Environmental Effects of Spent Lubricating Oil on the Physical and Chemical Properties of Soil in Orji Mechanic Village Imo State

Eze, Sampson Ajachukwu; Umunnakwe, Johnbosco E.; Njoku, Macdonald Ugochukwu Nwachukwu, Joseph; Emereibeole Enos I.
Corresponding Author:
Eze, Sampson Ajachukwu (sameze88@gmail.com)
Department of Environmental Management,
Federal University of Technology Owerri, Nigeria.
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Abstract
The study investigated the effects of spent oil lubricants on soil physical and chemical properties. Twelve (12) different soil samples were collected from the auto-mechanic villages and from the FUTO university agricultural land that served as the control. Two (2) samples were collected from these three points $5^0$31.114N $7^0$02.703E, 5^0 31.165 N $7^0$2.670E and$5^0$23.35N $6^0$59.176E at profile of 0-15cm and 15-30cm. Twenty three (23) different parameters were analyzed for the soils such as pH, bulk density, total organic carbon, particle size distribution, heavy metals of Ni, Cu, Zn, Ar, Cd, Hg and Pb. Standard methods were employed in the course of the analysis such as the use of Atomic Absorption Spectrometer model FS 240 Varian, Jewniary, digital pH meter for pH measurement, Refractometer model E- Line R.ATC- Range order code 44-803 for salinity measurements and titrimetry methods for the remaining parameters. All the parameters tested was in good condition except for the soil pH and concentrations of heavy metals which were more significant as pH of the auto-mechanic soils were acidic in the range of 4.3- 5.0 in comparison with the control with mean value 5.6. Heavy metals were higher and richer in auto mechanic soils than in the control and their concentration decreases in this trend Cu 0.940> Hg 0.211> Ni 0.093> Zn 0.051> Pb 0.021> Cd 0.015 >Ar 0.003; Hg 1.385> Cu 0.853> Ni 0.079> Zn 0.041> Cd 0.04> Pb 0.034>Ar 0.004 for the soil auto- mechanic soil 1 and 2. Ar had zero values in the soils of the control. Pearson Correlation coefficient was computed in testing the hypothesis using SPSS v. 20 where significant positive correlations were obtained at values 0.957 and 0.99. P value 0.00; 0.874 and 0.999, P 0.00; 0.997 and 0.912, P 0.000; 0.997 and 0.918 P 0.000 all at 0.01 level of significance. The null hypothesis was rejected on the basis of the significant correlations for relationships between the use of lubricants and physico chemical variables, physico chemical variables and depths of the soil across the profile, use of oil lubricants and soil particle size distribution, use and disposal of oil lubricants and soil texture. Recommendations were made like adherence to proper disposal of auto mechanic wastes, use and enforcement of Environmental Management Plan in auto- mechanic workshop villages and remediation measures to correct the concentration of parameters as identified using phyto- remediation for a sustainable soil and environmental management in the vicinities of the workshop.

Keywords: *Soil Quality, Contamination, Environment, Correlation, Auto- mechanic Workshops, Heavy Metals and Sustainability.*

1. Introduction

Soil is the most vital non-renewable natural resource, an actively living system which perform major environmental functions consist of diversity of micro and macro fauna and flora, that plays major role in maintaining the soil quality (Sultan Ishaq *et al,* 2015).

Soil physico-chemical characteristics are dynamic and vary across space and time because they are governed by natural soil formation processes and environmental influences such as parent material, climate, topography, and patterns of land use. These variations affect attributes such as soil pH, organic carbon content, electrical conductivity, and nutrient availability, reflecting differences in soil orders and management histories (Gowthamchand*et al.,* 2023). The pressures of human population on land resources have increased the need to appraise land-use change effects on soil quality. One of the main factors affecting soil quality and associated nutrient loss is improper land use and land-use change (Abshiba*et al.,* 2025).

Soil quality includes physical, chemical, and biological properties of soil that depends on the soil nutrient pools and reserves, which are modulated by land use and a number of other management factors (Abshiba*et al.,* 2025). Many studies have shown that land-use transformation can affect soil physical and chemical properties in such a way that soil physical and chemical properties are altered and impaired. (Khresat, Al-Bakri, and Al-Tahhan 2008). According to USEPA, (1993) some of the undesirable elements that commonly pollute the environment include natural organics (phenols, for-maldehyde); heavy metals (lead, nickel, zinc, cad-mium, copper, chromium); inorganic (ammonia, cyanides, fluorides, nitrites, and sulphites); synthetic organics (pesticides, herbicides, detergents); acid and alkaline substances; mineral oils, fats and floatable substances; suspended solids and colloids; nutrient substances like nitrogen, phosphorus, sulphates as well as radioactive materials.

In mechanic workshops, there are accidental or deliberate releases or discharge of petrol, diesel, solvents, grease, and lubricants on the land and the atmosphere. Many of these petroleum products are organic and synthetic chemicals that can be highly toxic and hazardous to soil fauna and man**.** The use of automobiles has also led to trace element and heavy metals-contaminated soil, which have grave consequences for soil dwelling organisms (Oladimeji *et al.,* 2025). Activities that take place at the mechanic villages are essentially of auto-mechanic repairs and invariably involve working with and spilling of oils, grease, petrol, battery electrolyte, paints and other materials which contain heavy metals unto bare soil.

As a result of the strong implications of pollution by auto-mobile workshops on the environment and delicate nature of the soils in the mechanic workshop in Orji Mechanic Village, this study will examine the seasonal concentrations of the physical, chemical and biological properties and some heavy metals across various horizons so as to determine the pollution effects of auto-mechanic work-shops on the soil environment and thus highlight and create awareness on the implications of this on the immediate environment while recommending a sustainable approach to soil conservation and management in the study area.

1.1 Aim and Objectives of Study

The main aim of this study aimed is to determine the seasonal variation of physical and chemical properties of soils at the vicinities of automobile mechanic village at Orji in Imo State where spent and lubricating oil are disposed. The Specific objectives of the study include to:

i. evaluate the seepage pollution potential of spent oil on soils by comparing their analysis with soils not contaminated by spent oil.

ii. determine the relationship between spent oil lubricants disposed and the soil physical and chemical qualities.

iii. generate soil data that will assist decision makers in planning for a sustainable land management in auto- mechanic workshop.

iv. create awareness on the effect of improper disposal of used engine spent oil in Orji Mechanic village through environmental awareness creation and sensitization.
v. suggest remedial measures for the polluted soils in the study area

2. Study Area Description

3.1 Study Area Description

Orji is a village part of the ancient kingdom of Uratta in Southeast Nigeria and is located within the coordinates 5°31′39″N 7°3′50″Ein Owerri North Local Government Area of Imo State. It is located and is one of several settlements along the Owerri-Okigwe road, including Umuchoke, Umuogowerem, Umuogii, Umukehi, Umuodu, Umuimeka, Umundula, Umuasonye, and Aro.



Figure 3.1: . Map of Nigeria Showing Owerri

3.1.1 Geography of Study Area

Geographically, Orji covers a land area of 408,725m2 (Nwachukwu et al, 2011). The town occupies the western periphery of the mother-clan, Uratta. Orji is bounded on the west by Umuodagu and Umunjam villages and in the east by Owaelu and Okwu; on the north by Obazu]; and on the South by Owerri town

3.1.2 Climate of Study Area

The study area is within the humid tropical and rainforest zone of Southeastern Nigeria. The rainfall distribution pattern is reminiscent of the scenario in Southern Nigeria. The rainfall regime is bimodal and peaks in July and September with little dry season known as August break in-between. The rainy or wet season begins about February or March and last till

October or early November.
This is typically an equatorial tropical rainforest climate type.
Rainy (wet) season is characterized by relatively high temperature (33oc) and high relative humidity. Chilly and dry harmattan wind is experienced in dry season. This lowers environmental temperature appreciably, especially in the months of December and January. The study area records average maximum and minimum temperatures of about 32^0c and 25^0c respectively and annual mean rainfall of about 2000mm.
Dips in rainfall occur around the mid-periods between June and September.

3.1.3 Geology of Study Area
Along with the effects of climate, relief, organisms and time, the underlying geology or 'parent material' has a very strong influence on the development of soils. Orji shares sandy Benin Formation (Okoro *et al,* 2013). Imo Shale (Paleocene-Eocene) covers about 25% of the Owerri North axis

3.1.4 Vegetation of Study Area
The study area falls within the rain forest belt and characterized by growth of tall trees amidst thick undergrowth. Oil palm trees are common while swampy areas have thick cover of raffia palm. Lowlands are thickly vegetated with forest trees, while the highlands consist mainly of grasses with trees and shrubs sparsely distributed. In some areas, only isolated stands of a few forest emergent trees remain as evidence of the original forest. This is due to high rate of human activities in form of deforestation as lands are cleared for purposes of farming and construction, industrial, tourist and institutional establishment

3.1.5 Population and Land Use
Orji, part of Owerri North Local government has a population of 175,395 at the 2006 census. Wikipedia, (2015).
The Orji mechanic village was established in the year 1987 and has a land area of 0.41km^2 and was established in 1987 (Nwachukwuet *al,*2010).

MAP OF IMO STATE

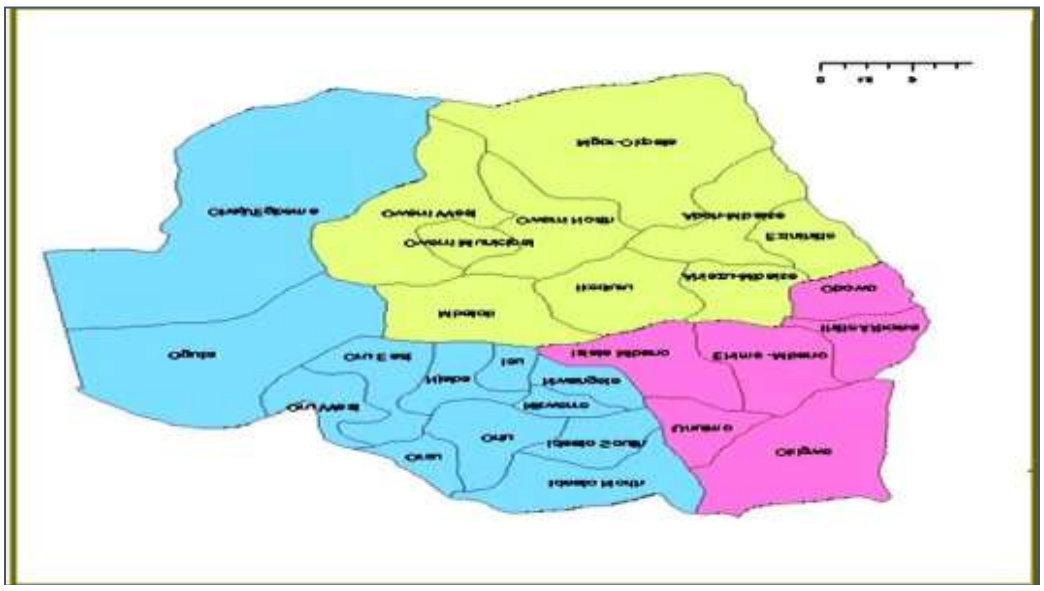


Figure 3.2: Map of Imo State Showing Owerri North

3. Methodology

3.1 Data Collection

For the purpose of this study, soil survey will be conducted.
Following the guideline by FAO, (1977), a standard profile pit will be dug extending 2m by 1m in dimension and at least 4ft deep.
This will be made in three different points covering two entire land uses: two profile pits at the mechanic workshop (mechanic land use) and one serving as the control far away from the mechanic workshop Federal University of Owerri (FUTO Agricultural Land Use).
In each of the profile pit, two samples will be collected making it a total of six (6) on the whole. One will be sampled from the top soil ie. 0-15cm and the other from the sub soil from 15-45cm.
The soil samples collected will be described in situ for their physical characteristics before being taken to the laboratory for analysis.

3.1.1 Sampling Tools

i. The map of the study area as a guide to the area
ii. Hand shovel for digging of the soil profile pit
iii. Munsell Colour chart for determining soil colour on the site
iv. Field note book for recording all observation and description made during the field work
v. Soil auger for sampling of soils
vi. Soil sampling bags and polythene for collecting the samples for laboratory analysis
vii. Indelible markers for marking and labeling of the sample bags
viii. Hand held GPS for noting the coordinates of the study area
ix. Digital camera for taking photographs at the site

3.1.2 Site Description where the samples were collected:

Mechanic soil 1 and 2 consist of the environment where the auto- mechanic activities are performed where the engineers perform their functions, servicing and maintenance of vehicles. As reflected in plate 1.0 – plate 6.0. Some trees like mangoes, oranges were seen at the site, economic activities were performed at the site as well where buying and selling of goods and services are in place. Also, in some areas, there were dumpsites were wastes of all kinds were disposed indiscriminately. Around the vicinity of the mechanic village, households were seen as they cluster in the area where some of them engage in urban agriculture in growing of some few crops.
At the control site at FUTO agricultural land, the site was an agricultural farm mixed with weeds. Cassava plants and other vegetation were seen in the site where the soil was collected which were unpolluted to serve as the control site.

Analysis

In the laboratory, the samples were air- dried, ground and sieved through 2mm mesh size sieve and subjected to physical, chemical and biological analysis.

3.2 Soil Physical Analysis

Particle Size Distribution
This was carried out by Bouyoucos hydrometer method. The dried soil sample was dispersed with solution of sodium hexametaphosphate (Calgon 44g/l) and sodium carbonate (8g/l) in a less than 2mm mesh size. 5ml of distilled water was added and stirred while the content of the container was transferred quantitatively into a litter measuring cylinder.
Hydrometer and first reading was taken 40 seconds. Textural triangle was used to obtain the

sand, silt and clay fractions.

3.2.1 Soil Texture Determination

As the particle size distribution was determined, the soil was subjected to a textural class using the United State Department of Agriculture (USDA) textural triangle.

3.2.2 Determination of Silt and Clay

Soil suspension was mixed in a hydrometer jar with a paddle, after which the paddle was removed and the hydrometer immediately inserted. Froth on the surface of the jar was removed, and one drop of amyl alcohol was added, the hydrometer reading was taken 40 seconds after withdrawing the paddle. The hydrometer reading gave (R sc)
Percentage silt plus clay was then calculated using the formular
% [silt+clay] (w/w)= (Rsc-Rb) × 100 / oven –dry soil (g) (3.1)
Rc = Hydrometer reading
Rsc = Hydrometer reading 40 seconds after withdrawing the paddle.

3.2.3 Determination of Clay

A sample of soil suspension in the hydrometer jar was mixed with the paddle, and withdrawn from the hydrometer jar with care, and the suspension was left undisturbed. After 4 hours, the hydrometer was inserted, and the hydrometer reading Rc was taken. Percentage clay and silt in the soil was calculated using the formular below
% clay (w/w) = (Rc-Rb) × 100 / oven-drysoil (g)(3.2)
Rb = Hydrometer reading
Rc = Hydrometer reading after 4 hours inserting hydrometer
% silt (w/w) = [%silt +clay (w/w)] – [%clay (w/w)] (3.3)

3.2.4 Determination of Sand

After taking readings required for clay and silt, the suspension was poured quantitatively through a 50 µm sieve. The sieve was washed until water passing the sieve became clear. Then the sand was quantitatively transferred from the 50ml beaker of a known weight. The sand was allowed to settle in the beaker and excess water was discarded.
The beaker was dried with sand overnight at 105ºc. the beaker and its content was cooled in a dessicator. Thereafter it was re- weighed. The percentage sand in the soil was calculated with the formular below
% sand (w/w) = sand weight × 100 / oven – dry soil (g) (3.4)
Where weight of sand also was calculated subtracting the weight of the beaker from the weight of the soil and beaker.
Thus the following:
Sand weight (g) = [Beaker +sand (g)] – (Beaker (g)] (3.5)

3.2.5 Determination of Moisture Content

Soil moisture content was determined was determined by using an oven drying method in which samples were dried to constant weight at 105ºc (Ahuja et al, 1976) and the differences in mass of wet and dry samples recorded and expressed in percentage. In doing so, about 20 g of wet soil sample placed in a container was weighed and its mass M was recorded. The soil sample was dried in an oven (105-110ºc) for about 24 hours when it becomes perfectly dry. Its dry mass, Md was then determined and the water content calculated from the relation

W = ww /wd × 100% (3.6)

Mc = Ww- M / Wd- M × 100%(3.7)

Moisture content = Ww- M / Wd – M × 100%(3.8)
Where mass of the empty container = M
Mass of wet soil + empty container = Ww
Mass of oven dry soil = empty container = Wm

3.2.6 Determination of Bulk Density

Soil bulk density was determined using the core method, where a cylindrical soil sampler was driven into the soil, removed carefully to preserve natural structure, and the intact soil core was trimmed and weighed for dry density calculation (USDA-NRCS, 2024).
The two cylinders were then separated, retaining the undisturbed soil in the inner cylinder. The soil extending beyond each end of the sampler holder were also trimmed and flushed with each end with a straight edge knife. At this time, the soil sample volume was established to be the same as the volume of the sample holder. The soil was then processed and then transferred to a container, weighed and placed in an oven at 105ºc. The soil sample was weighed and re weighed again until a constant weight was reached. The bulk density was calculated as the ratio of the oven dry mass of the soil sample to the sample volume.
Bulk density was calculated using the formular:
Cb = MS / Vt(3.9)
Where
Ms = Mass of the oven dry soil (g)
Vt = Total soil volume (cm3) assumed to be equal to volume of cylinder: and this was calculated from the formular
Vt = πr2h(3.10)
Where:
Π= 22/7
R= radius
H= height

Soil Chemical and Biological Analysis

Determination of Soil pH

Soil pH for the samples were determined following the method adopted by Quispe et al. (2024). The 20 grams of air-dried soils were weighed into a 100 ml of glass beaker. 20 ml of distilled water was added using a graduated cylinder. The suspension was mixed thoroughly with a glass rod and allowed to stand for 30 minutes to maintain equilibrium. And during this period, the suspension was stirred every 10 minutes using a glass rod for one hour. Then the electrode of the pH meter was inserted into the partially settled suspension (to the depth of of 3cm) and the pH reading taken to represent the degree of acidity or alkalinity of the samples.

3.4.7 Determination of Exchangeable Cations

Exchangeable cations of Sodium, Potassium, Magnesium and Calcium ions were extracted according to the ammonium acetate extraction method. 30 ml of 1NH4OAC was added into 5 g of air-dry soil and this was shaken on a mechanical shaker for 2 hours. Then the suspension was centrifuged at 2000rpm for 10 minutes, the clear supernatant was carefully decanted into a 100ml volumetric flask. Another 30 ml of NH4OAC solution was added and shaken for 30 minutes, centrifuged and the supernatant was transferred into the same volumetric flask. This was repeated again severally and transferred into the same volumetric flask. The solution was made up to mark by adding more NH4OAC solution. Potassium (K) and Sodium (Na) were determined on a flame photometer while Magnesium (Mg) and Calcium (Ca) were

determined on an Atomic Absorption Spectrometer (AAS).

Determination of Organic Carbon and Organic Matter

Wet digestion method of Blacks (1965). A representative sample was taken, ground and passed through a 0.5 mm sieve. Soil samples were weighed out in duplicates and transferred to 250 ml Erlenmeyer flask. 10 ml of 1 NK2CrO7 solution was pipetted accurately into a flask and swirled gently to disperse the soil. 20 ml of concentrated H2SO4 was added rapidly using an automatic pippete, directing the stream into the suspension. Immediately the flask was gently swirled until soil and reagents are mixed, and then swirled vigourosly for 1 minute. The flask was allowed to stand on a sheet of asbestors for about 30 minutes. 3 drops of indicator was added and titrated with 0.5 FeSO4 solutions. As the end point approached, the solution turned a greenish cast and then changes to dark green. At this point FeSO4 was added drop by drop until the colour changes sharply from green to red. Blank titration was also made in the same manner, but without soil, to standardize the dichromate. The result was calculated using the formular below:

$$\% \text{ Organic C} = \frac{(\text{MeK2 Cr2 O7- FeSO4}) \times 0.003 \times 100 \times F}{\text{g of air – dry soil}} \quad (3.11)$$

Where:
Correction factor, f = 1.33
Me = Normality of solution × ml of solution used

Calculation of Percentage Organic Matter
Percentage organic matter was calculated by multiplying the percentage organic matter with Van Denmelen's correction factor
% organic matter = % organic carbon × 1.724
Where 1.724 is the Vandenmelen's correction factor.

Determination of Bulk Density

Soil bulk density was determined by the procedure of undistributed soil core sample which is dried in the oven at a temperature of 110ºc. The dried soil sampled was used in calculating the bulk density as:

$$\text{Bulk density} = \frac{\text{mass of oven dried soil sample}}{\text{volume of sample}} \quad (3.12)$$

Determination of Total Nitrogen
Nitrogen was determined using Macro Kjeldahl method of bremmer and Mulvaney (1982). 10 g of air-dried soil was weighed into a 500 ml macro kjeldahl flask and 250 ml of distilled water was added.

4 Result Presentation

4.1 Results

This comprises the presentation and analysis of the primary data obtained from the research work. The primary data consists of the results of the laboratory analysis of the soils of the mechanic workshop sites against the control soils. This is followed by a logical presentation of descriptive and inferential statistics to arrive at a useful conclusion from hypothesis of the research.

Table 4.1: Results of the Physiochemical Parameters and their mean distribution

S/N		Mechanic Soil (1) 0-15 cm	Mechanic Soil (1) 15-30 cm	Mechanic 1 Mean	Mechanic Soil (2) 0-15 cm	Mechanic Soil (2) 15-30 cm	Mechanic 2 Mean	Control 0-15 cm	Control 15-30 cm	Control Mean
1	pH	5	4.9	**4.95**	4.8	4.3	**4.55**	5.8	5.4	**5.6**
2	Temperature	29	29.2	**29.1**	29	29.1	**29.05**	29.3	29	**29.15**
3	Conductivity, µs/cm	110	124	**117**	108	127	**117.5**	96	44	**70**
4	Salinity, mg/L	6649.4	5912.5	**6280.95**	7900.2	7241.9	**7571.05**	5991.1	5332.8	**5661.95**
5	Sodium, mg/L	5.219	6.287	**5.753**	3.873	5.176	**4.5245**	7.987	5.489	**6.738**
6	Calcium, mg/L	14.673	16.909	**15.791**	13.769	16.476	**13.769**	14.576	13.567	**14.0715**
7	Total Chloride, mg/L	3680.7	8808.2	**6244.45**	4373.1	4008.7	**4190.9**	3316.3	2951.9	**3134.1**
8	Nitrate(NO^{-}_{3}), mg/L	62.8	38.2	**50.5**	69.4	32.1	**50.75**	20.6	4.8	**12.7**
9	Nitrate-Nitrogen (NO_3-N), mg/L	14.8	8.4	**11.6**	4.4	1.4	**2.9**	4.7	1.1	**2.9**
10	Potassium, mg/L	5.879	4.687	**5.283**	8.456	5.589	**7.0225**	4.134	5.196	**4.665**
11	Phosphorus (P), mg/L	16.4	14	**15.2**	18	12.4	**15.2**	8.4	6.7	**7.55**
12	Iron, mg/L	0.038	0.046	**0.042**	0.024	0.029	**0.0265**	0.017	0	**0.0085**
13	Manganese, mg/L	0.311	0.128	**0.2195**	0.221	0.118	**0.118**	0.078	0.016	**0.047**
14	Copper, mg/L	1.086	0.795	**0.9405**	1.379	0.327	**0.853**	0.382	0.286	**0.334**
15	Zinc, mg/L	0.049	0.053	**0.051**	0.058	0.024	**0.041**	0.032	0.028	**0.03**
16	Arsenic, mg/L	0.002	0.004	**0.003**	0.003	0.006	**0.0045**	0	0	**0**
17	Cadmium, mg/L	0.013	0.018	**0.0155**	0.012	0.068	**0.04**	0.003	0.01	**0.0065**
18	Mercury, mg/L	0.166	0.256	**0.211**	0.872	1.898	**1.385**	0.067	0.007	**0.037**
19	Lead, mg/L	0.025	0.017	**0.021**	0.012	0.056	**0.034**	0.011	0.006	**0.0085**
20	Nickel, mg/L	0.078	0.108	**0.093**	0.069	0.089	**0.079**	0.018	0.016	**0.017**
21	**Bulk density, g/mL**	1.215	1.182	**1.1985**	1.19	1.163	**1.1765**	1.382	1.219	**1.3005**
22	Organic matter,%	8.5	3	**5.75**	9	9	**9**	2	5	**3.5**
23	Total Organic Carbon, %	7.59	8.69	**8.14**	11.8	12.42	**12.11**	0.69	2.76	**1.725**
24	Elevation (ft)	430.6		**430.6**	428.9		**428.9**	164.1		**164.1**
25	Coordinates N	5031.114		**5031.114**	5031.165		**5031.165**	5023.35		**5023.35**
	E	7002.703		**7002.703**	7002.67		**7002.67**	6059.176		**6059.18**

Source: Authors Computation 2015

Table 4.2: Particle Size Distribution for the Soil Samples

S/N	Mesh size (mm)	Mechanic Soil (1) 0-15 cm	Mechanic Soil (1) 15-30 cm	Mech 1 Mean	Mechanic Soil (2) 0-15 cm	Mechanic Soil (2) 15-30 cm	Mech 2 Mean	Control 0-15 cm	Control 15-30 cm	Control Mean
1	4.75	-	-	-	2.37	8.18	5.275	-	-	-
2	3.35	-	-	-	0.2	0.23	0.215	-	-	-
3	1.18	3.69	1.16	2.425	15.53	16.39	15.96	-	0.32	0.32
4	1	2.78	8.22	5.5	9.81	6.59	8.2	-	2.58	2.58
5	0.425	54.53	43.2	48.865	42.03	35.92	38.975	60.45	61.72	61.085
6	0.3	15.22	13.51	14.365	10.14	8.4	9.27	18.2	10.12	14.16
7	0.212	17.19	16.47	16.83	11.64	10.63	11.135	18.42	18.94	18.68
8	0.125	3.4	3.63	3.515	2.82	2.84	2.83	2.45	4.43	3.44
9	0.106	1	1.12	1.06	0.97	1.11	1.04	0.24	0.73	0.485
10	0.075	0.75	1.1	0.925	1.83	1.74	1.785	0.08	0.38	0.23
11	0.053	-	-	-	0.08	0.05	0.065	-	-	-
12	<0.053	1.44	11.59	6.515	2.58	4.82	3.7	0.16	0.78	0.47
13	TOTAL	100	100	100	100	100	100	100	100	100

Source: Authors Computation 2015

Table 4.3: Soil Texture

S/N	Textural class Percentage (%)	Mechanic soil (1) 0-15 cm (%)	Mechanic Soil (1) 15-30 cm (%)	Mech 1 Mean	Mechanic Soil (2) 0-15 cm (%)	Mechanic Soil (2) 15-30 cm (%)	Mech 2 Mean	Control 0-15 cm (%)	Control 15-30 cm (%)	Control Mean
1	Pebble stone	0	2.57	1.285	8.43	0	4.215	0	0	0
2	Very coarse sand	3.69	1.16	2.425	15.53	16.39	15.96	0	0.32	0.16
3	Coarse sand	2.78	8.22	5.5	9.81	9.59	9.7	0	2.58	1.29
4	Medium sand	69.75	56.7	63.225	52.17	19.03	35.6	78.65	71.84	75.245
5	Fine sand	21.59	21.22	21.405	15.43	14.68	15.055	21.11	24.1	22.605
6	Very fine sand	0.75	1.1	0.925	2.91	1.79	2.35	0.08	0.38	0.23
7	Silt	1.44	11.59	6.515	2.58	4.82	3.7	0.16	0.78	0.47

Source: Authors Computation 2015

4.1.3Descriptive Statistics Results

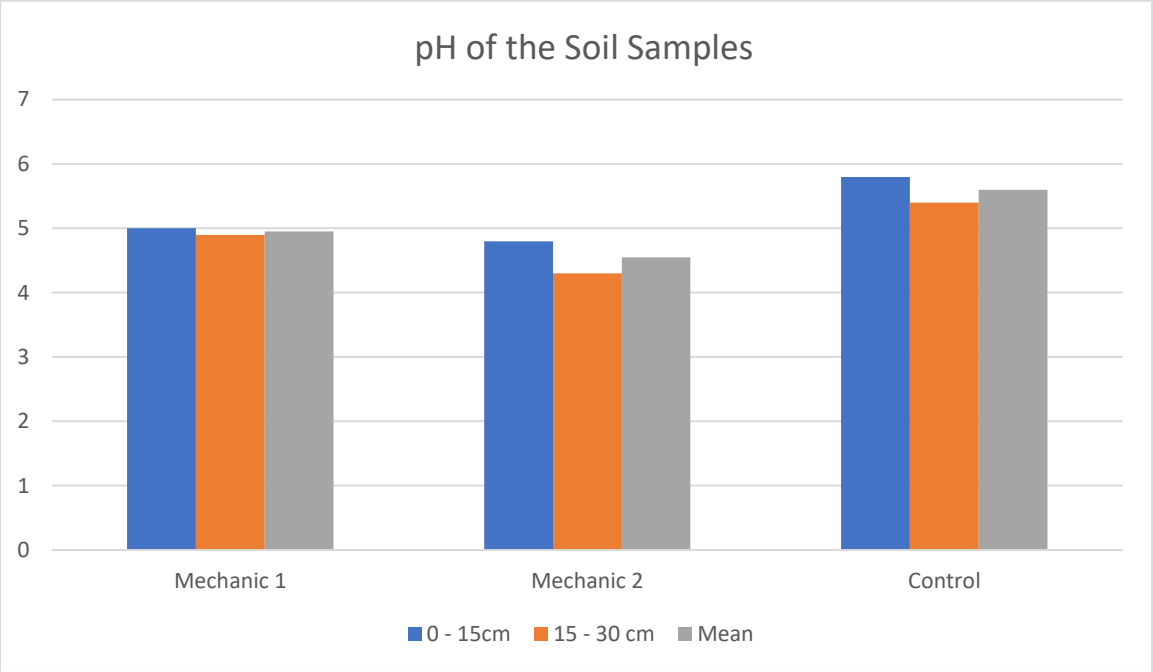


Figure 4.1: Soil pH for the Soil Samples

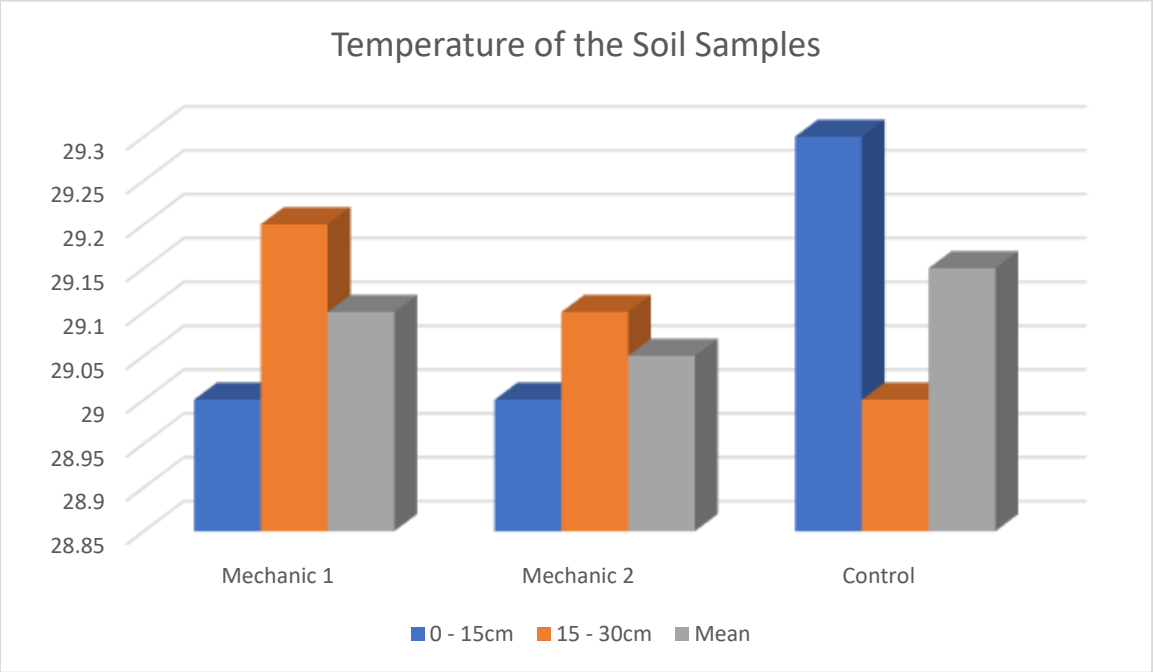


Figure 4.2: Temperature for the Soil Samples

Table 4.1 showed the results of physic chemical properties of the soils sampled consist of the soil mechanic village I, II and the control (Agricultural land use). As well as the respective mean values for the stated parameters.

Soil pH values for the soils were in the range of 4.3-5.8, soil pH for the control soil were higher with the range of 5.4- 5.8 as reflected in fig 4.1.

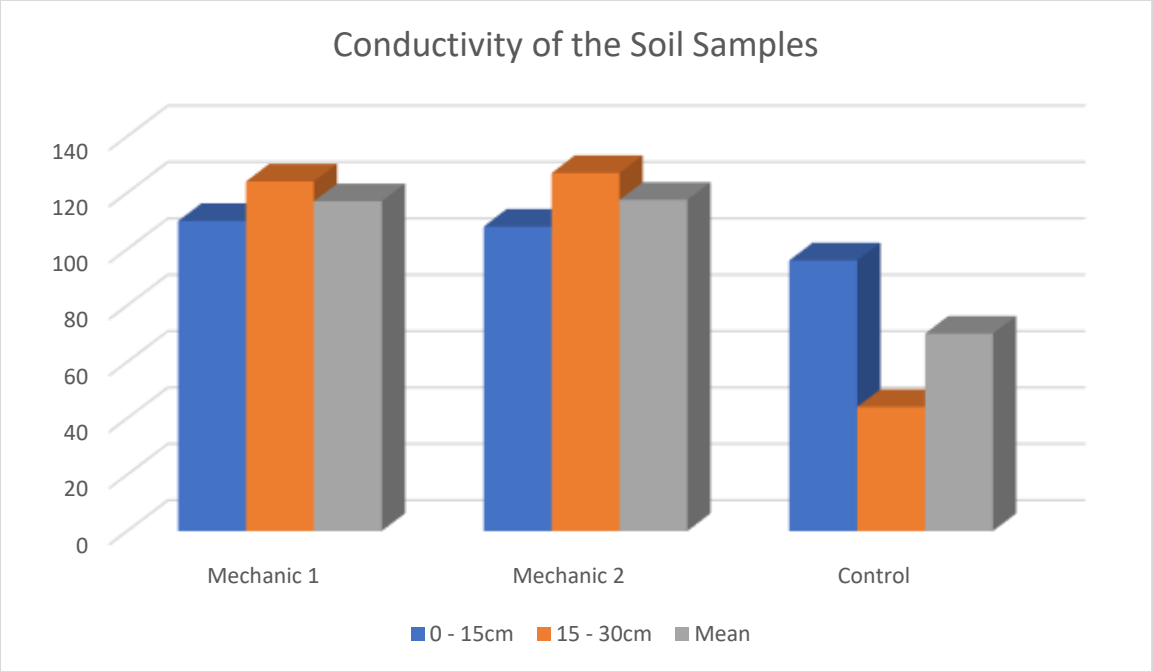


Figure 4.3: Conductivity Values for the Soil Samples

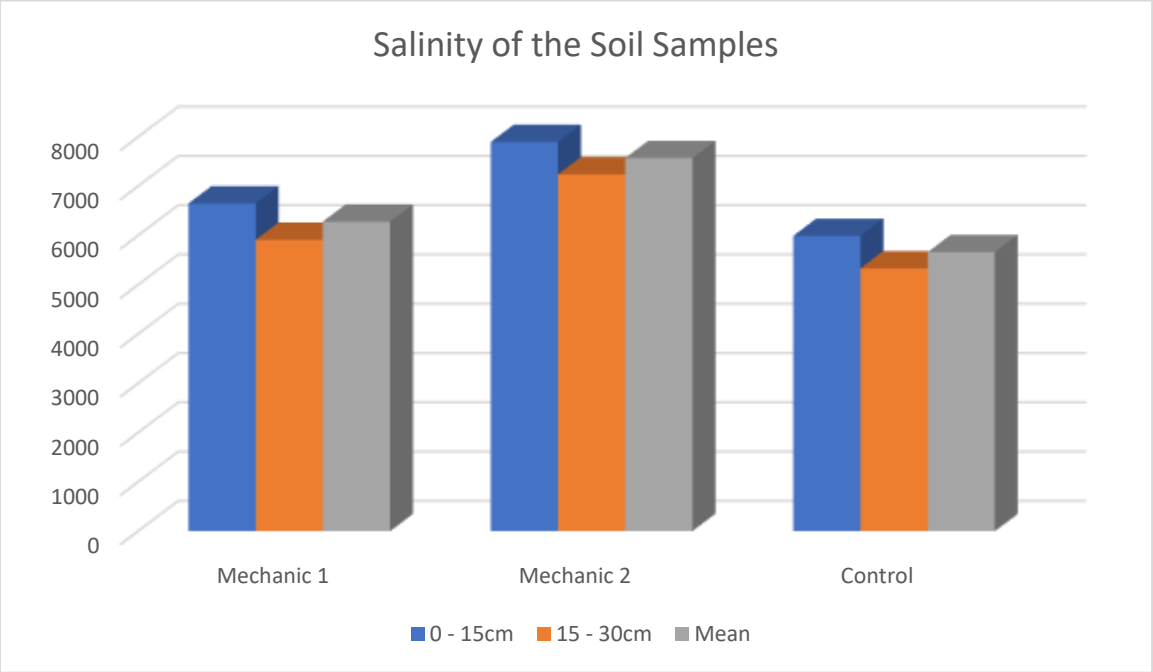


Figure4.4: Salinity Values for the Soil Samples

Soil temperatures for the soils were slightly the same with little variation within the range of 29-29.3 as reflected in fig 4.2. Soil salinity values were higher with a value of 5332.8 – 7900.2 mg/l. with higher values on soil mechanic II ranging from 7241-7900mg/l as fig 4.4 shows.

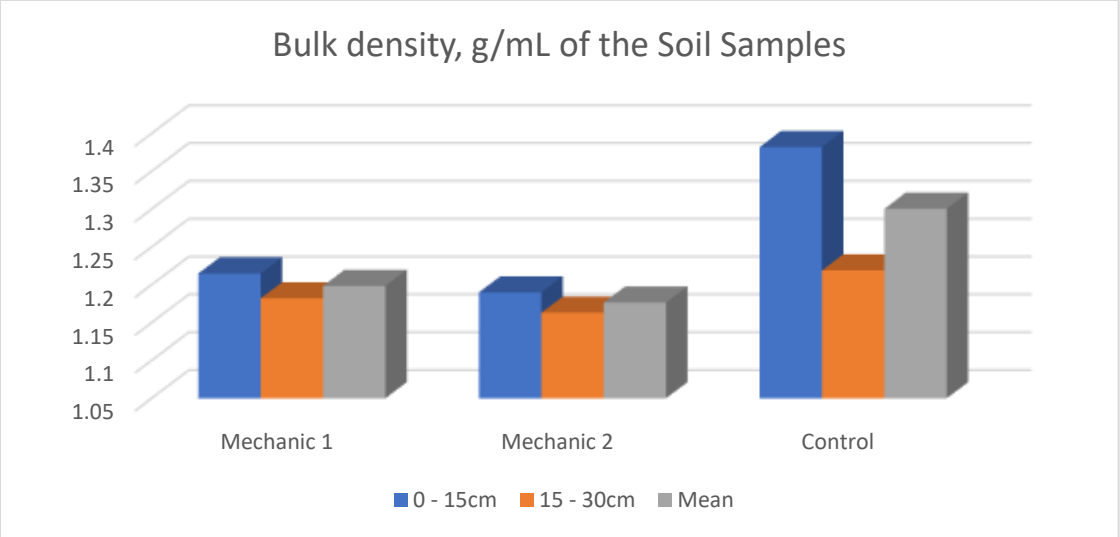


Figure 4.5: Bulk Density Values for the Soil Samples

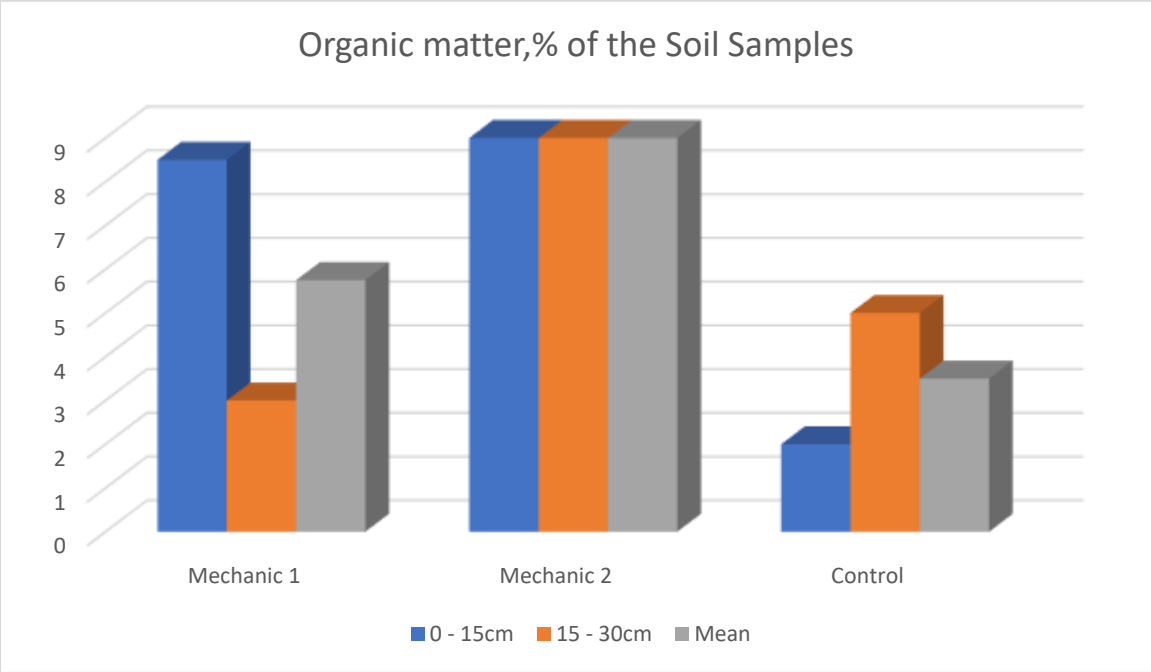


Figure 4.6: Organic Matter Values for the Soil Samples

Soil Nitrate in mg/l for the mechanic soils ranged from 32.1-69.4mg/l against 4.8-20.6 of control soil not polluted by auto mechanic activities. Potassium and phosphorous values for the soils has close values ranged from 4.134mg/l – 8.45mg/l and 6.7- 18.00mg/l respectively for both control and the mechanic soils

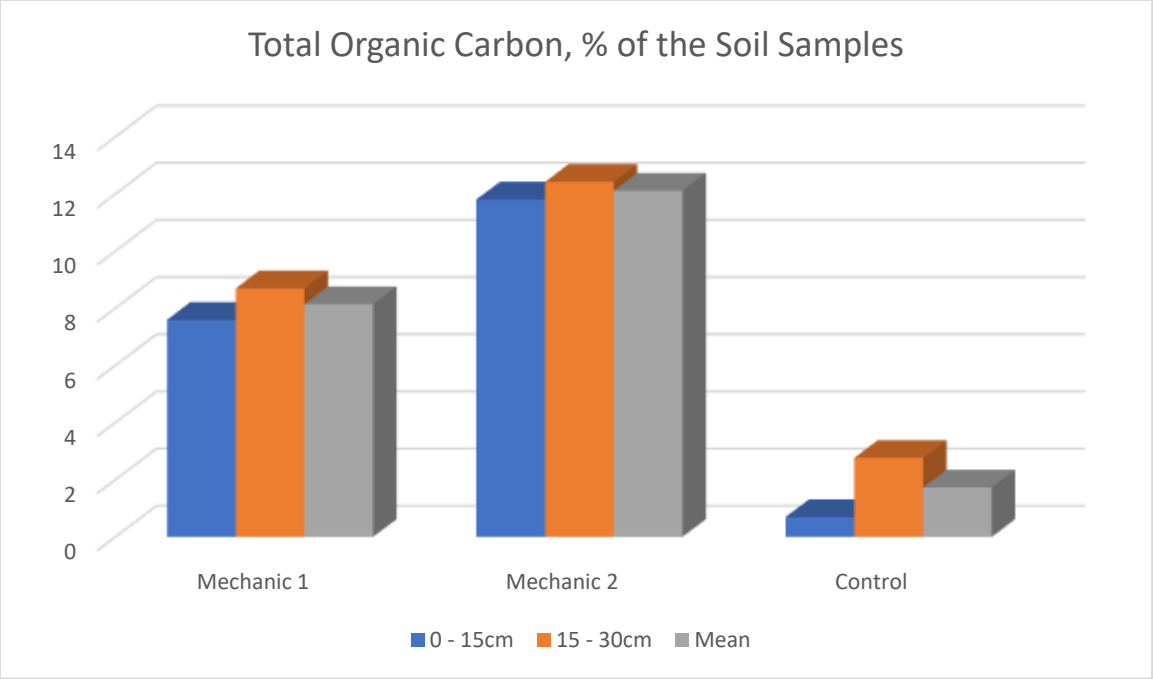


Figure 4.7: Total Organic Carbon Values for the Soil Samples

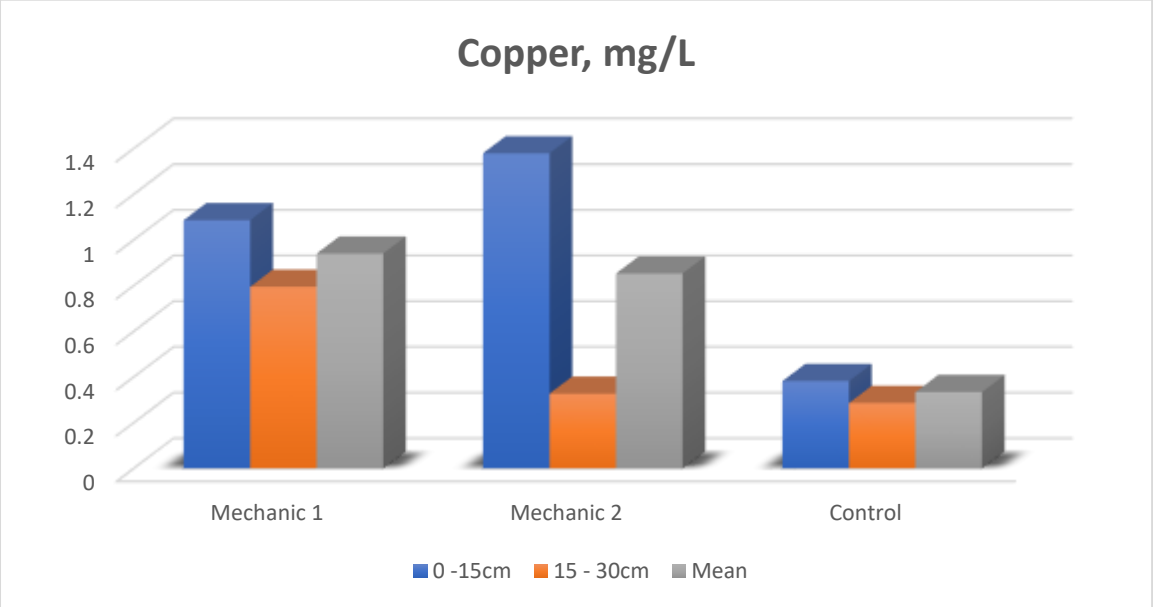


Figure 4.8: Copper Results for the Soil Samples

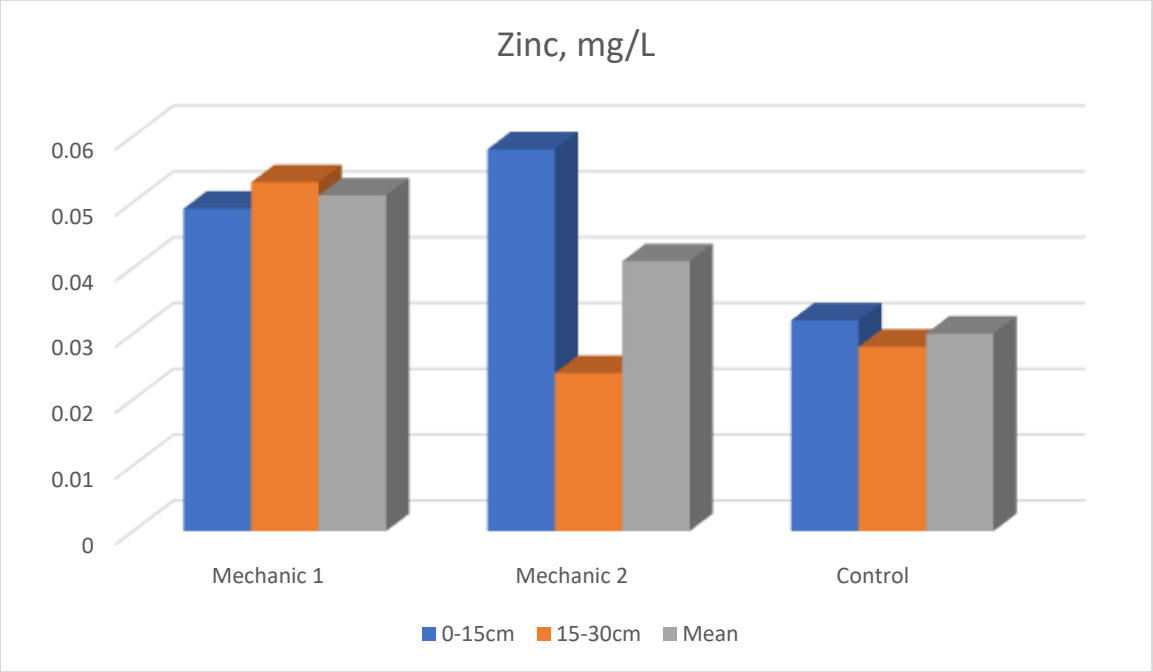


Figure4.9: Zinc Values for the Soil Samples

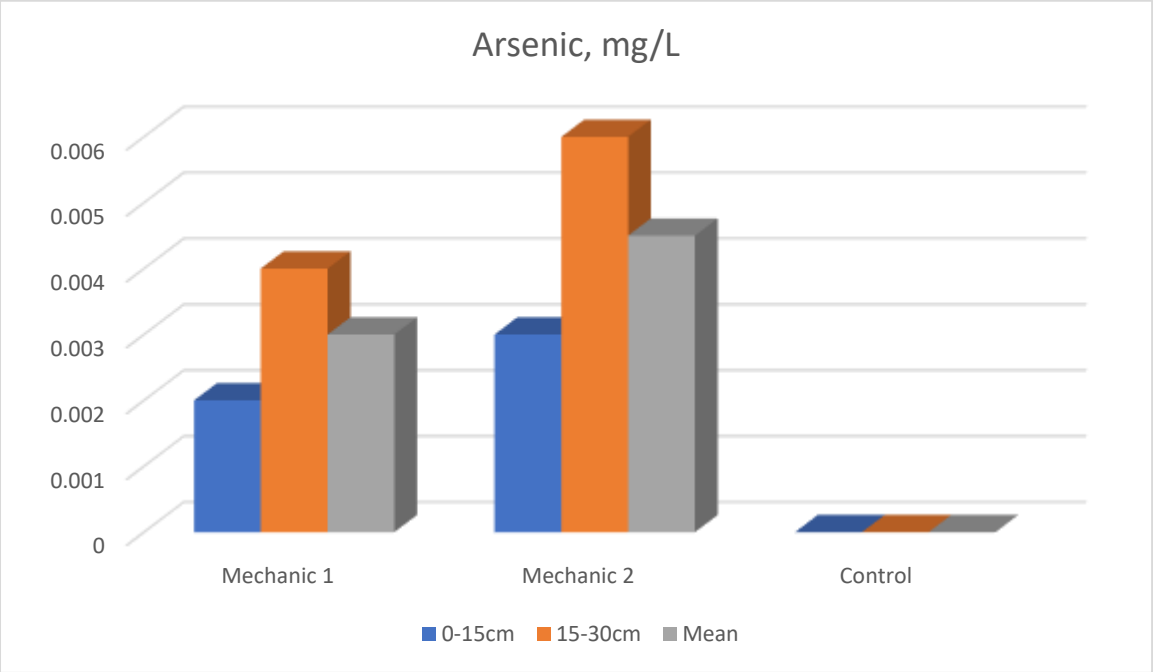


Figure 4.10: Arsenic Results for the Soil Samples

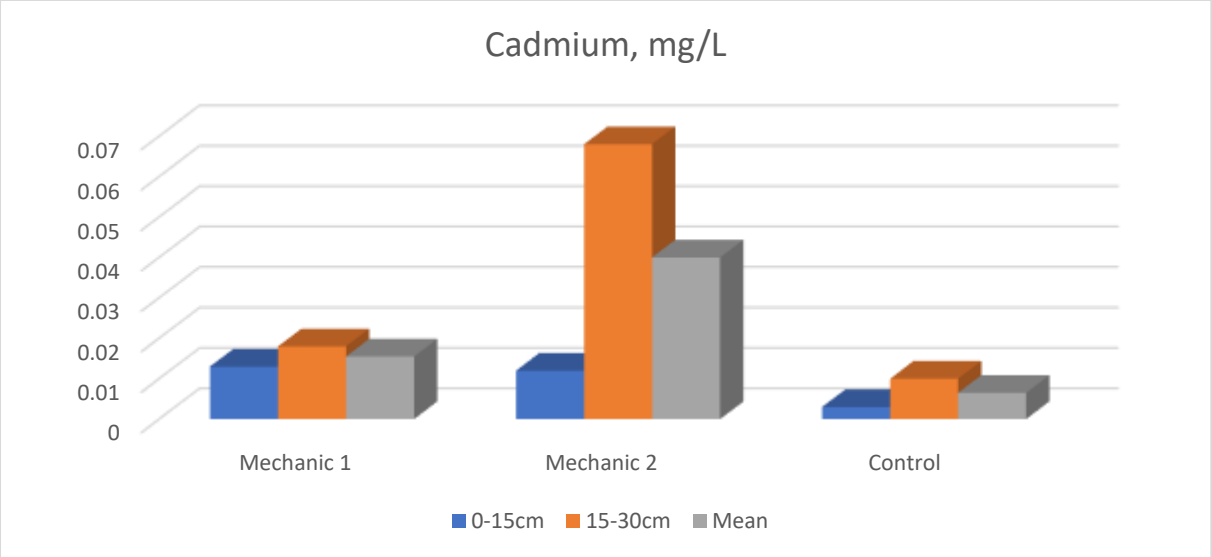


Figure 4.11: Cadmium Results for the Soil Samples

In table 4.2, the particle size distribution for the soil samples were shown with various mesh sizes ranging from mesh sizes 4.75 – 0.053mm. Mesh sizes between 0.425- 0.212mm characterized the texture reflected in table 4.3 between medium – fine sand in texture

Table 4.4: Summary of Decreasing Trend of Metals in the Soil Samples

Layer	Soil Mechanic 1	Soil Mechanic 2	Control
0-15cm	Cu>Hg>Ni>Zn>Pb>Cd>Ar	Cu>Hg>Ni>Zn>Cd>Pb>Ar	Cu>Hg>Zn>Ni>Pb>Cd>Ar
15-30cm	Cu>Hg>Ni>Zn>Pb>Cd>Ar	Hg>Cu>Ni>Cd>Pb>Zn>Ar	Cu>Zn>Ni>Cd>Hg>Pb>Ar
Mean	Cu>Hg>Ni>Zn>Pb>Cd>Ar	Hg>Cu>Ni>Zn>Cd>Pb>Ar	Cu>Hg>Zn>Ni>Pb>Cd>Ar

Source: Authors Field Work 2016

4.1.4 Hypothesis Testing Results

Relationship between use of oil lubricants and the physicochemical variables of soil across horizon

The result of the relationship between the use of oil lubricants in the auto mechanic workshop village and the physicochemical variables of soil across horizon is based on the relationship between

(1) Soil Control site and Soil Mechanic site 1;
(2) Soil Control site and Soil Mechanic site 2;

The result of the correlation coefficient is based on the Physical and chemical properties on Table 1 (serial numbers 1- 13 and 21-23). The mean of two soil samples used and the result is shown on Table 4.5:

Table 4.5: Correlation Coefficients of the physicochemical variables of Mechanic 1, Mechanic 2 and Control soils

		Control	Mechanic 1	Mechanic 2
Control	Pearson Correlation	1		
	Sig. (1-tailed)			
	N	16		
Mechanic 1	Pearson Correlation	**.957****	1	
	Sig. (1-tailed)	**.000**		
	N	**16**	16	
Mechanic 2	Pearson Correlation	**.999****	.957**	1
	Sig. (1-tailed)	**.000**	.000	
	N	**16**	16	16

**. Correlation is significant at the 0.01 level (1-tailed).

Table 4.6: Correlation between physicochemical variables in Depth 1 (0-15 cm) and Depth 2 (15- 30 cm), for Mechanic 1

		Mech 1 Depth 1
Mech 1 Depth 2	Pearson Correlation	.874**
	Sig. (2-tailed)	.000
	N	16

**. Correlation is significant at the 0.01 level (2-tailed).
Coefficient = 0.874, *p* 0.000

Table 4.7: Correlation between physicochemical variables in Depth 1 (0-15 cm) and Depth 2 (15- 30 cm), for Mechanic 2

		Mech 1 Depth 1
Mech 1 Depth 2	Pearson Correlation	.999**
	Sig. (2-tailed)	.000
	N	16

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4:8: Relationship between use of oil lubricants and the soil particles of soil across horizon

		Particle Size Distribution (Control)	Particle Size Distribution (Mech 1)	Particle Size Distribution (Mech 2)
Particle Size Distribution (Control)	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	12		

Particle Size Distribution (Mech 1)	Pearson Correlation	**.991****	1	
	Sig. (2-tailed)	**.000**		
	N	**12**	12	
Particle Size Distribution (Mech 2)	Pearson Correlation	**.912****	.916**	1
	Sig. (2-tailed)	**.000**	.000	
	N	**12**	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.9: Relationship between use and disposal of oil lubricants and the soil textureof soil across horizon

		Soil Texture (Control)	Soil Texture (Mech 1)	Soil Texture (Mech 2)
Soil Texture (Control)	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	7		
Soil Texture (Mech 1)	Pearson Correlation	**.997****	1	
	Sig. (2-tailed)	**.000**		
	N	**7**	7	
Soil Texture (Mech 2)	Pearson Correlation	**.918****	.916**	1
	Sig. (2-tailed)	**.003**	.004	
	N	**7**	7	7

**. Correlation is significant at the 0.01 level (2-tailed).

4.2 Discussions

For the heavy metals, Table 4.1 showed the results as it is contained and reflected in figures 4.8 to 4.11. in soil mechanic 1, the heavy metal concentration decreases in the following order Cu 0.940 > Hg 0.211 > Ni 0.093 > Zn 0.051 > Pb 0.021 > Cd 0.015>Ar 0.003. Whereas in soil mechanic 2, close results was also obtained as well in the following order: Hg 1.385> Cu 0.853> Ni 0.079 > Zn 0.041 > Cd 0.04>Ar 0.004 and for the control soil samples, the decreasing concentration of the heavy metals is as shown in the following trend: Cu 0.334> Hg 0.037 > Zn 0.03 > Ni 0.017 > Pb 0.008> Cd 0.0065>Ar 0.000. Other details of decreasing trend of heavy metal concentration as shown in table 4.9 as Cu and Hg leads in high concentration for the soils as well as Ar taking theleast abundance for the entire soils.

Soil temperatures for the soils were slightly the same with little variation within the range of 29-29.3 as reflected in fig 4.2. Soil salinity values were higher with a value of 5332.8 – 7900.2 mg/l. with higher values on soil mechanic II ranging from 7241-7900mg/l as fig 4.4 shows. For individual concentration in comparison with Soil mechanic 1 and 2 with the control soils, it was clear that heavy metal concentration was in relatively more in abundance in soil mechanic soils 1 and 2 than in the control soil samples as it has been reflected in the figures 4. 8- 4.11. That shows the significant impact of auto mechanic pollution and heavy metal concentration. Referencing Table 4.5 the results showed that the coefficient of the correlation between the physicochemical variables of the samples of Control Soil and Mechanic 1 Soil is 0.957 with significant value of 0.000. Also, the coefficient of the correlation between the physicochemical variables of the samples of Control Soil and Mechanic 2 Soil is 0.999 with significant value of 0. 000.Generally, there is significant positive relationship between the physicochemical variables in oil lubricated soil samples

collected from mechanic 1 and 2 respectively. Based on the decision rule, the coefficients are positive and above 0.7. This indicates a strong positive correlation. Also, the significant value is less than 0.05 levels, thus we reject the null hypothesis and accept the alternate hypothesis. Thus, the study concludes that there is a strong positive relationship between the physicochemical properties of soil with deposits of oil lubricants (mechanic 1 & 2) and the physicochemical properties of soil without oil deposits. This implies that oil lubricants do not significantly alter the physicochemical properties of soil.

pH

Low pH value was recorded for the soil from the auto-mechanic village in comparison to control and it was below the neutral level indicating that both soils were acidic.

Conductivity

Analysis of the soil samples revealed that Conductivity was higher in mechanic soil 2 than in mechanic soil 1 and both had conductivity value that was considerably higher than the control station. This finding is in-line with the study done by Akpoveta*et al.,* (2010) for automobile dumpsites at Agbor and Abraka, Nigeria. The high conductivity may be attributed to the availability of definite amount of metal substances in the wastes at the auto- mechanic village whose content are eventually leached into the underlying soils and hence leads to an increase in the concentration of some ions such as sodium, calcium and others as is reflected in table 4.1 above.

Total Organic Carbon

The levels of total organic carbon in the soils of the auto-mechanic villages were higher than that of the control soils and thus indicated the possible presence of Organic matter content which normally increases following the addition of carbonaceous substances as was the case in this study due to the presence of used oil and other carbonated fluid in the auto-mechanic villages and according to Osuji *et al.,* (2006) this might cause an increase in the presence of soil micro-organisms which are in the business of breaking down organic compounds in soils.

Heavy Metals

Result showed that heavy metals concentrations in the soil samples were higher in the auto-mechanic village than the control. According to Nwachukwu *et al.,* (2010), engine oil and other transmission fluids collect heavy metals such as lead, cadmium, zinc, iron and copper when an automobile engine is running and they remain in the used oil. When it is discharged, it increases the concentration of heavy metals in soils and was responsible for the higher concentration in the auto-mechanic village soils than the control which is not exposed to high volume of waste engine oil. A similar result have been reported by Nwachukwu *et al.,* (2010) from Okigwe, and Nekede mechanic villages in Imo state Nigeria, and by Adelekan and Abegunde (2011) from auto mechanic villages in Ibadan, Nigeria. These high levels observed may be connected with the large amounts of waste engine oil and other chemical fluids discharged in the markets, metal scrap deposits, welding and other wastes that are potential sources of heavy metals in the environment and vicinity of the auto mechanic workshop villages. Copper, mercury and nickel had the highest concentration in the values of the heavy metals analyzed from the soil samples collected.

High copper (Cu) concentrations were recorded for the auto-mechanic village in comparison to the control stations. This may have resulted from electrical components such as wires in addition to waste oil. Cadmium was detected in all three soils but the concentration in the control soil was far lower than the auto-mechanic village. According to (Jarup, 2003) the presence of Cadmium could be due to the dumping of PVC plastics, nickel-cadmium

batteries, motor oil and disposal sludge in the auto-mechanic village. The presence of cadmium in automobile waste dump soils have also been reported by Uba *et al* (2007) and Myung (2008). Heavy metals are inherently persistent pollutants in the environment because they are non-biodegradable, allowing them to remain in soil systems long after they are introduced. Once introduced into soils, heavy metals undergo various geochemical transformations that influence their mobility, bioavailability, and capacity to move into water and plant systems. Their persistent nature and ability to bioaccumulate in living tissues pose significant ecological and human health risks, including organ damage, neurological effects, and elevated toxic burden through trophic transfer in food chains (Oladimeji *et al.,* 2025).

Nickel (Ni) had concentration ranges 0.069- 0.108 for the mechanic soils. Global input of nickel to the human environment is approximately 150,000 and 180,000 metric tonnes per year from natural and anthropogenic sources respectively, including emissions from fossil fuel consumption, and the industrial production, use, and disposal of nickel compounds and alloys (Begum *et al.,* 2022), which could be responsible for the higher concentration found in the auto-mechanic village. Nickel is known to accumulate in plants and with intake of too large quantities of Ni from plants grown on nickel rich soils (such as tea, beans, vegetables), there are higher chances of developing cancers of the lung, nose, larynx and prostrate as well as respiratory failures, birth defects and heart disorders (Begum *et al.,* 2022). Exposures by inhalation, ingestion or skin contact occur in nickel and nickel alloy production plants as well as in welding, electroplating, grinding and cutting operations which are done in auto-mechanic workshops. Vehicular emissions have been identified as significant contributors to lead contamination in urban environments, with roadside soils around high-traffic areas in Nigeria showing elevated concentrations of lead and other heavy metals due to vehicle exhaust and traffic-related deposition (Nduka *et al.,* 2023).

Concern for lead concentration in automobile workshop soils may therefore arise principally due to the fact that mechanic workshop could be identified as playground or near residential areas where children play about freely.

However, Pb concentration was obtained from a sample collected from mechanic soil 1 and 2 with a concentration range of 0.012-0.056 parts per million which is less than the maximum permissible limits (MPL) of Pb recommended by WHO which is 15 ppm (15 part per million). Since lead is a very poisonous element, it is advisable not to use the soil from these mechanic workshops for crop cultivation since its toxicity can result in significant illness and reduced quality of life (Ferner, 2001).

5. Summary of Research Findings

The study aimed to investigate the effects of automobile mechanic activities on soil contamination and its associated impacts on the environment. Key findings from the research include:

Higher Soil Contamination: The soils of the auto mechanic villages exhibited higher levels of heavy metals than the control soils from the Federal University of Technology Owerri (FUTO). This was due to the activities of automobile workshops, including servicing, maintenance, and the improper disposal of spent oils and lubricants.

Heavy Metal Concentration: The concentration of heavy metals in the mechanic soils showed significant values, with soil depths reflecting this contamination. The metals followed a decreasing trend in terms of relative abundance across different mechanic soil sites: Cu > Hg > Ni > Zn > Pb > Cd > Ar.

Soil Physico-Chemical Properties: The physicochemical properties of the mechanic village soils were influenced by the activities of the auto mechanics, leading to degradation in soil quality. The study found significant positive correlations between soil physicochemical values and the use of oil lubricants, as well as between soil variables and depth.

Health and Environmental Risks: The high concentrations of heavy metals, especially Cu, Hg, and Ni, present risks to the health of inhabitants engaged in farming within these mechanic villages. Furthermore, there is potential for runoff contamination that could affect nearby water resources, posing a threat to both agricultural activities and human health.
Impact on Soil Fertility and Water Resources: Soil contamination poses a long-term risk to the surrounding environment, including nearby farmland and water bodies. The improper disposal of auto-mechanic waste significantly contributes to the accumulation of heavy metals, and the lack of proper waste disposal practices exacerbates the contamination levels.

6. Conclusions

This study highlights the severe soil contamination caused by the indiscriminate disposal of auto-mechanic waste, particularly spent oil and lubricants, in mechanic villages. The research demonstrated that these activities led to the accumulation of heavy metals, which negatively impacted soil quality and posed serious risks to human health and environmental sustainability. The observed contamination of the soils in these villages, particularly with metals like Cu, Hg, and Ni, exceeds safe limits, leading to degradation of soil health and posing a direct threat to the surrounding ecosystems and communities.
The findings of this study reinforce the urgent need for proper waste management in mechanic villages to mitigate soil contamination. Without proper intervention, the effects of this pollution could extend to surrounding agricultural lands, water sources, and local communities, contributing to long-term ecological damage and health risks. Therefore, measures to control soil contamination, improve waste disposal practices, and restore contaminated areas are essential for ensuring environmental and public health safety.

7. Recommendations

Based on the findings and conclusions of this study, the following recommendations are made to mitigate the environmental impact of automobile mechanic activities:

a. **Proper Disposal of Auto Mechanic Waste:** It is critical that mechanic workshops adopt proper waste disposal practices. Used oils and other hazardous waste should be managed through designated recycling and disposal channels to prevent soil contamination.

b. **Phyto-remediation of Contaminated Soils:** Phyto-remediation measures should be implemented at the contaminated sites to mitigate the heavy metal pollution. The use of plants to absorb and degrade contaminants in the soil should be prioritized, and the potential of various plants for remediation should be explored.

c. **Ongoing Awareness for Mechanic Workshops:** Mechanic workshop owners and workers should be regularly educated on the level of soil contamination caused by their activities. Awareness campaigns should target not only the workers but also the management and directors of auto-mechanic workshops.

d. **Farmer Awareness on Soil Contamination:** Farmers residing near mechanic villages should be informed about the risks of planting crops in contaminated soils. Restricting agricultural activities in highly contaminated areas will help protect food safety and public health.

e. **Environmental Management Plan:** It is recommended that a comprehensive Environmental Management Plan (EMP) be implemented for mechanic villages. Regular monitoring and follow-up checks should be part of the plan to ensure that the measures in

place do not harm the surrounding environment and that best practices are adhered to.

f. **Legislation to Control Waste Disposal:** There is an urgent need for legislation to curb the indiscriminate dumping of used oils and lubricants. Strict regulations should be enforced to manage hazardous wastes and ensure safe disposal methods are followed.

g. **Regular Soil Monitoring:** It is recommended that regular soil testing and monitoring of soil parameters be carried out in mechanic villages. These tests will provide critical data for tracking contamination levels and assessing the effectiveness of pollution mitigation measures.

h. **Water Quality Monitoring:** Investigations into the potential contamination of nearby water bodies should be undertaken. This includes both surface and groundwater, as pollutants from mechanic workshops can easily be transferred through runoff or seepage into water sources. Regular monitoring will help ensure that drinking and irrigation water quality remains safe.

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