**A PROJECT**

**ON:**

**THE EFFECT OF SOLID WASTE DUMPING ON THE SOIL PROPERTIES OF THE VICINITY OF UYO VILLAGE DUMPSITE, UYO, AKWA IBOM STATE.**

**BY:**

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**CHAPTER ONE**

**INTRODUCTION**

**1.1 BACKGROUND OF STUDY**

Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. Waste generation has been an issue for communities since the beginning of civilization. Waste is generated due to goods and service production and the utilization of natural resources. There are many barriers to the proper management of waste. In Nigeria, irregular increases in population, industrialization and changes in consumption patterns have complicated solid waste management (Uzoigwe *et al.*, 2012). The impact of poor waste management on soil properties and human well-being cannot be overemphasized. Individuals living around the dumpsites are at high risk due to the potential of waste to pollute the water, food, soil, vegetation and air around them.

Municipal solid wastes (MSW) are undesirable materials mainly consisting of household wastes and so are called household garbage. They also include similar waste to MSW such as wastes from industrial companies, crafts, trades, hotels, schools, public services, hospitals and municipal services such as; road wastes, parks and gardens' maintenance, and from other recreational facilities (Abur *et al.,* 2014). Majority of the wastes generated from these sources ends up in the dumpsites. Across many cities in Nigeria, wastes are usually burnt outdoors and ashes are poorly disposed. This act destroys the organic components of the environment and invariably affect the various properties of the soil (Njoroge *et al.,* 2007).

The incidence of poor waste handling that has infringed on vital environmental components includes but not limited to soil, water and to air quality. Also, the magnitude of commercialization, industrialization and population expansion of most cities (including Uyo) has also had its attendant adverse effects on the volume of waste released to the environment. The problems posed by improper and ineffective management of Municipal Solid wastes (MSW) has become an issue of global concern over the past decades. The magnitude of waste stream has acquired some abrupt dimensions, with corresponding ineffective and inadequate management strategies, including insufficient funding on the part of Government (Doan, 1998; Schwarz-Herion, 2008; Amuda *et al.,* 2014, Hossain *et al.,* 2014; Angaye *et al.,* 2015). In most developing countries, anthropogenic activities associated with the precarious disposal of MSW poses more grave consequences to the ecosystem (including the soil chemical, biological and physical properties), besides being threat to public health (Adamu *et al.,* 2014).

The movement of contaminants from dump sites where wastes are disposed to surrounding ecosystems is complex and involves biological and physio-chemical processes (Adeyi *et al.,* 2014). Open dumpsites could be a source of microbial and toxic chemical pollution of the soils of the dumpsites. This can also pollute hand dug wells, posing serious health risks and leading to the destruction of biodiversity in the environment (Mpofu *et al.,* 2013).

The composition of the wastes influences the concentration of the leachates constituents which may be adsorbed in to the soil during this diffusion thereby altering the initial properties of the soil and it outcome is hazardous to both plant and animals (0gbeibu *et al.,* 2013).

This process creates soil and water pollution, and offensive odors, which increase with an increase in ambient temperature levels (Shaikh *et al.,* 2012). Toxic or contaminable leachates from dumpsites could be transformed physically, chemically or biologically and transported via the air, or through runoffs which can contaminate either the soil surface or/and groundwater (Christensen *et al.,* 1998; Kola-Olusanya, 2012). Also, toxic fumes and greenhouse gases are also being produced by precarious or uncontrolled in-situ burning, which could have acute or chronic environmental health and consequences (Adekunle *et al.,* 2011; Ayuba *et al.,* 2013; Okeke, 2014).

The management strategies of municipal solid wastes varies per country but not limited to landfill system, incineration and recycling. Underdeveloped nations like Nigeria, Ghana and India uses the landfill system, while developed nations like; the United States, Japan and Australia mostly uses the recycling method (Onwughara *et al.,* 2010). Although in Nigeria waste recycling has been encouraged by all stakeholders, unfortunately it is yet to attain full recognition due to slow implementation of the policy and insufficient funding. As such the commonest method of disposal in Nigeria still remains open dump landfill system and institu incineration (Momodu *et al.,* 2011), which are very prone to environmental pollution as observed around Uyo Village Road dumpsite.

**1.2 PROBLEM STATEMENT AND JUSTIFICATION**

Solid waste pose a threat in Uyo municipality and are attributed to the hazards faced by the households living near the dumpsite. There is no sewage existing in Uyo Village Road. Safe and acceptable solid waste management practices are of serious concern from the environmental point of view. The concern comes from both poor policies and solutions proposed by all associated authorities of the government for the management of solid waste and a perception that many solid waste management facilities use poor operating procedures. Lack of support from the authorities such as the Local Government Authority, Uyo Capital City Development Authority, Akwa lbom State Ministry of Environment and Mineral Resources and other stakeholders in the environmental sector has led to negative impacts on the environment.

There is paucity of information on the effect of solid waste dumping on the soil chemical, physical and biological properties of the Uyo Village Road, hence this is the purpose of this study.

**1.3 OBJECTIVES OF THE STUDY**

i. To determine the effect of solid waste dumping on the chemical properties of the soil around Uyo village road dumpsite.

ii. To determine the effect of solid waste dumping on the physical properties of the soil around Uyo village road dumpsite.

iii. To determine the effect of solid waste dumping on the biological properties of the soil around Uyo village road dumpsite.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Introduction**

Municipal solid waste (MSW) normally termed as ‘‘garbage’’ or ‘‘trash’’ is an inevitable by-product of human activity. Solid waste are majorly waste that are on solid form and disposed in the dumpsite after it initial or primary use and these ranges from bottles, glass ware, plastic, agricultural waste and so on. Population growth and economic development lead to enormous amounts of solid waste generation by the dwellers especially in the urban areas (Karishnamurti and Naidu, 2003). Thousands of tons of solid waste are generated daily in African countries (Asuma, 2013). In Nigeria, less than half of the solid waste produced is collected and 95 percent of that amount is either indiscriminately thrown away at various dumping sites on the periphery of urban centers or at a number of so-called temporary sites and typically empty lots scattered throughout the city (Abiye and Haile, 2012). Present day waste disposal is far more advanced than the indiscriminate dumping that occurred in the past, employing modern techniques to better manage a wide range of anthropogenic wastes (Asuma, 2013). Open and unscientific dumping of municipal solid waste is one of the most common methods adopted since years in almost all the cities. One of the main objectives in the design of a landfill site should be the proper management of polluted water and leachate migration, therefore mitigating the risk of health and environmental damage (Taylor and Allen, 2006). Dumpsites are considered a major threat to groundwater resources, either through waste materials coming into contact with groundwater underflow, or through infiltration from precipitation (Taylor and Allen, 2006). The dumpsites solid waste often releases interstitial water and by-products that contaminate the water moving through the deposit, as well as liquids containing several different organic and inorganic compounds that sit at the bottom of the deposit and seep into the soil, affecting its biological, physical and chemical properties (Al-Yaqout and Hamoda, 2003).

**2.2 Anthropogenic Sources of solid wastes**

Anthropogenic source of wastes implies the man-made origination of waste in the environment (Asuma, 2013). The sources of waste in the environment is inexhaustible but not limited to domestic and industrial sources. These include such wastes from; industrial companies, crafts, trades, hotels, schools, public services, hospitals and municipal services such as; road wastes, parks and gardens' maintenance, and from other recreational centers (Adekunle *et al.,* 2011; Ayuba *et al.,* 2013; Abur *et al.,* 2014). In Nigeria, municipal waste density ranges from 280 - 370 kg/m, while the rate of daily waste generation is about 0.44 - 0.66 kg/capital/day with an annual generation of 25 million tons (Ogwueleka, 2009). Urban municipal solid waste is usually generated from human settlements, small industries and commercial activities (Singh *et al.,* 2011). These solid waste ranges from bottles, glassware, plastics and other wastes in solid form which are discarded after it primary use (Abur *et al.,* 2014).

**2.3 General impact of solid waste on the environment**

The environment is the immediate surrounding around us (Adekunle *et al.,* 2011). Indiscriminate and inappropriate management of waste have adverse impact in the environment and the inhabitant of the area (Ayuba *et al.,* 2013). Excluding the alteration of soil chemical, physical and biological properties; wastes also have some detrimental impact in the environment from economical to health impact. Economically, waste impede the efficient utilization of land for production activities (Edem, 2007). Wastes equally alter the aesthetic of an environment, making such an environment less attractive for investment purpose (Essie and Hanson, 2010). Wastes also causes health threat by polluting water bodies both surface and underground water which can invariably upset severe illness to the inhabitant of the environment (Sharma and Shah, 2005). The available scientific evidence on the waste-related health effects is not conclusive, but suggests the possible occurrence of serious adverse effects, including mortality, cancer, reproductive health, and milder effects affecting well-being. Some waste will eventually rot, but not all, and in the process it may smell, or generate methane gas, which is explosive and contributes to the greenhouse effect (Karak *et al.,* 2012). Leachate produced as waste decomposes may cause pollution. Burning medical waste releases many hazardous gases and compounds, including hydrochloric acid, dioxins and furans, as well as the toxic metals lead, cadmium, and mercury. It also releases large amounts of carbon dioxide, worsening climate change and global warming in the environment (Hazra and Goel, 2009; Essien and Hanson, 2013).

**2.4 Soil chemical properties**

Soil is a complex mixture of organic and mineral components (Balasubramanian, 2017). Soil chemical properties indicate biogeochemical processes in soils and their influence on the bioavailability, mobility, distribution, and chemical forms of both plant essential elements and contaminants in the terrestrial environment (Balasubramanian, 2017). Soil chemical properties include; soil pH, electrical conductivity, total organic carbon, cation exchange capacity and heavy metals concentration.

**2.4.1 Soil pH**

Soil pH measures the concentration of hydrogen ion (H+) in the soils and is the major cause of soil acidity which affects the performance of crops and activities of micro-organisms (Francis *et al.,* 2020). Soil pH refers to a soil’s acidity or alkalinity and is the measure of hydrogen ions (H+) in the soil and it is one of the soil chemical properties. A high amount of H+ corresponds to a low pH value and vice versa. The pH scale ranges from approximately 0 to 14 with 7 being neutral, below 7 acidic, and above 7 alkaline (basic). In a study conducted by Hanson and Essien (2013) at Old Stadium Road dumpsite along Wellington Bassey Way, Uyo, Akwa Ibom State indicated that values of pH in waste dumpsite site ranged from 7.13 – 7.92, which was higher than the surrounding soils indicating non-alkaline soil, and conforming to the generally very acidic soil of the region (AK-RUSAL, 1989), which is the result of excessive rainfall-runoff saturation of soil resulting in reducing clay content in most cases. The high pH (alkaline in reaction) is attributed to the organic accumulated on the soils. This means that organic solid waste accumulation could significantly reduce soil acidity, and confirms observation by (Isirimah, 2000) that there is increase in salinity in soils under accumulated municipal solid waste. The level of the salinity however, may depend on the composition of the solid waste.

Comparatively, soils under this was more alkaline than the one under waste dumpsite at Allahabad India which tended to neutral - alkaline (6.13 – 7.1) (Tripathi and Misra, 2010).

**2.4.2 Electrical conductivity**

Electrical conductivity is the potential of the soil to conduct electricity. This chemical property is anchored in a lot of determinant. Essien and Hanson (2013) in their study also noted that the values of electricity ranged from 0.15 – 0.80 dS/m in waste dumpsite soil which is in contrast to that of the surrounding soil (0.03 – 0.06 dS/m), which indicates significant higher electricity conductivity at waste dumpsite soil than in surrounding soil. The high electricity conductivity is salt-related and may be attributed to the salinity content of the accumulated waste which leachate infiltrated the in-situ soil causing increase in salt content in the waste dumpsite soil (Suresh, 2008, Essien and Hanson, 2013).

Agunwam (2010) in his study in a dumpsite in Enugu state also observed that soil under accumulated municipal waste is characterized with high electrical conductivity value due to increase in salt content. Variability was rather high for waste dumpsite soil but very high in control soil indicating very heterogeneous soil property; however, with the value of electrical conductivity (dS/m) < 0.8, the salinity was low, implying that waste dumpsite soil could retain more cations in it exchange site due to increased negative changes in the exchange complex, it is indicated by high electrical conductivity content.

**2.4.3 Cation Exchange Capacity**

This is the sum total of the acidic and basic cation present in the soil solution. Essien and Hanson (2013) studies indicated that there is a higher Cation exchange capacity in waste dumpsite and was attributed to its high basic cation content. This implies that the fertility status of waste dumpsite soil may be better than that of surrounding soil. Cation variability in control soil was 21.31% while that of waste dumpsite soil was 7.78% and a significant variability was observed between the cations and Ca was highest in waste Dumpsite soil. Comparatively, this corresponds with that of Suresh (2008).

**2.4.4** **Total Organic Carbon (TOC)**

Organic carbon reflects organic matter (the decomposed carbon in a material). Values of Total organic carbon in waste dumpsite soil ranged from 2.10 – 5 76% and the surrounding soil, ranged between 0.36 and 1.23 (Essien and Hanson, 2013). Generally, most of the materials in the waste area were organic in nature, therefore so high Total carbon soil was expected in waste dumpsite soil than in control soil (Edem, 2007). Variation of Total organic carbon in waste dumpsite soil and control soil was significant.

**2.5 Soil physical properties**

Soil physical properties of soil include; color, texture, structure, porosity and density, consistence. Colors of soils vary widely and indicate such important properties as organic matter, water and redox conditions. Soil texture, structure, porosity, density and consistence are related with types of soil particles and their arrangement. There are two types of soil particle: primary and secondary soil particles (Edem, 2007).

Soil is comprised of minerals, soil organic matter (SOM), water, and air. The composition and proportion of these components greatly influence soil physical properties, including texture, structure, and porosity, the fraction of pore space in a soil. In turn, these properties affect air and water movement in the soil, and thus the soil’s ability to function. Soil texture can have a profound effect on many other properties and is considered among the most important physical properties (Tripathi and Misra, 2010). Texture is the proportion of three mineral particles, sand, silt and clay, in a soil (Agunwam, 2010). These particles are distinguished by size, and make up the fine mineral fraction. Particles over 2 mm in diameter (the ‘coarse mineral fraction’) are not considered in texture, though in certain cases they may affect water retention and other properties. The relative amount of various particle sizes in a soil defines its texture, i.e., whether it is a clay, loam, sandy loam or other textural category. Soil structure is the arrangement and binding together of soil particles into larger clusters, called aggregates or ‘peds.’ Aggregation is important for increasing stability against erosion, for maintaining porosity and soil water movement, and for improving fertility and carbon sequestration in the soil (Nichols *et al.,* 2004). ‘Granular’ structure consists of loosely packed spheroidal peds that are glued together mostly by organic substances (Isirimah, 2000).

Soil texture and structure influence porosity by determining the size, number and interconnection of pores (Agunwam, 2010). Coarse-textured soils have many large (macro) pores because of the loose arrangement of larger particles with one another. Fine-textured soils are more tightly arranged and have more small (micro) pores. Unlike texture, porosity and structure are not constant and can be altered by management, water and chemical processes (Edem, 2007).

**2.6 Soil biological properties**

The soil environment teaming with biological life and is one of the most abundant and diverse ecosystems on earth. Soil biota, including flora (plants), fauna (animals) and microorganisms, perform functions that contribute to the soil’s development, structure and productivity (Isirimah, 2000).

Soil Flora are plants that act on the soil environment by aiding in structure and porosity, and in supplying SOM via shoot and root residue. Root channels can remain open for some time after the root decomposes, allowing an avenue for water and air movement. Roots also act to stabilize soil through aggregation and intact root systems can decrease soil loss. The ‘rhizosphere,’ the narrow zone of soil directly surrounding plant roots, is the most biologically active region of the soil. It contains sloughed root cells and secreted chemicals (i.e., sugars, organic acids) that provide organisms with food (Sulaiman *et al.,* 2016). Soil fauna work as soil engineers, initiating the breakdown of dead plant and animal material, ingesting and processing large amounts of soil, burrowing ‘biopores’ for water and air movement, mixing soil layers, and increasing aggregation (Obute *et al.,* 2010). Important soil fauna include earthworms, insects, nematodes, arthropods and rodents. Earthworms are considered one of the most important soil fauna. Through the process of burrowing, they provide channels that increase a soil’s porosity, WHC, and water infiltration (Lee, 2010). They also increase further biotic activity by breaking down large amounts of SOM through digestion and supplying nutrient-rich secretions in their casts (Savin *et al.,* 2012). Furthermore, earthworms are able to build soil by moving between 1 to 100 tons of subsoil per acre per year to the surface, possibly helping offset losses by erosion (Magdoff and van, 2000).Soil microorganisms (microbes) are invisible to the naked eye. However, their effect on numerous soil properties are far-ranging (Obute *et al.,* 2010). Microorganisms represent the largest and most diverse biotic group in soil, with an estimated one million to one billion microorganisms per one gram of agricultural top soil (Tugel and Lewandowski, 1999). Microbes aid soil structure by physically surrounding particles and ‘gluing’ them together through the secretion of organic compounds, mainly sugars. This contributes to the formation of granular structure in the A horizon where microbial populations are greatest (Obot and Rebecca, 2013).

Soil microbes include bacteria, protozoa, algae, fungi and actinomycetes. Bacteria are the smallest and most diverse soil microbes. Bacteria are important in soil organic matter decomposition, nutrient transformations and small clay aggregation. Some bacteria carry out very special roles in the soil, such as Rhizobia, the nitrogen-fixing bacteria associated with legume roots. Protozoa (e.g., amoebas, ciliates, flagellates) are mobile organisms that feed on other microbes and soil organic matter (Osunwoke and Kuforiji, 2012). Algae, like plants, photosynthesize and are found near the soil surface (Osunwoke and Kuforiji, 2012). Fungi are a diverse group of microbes that are extremely important in the breakdown of SOM and large aggregate stability. Many fungi have long ‘hyphae’ or ‘mycelia’ (thin thread-like extensions) that can extend yards to miles underneath the soil surface and physically bind soil particles (Nichols *et al.,* 2004). Actinomycetes are a microbial group that are classified as bacteria, but have hyphae similar to fungi. They are important for SOM breakdown, particularly the more resistant fractions, and give soil much of its ‘earthy’ odor (Nichols *et al.,* 2004).

**CHAPTER THREE**

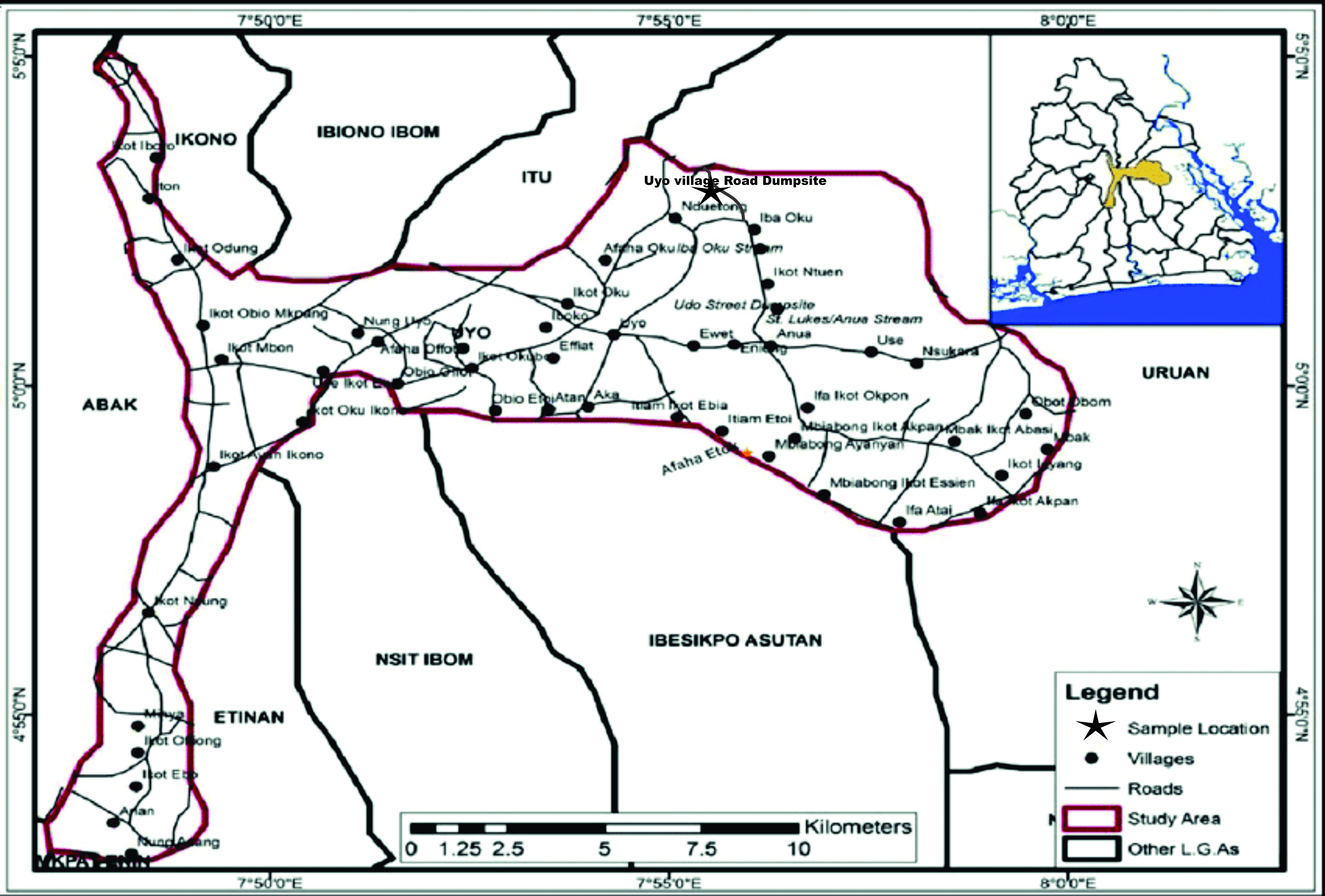
**MATERIALS AND METHODS**

**3.1 Study Area**

This study was conducted in Uyo Village road dumpsite located in Uyo Capital City, Akwa Ibom State which lies between latitudes 4°58'N and 5°04'N and longitudes 7°51'E and 8°01'E. It is bounded in the north by Ikono, Itu and Ibiono Ibom Local Government Area (LGA). In the East, it shares boundary with Uruan Local Government Area (LGA) in the west we have Abak LGA while in the south it is bounded by Ibesikpo Asutan and Nsit Ibom Local Government Areas. The city covers an area of about 214.31 square kilometers. It can be accessed by road via Abak road, Nwaniba road, Uyo-Itu/Calabar road and Aka-Nung Udoe road, Ikot Ekpene road and Oron road.

The vegetation is rain forest and it is within the humid tropical region with a mean annual rainfall ranging from 2500-3000mm. temperature of 24oc and a relative humidity ranging from 75%-79%. Soils in this region are acidic (Udoh, 2008).

The municipal dumpsite is located at the uyo village road. It is an open dump sited in an upland area, with the waste transect located low land of the dumpsite. Its topography is basically plane except a few sloppy terrain which ends in a ravine. The area lacks functional drainage system and it is always flooded each time it rains heavily. Due to poor disposal of municipal wastes, the area is faced with the problem of indiscriminate dumping of wastes on streets and roads causing serious environmental pollution and invariably affecting the soil chemical and physical properties.



**Figure 1; The Geology of the Study Area**

**3.2 Sampling and Samples treatment**

The soil samples was randomly collected from the Uyo village road dumpsite at a depth of 0-10, 10-20, 20-30cm. Leachate samples was collected at the dumpsite itself, stored in 500ml polyethylene bag which was used for soil chemical and physical properties analysis. Other samples were collected from the dumpsite 600m away from the dumpsite to serve as control samples. The soil samples was placed inside polyethylene bags and covered with aluminum foil and transported in a cool box and stored under suitable temperature until analysis. The pretreatment of the soil specimen in the dumpsite which involve removal of metals and solid waste.

**3.3 laboratory Analysis**

**3.3.1 Particle size analysis**

Particle size analysis was using the Bouyoucos (1951) hydrometer method as described by Udo et al., (2009). After dispersing the soil particles with sodium-hexametaphosphate solution, the textural class of the soil was determined using textural triangle.

**3.3.2 Bulk density**

Bulk density was determined by the method described by Dane and Topp (2002). Soil samples was oven dried at 1050C to a constant mass and bulk density calculated using the equation.

lb = Ms/Vt

Where;

lb = bulk density (Mg m-3)

Ms = Mass of oven dry soil (kg)

Vt = Total volume of soil (m3)

The total volume of soil was calculated from the internal dimensions of the cylinder.

**3.3.3 Total porosity**

Total porosity was calculated from the values of particle and bulk density relationship as follows;

F = [l-(lb/ls)]

Where;

F = Total porosity (m3/m3)

lb = Bulk density (Mg/m3)

ls = particle density (Mg/m3)

**3.3.4 Macro porosity**

Macro porosity was calculated from the values of total porosity and field water capacity of the soil as follows;

fa = ft-~~O~~v

Where;

fa = macro porosity (m3m-3)

ft = total porosity (m3m-3)

~~O~~v = volume of water held at field capacity (m3/m3)

**3.4 Chemical analysis**

**3.4.1 Soil pH**

Soil pH was determined in water and in KCl using 1:2.5 soils to water suspension and the pH value was read using a glass electrode pH meter.

**3.4.2 Electrical conductivity**

Electrical conductivity was determined using a conductivity bridge as described by Udo *et al.,* (2009).

**3.4.3 Organic carbon**

Organic carbon was measured by the dichromate wet oxidation method of walkey and Black (Nelson and Sommer, 1996).

**3.4.4 Total Nitrogen**

Total nitrogen was done by the kjedahl digestion and distillation method as described by Udo *et al., (*2009).

**3.4.5 Available phosphorus**

Available phosphorus was determined by the Bray P1 method. The phosphorus in the extract was measure by the blue method of Murphy and Riley (1962).

**3.4.6 Exchangeable bases**

Exchangeable bases (Ca, Mg, Na and K) was extracted using normal ammonium acetate (IN NH4OAC) solution (Thomas, 1982). The exchangeable K and Na was obtained by flame photometer using atomic absorption spectrophotometer (Jackson, 1970)

**3.4.7 Effective Cation Exchange Capacity (ECEC)**

ECEC was obtained by summation method, i.e., the sum of the exchangeable bases and exchangeable acidity (IITA, 1979. Anderson and Ingram, 1993). Base saturation was calculated as follows;

%BS= TEB/ECEC X 100

Where;

TEB = Total exchangeable bases

BS = Base saturation

ECEC = Effective Cation Exchange Capacity

Each analysis was done in duplicate, and the average of results was taken. The result of the study was interpreted using the interpretation guide for evaluating soil chemical properties as adapted from Iren and Ediene (2017).

**3.5 Microbial Assay**

The population of soil microorganisms was determined using the dilution spread plate technique. Nutrient agar (NA) and potato dextrose agar (PDA) were used to culture bacteria and fungi, respectively. A dilution blank was prepared by dispersing 1g of fresh soil in 9ml of sterile water. Thus was 10-1 dilution. After shaking, 1ml of the dilution was transferred aseptically into another 9ml of sterile water to give a 10-2 dilution. This process was repeated 5 times (each new dilution made from the prepared dilution) until 7 dilutions were obtained (10-1 to 10-7). Dilution 10-4 to 10-7 were inoculated on the nutrient agar (NA) plates as follows: 0.1ml of a dilution was dropped on a plate and spread over the plate with a sterile plastic spreader.

After spreading, the lid was replaced, labelled and the plate inverted for incubation which was done at 260C for one week. Each inoculated plate was in triplicate. Dilution 10-3 to 10-5 were inoculated on the PDA plates following the same procedure. After incubation, the plates were laid out for visual observation and counting of colonies. Assuming each colony was produced by a single organism, the number of bacteria and fungi in the soil samples were calculated using the formular: average colony forming units (cfu)/plate /0.1 ml/ 0.1 ml dilution/grams of soil/ml.

**3.6 Data Analysis**

The data obtained were analyzed using the SPSS statistiscal software 21. One way analysis of variance (ANOVA) was used to determine differences between treatment means and will be separated using Duncan’s multiple range test (DMRT) at a 5% level of significance (Duncan, 1955).