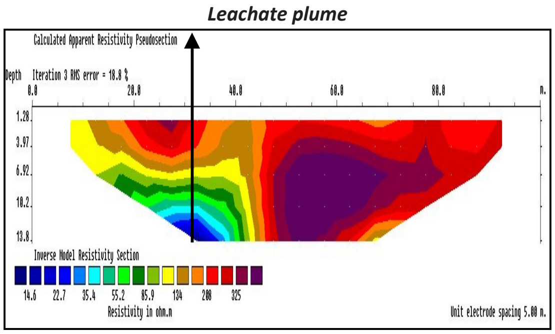


Fig 6: Inverted resistivity imaging obtained from Uzebba community profile five

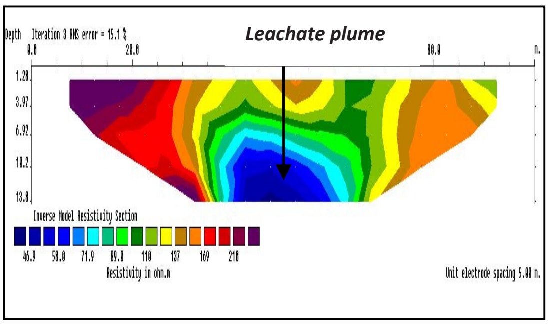


**Fig 7**: Inverted resistivity imaging obtained from Uzebba community profile six

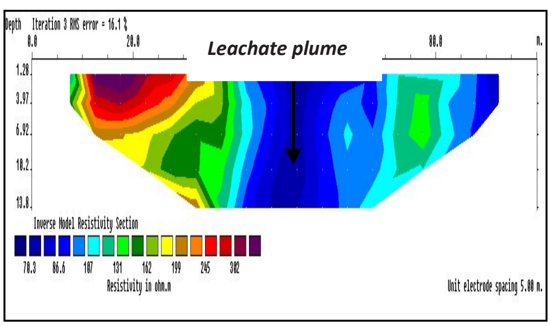


**Fig 8**: Inverted resistivity imaging obtained from Uzebba community profile seven.

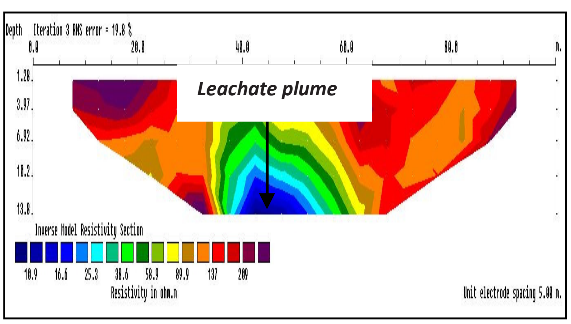


**Fig 9**: Inverted resistivity imaging obtained from Uzebba community profile eight.

Figure 10 is the collated 3D slices obtained in Uzebba community in one of cassava processing station which clearly shows all the eight profiles in 3D format, collated from 2D to 3D. The resistivity ranges from 1 Ωm to 780 Ωm with a depth of 21.9 m.

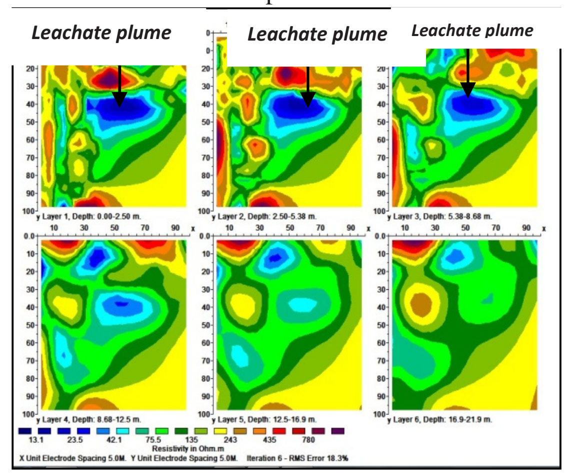


**Fig 10**: Collated Inverted 3D slice obtained from Uzebba community

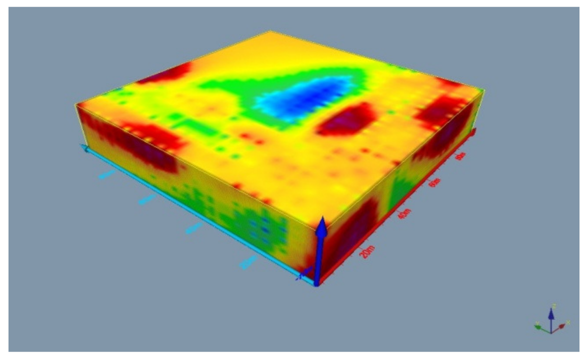

**Fig 11**: The block view of the 3D block obtained from Uzebba community

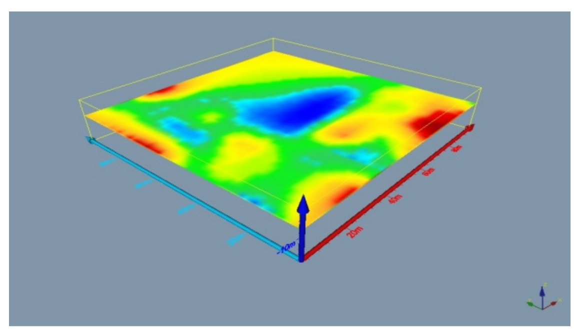

**Fig 12**: the top surface view of the 3D block obtained from Uzebba community

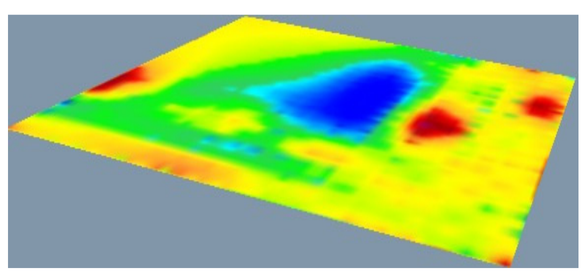

**Fig 13**: The bottom surface view of the 3D block obtained from Uzebba community

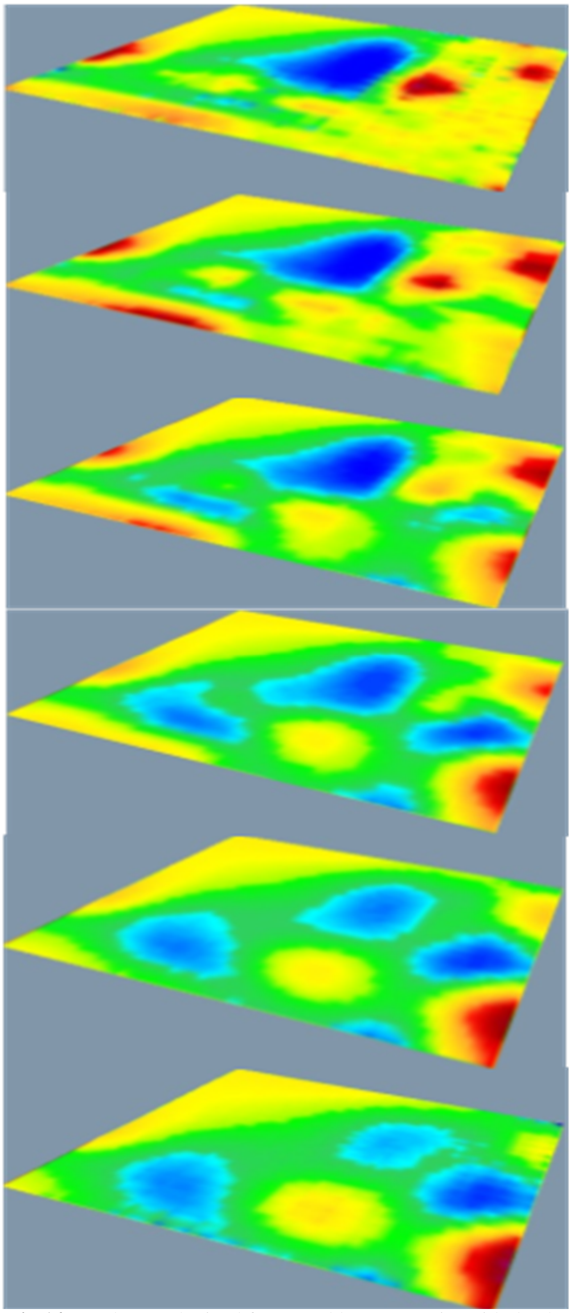

**Fig 14**: 3D layers obtained from Uzebba community with depth

The first layer in Fig 14 fall between 0.00 m - 2.50 m, Followed by the second layer with a depth of 2.50 m – 5.38 m, third layer with 5.38 m – 8.68 m, fourth layer with 8.68 m - 12.50 m, fifth layer with 12.50 m - 16.90 m, and the last layer with 16.90 m - 19.90 m.

The survey in Uzebba community shows that the cassava processing mill is over sixteen years, and hence the area is prone to a good age of leach material that has been wash down to the subsurface by weathering of the cassava waste materials from the top soil to the sub soil which has sediment, the images obtained from the survey clearly shows that the area is contaminated in the eight lines that were profiled. In figure 2 the resistivity of the survey line ranges from 1Ωm to 458 Ωm in the profile with a spread of 100 m and a depth of 13.8 m, The entire profile is characterized by relative low resistivity at the sub layer and the plumes were delineated at a depth of 11 m which indicates area with low resistivity and high porosity with the flow path of the plumes migrating downwards. Figure 3 and 4 are the Profiles acquired from the same location about 10 m apart, the two profiles clearly show that the resistivity range from 1 Ωm to 381 Ωm, with a depth of 13.8 m. The plumes in these profiles have migrated from the surface to the subsurface to a depth of 12 m. Figure 5 to 7 are profiles acquired in the same place, The Profiles clearly shows the plumes which has actually migrated from the surface to the subsurface to a depth of 12 m. The profiles are characterized by low resistivity values at the subsurface layer, there is indication of the presence of high ionic content; hence there is increase in conductivity of the contaminated zone. Figure 8 shows that the resistivity range from 1 Ωm to about 782 Ωm with a depth of 13.8 m, the top layer in this profile is characterize by low resistivity values from the beginning of the profile at the midpoint and at the end of the profile, the contaminated area can also been seen clearly at the 55 m of the spread where the cassava processing machine is sited. The dark blue colour at the top layer with a resistivity of 10 Ωm - 30 Ωm and a depth of 1.28 m – 10 m show the flow path of the plume indicated by an arrow head. In figure 9 the plume was observed at the depth of 12 m. The collated 3D slice obtained in Uzebba community shows all the eight profiled lines in 3D format, collated from 2D to 3D. The resistivity ranges from 1 Ωm to 780 Ωm with a depth of 21.9 m. The top layer in the collated 3D images in figure 10 is characterize by relatively high resistivity values from the beginning of the profile at the top part of the profiles, the contaminated area can been seen clearly at the 40 m - 50 m of the spread of the profiles where the cassava processing machine is cited in the first three layers. The dark blue colour at midpoint of the first three layers with a resistivity of 6 Ωm - 8 Ωm with a depth of 5 m – 8 m shows the plume indicated by an arrow head in the first three layers. It will be notice at the midpoint of the spread where all the debris of leach material has settled has a low resistivity values which indicate the contaminated zone with a depth of 2 m-8 m. The sub and subsurface part of the various layers of the collated 3D images have a high resistivity value which can be interpreted as mixture of compacted clay sediment and lateritic soil. It can be seen from the continues migration of the plume up to the last layer but reduces as a function of depth as seen from the images obtained in figure 10.

The images obtained shows a continue migration of the plumes delineated in all the profiled lines down the depth of investigation which is a treat to the groundwater resource in the surveyed area. Figure 11-13 shows the 3D block and figure 14 shows the various layers with depth of the 3D obtained from the survey in Uzebba study area.

***Conclusion*****:** The geoelectrical investigations performed at Uzebba community in Edo North, from Cassava Processing mill allowed us to indicate some of the permeable zones where the infiltration of contaminations occurs. The results from the ERT clearly show that at a depth of 2.5m-21.9m with resistivity values of 6.2Ωm-13.1Ωm the plumes were delineated. Under favorable hydrological and geological conditions, the plumes delineated will slowly migrate into the aquifers with a function of time and age of cassava processing in the area.

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