FORMS AND DISTRIBUTION OF NITROGEN IN SELECTED DOMESTIC DUMPSITES IN UGHELLI METROPOLIS, DELTA STATE

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A PROJECT SUBMITTED TO THE DEPARTMENT OF
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CERTIFICATION

This is to certify that this Project work titled **“Forms and Distributions of Nitrogen in Selected Domestic Dumpsites in Ughelli Metropolis, Delta State, Nigeria”** was carried out by **Emmanuel Simon WURUKESEYE** with Matriculation Number **AGR1700343** of the Department of Soil Science and Land Management, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria.

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MR. M. A. ERHAYIMWEN ***Supervisor***	**DATE**

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DR. (MRS.) A. O. BAKARE ***Head of Department***	**DATE**

DEDICATION

This work is dedicated to God Almighty for guidance, provision, and protection I received throughout my course of study in the University of Benin. I am forever grateful to You Heavenly Father.

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TABLE OF CONTENTS

CHAPTER ONE

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

LIST OF TABLES

Title

Page

LIST OF FIGURES

Title

Page

ABSTRACT

This study examined the forms and distribution of nitrogen in selected domestic dumpsites in Ughelli Metropolis, Delta State. Soil samples were collected using the soil auger from three different sample locations in Ughelli Metropolis, Ughelli North Local Government Area Delta State. The soils were analyzed for some chemical and physical properties. Some physical properties determined include the soil textural classes such as sands, clays, and silts. Some chemical properties studied in this experiment included pH, Total Nitrogen, Organic Nitrogen, Inorganic Nitrogen, Exchangeable Cations, Available Phosphorus, Organic Carbon, and Organic Matter.

The results show that the predominant textural class was sand, with varying proportions of sand, silt, and clay. Sites 1, 2, and 3 had material compositions, with total sand dominance in the topsoils and increasing clay contents at increasing soil depths (30 - 60 cm). pH values ranged from 6.40 to 5.79 with mean value (6.10), 6.11 to 5.57 with a mean (5.18), and 6.61 to 5.63 with a mean (6.12) in Sites 1, 2 and 3 respectively. Organic carbon content was highest in topsoils (0 - 30cm) across all sites while total nitrogen exhibited variations across soil depths with high amounts in the topsoils (0 -30cm). Available phosphorus content decreased down soil depths, while exchangeable cations showed soil depth-related trends. The presence of exchangeable cation decreased with depth. However, there was little or no changes in the contents of Magnesium and Potassium at 30-60cm depth across sites 2 and 3. Exchangeable Acidity was found to increase with increasing depth across the various sites. Organic and Inorganic Nitrogen contents were found to decrease with increasing depth across the various selected dumpsite in Ughelli Metropolis Delta State. In general, both organic and inorganic nitrogen in the selected domestic dumpsite were found to correlate positively with some soil physical and chemical properties. The experiment shows that dumpsite nitrogen contents of the study areas were greatly influenced by type of waste materials, presence of leachate, surrounding groundwater and environmental conditions.

CHAPTER ONE

2.0 INTRODUCTION

Nitrogen is one of the primary nutrients necessary for the growth of plants, essential for the development of amino acids, proteins, chlorophyll, and other essential plant molecules. (Jakiel *et al.* 2019). A dumpsite is an area where the waste materials are disposed of, and its nitrogen content may significantly influence the growth of surrounding vegetation. Waste materials deposited in dumpsites includes household garbage, industrial waste, and hazardous waste. These sites are often located in urban areas and can cause significant health and environmental problems (Sharholy *et al.,* 2008).

According to a report by the World Bank (2012), dumpsites are a common form of waste disposal in developing countries, where proper waste management systems are not in place. The report states that open dumpsites pose serious environmental and health risks, including contamination of air, water, and soil, which can negatively impact human health as well as wildlife.

According to Liang *et al.,* (2017), organic waste is a significant reservoir of nitrogen, which is critical for the growth and productivity of crops. The report further suggests that the excess nitrogen content in dumpsite leachate can cause environmental problems, but proper management, such as recycling the organic waste, can enhance nitrogen availability and crop production.

Nitrogen is an essential nutrient for the decomposition of organic waste materials by microorganisms. These organisms, including bacteria and fungi, need nitrogen for their metabolic processes in order to break down the organic matter in the soil at the dumpsite.

Nitrogen-rich waste materials such as food scraps or green wastes provide a source of nitrogen for these decomposers aiding in the breakdown of organic waste (Sommers *et al.,* 2015).

Nitrogen as primary nutrient necessary for the growth of plants, and its availability determines the productivity and sustainability of ecosystems. Dumpsites contribute significantly to soil nitrogen because of the diverse sources of waste materials, which contain different forms of nitrogen compounds (Jakiel *et al.,* 2019). According to a study by Atubi *et al.,* (2014), dumpsites are a significant source of nitrogen pollution in soils due to the high nitrogen content of waste materials.

In addition, improper disposal of waste materials, such as open burning, leachate discharge and compaction, contribute to the release of nitrogen compounds into the soil. The presence of nitrogen in the soil can also affect the physical, chemical, and biological properties of the soil, as well as have detrimental effects on plant growth and water quality. Chen and He (2014) investigated the contribution of land fill leachate to riverine nitrogen pollution in China. They found that landfills contribute a substantial amount of nitrogen to water bodies.

Moreover, the interaction between dumpsite soil nitrogen and organic matter is an important consideration in the management of nitrogen in dumpsites. According to Jimenez *et al.,* (2014), the interactions between nitrogen and organic matter in soil influence nitrogen cycling availability, and retention. Amadi *et al.,* (2015) investigated the changes in nitrogen mineralization and organic matter decomposition rates in dumpsite soils. The report shows that the levels of soil nitrogen and organic matter had a significant effect on the rates of mineralization and decomposition, with higher levels leading to faster rates of both processes.

In addition, the nature and composition of organic matter in dumpsite soils may also affect nitrogen transformation processes and ultimately determine the release rates of nitrogen pollutants into the environment. Dumpsite soil nitrogen is an important component of waste management and environmental protection. The presence of nitrogen in dumpsite soils and its interactions with organic matter can have significant impacts on plant growth, water quality, and soil properties. Therefore, effective nitrogen management at dumpsites is necessary for sustainable waste management and environmental conservation (Ouda *et al.,* 2016).

The main objective of the study is to determine the forms and distribution of Nitrogen in selected dumpsites in Ughelli Metropolis Delta State.

2.1 Specific objectives

To determine:

(i) Some physical and chemical characteristics of soils of domestic dumpsites.

(ii) Interactions between forms of Nitrogen and some physical and chemical properties.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 Elemental Nitrogen

Nitrogen is a chemical element with the symbol N and atomic number seven (7). It is also known as molecular nitrogen or simply N_2, a colorless and odorless gas that makes up approximately 78% of Earth's atmosphere by volume (Daranlot *et al.,* 2012). It is a non-metallic element that belongs to the group of diatomic gases, which means that it exists as a molecule composed of two nitrogen atoms bonded together by a triple covalent bond (Rappe *et al.,* 1992).

Nitrogen is an essential element for life on Earth, as it is a key component of amino acids, nucleic acids, and other biomolecules. It is also used in various industrial processes, such as the production of fertilizers, explosives, and semiconductors (Navarro-González *et al.,* 2001).

Despite its abundance in the atmosphere, elemental nitrogen is relatively inert and unreactive under normal conditions. This is due to the strength of the triple bond between the nitrogen atoms, which requires a significant amount of energy to break (Mastral *et al.,* 2003).

However, certain bacteria and other microorganisms are capable of converting atmospheric nitrogen into a form that can be used by plants and other organisms. This process, known as nitrogen fixation, is essential for maintaining the balance of nitrogen in the biosphere (Santos *et al.,* 2012).

2.2 Position in the Periodic Table

The periodic table is a tabular arrangement of chemical elements, organized based on their atomic number, electron configuration, and recurring chemical properties. It was first proposed by Dmitri Mendeleev in 1869 and has been revised and expanded over time.

Nitrogen (N) is located in Group 15 (also known as group V) of the periodic table. It is in the p-block and occupies the 2nd period. Its atomic number is 7, which means it has 7 protons in its nucleus. ("The nature and properties of soils," 1952)

2.3 Atmospheric Distribution of Nitrogen

Nitrogen gas is the most abundant gas in Earth's atmosphere, accounting for about 78% of the total volume (Solomon *et al.,* 2015). Nitrogen is generally considered to be an inert gas because it is relatively unreactive under normal atmospheric conditions, and it does not readily take part in chemical reactions that affect atmospheric composition.

The distribution of nitrogen in the atmosphere is relatively uniform throughout the troposphere, the lowest layer of the atmosphere, which extends from the Earth's surface up to an altitude of about 10-15 km (Solomon *et al.,* 2015). However, the concentration of nitrogen declines with increasing altitude, as the atmosphere becomes less dense. Above the troposphere, in the stratosphere and mesosphere, nitrogen concentrations continue to decrease, but at a slower rate, due to the presence of the Earth's magnetic field, which helps to confine the gas in these upper regions (Solomon *et al.,* 2015).

While the concentration of nitrogen in the atmosphere is generally stable and does not fluctuate significantly over time, there are some natural and human activities that can affect the relative concentrations of this gas and other gases in the atmosphere. For example, biological processes that involve fixation of nitrogen by plants and bacteria, as well as lightning activity, can contribute to fluctuations in nitrogen concentrations in the atmosphere, particularly in localized regions (Solomon *et al.,* 2015).

2.4 Nitrogen Distribution in the Ecosystem of Soils

The distribution of nitrogen in the soil ecosystem depends on various factors such as soil texture, pH, organic matter content, and microbial activity (Bobbing *et al.,* 2010). Nitrogen exists in the soil in various forms, including organic nitrogen, ammonium, nitrate, and atmospheric nitrogen, and is continuously transformed through various biogeochemical processes (Hodge *et al.,* 2001).

Nitrogen in the soil is mainly held in organic matter, and its availability to plants depends on the rate of decomposition of organic matter by soil microbes. The decomposition of organic matter releases ammonium ions, which can either be taken up by plants or transformed into nitrate through nitrification by soil bacteria (Treseder, 2013). Nitrate is readily available to plants, and its uptake is essential for plant growth and development.

The distribution of nitrogen in the soil ecosystem is also influenced by human activities such as agriculture, which involves the application of fertilizers, animal waste, and other organic inputs. These inputs can temporarily increase the availability of nitrogen in the soil, but they can also contribute to environmental problems such as nitrate leaching, eutrophication, and greenhouse gas emissions (Davidson and Janssens, 2006).

The complex process of nitrogen cycling in the soil ecosystem involves interactions between soil microbes, plants, and external factors (Reich *et al.*, 2006). Understanding the distribution of nitrogen in the soil ecosystem is critical for managing soil fertility and for addressing environmental problems associated with nitrogen pollution (Wei *et al.,* 2003).

2.5 Domestic Dumpsite Nitrogen Forms

Nitrogen exists in various forms in domestic dumpsites (Ferronato and Torretta, 2019). These forms include inorganic and organic forms. Inorganic forms of dumpsite soil nitrogen are ammonium (NH_4^+), nitrites (NO_2^-), and nitrates (NO_3^-), while organic nitrogen are parts of the microbial body of soil dwelling micro-organisms and within the structures of soil organic matter (Dugdale and Goering, 1967). These forms of nitrogen come from a variety of waste sources, including hazardous, organic, agricultural, and industrial waste (Igoni *et al.,* 2007).

2.5.1 Inorganic Forms of Domestic Dumpsite Nitrogen

Nitrite, nitrate, and ammonium are examples of the inorganic nitrogen found in domestic dumpsites (Wakida and Lerner, 2005).

2.5.1.1 Nitrites

Nitrites are important intermediates in the nitrogen cycle and are found in dumpsite soils due to the decomposition of nitrogen-containing waste materials. The chemistry of nitrites in domestic dumpsite soils is complex and influenced by various factors such as pH, temperature, and microbial activity (Green *et al.,* 1982).

Nitrite ions can also be formed through the reduction of nitrate ions under anaerobic conditions (Zhang *et al.,* 2017).

The presence of nitrites in domestic dumpsite soils can be beneficial or harmful depending on the concentration and the surrounding environmental conditions. Low concentrations of nitrites can stimulate plant growth by serving as a nitrogen source while high concentrations can inhibit plant growth and cause toxicity to microorganisms (Kumar *et al.,* 2018).

The chemistry of nitrites in domestic dumpsite soils is affected by the pH of the soil. Nitrites are stable in acidic soils ($pH < 7$) but can be oxidized to nitrate ions in alkaline soils ($pH > 7$) (Zhang *et al.,* 2017). The temperature also plays a crucial role in the chemistry of nitrites in dumpsite soils. High temperatures can enhance the activity of microorganisms responsible for nitrification and denitrification, thus increasing the concentration of nitrites in the soil (Kjeldsen *et al.,* 2002).

Microbial activity is a significant factor influencing nitrite chemistry in dumpsite soils. It has been found that the presence of denitrifying bacteria in dumpsite soils can reduce nitrite ions to nitrous oxide (N_2O) and nitrogen gas (N_2) through a series of reduction reactions. This process is essential in reducing the concentration of nitrites in the soil and preventing the accumulation of toxic levels (Zhang *et al.,* 2017).

Nitrite ions are important to plants because they can be converted into nitrate by bacteria such as Nitrobacter, which can be used as a source of nitrogen for plant growth. Nitrites can also act as a signaling molecule in plant responses to stress. In addition, nitrite ions can be toxic to plants when present in excess (Shen *et al.,* 2015). Nitrites can be important to animals that consume plants grown in domestic dumpsite soils because nitrate ions can be converted to nitrite ions in the digestive tract. However, high levels of nitrites can be toxic to animals, as they can convert hemoglobin to methemoglobin, reducing the blood's capacity to carry oxygen (Berlett, and Stadtman, 1997).

The deficiency of nitrites in domestic dumpsite soils is rare, as they are a byproduct of the decomposition of organic matter. However, excess levels of nitrites can be toxic to plants and animals. These toxic effects can be mitigated by the presence of other nitrogen-containing compounds, such as ammonium ions, which can reduce the availability of nitrite ions (Nagredan *et al.,* 2003).

2.5.1.2 Nitrates

Nitrates are commonly found in domestic dumpsite soils because of the presence of organic waste. These nitrates can undergo various chemical reactions, including transformation, reduction, and adsorption, leading to changes in their environmental fate and behavior (Green *et al., 1982b*).

Nitrate undergoes transformation. Transformation is a process in which nitrates are converted into different forms due to the action of microorganisms in the soil. Ammonification, denitrification, and nitrification are the main microbial processes that lead to the transformation of nitrates. During ammonification, nitrates are reduced to ammonium ions by soil bacteria (Nurul Islam *et al.*, 2014). Similarly, during denitrification, nitrates are converted into nitrogen gas, which escapes into the atmosphere (Belaid *et al.*, 2013). In contrast, during nitrification, ammonium ions are oxidized into nitrites and nitrates by soil bacteria (Bardgett and van der Putten, 2014).

Reduction is a chemical reaction that occurs when nitrates react with organic matter in the soil. This reaction results in the formation of different compounds, such as nitrous oxide, nitric oxide, and ammonia (Belaid *et al.,* 2013). The process of nitrate reduction is influenced by various factors such as pH, temperature, and the presence of microorganisms in the soil (Huang *et al.,* 2013). Under anaerobic conditions, nitrate reduction leads to the formation of nitrous oxide, which is a potent greenhouse gas that contributes to climate change (Mousavi *et al.,* 2014).

Adsorption of Nitrates is a situation in which nitrates become attached to the surface of soil particles. The extent of adsorption depends on the chemical properties of the soil, such as its pH, organic matter content, and mineralogy (Huang *et al.,* 2013). The adsorption of nitrates to soil particles can reduce their mobility and availability to plants. In addition, excessive nitrate adsorption can lead to soil acidification, which can negatively impact plant growth and reduce microbial activity in the soil (Nurul Islam *et al.,* 2014).

Nitrates are important to plants because they are a source of nitrogen, which is necessary for the production of amino acids, nucleic acids, and proteins. Nitrates can be taken up by plant roots, and then they are used to synthesize various plant components (Green *et al.,* 1982c).

2.5.1.3 Ammonium

Ammonium is a common form of nitrogen in domestic dumpsite soils, and it is essential as a nutrient for plant and animal growth (Okwute *et al.,* 2007). Ammonium is a positively charged ion that contains one nitrogen atom and four hydrogen atoms. It is produced when organic matter, such as food and plant waste, decomposes and releases ammonia gas (NH_3). Ammonia then dissolves in water to form ammonium ions (Wakida and Lerner, 2005b).

Ammonium is one of the most prevalent nitrogen forms in domestic dumpsite soils because of the decomposition of organic matter, and it plays a vital role in plant growth and microbial. Ammonium in soils undergoes several chemical processes like adsorption, desorption, transformation, and oxidation that impact its mobility, bioavailability, and environmental fate (Ferronato and Torretta, 2019c).

Adsorption of Ammonium is a physicochemical process by which ammonium gets attached to soil constituents like clay minerals, organic matter, or iron- and aluminum oxides. The surface area, type, and concentration of soil adsorbents determine the adsorption capacity of ammonium ions. Adsorption stabilizes ammonium in the soil, reducing the potential loss through leaching due to its low volatility (Gajewska and Sklodowska, 2016).

Desorption of Ammonia is the reverse of adsorption and occurs when ammonium ions are released from the soil surface due to environmental changes like fluctuations in soil pH, moisture, or high soil temperatures (Fendorf and Sutton, 2017). Kopaček *et al.,* (2019) reported that prolonged high temperature and soil acidification due to acid rainstorms increased the rate of ammonium desorption from soil particles and mobilized it to surface runoff or groundwater, posing environmental concerns.

Ammonium is transformed into various nitrogen forms due to microbial activity in the soil, and this process involves nitrification and ammonification. During ammonification, soil microorganisms convert organic nitrogen compounds into ammonium ions, which can be further transformed to nitrate by nitrifying bacteria (Khan *et al.,* 2018). On the other hand, nitrification is the oxidation of ammonium to nitrite and then nitrate by nitrifying bacteria (Sheoran *et al.,* 2020). Ammonia volatilization and denitrification are other significant chemical processes that cause the loss of ammonium from the soil environment, leading to soil degradation and environmental pollution (Shkir *et al.,* 2016).

Oxidation of Ammonium is the conversion of ammonium to nitrate through nitrification. Nitrification is a two-step process that starts with the oxidation of ammonium to nitrite by Nitrosomonas bacteria. In the second step, Nitrobacter bacteria oxidize nitrite to nitrate (Kammann *et al.,* 2015). The reaction requires oxygen and a relatively neutral to alkaline soil pH to be effective (Yang *et al.,* 2012).

High levels of ammonium in domestic dumpsite soils can also contribute to ammonia volatilization, which results in atmospheric pollution and can harm human health. Ammonium can also be toxic to plants at high concentrations, causing symptoms like stunted growth, leaf yellowing, and root damage (Britto *et al.,* 2001).

Deficiency of ammonium in domestic dumpsite soils is uncommon, as it is a by-product of organic matter decomposition. However, inadequacy or excess concentrations of ammonium can have negative effects on plant and animal health (Thamdrup and Dalsgaard, 2002).

2.5.2 Organic forms of Domestic Dumpsite Nitrogen

Proteins, amino acids, peptides, urea, and humic substances are some examples of the organic nitrogen compounds that are frequently found in domestic dumpsites as a result of the decomposition of organic matter (Akinbile, 2012).

2.5.2.1 Proteins

Proteins are macromolecules composed of amino acids linked by peptide bonds. They are complex natural polymers with unique structural and functional properties. Proteins in dumpsite soils undergo enzymatic and physicochemical transformations due to microbial action, leading to the formation of amino acids, peptides, and other nitrogenous compounds (Shan *et al.,* 2020).

Domestic dumpsite soils are a rich source of proteins derived from organic waste. Proteins in dumpsite soils can originate from various sources, including human and animal excreta, food waste, industrial effluents, and other organic wastes. Protein-rich materials such as meat, fish, and dairy products, when discarded as waste, contribute significantly to the increase of proteins in dumpsite soils (Hodges *et al.,* 2010).

Proteins are critical to plant growth and development, and plant proteins can be utilized by humans and other animals as a source of essential amino acids. Soil proteins, when degraded by soil microorganisms, release amino acids, which act as precursors to nucleotides, enzymes, and sugars essential for plant growth (Shan *et al.,* 2020). Nitrogen is an essential element for plant growth, and proteins are a primary source of nitrogen in the soil for plant uptake. Proteins also play a vital role in animal nutrition, supplying energy and essential amino acids for growth, maintenance, and reproduction (Tahir *et al.,* 2013).

Domestic dumpsite soils prone to protein deficiency are those that have undergone significant degradation due to improper waste management, soil erosion, and over-cultivation. Protein deficiency can lead to reduced soil fertility, impairing plant growth and development and impacting crop yields and animal nutrition. Protein deficiencies can also lead to significant environmental problems such as emission of greenhouse gases, soil acidification, and degradation of soil structure (Jarecki, 2017).

2.5.2.2 Amino Acids

Amino acids are organic compounds with both an amino group (-NH_2) and a carboxyl group (-COOH) attached to a central carbon atom. They are the building blocks of proteins, which are macromolecules composed of amino acids linked by peptide bonds. Amino acids in dumpsite soils undergo enzymatic and physicochemical transformations due to microbial action, leading to the formation of peptides, proteins, and other nitrogenous compounds (Shan *et al.,* 2020).

Amino acids in dumpsite soils can originate from various sources, including human and animal excreta, food waste, industrial effluents, and other organic wastes. Protein-rich materials, when discarded as waste, contribute significantly to the increase of amino acids in dumpsite soils (Hodges *et al.,* 2010).

Amino acids are critical to plant growth and development, and they play a vital role in photosynthesis, plant metabolism, and stress tolerance. Nitrogen is an essential element for plant growth, and amino acids are the primary source of nitrogen in the soil for plant uptake. Amino acids can also improve the quality and yield of crops by enhancing the availability and uptake of other nutrients like phosphorus and potassium (Shan *et al.,* 2020). Amino acids are also important to animal nutrition, supplying energy and essential amino acids for growth, maintenance, and reproduction (Tahir *et al.,* 2013).

Dumpsite soils prone to amino acid deficiency are those that have undergone significant degradation due to improper waste management, soil erosion, and over-cultivation. Amino acid deficiency can lead to reduced soil fertility, impairing plant growth and development and impacting crop yields and animal nutrition. Amino acid deficiencies can also lead to significant environmental problems such as emission of greenhouse gases, soil acidification, and degradation of soil structure (Jarecki, 2017).

2.5.2.3 Peptides

Peptides are organic compounds that are composed of two or more amino acids linked by peptide bonds. They can be obtained from a variety of sources, including the decomposition of organic matter, microbial activity, and the degradation of proteins. Peptides in dumpsite soils can also originate from the disposal of organic waste (Chen *et al.,* 2017). Peptides play a critical role in promoting plant growth in dumpsite soils. Studies have shown that peptides stimulate root growth, increase nutrient uptake, and improve soil structure. Peptides can also promote the growth of beneficial microorganisms, which can enhance plant productivity and health (Hall, 2002).

Peptides can be a valuable source of nutrients for soil-dwelling organisms and can promote their growth and reproduction. Peptides also have advantages for animals that live in dumpsite soils, including soil-inhabiting organisms, soil-dwelling animals, and those that rely on plants that grow in the soil (Hancock and Scott, 2000).

The degradation of organic matter can lower peptide availability and quality, and the presence of contaminants can suppress microbial activity and lower peptide synthesis in dumpsite soils, among other causes of peptide deficiency (Szymczak *et al.,* 2004).

2.5.2.4 Urea

Urea is an organic compound with the empirical formula CON_2H_4. It is a crystalline solid that dissolves readily in water and is readily hydrolyzed to form ammonium and bicarbonate ions. In dumpsite soils, urea undergoes enzymatic and physicochemical transformations due to microbial action, leading to the formation of ammonia, which can be taken up by plants for nitrogen metabolism (Shan *et al.,* 2020).

Dumpsite soils are a rich source of urea derived from organic waste. Urea can originate from various sources, including human and animal excreta, food waste, and other organic wastes. Urea is also a common ingredient in agricultural fertilizers, which can contribute to urea accumulation in dumpsite soils (Hodges *et al.,* 2010).

Urea is an important source of nitrogen for plant growth and development, and it is widely used as a fertilizer in agriculture. Urea is readily soluble in water, which makes it highly bioavailable to plants and facilitates rapid uptake. Nitrogen is an essential element for plant growth, and urea serves as a primary source of nitrogen in the soil for plant uptake. Animals can also benefit from urea's high nitrogen content. When consumed in moderation, urea can help to increase feed intake and improve animal health and productivity (Tahir *et al.,* 2013).

Urea deficient dumpsite soils are those that have undergone significant degradation due to improper waste management, soil erosion, and over-cultivation. Urea deficiency can lead to reduced soil fertility, impairing plant growth and development and impacting crop yields and animal nutrition. Urea deficiencies can also result in significant environmental problems, such as greenhouse gas emissions and water pollution (Jarecki, 2017).

2.5.2.5 Humic Substances

Humic substances are heterogeneous mixtures of macromolecules such as humic acids, fulvic acids, and humin that are naturally occurring organic compounds that are widely distributed in soils, sediments, and natural waters (Guo et al., 2019). The most prevalent type of acid is humic acid, which is distinguished by its high molecular weight, dark brown color, and capacity to form insoluble complexes with metals (Hayakawa and Nonomura, 1987). Fulvic acids have a lower molecular weight, are yellow to light brown in color, and are more water-soluble than humic acids. Humic acids are the most prevalent and are distinguished by their high molecular weight, dark brown color, and ability to form insoluble complexes with metals (Tang *et al.,* 2014).

The breakdown of organic matter, such as plant matter, animal waste, and other biodegradable materials, is the main source of humic substances in dumpsite soils (Li *et al.*, 2019). Although the humic substances present in dumpsite soils may be altered by the presence of various contaminants, such as heavy metals, hydrocarbons, and other toxic substances, the primary sources of humic substances in dumpsite soils are the decomposition of organic matter, including plant material, animal waste, and other biodegradable materials (Haitzer *et al.,* 2003).

The importance of humic substances in dumpsite soils stems from their ability to improve soil structure, water retention, and nutrient availability (Allard and Arsenie, 1991). Humic compounds also have high cation exchange capacity, which promotes the retention and release of nutrients such as nitrogen, phosphorus, and potassium. These compounds can form stable complexes with metals and reduce their bioavailability, thereby minimizing their toxicity to plants and animals (B. Liang *et al.,* 2006). Humic substances have been shown to sequester carbon in soils, playing a critical role in reducing the effects of climate change. They are a significant component of the global carbon cycle (Schmidt *et al.,* 2011).

Due to the degradation of organic matter, which may be accelerated by the presence of toxic chemicals that inhibit microbial activity, humic substances may be deficient in dumpsite soils despite their many benefits. This deficiency can result in reduced soil fertility, increased erosion, and decreased plant productivity (Chen *et al.,* 2004).

2.6 Domestic Dumpsite Nitrogen Distribution

The distribution of nitrogen in domestic dumpsites can vary depending on various factors such as the waste composition, management practices, and environmental conditions. Nitrogen is an essential nutrient for plant growth and is typically found in organic matter. However, excessive nitrogen in domestic dumpsites can lead to environmental problems such as eutrophication and groundwater contamination (Marklund *et al.,* 2003).

A study conducted by Xu *et al.,* (2013) in a landfill in China found that nitrogen concentrations decreased with depth. The report stated that the highest nitrogen concentration was found in the topsoil layer (0-20 cm) with an average concentration of 0.63g/kg. The concentration decreased steadily with depth, reaching an average concentration of 0.23g/kg at a depth of 80-100cm. This trend was attributed to the microbial decomposition of organic matter in the upper layers of the landfill

A similar report by Thiyagarajan *et al*., (2009) in a dumpsite in Bangalore, India, also found a decrease in nitrogen concentration with depth. The study found that the highest nitrogen concentration was found in the upper layer (0-15 cm) with an average concentration of 6.52 g/kg. The concentration decreased with depth, reaching an average concentration of 3.18 g/kg at a depth of 75-90cm. The authors attributed this trend to biodegradation processes that consume organic matter and release nitrogen through microbial activities.

Gao *et al.,* (2019) found that the highest concentrations of ammonium and nitrate were found in the upper soil layer (0-20 cm) of the landfill, while the concentration of nitrite was highest in the intermediate layer (20-40 cm). The study also found that the concentration of organic nitrogen was highest in the lower soil layer (60-80 cm), suggesting that decomposition and mineralization of organic matter occurred more slowly in deeper layers.

Another report by Kjeldsen *et al.,* (2002) also found that the concentrations of nitrogen in landfill soil varied with depth, but the authors noted that the distribution of nitrogen was influenced by landfill age and composition. The study found that the distribution of ammonium was highest in the upper layers of a recently closed landfill, while the concentration of nitrate increased with depth. The authors suggested that the distribution of nitrogen in landfill soil could be affected by changes in waste composition and degradation rates. Mahapatra *et al.,* (2020) investigated the distribution of organic nitrogen in a domestic dumpsite in India and found that the highest concentration of organic nitrogen was found in the upper soil layer (0-15cm), with decreasing concentrations at deeper soil depths. The authors noted that the high concentration of organic nitrogen in the upper layer could be attributed to the deposition of fresh waste and the accumulation of decomposed organic matter.

Giridharan *et al.,* (2017) investigated the In distribution of organic nitrogen in a closed domestic dumpsite in India and found that the concentration of organic nitrogen was highest in the topsoil layer (0-20cm) and decreased with depth. The authors noted that the concentration of organic nitrogen was influenced by factors such as waste composition, soil moisture content, and microbial activity.

In contrast, Vingiani *et .,* (2007) in a landfill in Italy found out that nitrogen concentrations increased with depth. The study found that the highest concentration of nitrogen was found at a depth of 120-150cm with an average concentration of 0.36 g/kg. They suggested that this trend may be due to the anaerobic conditions at deeper depths that favor the production of ammonia and other nitrogen-containing compounds.

Studies generally indicate that nitrogen concentrations decrease with depth due to microbial degradation of organic matter; however, the distribution of nitrogen dumpsites can vary depending on various factors such as waste composition, management practices, and environmental conditions. These findings highlight the importance of proper waste management practices to minimize nitrogen release and potential environmental impacts (Marklund *et al.,* 2003b).

CHAPTER THREE

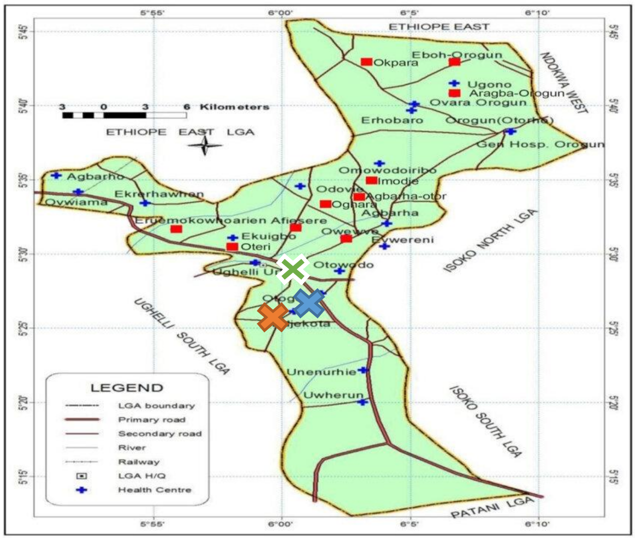
3.0 MATERIALS AND METHODS

3.1 Study Area Description

Three Domestic Dumpsites of Ughelli Metropolis were used for this research with GPS coordinates of Latitude 5°28′41″N and Longitude 5°59’43”E, Latitude 5°29′29″N and Longitude 6°00'05"E, and Latitude 5°29'18”N and Longitude 5°59'43"E.

Fig 1: Map of Nigeria Showing the State of Study

Fig 2: Map of Delta State Showing LGA of Study



Key: Area of Study

✖ 1
✖ 2
× 3

Fig 3: Map of Ughelli North Showing points of Study Area

3.1.1 Soil Sampling

Soil auger was used in making boring points at depth intervals of 0-30cm, and 30-60cm at 3 different points in a study area, soil samples were collected in three study areas having a total of 18 soil samples bulk. The samples were analyzed in Soil Science Laboratory using standard procedures.

3.1.2 Experimental Design

The experiment layout was in randomized complete block design.

3.1.3 Sample Preparation and Laboratory Analysis

The soils collected from each depth were air-dried crushed and passed through a 2mm sieve. The sieved samples were analyzed for some physical and chemical properties using standard laboratory procedures.

3.2 Soil Sample Collection

At each location an area measuring 300 meters by 200 meters was marked out and the area divided into 3 equal parts. Each part forms a replicate and each replicate soil samples were collected from 0-30cm and 30-60cm soil depths using soil auger. A total of 18 samples were collected, having 6 soil samples per location. The samples were labeled and stored in polythene bags.

3.3 Soil Sample Preparation

The soil samples collected were taken to the laboratory, air-dried for a period of 48 hours. The samples were grounded and sieved using a 2mm sieve to remove dirt and plant debris.

3.4 Laboratory Analysis of Soil Samples

3.4.1 pH 1:1 in H_2O

-20g of Soil sample of fine tilt was weighed in 50ml beaker.

-20ml of distilled water was added and the mixture was stirred intermittently for 30 minutes.

-The pH was measured in a standardized pH meter and pH was recorded as soil pH in H_20 1:1 (Tan, 2002).

3.4.2 Particles Size Determination

The particle sizes were determined using the hydrometer method of Bouyoucos (1951) as modified by Day (1965), and reported by Dhyan *et al.,* (1991).

-51g of air-dry or was placed into a soil shaking bottle.

-100ml of calgon was added and was allowed to soak for 30 minutes.

-The mixture was stirred with a mechanical stirrer.

-The soil suspension was transferred into a sedimentation cylinder and was filled to mark with distilled H_2O.

-A plunger was inserted and was moved up and down to mix the content thoroughly, while the sediment was dislodged with their upward strokes of the plunger near the bottom, the hydrometer was lowered carefully into the suspension and readings were taken after 40 seconds (R40 sec).

-The temperature reading was taken thereafter with a thermometer.

-The second reading came up in 120 minutes time. While the first (R40 sec) reading calculated for % silt + clay, the second reading calculated only for % clay and was subtracted from % silt + clay to get % silt and both % silt and clay was subtracted from 100 to get % sand.

3.4.3 Percentage Organic Carbon

This was determined using Walkley-Black (1965) method of chromic acid wet oxidation reported by Tan (2002).

-1g of soil sample was weighed into 250ml conical flask.

-10ml of IN $K_2Cr_2O_7$: solution was added and the mixture was swirled for proper mixing.

-20ml of conical H_2SO_4 was added carefully. The mixture was again swirled to mix up and was left for 30 minutes and thereafter 100ml of distilled water was added.

-The mixture was swirled again.

-5 drops of ferroin indicator was added.

-The excess chromic acid was titrated with 0.5N ferrous sulphate to dirty brown end-point (Tml).

-A blank was run, using the sample procedure, but without soil sample (Bml).

-The blank measured the amount of reducing substance present in the reagents as impurities.

- % organic carbon was calculated as follows:

= (Bml-Tml) x 0.5 x 0.003 x 1.33 x 100/ Weight of sample used

3.4.4 Organic Matter

The organic matter was computed by multiplying the value of the organic carbon by a value of 1.724.

3.4.5 Exchangeable Acidity (Al^{3+} and H^+)

-5g of soil sample was weighed into a 250ml soil shaking bottle.

-100ml of 1M KCl was added as the extracting solution.

-It was shaken for 1 hour.

-The mixture was filtered into a 100ml volumetric flask with 1M KCI.

- 25ml of KCI extract was pipetted into 250ml conical flask.

- 100ml of distilled water was added.

-5 drops of phenolphthalein indicator were added and the solution was titrated with 0.01N NaOH to a first permanent pink end-point with alternate stirring and standing.

Note: The volume of base used, should not be 0.5ml under normal condition, because of the low acidity content of some soils. Other tissues are to find the mean. The mean value base (NaOH) is equivalent to the total amount acidity (H + Al) in the aliquot taken.

Calculation:

Acidity in mmol/100g = M x T x VI/V2 x 100/wt

Where:

M-Molarity of NaOH

T-Titre Value of base

VI- Volume of extract

V2- Volume of aliquot

Wt- Weight of sample used

Summation method:

(a) EB = Exchangeable bases

=cmol/of (Ca + Mg + Na)

(b) ECEC= Exchangeable bases + Exchangeable acidity

i.e. =cmol (Ca + Mg + K+ Na) + emol (H+ Al)

=TEB+EA

3.4.6 Exchangeable Cations

-10g of soil sample was weighed into 250ml soil shaking bottle and left overnight after adding 1M NH_4OAC which was proposed in 1933 by Schollenberger *et al.,* (1982). The mixture was filtered using Whatman No. 1 filter paper into 100ml volumetric flask and made up to mark with NH_4OAC. From the leachate, Ca and Mg were determined by titration while Na and K were read in a flame photometer, and each element was expressed in cmol/kg.

Determination of Ca and Mg (EDTA Titration)

-10ml of the 1M NH_4OAC extracted leachate was pipetted into a 250ml conical flask (V2).

-30ml of distilled water was added.

-8ml of NH_3 solution (conical) was added.

-5 drops of 2% KCN was also added; followed by 5 drops of 5% hydroxyl ammonium chloride ($OHNH_3Cl$).

-3 drops Eriochrome Black T indicator (EBT) was added. The mixture was then titrated with 0.01M EDTA, from red-wine-blue.

Ca Determination

-10ml of extract was pipetted into 250ml conical flask (V2).

-50 ml of distilled water was added.

-2ml 2% KOH was also added.

-5 drops of % KCN followed by 5 drops of $OHNH_3Cl$.

-5 drops of calgmit were added and the mixture was titrated also using EDTA (0.01M).

Calculation:

Ca in mmol/100 subscript 5=M x T (EDTA) x VI/V2 x 100/wt of sample x 40

Where:

T-Titre value

M(EDTA)-Molarity of EDTA

V1-Volume of extract

V2-Volume of aliquot

40-Molecular weight of Ca

3.4.7 Percentage Nitrogen (Kjeldahl Method)- CA. Black (1965) as reported by Carter (1993)

-0.20g of fine earth was weighed into 10ml conical flask.

-A catalyst mixture of K_2SO_4 + $CUSO_4$+SeO_2 was added to aid quick digestion.

-15ml of cone H_2SO_4 was added and a glass curved funnel (specially made to prevent direct escape of ammonia (NH_3) the heating was done on an electric cooker till the solution become very clear.

-It was left to cool down to room temperature.

-The digested soil was filtered into 100ml volumetric flask and was made up to mark.

-The mixture was turned thoroughly and severally and was kept waiting for distillation.

-During distillation, 10ml aliquot was taken into a 500ml Kjeldahl flask.

-30ml of distilled water was added.

-15ml of 10N NaOH was added and it was set-up in the distillation apparatus.

-25ml distillate was collected and was titrated back with 0.01N HCl.

-Total % nitrogen was calculated as follows:

M x T x 14/100 x VI/V2 x 100/wt of sample

Where:

M-Molarity of acid

T-Control titre value

V1- Final Volume of digest

V2- Volume of digest used for distillation

3.4.8 **Determination of Inorganic Nitrogen**

-5g of soil was weighed to 250ml extraction flask (Alkaline Phenate Method).

- Sodium Acetate solution (25ml) was added.

-The mixture was shaken for few minutes.

- It was filtered using Whatman No.45 filter paper.

-The extracts was determined calorimetrically and read in a spectrophotometer at 636nm against the ppm on blank.

3.4.9 Determination of Organic Nitrogen

Organic nitrogen was determined by subtracting inorganic nitrogen from total percentage nitrogen.

3.4.1 Statistical Analysis

The data obtained were analyzed using Genstat computer package. The difference between the means were separated using Duncan multiple range tests at 5% level of probability.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Soil Particle Size Distribution

The particle size distribution of the soils is shown (Table 1). All soil depths within the three locations show sequences of sands, silts and clay deposits. Textural classes were dominated by the sand fractions. At site 1, 2, and 3, particle sizes were dominantly total sand which was higher in soil depths 0-30 cm as compared to soil depths 30-60cm. For site l, particle sizes decrease as soil depth increases with mean value of 859.44g/kg. Clay fractions increases as the soil depth increases for location 1, 2, and 3 with site 1 having the highest amount of clay with a mean of 66.33g/kg. Silt contents were higher at site 2 by a mean value of 76.0g/kg and they decreased with increasing soil depths while clay was slightly depleted in the topsoil of all the soils, it gradually increased at the subsurface horizons. This may be associated with sediment deposition process, removal of clay and silt through runoff during intense rainfall as common in the area, as well as illuviation of clay due to percolation of flood waters (Igwe *et al.,* 2006).

4.2 Soil Chemical Properties (pH)

Table 2 shows that the pH values ranged from 6.40 at soil depth (0-30cm) to 5.79 at soil depth (30-60cm) with mean value (6.10), 6.11 at soil depth (0-30cm) to 5.57 at soil depth (30-60cm)with a mean (5.18), and 6.61 at soil depth (0-30cm) to 5.63 with a mean (6.12) in Sites 1, 2 and 3 respectively. They were mild acidic in reaction (in H_2O). From the three sites, pH values decrease as depth increases, thereby increasing acidity.

Table 4.1: Particle Size Distribution.

	Sand (g/kg)			Clay (g/kg)			Silt (g/kg}		
Site	Depth (cm)			Depth (cm)			Depth (cm)		
	0 – 30	**30 – 60**	**Mean**	**0 – 30**	**30 – 60**	**Mean**	**0 – 30**	**30 – 60**	**Mean**
1	872.33	843.67	859.44_{a}	46.00	86.67	66.33_{a}	81.67	69.67	75.67_{a}
2	871.33	848.00	859.67_{a}	45.33	83.33	64.33_{a}	83.33	68.67	76.00_{a}
3	873.00	848.33	860.67_{a}	45.00	84.67	64.83_{a}	81.00	67.00	74.00
Mean	872.22_{a}	846.67_{b}		45.55_{b}	84.89_{a}		82.00	68.44	-
LSD(0.05)	Ns			Ns				Ns	- -
LSD(0.05)	4.359			3.002				2.641	- -
LSD(0.05)	Ns			Ns				Ns	- -

ns = not significant at 0.05 level of probability.

Table 2: pH

Site	**Depth (cm)**		**Mean**
	0 – 30	**30 – 60**	
1	6.40	5.79	6.10_b
2	6.11	5.57	5.18_c
3	6.61	5.63	6.12_a
Mean	6.38_a	5.66_b	-
LSD(0.05)	-	0.141	-
LSD(0.05)	-	0.116	-
LSD(0.05)	-	0.200	-

ns = not significant at 0.05 level of probability.

4.3 Electrical Conductivity

Table 3 result shows the Electrical Conductivity of the three sites. Site 1 had high EC at soil depth 0-30 cm (0.43) and a low EC at soil depth 30-60cm (0.41) with a mean of 0.42. This follows the same pattern across the three sites establishing that EC decreases with increase in soil depth. According to USDA (2011), factors influencing the electrical conductivity of soils include the amount and type of soluble salts in solution, porosity, soil texture, soil moisture, and soil temperature. High levels of precipitation can flush soluble salts out of the soil and reduce EC.

4.4 Organic Carbon

In table 4, the values for organic carbon vary across the different sites 1 (30.10 – 19.67g/kg), 2 (29.30 – 15.63 g/kg) and 3 (32.87 - 15.28g/kg). These variations indicate that dumpsite soils are high in organic carbon levels and they conveniently decline with depth (Boruvka *et al*., 2012). The mean 24.88g/kg, 22.47g/kg and 24.08g/kg from site 1, 2, and 3 respectively, falls within the critical levels of 20-30 g/kg in soils as reported by Enwezor *et al*., (1989).

4.5 Total Nitrogen

In Table 5, the Total Nitrogen for site 1 was 2.5 g/kg at the topsoil, decreasing gradually down the soil to 0.77g/kg at depth 30-60cm. Site 2 and 3 recorded a mean of 1.32g/kg and 1.41 g/kg respectively, which was a lower amount compared to site 1. According to Chude *et al*., 2011, Total Nitrogen contents were high at topsoils due to high concentration of organic carbon as well as increased soil microbial activities.

Table 3: Electrical Conductivity

Site	Depth (cm)		Mean
	0 – 30	**30 – 60**	
1	0.43	0.41	0.42_a
2	0.43	0.36	0.40_a
3	0.49	0.39	0.44_a
Mean	0.45_a	0.38_a	-
LSD(0.05)	-	Ns	-
LSD(0.05)	-	Ns	-
LSD(0.05)	-	Ns	-

ns = not significant at 0.05 level of probability.

Table 4: Organic Carbon (g/ kg)

	Depth (cm)		
Site	**0 – 30**	**30 – 60**	**Mean**
1	30.10	19.67	24.88_{ab}
2	29.30	15.63	22.47_{a}
3	32.87	15.28	24.08_{b}
Mean	30.76_{a}	16.85_{b}	-
LSD(0.05)	-	-	2.615
LSD(0.05)	-	-	2.135
LSD(0.05)	-	-	3.698

ns = not significant at 0.05 level of probability.

Table 5: Total N (g/kg)

Site	Depth (cm)		Mean
	0 – 30	30 – 60	
1	2.53	0.77	1.65_a
2	1.95	0.68	1.32_c
3	2.03	0.78	1.41_b
Mean	2.17_a	0.75_b	-
LSD(0.05)	-	-	0.070
LSD(0.05)	-	-	0.057
LSD(0.05)	-	-	0.099

ns = not significant at 0.05 level probability.

4.6 Available Phosphorus Content

Available P content in Table 6 was highest at the top soils of site 1 (16.07), site 2 (16.50), and site 3 (14.23) followed by a decrease down the soil. Based on the sampling locations, the first soil depth (0-30cm) for all three locations recorded a mean of 15.60mg/kg this value was higher compared to the mean value (7.01) of the second depths (30-60cm). Low values of available P in certain dumpsite soils may be related to the low native phosphorus in the parent material, P-fixation, low organic matter and the inability of farmers to apply inorganic fertilizers (Eleke *et al.,* 2018).

4.7 Exchangeable Cation

In Table 7 exchangeable Calcium (Ca) ranged from 2.05 (0-30cm) to 0.75 (30-60cm) for site 1, 1.21 (0-30cm) to 0.64 (30-60cm) for site 2, and 2.38 (0-30cm) to 0.73 (30-60cm) cmol/kg for site 3 respectively. Magnesium (Mg) was 0.38cmol/kg to 0.27cmol/kg for 1, 0.32cmol/kg to 0.23cmol/kg for 2, and 0.42cmol/kg to 0.23cmol/kg for 3 respectively. Potassium (K) was also found to be 0.35 to 0.25, 0.28 to 0.20, and 0.39 to 0.20cmol/kg for sites 1, 2, and 3 respectively. Sodium (Na) also showed a decreasing trend with depth having 0.22 to 0.15, 0.17 to 0.13, and 0.25 to 0.17cmol/kg for sites 1, 2, and 3 respectively. The Calcium, Magnesium, Sodium, and Potassium contents for sites 1, 2, and 3, decreased as soil depths increased. However, Magnesium and Potassium followed a similar trend across the same depth for different locations. For the first 0-30cm across all three locations their values varied but at the 30-60cm depth, the variation decreased with sites 2 and 3 both having the same values for Magnesium and Potassium.

Table 6: Available P (mg/kg)

	Depth (cm)		
Site	**0 – 30**	**30 – 60**	**Mean**
1	16.07	7.52	11.79_a
2	16.50	6.93	11.71_a
3	14.23	6.60	10.42_a
Mean	15.60_a	7.01_b	-
LSD(0.05) Depth	-	-	Ns
LSD(0.05)	-	-	0.891
LSD(0.05)	-	-	Ns

ns = not significant at 0.05 level of probability.

Table 7: Exchangeable cations (cmol/kg).

	Ca Depth (cm)			Mg Depth (cm)			K Depth (cm)			Na Depth (cm)		
Site	0 – 30	30 – 60	Mean	0–30	30–60	Mean	0–30	30 – 60	Mean	0–30	30–60	Mean
1	2.05	0.75	1.40	0.38	0.27	0.33_{a}	0.35	0.25	0.30_{a}	0.22	0.15	0.19_{b}
2	1.21	0.64	0.92	0.32	0.23	0.28_{b}	0.28	0.20	0.24_{b}	0.17	0.13	0.15_{c}
3	2.38	0.73	1.56	0.42	0.23	0.33_{a}	0.39	0.20	0.29_{a}	0.25	0.17	0.21_{a}
Mean	1.88	0.70	-	0.37_{a}	0.25_{b}	-	0.34_{a}	0.22_{b}	-	0.19_{a}	0.15_{b}	-
LSD(0.05) Depth	-	-	0.230	-	-	0.032	-	-	0.025	-	-	0.023
LSD(0.05) Location	-	-	0.187	-	-	0.026	-	-	0.021	-	-	0.019
LSD(0.05) DxL	-	-	0.324	-	-	0.045	-	-	0.036	-	-	0.033

ns = not significant at 0.05 level of probability; figures bearing the same alphabets are not significant at 0.05 level of probability.

4.8 Exchangeable Acidity

In Table 8, the results indicated the presence of H^+ and Al^{3+}. The values of exchangeable acidity (H^+) were 0.03 to 0.12, 0.10 to 0.14, and 0.00 to 0.12, while that of Al^{3+} were 0.00 to 0.04, 0.03 to 0.07, and 0.00 to 0.05 cmol/kg for sites 1, 2, and 3 respectively. They increased as the soil depths increases in the three locations; the highest was observed at the 30-60cm depth of site 2. Conversely, little or no acidity was recorded at the topsoil of sites 1 and site 3. The resultant variability in the values of exchangeable acidity is attributable to aluminosilicate clay minerals releasing Al^{3+} and H^+ into the soil solution via isomorphous substitution, leaching and nutrient biocycling (Akamigbo and Nnaji, 2011; Ogunwale *et al.*, 2002) under repeated wetting and drying conditions. Exchangeable acidity and Aluminum saturation are also useful indices of horizon development of some dumpsite soils; because exchangeable Aluminum is relatively less mobile in soil and differential accumulation of may be attributed to in situ clay destruction (Okunsami *et al.*, 1987).

4.9 Organic Nitrogen

Organic Nitrogen was 1.60 to 0.45, 1.35 to 0.49, and 1.47 to 0.47 g/kg for sites 1,2, and 3 respectively. Although, the values varied from one site to another. However, Organic Nitrogen decreased with increasing soil depth. The first depths (0 - 30cm) recorded a mean of 1.47 across the difference sites, while the mean of depths (30 – 60cm) was 0.47 g/kg.

Table 8: Exchangeable Acidity (cmol kg^{-1})

Site	**H$^+$**			**Al^{3+}**		
	0 – 30	**30 – 60**	**Mean**	**0 – 30**	**30 – 60**	**Mean**
1	0.03	0.12	0.08	0.00	0.04	0.02
2	0.10	0.14	0.12	0.03	0.07	0.05
3	0.00	0.12	0.07	0.00	0.05	0.03
Means	0.05	0.13	-	0.01	0.05	-
LSD(0.05)	-	-	0.028	-	-	Ns
LSD(0.05)	-	-	0.023	-	-	0.026
LSD(0.05)	-	-	0.039	-	-	ns

ns = not significant at 0.05 level of probability.

Table 9: Organic Nitrogen (g/kg)

	Depth (cm)		
Site	**0 – 30**	**30 – 60**	**Mean**
1	1.60	0.45	1.02a
2	1.35	0.49	0.92a
3	1.47	0.47	0.97_a
Mean	1.47_a	0.47_a	-
LSD(0.05)	-	-	-
LSD(0.05)	-	-	0.150
LSD(0.05)	-	-	Ns

4.10 Inorganic Nitrogen

The values for inorganic nitrogen was lower compared to the organic nitrogen in the dumpsite. From table 10, the results shows that site 1, 2 ,3 have a higher concentration of inorganic nitrogen at the first depths (0 – 30 cm) when compared to the other soil depths (30-60cm). The mean concentration varies from one site to another with sites 1, 2, and 3, having a mean of 0.60, 0.50, and 0.49 g/kg respectively.

4.11 Correlation Coefficients of Organic and Inorganic N and Physical Properties

Results from Table 11 below shows that organic and inorganic nitrogen correlates positively with sand, silt and clay contents of the soil. This means that increase or decrease in organic nitrogen will lead to a corresponding increase or decrease in sand, silt, and clay contents respectively.

4.12 Correlation Coefficients of Organic and Inorganic N and some Chemical Properties

Chemical properties observed from the table 12 below shows a positive correlation with organic and inorganic nitrogen.

Table 10: Inorganic Nitrogen (g/kg)

Site	Depth (cm)		Mean
	0 – 30	**30 – 60**	
1	0.90	0.30	0.60
2	0.61	0.40	0.50
3	0.64	0.33	0.49
Mean	0.72	0.34	-
LSD(0.05)	-	-	Ns
LSD(0.05)	-	-	0.111
LSD(0.05)	-	-	0.192

Table 11: Correlation coefficients of Organic Nitrogen and Physical properties

Particle size				
	Sand	Silt	Clay	EC
Organic N	0.925*	0.899*	0.701*	0.534*
Inorganic N	0.808*	0.700*	0.806*	0.192*

* Not significant at 0.05 level of probability

Table 12: Correlation coefficients of Organic and Inorganic Nitrogen and some Chemical Properties

	Organic C	**Total N**	**Avail P**	**Ca**	**Mg**	**K**	**Na**	**H+**	**Al3+**	**pH**
Organic N	0.931*S	0.965*	0.948*	0.843*	0.808*	0.805*	0.713*	0.799*	0.704*	0.867*
Inorganic N	0.713*	0.873*	0.746*	0.751*	0.700*	0.692*	0.580*	0.598*	0.561*	0.832*

- Not significant at 0.05 level of probability

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study area shows distinctive characteristics with sand texture having dominance in particle size distribution. Soil pH is slightly acidic at the topsoils and moderately to strongly acidic at lower soil depths across various selected sites with exchangeable cation levels varying with soil depth and location. Organic carbon content is higher in location at the topsoils with a high mean value in site 1, while total, organic, and inorganic nitrogen although varies across all sites but deceases with soil depth. Available phosphorus is generally moderate at topsoils but low as soil depth increases. Magnesium and Potassium exhibits depth-related trends. Calcium and sodium content vary across the sites. Furthermore, clay content increases with soil depth However, soil chemical properties show that dumpsites nitrogen contents occupy the topsoils across various locations.

5.2 Recommendations

The research findings contribute valuable insights into forms and distribution of nitrogen in domestic dumpsites, highlighting the dominance of sand texture, acidity, and depth-related nutrient variations in the study areas. These insights emphasis the need for proper soil management strategies, nutrient adjustments, and waste disposal and pH corrections to enhance agricultural production and sustain the environment. Furthermore, it is recommended that more nutrient analysis be carried out in the study area from time to time to understand the forms and distribution of soil nitrogen as well as its environmental interactions and impacts.

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