Impacts of Open Waste Dumping on Surface and Sub-Surface Soil Using Integrated Geophysical and Geochemical Techniques in Oru Waste Disposal Site South-West Nigeria

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ABSTRACT

Moderate or relative high level of electrical conductivity in the soil helps in plant development. However, excessive concentration can be injurious to plants and public health. Higher conductivity profiles were observed around 80m to 120m with highest apparent conductivity of 309 mmho/m and 240 mmho/m respectively for vertical and horizontal dipole orientations at location adjacent to the dumpsite along Oru road using Electromagnetic Methods of Geophysical Prospecting. Soil samples were consequently collected from a selected portion of the dumpsite with a dimension of 40m by 16m from twenty (20) sampling points at different successive depths of 0.0-0.2m, 0.2-0.4m, 0.4-0.6m whose results were compared with results of two (2) control sampling points at separate distances of 200m each away from the investigated dumpsite. Physiochemical, Trace elements and heavy metals were analysed using Atomic Absorption Spectrometer (AAS) under standard laboratory conditions to assessing the concentration within the subsurface soil thereby creating subsurface cross-sectional profiles. The parameters analysed were pH, Electrical Conductivity, Cation exchange Capacity, Turbidity, Ca, Ni, As, Cd, Cu among others. The mean and corresponding standard deviation for the soil composition (58.79 ± 16.5, 57.31 ± 15.52, 57.28 ± 14.02); (34.615 ± 13.11, 34.63 ± 14.31, 33.67 ± 12.2); (9.7±8.87,10.1±8.04,10.32±5.67) for 0.0-0.2m, 0.2 - 0.4m, 0.4-0.6m, respectively recorded for Sand, Clay and Silt with sand composition exhibiting the highest value of 58.79±16.5. The result of the laboratory analyses further revealed that Mg^{2+} (0.697±0.589), Fe^{3+}(3.157±5.423), and Pb^{2+} (0.156±0.122) were higher than the permissible standards while all the identified physio-chemical parameters were generally within permissible standards of World Health Organization and Food Additive Organization. It was generally observed that the soil samples were generally slightly acidic with pH level ranging from 6.04 – 6.0 with Arsenic concentration gradually reducing from surface to the subsurface down to a depth 0.6m which possibly causes alteration in the properties of soil. The elevated values of aforementioned heavy metals can cause severe lethal impacts on plant community and public health.

Keyword: Dipole, Electrical Conductivity, Standard, Lethal, and Intercoil Spacing

INTRODUCTION

Environmental contaminations by solid wastes have been a serious issue in most countries of the world owing to the waste disposal method and management. Solid wastes are being generated on daily basis due to rapid growth and continuous increase in human population, urbanization, and industrial development (Karak *et al*., 2012, Akintola, 2014, Essienubong *et al*., 2019; Mouhoun-Chouaki *et al*., 2019). Decomposition of the dumped waste may produce toxic compounds, which could deteriorate and weaken the environment (Beyene and Banerjee, 2011; Kebede *et al*., 2016; USEPA, 2002). In developing nations like Nigeria, the adverse effects of inappropriate management of solid wastes on the ecosystem have been occurring at an alarming rate. The impact of solid waste dumpsites on the topsoil and subsurface soil has been the subject of extensive research. The rising threat of environmental deterioration due to the unchecked production and regulation of municipal solid waste (MSW) unique to developing countries is of grave concern and has consistently attracted public attention. Solid waste has become a source of pollution due to improper management, which has had numerous negative repercussions on the ecosystem that are injurious to human health and safety (Akinbile *et al.,* 2016a, Akinbile *et al.,* 2016b, Marfe and Stefano, 2016). Majority of these wastes come indifferent forms such as household, industry, biomedical and commercial activities, which requires specific technique for their management, otherwise could pose long term degrading effects on environment and general wellness of the inhabitants (Pattnaik and Reddy, 2010; Nta and Odiong, 2017).

Unlike in developed countries where there are adequate and efficient systems based on advanced technology to deal with waste management issues (Willson, 2007), waste management is limited by inefficient waste collection systems; characterized by poor coverage and inadequate waste disposal, disposal of household waste. Open dumping systems for waste disposal are a common phenomenon in Nigeria, especially in cities where the population continues to grow unabated due to urbanization. Ogwueleka (2009) reported that in Nigeria, he generated between 250 and 370kg/m3 of solid waste, which is higher than the density of solid waste generated in developed countries. Open dumpsites are the simplest and initially the cheapest method of waste disposal and they are the primary means of waste management in many developing countries. The disadvantage of this method goes beyond environmental impact and can also lead to health issues such as cancer (USEPA, 2007; USEPA, 2004). Communities near open dumpsites are liable to drinking contaminated water and substantial negative health outcomes. Release of contaminants from both functional and abandoned dumpsites pose a high risk to nearby soil and groundwater if not adequately managed (Onyekwere and Nwakama, 2022). Pollutants may also include inorganic metals, volatile organic compounds, polycyclic aromatic hydrocarbon (PAHs), chlorinated solvents and more (Oghenerukevwe et al., 2021; Longe and Balogun, 2010; Sam-Uroupa and Ogbeibu, 2021). Residents can therefore be exposed to these pollutants through dermal absorption, consumption of contaminated water, inhalation of toxic fumes and through the food chain.

Oru landfill under investigation is an old and active dumpsite which inhabitants claimed has been in operation for the past twenty-two years; it is located in the heart of Oru Town, southwestern Nigeria (Ishola et al., 2024). Oru Landfill contains many types of waste such garbage, paper, plastic, glass, scrap metal etc. Some of these wastes are heterogeneous materials which are largely non-biodegradable and have been compacted over many years, allowing long-term interaction with the landfill materials, soil, and the underground geological units. Wastes deposited in landfills undergo oxidation, corrosion of metallic components and decomposition of organic matter leading to the generation and release of leaching agents that can impact the surface, migrating its ways with unprecedented impacts on the subsurface soil and water resources (Ishola et al., 2024).

Study Area

Location and Accessibility

The study area is located in Oru-Ijebu between longitudes 6°56"N and 6°58"N and latitude 3°56"E to 3°51"E within the South Eastern part of Ogun state, where it shares a common boundary with Oyo state (Fig. 1). Ijebu-igbo is the local government headquarters of this area and other towns within the district include Awa, Oru, Ijesha-Ijebu, Ago-iwoye, Mamu. The area falls within the basement complex rock of Nigeria. The area extent is 10.5 km^2. Accessibility varies with the distribution of outcrops; most places were easily accessible, while some were close to the numerous footpaths (Ishola et al., 2024). In some areas there are also minor footpaths that have developed to minor road linking to various areas. The relief is moderately low forming ridges in some places an undulated plain dotted with small, isolated hills or hills rocks are noticed generally within Ago Iwoye. The general level of surface rises Northwards from about 0-500ft above the coast northward to the area of the crystalline rocks (Ishola et al., 2024).

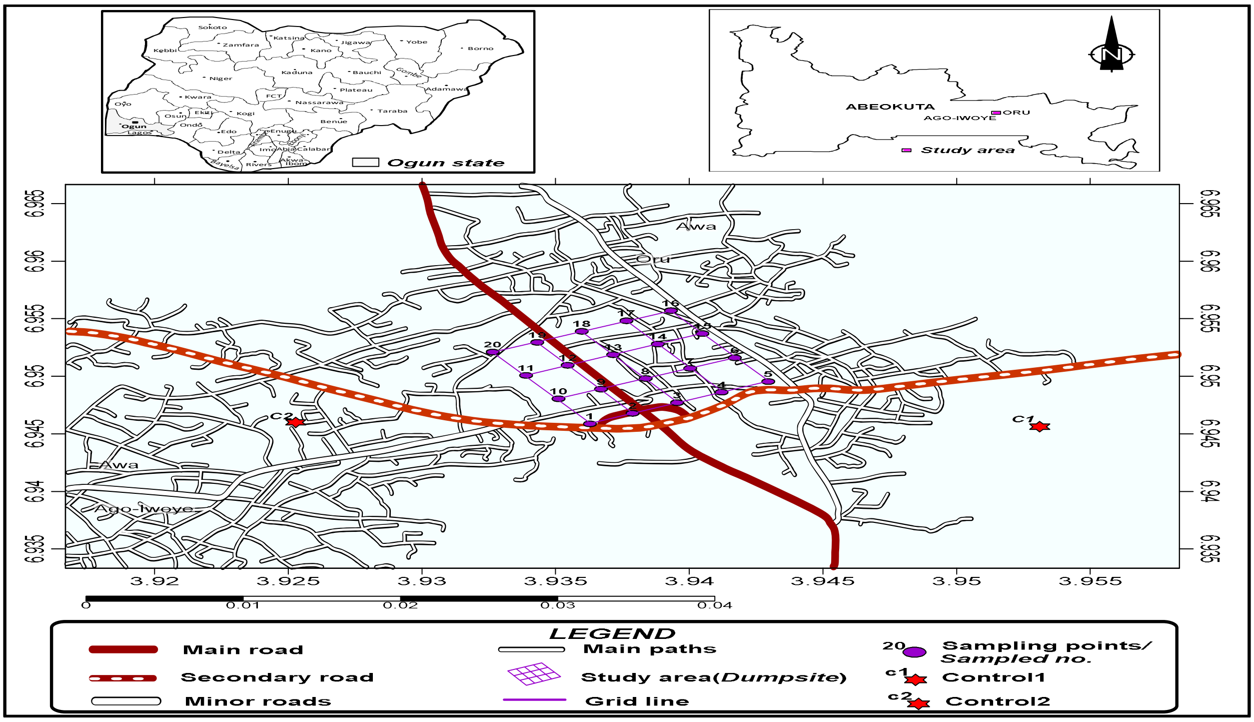

Figure 1: Location and Accessibility Map (Ishola et al., 2024).

Geology of the Study Area

The topography of the study area is generally undulating ranging from high to low relief. Highest peaks are 112m and lowest peak is 40m. The drainage patterns are dendritic and reflect the land forms, soil types and their occurrences. It should be noted that the drainage pattern of any area is influenced by the topography. It is also characterized by a double rainfall with peaks falling between June and September. December and January are relatively dry. The temperature is within the range of 26 ^{0}C to 36 ^{0}C (Ishola et al., 2024).

Oru-Ilaporu type is found locally in the basement complex rock in the southwest Nigerian state of Ogun. The major rocks found in the study area include Granite Gneiss, Banded Gneiss and Pegmatite; Pegmatite being the most common type of rock in the research region. The majority of the rocks in this area have undergone varying degrees of weathering, from recently formed formations to heavily weathered ones. Numerous related minerals have been identified, each with unique diagnostic features. These include quartz, biotite, hornblende feldspar, plagioclase, muscovite, and microcline feldspar (Ishola et al., 2024; Ishola and Olufemi, 2024).

MATERIALS AND METHOD

Geophysical Data Acquisition

Two electromagnetic profiles (using the Geonics EM34-3 equipment) were selectively carried out in Oru-Ijebu along the road opposite the dumpsite (Oru main road) to outline shallow conductive hydrogeological structures probably connected with local water circulation and fluid conductivity (Fig. 2); with the length of 200 m each to show conductivity changes with distance and depth in each location with an intercoil spacing of 10 m and 20 m. At each spacing two measurements were made using both, horizontal and vertical dipole mode. The main conductivity contrasts roughly can now be interpreted as the shallow expression of fractures affecting the sedimentary filling of the hydrogeological structure.

Geochemical Data Acquisition

Soil samples were collected on the dumpsite with a dimension of 40m by 12m from twenty (20) sampling points at different successive depths in each area; 0.0-0.2m, 0.2-0.4m, 0.4-0.6m which were compared with two (2) control sampling points at separate distance of 200m away from the investigated dumpsite using soil auger and shovel (Fig. 2). Soil samples collected in each case, were clearly labelled in a polythene bag, and transported to the laboratory for pretreatment and subsequent analyses for physiochemical properties namely soil pH, Electrical conductivity, Heavy metals, and Organic matter while trace elements that were also analysed for Cu, Zn, Cd, Mg, Ca, Pb, Mn and Ni using Atomic Absorption Spectrophotometer.

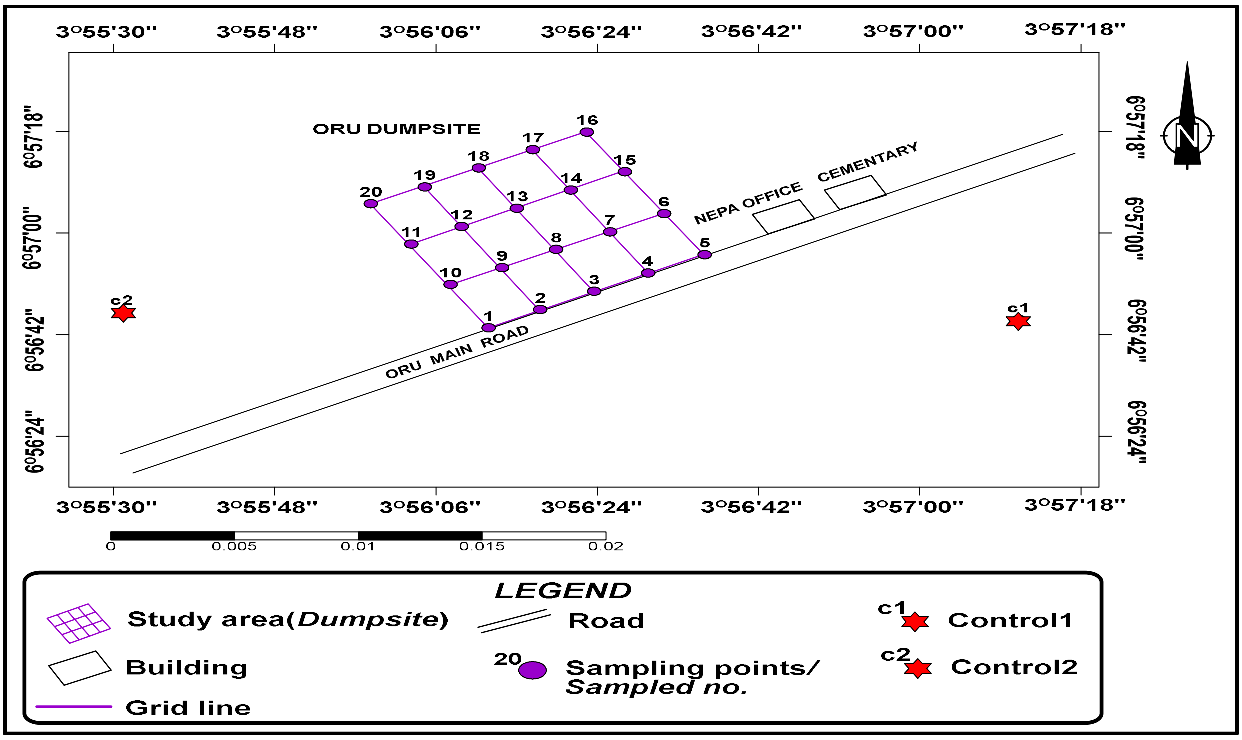

Figure 2: Field Set-Up/ Data Acquisition Map (Ishola et al., 2024).

RESULTS AND DISCUSSION

The traverse displayed appreciable variation in conductivity with recognizable positive peaks and broad anomalies delineated against their conductivity values with higher conductivity profiles observed around 80m to 120m with highest apparent conductivity of 309 mmho/m and 240 mmho/m respectively for vertical and horizontal dipole orientations observables at the two separate intercoil spacings (Fig. 3 and Fig. 4). Zones with peak positive vertical dipole anomalies are inferred conductive, typical of water–filled fissures and contaminant zones (Alvin et al., 1997), effect of appreciable weathering (Beeson and Jones, 1988; Ugwu and Nwosu, 2009; Ishola et al., 2019). These locations could be inferred as zones of interests of high contaminant loads.

pH it is the measure of H+ concentration in the samples. It is an important indicator of the chemical status of the dumpsite. It regulates the biogeochemical reactions and processes of the soils. The pH values of the soil at depth 0-20cm were between 6.9305±0.8161, while at depth 0.2-0.4m and 0.4-0.6m ranged between 6.8705±0.348, 6.82±0.7053 (Table 1-Table 5).

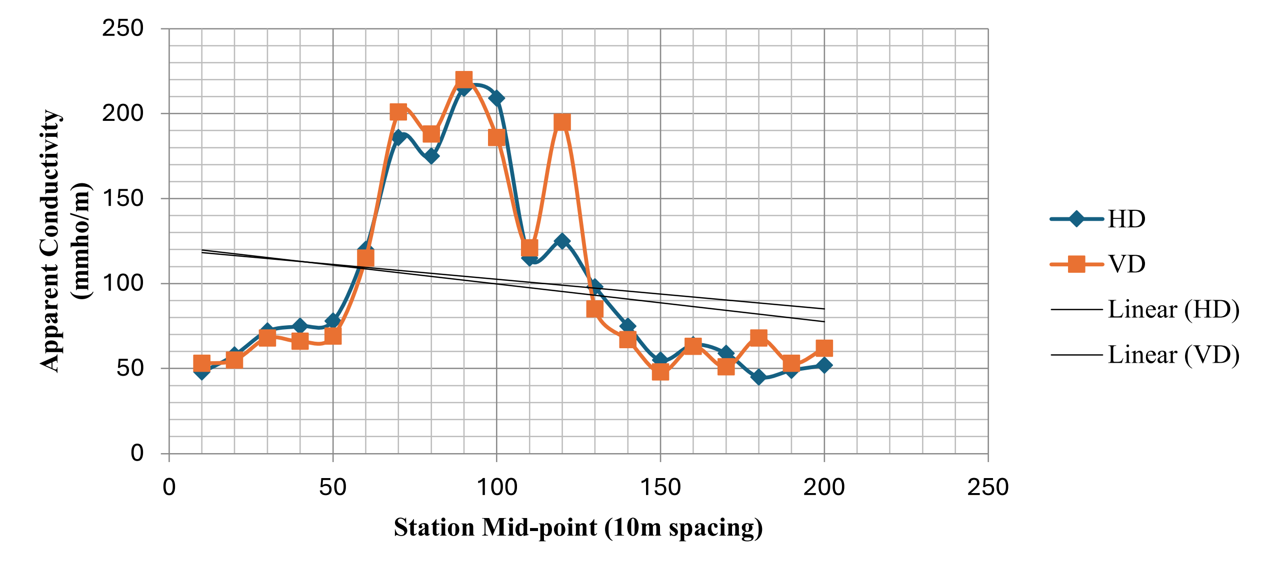

Figure 3: Conductivity Profile of Horizontal Dipole and Vertical Dipole Orientations at 10m spacing

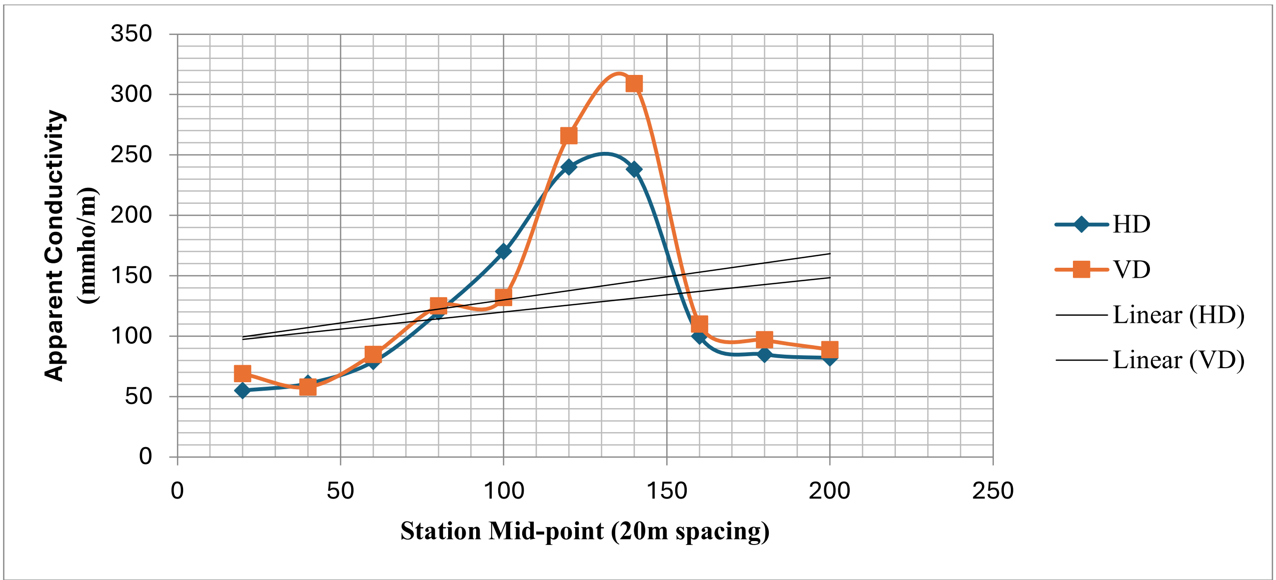

Figure 4: Conductivity Profile of Horizontal Dipole and Vertical Dipole Orientations at 10m spacing

The pH decreased down the profile in all the sites. According to Goswami and Sarma (2008) the soil pH may reduce with depth due to the leaching action of waste, mechanical composition, nature of soil. The pH of the soil samples in the current study showed slightly acidic nature. The slightly acidic nature represents a measure of the soil's acidity level. It indicates the concentration of hydrogen ions in the soil solution; it affects the nutrient availability, microbial activity, and plant growth. A slightly acidic pH enhances the availability of certain nutrients like phosphorous, potassium, and magnesium which are essential for plant growth. It also promotes the activity of beneficial soil microorganisms that contribute to nutrient cycling. However, excessively acidic soils can hinder the availability of other nutrients like calcium and may require adjustments to adjust to the pH. The pH is very crucial in terms of the mobility of metals, their bioavailability. Metal availability is very low when the pH is around 6.5-7.0 (Chimuka *et al*., 2005). Slightly acidic soil conditions result in nutrient availability, aluminium toxicity, especially in arid and semi-arid conditions thus favouring plant growth (Vijayalakshai et al., 2020; Tahri et al., 2005). The high pH value of the soil may be attributed to the quality of leachate leaching from the dumpsite (Elaigwu *et al*., 2007). The presence of carbonates, bicarbonates, sodium, potassium, and other acidic materials contribute to the slight acidic nature of the soil and the most optimal range of the pH of the compost for crop yield has been reported to be in the range of 5.5 - 8.5 (Goswami and Sarma, 2008). Another reason for the high pH may be mineralization of carbon, presence of basic cations caused by erosions, leaching and this is because basic cations increase as pH and CEC increase and vice versa and also the subsequent production of 0H- ions by ligand exchange along with the introduction of basic cations such as K^+, Ca^{2+}, Mg^{2+} (Mkhabela and Warman, 2005). Soils within the area are in the range of the Food and Agriculture Organization (FAO) and World Health Organization (WHO) limit which indicates that the soil around the area is safe for agriculture purpose (FAO, 2007, FAO, 2006). The EC mean and standard deviation value range of soil around the dumpsite in the study area at depth 0-0.2m was 155.99±51.65 while at depth 0.2-0.4m and 0.4-0.6m varies between 152.46±50.438 and 150.38±49.556, respectively (Table 1-Table 5). The result revealed that the effect of high EC in the dumpsite was due to the presence of ions in the soil and in wet filled pore soil which improves soil EC. Soils around the designated dumpsite area are not higher than the FAO and WHO limit which are (300–500 and 300 μs/cm respectively) this indicates crop suitability, water management and nutrient availability needed by the plants and people are in balanced value.

The availability of organic carbon (OC) in soils has resulted in rise in the cation exchange capacity which helps in the accumulation of nutrients taken in by plants. OC is the preserved carbon in organic matter. In the table below, it is shown that the percentage of organic carbon in soil around the dumpsite ranged from 26.704±29.254 at depths 0.0-0.2m while at 0.2-0.4m, and 0.4-0.6m are 24.24±29.751 and 23.03±30.076, respectively (Table 1-Table 5). Copper is an essential micronutrient required in the growth of both plants and animals. The concentration of Cu in all the samples analysed was lower than the WHO/FAO permissible limit of 0.50 mg/kg, the copper content in the soil at depth 0.0-0.2m, 0.2m-0.4m and 0.4-0.6m respectively ranged from 0.557±0.661, 0.52 ± 0.632 and 0.46 ±0.581. Mn is essential for plays a very essential role in the functioning of the central nervous system. The concentration of Mn ranged from 0.348±0.1903, 0.311±0.181, and 0.2335±0.165, respectively which are relatively above the WHO standard of 2.00 mg/kg but below the FAO standard of 5.00 mg/kg. This could interfere with nutrient uptake and affect plant growth and development, if it leaches into groundwater and surface water, it can cause potential harms to human and ecosystems. Fe is the fourth most common element in soil.

Among the micronutrients, Fe was the first micronutrient identified as essential for plant growth. In plants, iron is an essential element for respiration, photosynthesis, oxidation, and reduction processes. Low availability of iron in the soil is one of the main issues affecting the yield and quality of agricultural commodities globally, especially in alkaline and calcareous soils (Smith et al., 1996; Skye, 2006). This poor availability is directly related to physical, chemical, and biological activities taking place inside the rhizosphere because of interactions between soil and leaves. Soil samples collected from the dumpsite shows that there's an increased level of Fe at depth 0-0.2m and it reduces relatively in depth 0.4-0.6m (Table 1-Table 5). The samples show that the soils in the area have the Fe content below the WHO/FAO standard making the soil less hazardous to plants and humans. The number of exchangeable cations per unit mass of dry soil which perform a major importance in soil fertility is known as cation exchange capacity (CEC). It means the total number of exchangeable basic cations such as: Calcium (ca), Sodium (Na), Magnesium (Mg) and Potassium (K) ions were in the sampled soils; they rely on the competence of absorption of heavy metals. It depends on the summation of properties of soil and particular properties of soil elements like pH, clay, and organic matter (OM) contents of soil. It was revealed in the table below that the result of CEC in the studied dumpsite ranged from 2.0325±0.862, 1.4422±0.761, respectively at depth 0-0.2m, 0.2-0.4m, and 0.4-0.6m depth (Table 1-Table 5). The low CEC content in the sampled soil around the dumpsite was as a result of increase in sand fractions. The soil with low CEC content may yield insufficient Ca, Na, Mg, K, and low organic matter. The mean value of P in the dumpsite at depth 0-0.2m, 0.2-0.4m and 4.0-6.0m ranged from 9.778±4.0611, 8.77±4.092 and 7.967±3.785 respectively (Table 1-Table 5). The values of P in the studied dumpsite indicates that it reduces with depth, the low presence of P in some of the sampled soil around the dumpsite was due to higher content of non-biodegradable waste caused by micro-organisms, low level of organic matter (OM) and degradation of agricultural materials in the dumpsite. All sampled soils have P values less than the WHO/FAO standard (WHO, 2008; FAO, 2006). Therefore, the low P value was also attributed to other soil parameters such as low percentage of clay and sand fractions and low pH which reduces the binding sites of metals and also high leaching rate from sandy soils.

Table 1: Mean and Standard Deviation of Chemical Parameters at Depth 0.0-0.2m

CHEMICAL PARAMETERS	MEAN±SD	RANGE	WHO	FAO
pH	6.9305±0.8161	6.04 - 6.0	25	6.5 – 8.5
EC (us/cm)	155.99±51.65	171.4 - 160.5	300	300 - 500
TEMP (°C)	50.02±57.92	26.1 - 22.4	6.5 – 9.5	NA
H	4.122±9.874	26.1 - 22.4	NA	NA
Ca	0.292±0.125	0.36 - 0.18	NA	10 – 50
Na (mg/kg)	0.4005±0.1518	0.48 - 0.32	NA	0.3 – 0.5
Mg (mg/kg)	0.697±0.589	0.86 - 0.12	50.00	<5
CEC	2.0325±0.862	2.32 - 1.68	NA	NA
BS (%)	77.93±37.1043	95.44 - 93.45	NA	NA

TOC (٪)	26.704±29.254	24.1 - 16.9	NA	NS
TOM (٪)	23.008±7.661	41.55 - 29.19	NA	3
PO4 (mg/kg)	10.52±4.756	10.6 – 6.8	NA	NA
SO4 (mg/kg)	9.88±4.367	9.62 – 5.92	NA	NA
Fe (mg/kg)	3.157±5.423	3.1 – 0.23	0.30	5.0
Zn (mg/kg)	1.556±0.945	2.70 – 0.18	5.50	2.0
Cu (mg/kg)	0.557±0.661	0.48 – 0.34	73.3	<2
Mn (mg/kg)	0.348±0.1903	0.44 – 0.29	NA	NA
Cl (mg/kg)	0.366±0.131	0.36 – 0.25	NA	NA
NO3 (mg/kg)	0.081±0.1461	0.007 – 0.01	NA	NA
Pb (mg/kg)	0.156±0.122	0.14 – 0.05	0.01	<0.001
Cd (mg/kg)	0.1075±0.0561	0.15 – 0.04	74	NA
As (mg/kg)	0.059±0.0388	0.05 – 0.02	0.3	NA
Cr (mg/kg)	0.097±0.071	0.08 – 0.02	0.50	0.10
Ni (mg/kg)	0.0385±0.0252	0.03 – 0.01	67.9	NA
Br (mg/kg)	0.0023±0.0019	0.002– 0.001	NA	NA
Si (mg/kg)	0.0039±0.00651	0.002– 0.001	NA	NA
Tn (mg/kg)	1.8175±1.2523	2.41 – 1.52	NA	NA
P (mg/kg)	9.778±4.0611	9.8 – 5.8	NA	10 – 20
K	0.614±0.16501	0.61 – 0.39	NA	0.3 -0.5
I	0.00142±0.0007	0.0001 – 0.001	NA	NA

Table 2: Mean and Standard Deviation of Chemical Parameters at Depth 0.2-0.4m

CHEMICAL PARAMETERS	**MEAN±SD**	**RANGE**	**WHO**	**FAO**
PH	6.8705±0.348	9.11 – 6.03	25	6.5 – 8.5
EC	152.46 ± 50.438	209.52– 7.62	300	300 – 500
TEMP	48.772 ± 56.360	192.15– 25.0	6.5 – 9.5	NA
H	3.939 ± 9.435	27.15 – 0.08	NA	NA
Ca	0.2723 ± 0.130	0.66 – 0.12	NA	10 – 50
Na	0.4095 ± 0.0991	0.64 – 0.25	NA	0.3 – 0.5
Mg	0.47 ± 0.351	0.80 – 0.03	50.00	<5
CEC	1.4422± 0.761	3.22 – 0.007	NA	NA
BS	62.163±45.162	95.65 -1.22	NA	NA
TOC	24.24±29.751	93.35 – 7.13	NA	NS
TOM	17.95 ±7.41	35.34 – 8.9	NA	3
PO_4	10.422 ±5.01	20.39 – 5.71	NA	NA
SO_4	8.422 ±3.795	19.25 – 4.5	NA	NA
Fe	3.0445 ±5.454	20.22 -0.03	0.30	5.0
Zn	1.46 ±0.915	2.52 – 0.8	5.50	2.0
Cu	0.52 ± 0.632	2.35 -0.12	73.3	<2
Mn	0.311 ± 0.181	0.69 -0.10	NA	NA
Cl	0.327 ± 0.131	0.69 -0.20	NA	NA
NO_3	0.075 ± 0.138	0.62 – 0.002	NA	NA
Pb	0.1058 ± 0.064	0.29 – 0.006	0.01	<0.001
Cd	0.083 ± 0.057	0.23 -0.07	74	NA
As	0.046 ± 0.0335	0.15 -0.01	0.3	NA
Cr	0.0763 ± 0.0653	0.24 -0.006	0.50	0.10
Ni	0.0281 ± 0.0184	0.07 -0.002	67.9	NA
Br	0.00175±0.00145	0.006– 0.001	NA	NA
Si	0.002 ± 0.00152	0.006 -0.001	NA	NA
Tn	1.396 ± 1.382	3.85 – 0.08	NA	NA
P	8.77 ± 4.092	18.17 – 5.5	NA	10 – 20
K	0.548 ± 0.143	0.92 – 0.41	NA	0.3 – 0.5
I	0.0012 ± 0.00046	0.002 – 0.0001	NA	NA

Table 3: Mean and Standard Deviation of Chemical Parameters at Depth 0.4-0.6m

CHEMICAL PARAMETERS	MEAN±SD	RANGE	WHO	FAO
PH	6.82± 0.7053	8.92 – 6.01	25	6.5 – 8.5
EC	150.38± 49.556	201.78 -7.58	300	300– 500
TEMP	47.73±56.321	190.85 -21.60	6.5 -9.5	NA
H	3.89±9.12	27.07 -0.11	NA	NA
Ca	0.2412 ± 0.105	0.53 – 0.086	NA	10 – 50
Na	0.39±0.1093	0.65 – 0.21	NA	0.3 – 0.5
Mg	0.447±0.335	1.53 – 0.03	50.00	<5
CEC	3.36±5.774	97.02 – 1.26	NA	NA
BS	64.22±5.774	92.06 – 6.55	NA	NA
TOC	23.03±30.076	32.07 – 8.44	NA	NS
TOM	15.99±6.59	20.36 – 1.61	NA	3
PO_4	7.894±5.158	19.07 – 1.83	NA	NA
SO_4	7.091±5.158	20.43 – 0.16	NA	NA
Fe	2.837±5.545	2.53 – 0.01	0.30	5.0
Zn	1.1785±0.891	2.11 – 0.1	5.50	2.0
Cu	0.46 ±0.581	2.34 -0.12	73.3	<2
Mn	0.2335±0.165	0.63 - 0.03	NA	NA
Cl	0.261±0.136	0.58 - 0.1	NA	NA
NO_3	0.070±0.129	0.58 – 0.002	NA	NA
Pb	0.0970±0.1001	0.19 – 0.001	0.01	<0.001
Cd	0.067±0.054	0.21 – 0.03	74	NA
As	0.0315±0.024	0.09 – 0.01	0.3	NA
Cr	0.07±0.062	0.19 – 0.02	0.50	0.10
Ni	0.0137±0.0071	0.02 – 0.001	67.9	NA
Br	0.0019±0.0016	0.005 – 0.001	NA	NA
Si	0.0017±0.0015	0.005 – 0.001	NA	NA
Tn	1.140±1.310	3.42 – 0.04	NA	NA
P	7.967±3.785	16.65 – 4.20	NA	10 – 20
K	0.49±0.126	0.85 – 0.36	NA	0.3 – 0.5
I	0.79±1.9440	5.5 – 0.01	NA	NA

Table 4: Mean±SD of Chemical Parameter of Control Site at Depth 0.0-0.2m

CHEMICAL PARAMETERS	MEAN±S.D	RANGE	WHO	FAO
PH	7.15±2.460	8.89 – 5.41	25	6.5 – 8.5
EC	133.47±6.788	138.27 – 128.67	300	300 – 500
TEMP	20.75±0.0283	20.77 – 20.73	6.5 9.5	NA
H	0.04±0	0.004	NA	NA
Ca	0.215±0.0070	0.22 – 0.21	NA	10 – 50
Na	0.325±0.0070	0.33 – 0.32	NA	NA
Mg	0.44±0.0567	0.48 – 0.40	50.00	< 5
CEC	1.515±0.191	1.65 – 1.38	NA	NA
BS	46.33±0.0707	46.38 – 46.28	NA	NA
TOC	9.715±0.587	10.13 – 9.30	NA	NA
TOM	9.285±0.275	9.48 – 9.09	NA	NA
PO4	3.18±0.099	3.25 – 3.11	NA	NA
S04	0.36±0.057	0.40 – 0.32	NA	NA
Fe	0.365±0.205	0.51 – 0.22	0.30	5.0
Zn	0.165±0.007	0.17 – 0.16	5.50	2.0
Cu	0.12±0.014	0.13 – 0.11	73.3	< 2
Mn	0.025±0.0070	0.06 – 0.05	NA	NA

Cl	0.145±0.035	0.19 – 0.16	NA	NA
NO3	0.001±0	0.001 – 0.001	NA	NA
Pb	0.035±0.0212	0.05 – 0.03	0.01	< 0.001
Cd	0.025±0.007	0.03 – 0.02	74	NA
As	0.01±0	0.01	0.3	NA
Cr	0.01±0	0.01	0.50	0.10
Ni	0.015±0.007	0.02	67.9	NA
Br	ND±ND	ND	NA	NA
Si	ND±ND	ND	NA	NA
Tn	1.33±0.254	1.83 – 1.17	NA	NA
P	2.545±0.446	2.87 – 2.58	NA	10 – 20
K	0.395±0.205	0.54 – 0.35	NA	0.3 – 0.5
I	ND±ND	ND	NA	NA

Table 5: Mean±SD of Chemical Parameter of Control Site at Depth 0.2-0.4m

CHEMICAL PARAMETERS	**MEAN±S.D**	**RANGE**	**WHO**	**FAO**
PH	5.44±0.438	5.75 – 5.13	25	6.5 – 8.5
EC	124.52±2.814	126.51 -122.53	300	300 – 500
TEMP	20.82±0.042	20.85 – 20.77	6.5 – 9.5	NA
H	0.045±0.0070	0.05 – 0.04	NA	NA
Ca	0.265±0.035	0.29 – 0.24	NA	10 – 50
Na	0.325±0.007	0.33 -0.32	NA	NA
Mg	0.38±0.056	0.42 – 0.34	50.00	< 5
CEC	1.475±0.205	1.62 – 1.33	NA	NA
BS	46.16±0.070	46.21 – 46.11	NA	NA
TOC	7.805±1.845	9.11 – 6.50	NA	NA
TOM	2±0.424	9.32 – 9.09	NA	NA
PO4	3.15±0.141	3.25 – 3.05	NA	NA
S04	0.285±0.162	0.40 -0.17	NA	NA
Fe	0.215±0.106	0.29 – 0.14	0.30	5.0
Zn	0.155±0.0070	0.16 – 0.15	5.50	2.0
Cu	0.105±0.0070	0.11 – 0.10	73.3	< 2
Mn	0.025±0.0070	0.03 – 0.02	NA	NA
Cl	0.145±0.0353	0.17 – 0.12	NA	NA
NO3	0.001±0	0.001	NA	NA
Pb	0.035±0.0212	0.05 – 0.02	0.01	< 0.001
Cd	0.025±0.0070	0.03 – 0.02	74	NA
As	0.01±0	0.01	0.3	NA
Cr	0.01±0	0.01	0.50	0.10
Ni	0.015±0.0070	0.02 – 0.01	67.9	NA
Br	ND	ND	NA	NA
Si	ND	ND	NA	NA
Tn	1.33±0.254	1.51 – 1.15	NA	NA
P	2.545±0.445	2.86 – 2.23	NA	10 -20
K	0.395±0.205	0.54 – 0.25	NA	0.3 – 0.5
I	ND	ND	NA	NA

Table 5: Mean±SD of Chemical Parameter of Control Site at Depth 0.4-0.6m

CHEMICAL PARAMETERS	MEAN±S.D	RANGE	WHO	FAO
PH	5.44±0.438	5.75 – 5.13	25	6.5 – 8.5
EC	124.52±2.814	126.51 -122.53	300	300 – 500
TEMP	20.82±0.042	20.85 – 20.77	6.5 – 9.5	NA
H	0.045±0.0070	0.05 – 0.04	NA	NA
Ca	0.265±0.035	0.29 – 0.24	NA	10 – 50
Na	0.325±0.007	0.33 -0.32	NA	NA
Mg	0.38±0.056	0.42 – 0.34	50.00	< 5
CEC	1.475±0.205	1.62 – 1.33	NA	NA
BS	46.16±0.070	46.21 – 46.11	NA	NA
TOC	7.805±1.845	9.11 – 6.50	NA	NA
TOM	2±0.424	9.32 – 9.09	NA	NA
PO4	3.15±0.141	3.25 – 3.05	NA	NA
S04	0.285±0.162	0.40 -0.17	NA	NA
Fe	0.215±0.106	0.29 – 0.14	0.30	5.0
Zn	0.155±0.0070	0.16 – 0.15	5.50	2.0
Cu	0.105±0.0070	0.11 – 0.10	73.3	< 2
Mn	0.025±0.0070	0.03 – 0.02	NA	NA
Cl	0.145±0.0353	0.17 – 0.12	NA	NA
NO3	0.001±0	0.001	NA	NA
Pb	0.035±0.0212	0.05 – 0.02	0.01	< 0.001
Cd	0.025±0.0070	0.03 – 0.02	74	NA
As	0.01±0	0.01	0.3	NA
Cr	0.01±0	0.01	0.50	0.10
Ni	0.015±0.0070	0.02 – 0.01	67.9	NA
Br	ND	ND	NA	NA
Si	ND	ND	NA	NA
Tn	1.33±0.254	1.51 – 1.15	NA	NA
P	2.545±0.445	2.86 – 2.23	NA	10 -20
K	0.395±0.205	0.54 – 0.25	NA	0.3 – 0.5
I	ND	ND	NA	NA

High levels of Arsenic in the soil can have detrimental effects on both plants and human health. Plants that grow around areas with high As content tends to have reduced plant growth, alteration in the physical and chemical properties of the soil, contamination of ground water occurs when As leach from the soil into groundwater causing hazardous effects to humans and ecosystem. Soil samples collected in the area indicates that the level of As concentration in the soil occurs at depth 0.2-0.4m and reduces down from 0.4-0.6 m comparably lower in the control sites (Table 1-Table 5). Effects of high As on humans includes skin issues, respiratory problems, increased risks of cancer, high blood pressure and relatively adverse effects on plant growth. When there is high concentration of lead (Pb) in the soil, it can lead to detrimental effects on both the environment and human health. From the Tables shown below, the level of Pb at the dumpsite ranges from 0.156 – 0.049 ppm and the control soil range from 0.095–0.02 ppm (Table 1-Table 6). The level of Pb at the dumpsite and the control are both above the WHO standard for Pb levels in soils and this can lead to soil pollution, which can have harmful effects on plants, animals, and even disrupt the ecosystem and negatively impact biodiversity.

When the soil has a high EC (electrical conductivity), it means that the soil has a high concentration of dissolved salts and minerals. EC is a measure of the soil's ability to conduct electric current, and it can negatively affect plant growth and development, damage plant tissues, hinder nutrient intake while some plants can tolerate higher salt levels most crops prefer soils with lower EC values for optimal growth. The EC level at the control soil ranges from 143-116 μs/cm which is lower than that of the dumpsite (Table 1-Table 6). Soil temperature affects the activity and metabolism of soil micro-organisms, higher temperatures can enhance microbial activity leading to increased nutrient cycling and decomposition of organic matter. Temperature influences seed germination, root development, availability, and uptake of nutrients by plants. Soil temperature influences water availability and evaporation rates (Akinbile, 2016c). At the dumpsite the temperature of the soil is relatively high in the area and plants that grow around this area of the dumpsite may have difficulty establishing roots and absorbing nutrients, compared to the dumpsite samples the control samples are relatively low and microorganisms such as bacteria and fungi are less active in low temperature leading to reduced microbial activity which can impact nutrient cycling and organic matter decomposition in the soil.

Cadmium is a toxic element that can be absorbed by plants and accumulate in their tissues, potentially entering the food chain. High level of cadmium in the soil can be harmful to human health such as kidney damage, respiratory problems, risks of cancer and gastrointestinal issues and can also affect plants growth and development, nutrient imbalances, chlorosis and leaf damage, reduced seed germination. Soil samples at the control have relatively low Cd content and there will be low risk of health issues, and low damage to the ecosystem and the environment. High levels of As content tends to have reduced plant growth, alteration in the physical and chemical properties of the soil, contamination of ground water occurs when As leach from the soil into groundwater causing hazardous effects to humans and ecosystem. Effects of high As obtained in the study area on humans includes skin issues, respiratory problems, increased risks of cancer, high blood pressure and relatively adverse effects on plant growth. It is important to regularly monitor soil arsenic levels to take appropriate measures to minimize exposures, regardless of whether the levels are high or low (Liu et al., 2012).

CONCLUSION

The impact of an active dumpsite on soil quality in the residential Oru community was investigated in this study using composite Geophysical and Geochemical techniques. Higher conductivity profiles were observed around 80m to 120m with highest apparent conductivity of 309 mmho/m and 240 mmho/m respectively for vertical and horizontal dipole orientations at location adjacent to the dumpsite along Oru road which necessitated the sampling of the soil samples of the anomalous area using geochemical methods (Fig. 3 and Fig. 4). According to the findings, some of the measured soil parameters generally decreases with depth and exceeded the standard limits especially Temperature, Iron, lead, Chromium, and sometimes

Nickel threatening the edible plant growth and posing health and safety risks to local residents because unmanaged or poorly managed dumpsite may lead to pollution of water resources, soil, air, and affects the flora and fauna to varied extent. The study revealed that the soils near the dumpsite may be exposed to poisonous pollutants derived from dissolved wastes emanating from the dumpsite which can lead to landfill leachate infiltrations and can directly affect the soil quality, surface and subsurface water system thereby causing large–scale disturbances in the ecosystem structure and balance.

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