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Evaluating the Physico-Chemical Status of Soils around some Designated Automobile Repair Garages in KHANA, Rivers State, Nigeria

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ABSTRACT

Automobile repair garages are ubiquitous and indiscriminately sited in Nigeria. The spent waste both liquids and solids are generated and disposed-off into the soil from their operations. There is the pressing need to assess the physicochemical status of the surrounding soil that is used as a natural sink. Thus, the study assessed the physicochemical properties soils from selected automobile repair garages in Khana, Rivers State, Nigeria, so as to prevent any potential threat to the surrounding soils. Sampling, preparation, and analysis of surface soils were carried out according to standard methods. The mean results were: pH (6.39±2.26), EC (µS/cm) (84.64±2.38), phosphorus (mg/kg) (9.07±1.06), % TOC (13.56±0.41), % TN (1.59±0.11), % silt (18.21±0.45), % sand (55.75±1.13), and % (26.04±1.44). When comparing the results obtained from the impacted sites with those of the control, it was revealed that the physicochemical properties of the impacted soils were higher. Similarly, these were relatively higher than the result at the control sites. The high concentration was attributed to the activities of the automobile repair garages in the area. It is therefore inferred from the result that the activities of automobile repair garages in the areas generate waste, which alters the natural physicochemical properties in the soils. The citizens especially farmers and other artisans should be educated on the health implications and consequences associated with dumping waste whose chemical compositions may not be known inappropriately, while modern control disposal methods to mitigate the implicit dangers of the current practice are hereby advocated.

Keywords: Automobile repair garages, assessment, environment, physicochemical properties, Rivers State, TOC

INTRODUCTION

Automobile repair garages are one of the small-scale industries that are predominating in Nigeria, as well as local government areas (LGA), streets in towns, villages, and shanties. Oguntimehin and Ipinmoroti (2008) explain that the high rate of automobile repair garages in the country (Nigeria) is a result of the increasing inflow of "Tokunbo" (fairly-used) vehicles into the country.

Over the years, the activities of automobile repair garages such as spray painting, automobile electrification, recharging of automobile batteries, automobile body work/panel beating, wheel alignment, welding and soldering, vulcanizing, mufflers and exhaust systems, brakes and steering, automobile air conditioner repairs, engine and gearbox overhauls, and automobile glass repairs and installations have generated a prodigious amount of waste (Timothy et al., 2022). The wastes generated comprise gaseous, liquid, and solid wastes. Toxic chemicals (chlorinated compounds, solvents, and glycols), hydrocarbons (VOCs and PAHs), waste water, leaded gasoline, hydraulic fluids, used batteries, electrolytes, spent lubricants, spilled oil, paints, and aerosol cans are just a few examples (Johnbosco, 2020; Timothy et al., 2022). Others are electrodes, carbides, tyres, metal scrap (worn-out parts that contain heavy metals), plastics, and refrigerants (Pam et al., 2013).Similarly, auto-mechanic workshops provide body repair and painting services involving the use of highly toxic and hazardous materials (Kawo et al., 2018; Mohiuddin et al., 2011). Auto-mechanic repair shops generate several types of waste during their daily operations including overhauling of vehicle engines, metal fabrications and automobile panel beating. Popular wastes associated with the mechanic workshops are spent oils, greases, lubricants and paints (Amusan et al., 2003; Maha, 2022). Poor handling and management of the used fluids and solvents coupled with the improper disposal of large amounts of waste from different sources into water drains, streams, rivers, farm lands, open vacant plots is a common practice in Nigeria (Okonokhua et al., 2007; Udousoro et al., 2010). As a result, physical changes to the environment occur, such as changes in the tranquilly, aesthetics, or chemical composition of the surrounding air, water, and soil. Iyama et al (2022) in their study of soil fertility status of aged and abandoned dumpsites in Port Harcourt recorded a range of 2.62±0.00 - 6.52±0.00 showing very highly acidic soil in the lower range while the upper range was less acidic in similar soil terrain.

According to Adewoyin et al., (2013), it was quite imperative from the results of the analytical studies of the physicochemical parameters determination of the auto-mechanic soil from villages of Ibadan metropolis that there is a high degree of contamination and pollution. It has been observed that the various pollutants including oil and grease build up to very high concentrations in the soil seeping or percolating into the groundwater, thereby posing great hazards to the people that consume the water, and also great hazards to the soil for farmers due to poor aeration. These waste products are arbitrarily disposed of in the immediate environment without due consideration of their health-associated implications (Adewoyin et al., 2013). However, freely disposed waste may have the potential to alter both the physical and chemical properties of the soil environment when it interacts with it, resulting in contamination (Adewoyin et al., 2013). Studies on available phosphorus showed high concentrations as in were within the range reported by Adewole and Uchegbu (2010) and Nwosu (2016) but lower than the results published by Anegbe et al. (2018); Ezigbo (2014); Jolaoso et al. (2019); Maleki et al. (2014) earlier. Durak et al. (2010) also studied the determination of physical and chemical properties of soils under different land managements. Abhulimhen (2016) investigated the impacts of automobile mechanic workshops on the concentrations of pH, EC, and particle size distribution in urban soil sourced from automobile workshops in Ikoku mechanic village, Mile 3 Diobu, Port Harcourt, Rivers State in Nigeria noting TOC, EC, pH generally higher in soils under the influence of automobile mechanic workshop activities than sites with no such influence.

Although the selected sites have been in operation for decades, the status of the physicochemical parameters in the soil is questionable and could be a cause for concern; therefore, there may be environmental damage and health risks associated with the activities of these numerous automobile repair garages on the surrounding soil in the areas where they operate, especially the consumption of farm produce and fish by native farmers and fishermen, which are the two major non-formal occupations of the indigenous people. On the basis of the above, it became necessary to carry out this research in order to ascertain this speculation. Amukali and Bariweni (2020) during their study of the distribution of physicochemical parameters through soil profiles around auto-mechanic workshop clusters in Yenagoa Metropolis, Nigeria observed that the operational presence of auto-mechanic workshop clusters impacted the physicochemical parameters of soils within closer vicinities as top soils and reference points (0m) more significantly than soils farther away from their vicinities. This raises health, environmental and food productivity concerns in soils of the study area. Earlier studies by Amos et al., (2023) have shown that the pH of the soil from auto-mechanic workshops in Lafia ranged from: (5.87-6.20), conductivity (77.59-126 s/m), organic carbon (0.63-0.93), organic matter (1.08-1.60), sand (66.14-89.05), clay (4.91-14.95), silt (6.04-22.03), sulphate (2.16-3.14), and phosphate (2.16-4.08).

The study is aimed at assessing the physicochemical content of pH, electrical conductivity, phosphorus, total nitrogen, total organic carbon and soil distribution pattern in soils from selected automobile repair garages in Khana local government areas of Rivers State, Nigeria. The information acquired will help in advancing the understanding, particularly for soil and agricultural researchers, of the dynamics of environmental consequences occasioned by the activities of automobile garages. If not properly checked, these could become in the long or short run, these constitute pollution threats to the environment (Adewoyin et al., 2013). Many researchers have evaluated and confirmed the impact of the activities of automobile repair garages on the surrounding soil in different parts of the world and found that soil contamination and alteration of physicochemical properties are considered to be good indicators of the level of environmental pollution by anthropogenic inputs (Eneji et al., 2017).

Therefore, the high level of hydrocarbon activities coupled with the influx of fairly used vehicles know as Belgium or Tokumbo has really increased the use of petrochemicals which act as solvents, grease, oil and washing materials by the mechanics hence making the soil a sink. This study exposes some of the physicochemical impacts as well as the soil structure of the designated sites.

MATERIALS AND METHODS

Description of Study Area

The study area is Khana Local Government Area, and it is one of the 23 local government areas that make up River State in the Niger Delta of Nigeria. Khana LGA is bordered on the north by Oyigbo Local Government Area, on the east by the Imo River, which demarcates Rivers State from Akwa-Ibom State, on the south by Andoni and Opobo Local Government Areas, and on the west by Tai and Gokana Local Government Areas. It comprises three districts, viz., Babbe, Kenkhana, and Nyokhana, with sixty-nine towns and villages, with its administrative seat in Bori, which is the traditional headquarters of the Ogoni people (Timothy et al., 2022). Khana LGA covers an area of 560 square kilometres (km^2) and had a population of 294,217 at the 2006 census (Elum & Tigiri, 2018; National Population Commission, NPC, 2009). It is located at a geographical coordinate of 4°40'22" north and 7°22'13" east. Khana is one of the agricultural hubs of the state (Timothy et al., 2022). The sampled communities are shown in Figure 1 below.

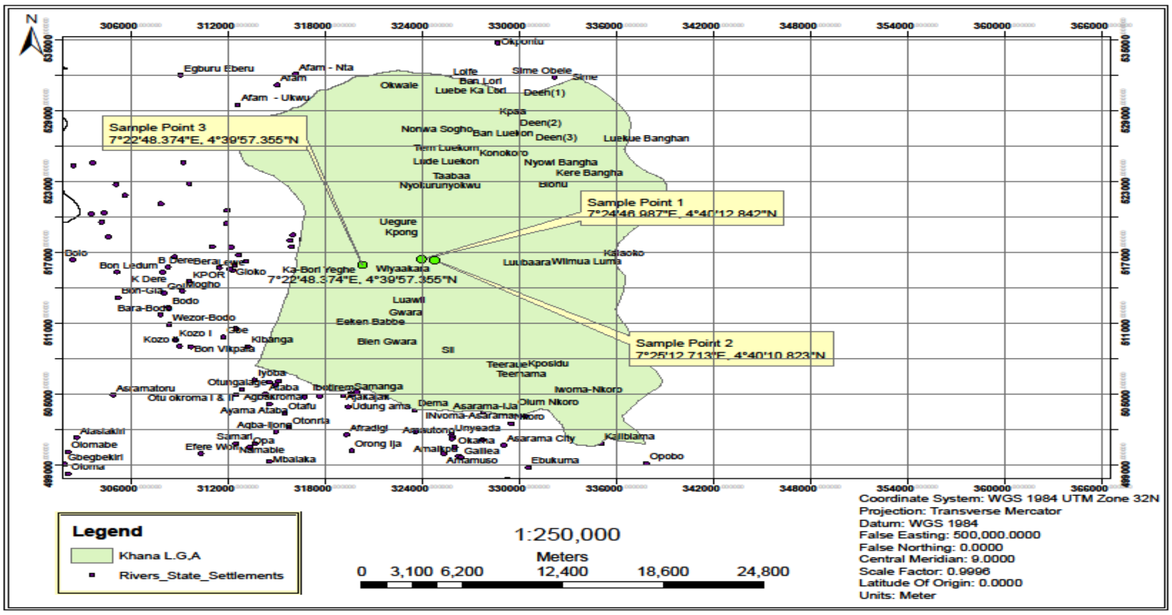

Figure 1: Sampling Stations for the Study (Source: Field Survey, 2022)

Sampling and Sample Preparation

Three composite soil samples were collected six times at a depth of 0–20 cm from three (3) different automobile repair garages identified as impacted sites (as prescribed by Marcus et al., 2017); a control soil sample was randomly collected from a pristine farmland located not less than 100 km from each of the impacted sites where there were no existing industry or commercial undertakings using a hand auger. Thus, a total of twenty-four (24) soil samples were collected and analysed six times within the period of eleven months (November 2021 to September 2022). In each month, three (3) top composite soil samples from the chosen automobile repair garage were collected, stored in sample bags, and labelled as Station 1, Station 2, and Station

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3, representing surface soil samples surrounding automobile repair garages in selected communities of Khana LGA. Control soil samples were also collected six times, just as those from the impacted sites, stored in polythene bags, and coded as "control samples" (CS). The preserved samples were then transported to the laboratory for pretreatment before examination and analysis to quantify the levels of the different physicochemical parameters and polycyclic aromatic hydrocarbons in the soils.

Sample Analysis

Determination of pH and Electrical Conductivity

The method employed by Iyama et al. (2023) was applied in the examination of the pH of the soil. A 10 g sample of the air-dried soil was weighed into a 100-ml beaker, followed by the addition of 200 ml of distilled water to the sample in the beaker. The mixture in the beaker was stirred using a glass rod and allowed to stand for a period of 30 minutes. A pH metre was then inserted into the mixture at the time when it had partially settled, and the reading on the pH metre was determined and recorded. The measurement of the electrical conductivity of the soil was carried out using a hand-held electrical conductivity metre (multi-parametre, Hanna HI 9828). The conductivity of the soil was measured using a ratio of 1:5 between the soil and distilled water solution.

Determination of Percentage Total Organic Carbon

To ascertain the total organic carbon of the soil samples, the procedure described by Marcus (2011) was used. A 250-mL Erlenmeyer flask was filled with 1 g of the air-dried soil sample, 10 mL of the $K_2Cr_2O_7$ solution, and 20 mL of concentrated H_2SO_4. The flask was swirled for one minute and allowed to stand for 30 minutes for the reaction to be fully completed. The flask's contents were then mixed with 50 mL of distilled water and 10 mL of orthophosphoric acid. The solution's supernatant was used to determine the total organic carbon of the soil. Then, spectrophotometric measurements were made at the 590 nm absorbance wavelength. The same procedure was used to prepare the blank, but without the soil sample.

Determination of Percentage Total Nitrogen

The Kjeldahl method was used to determine the total nitrogen (TN), as prescribed by Kalambe (2021). It entails digestion, distillation, and titration. The sample soil was broken down in hot, concentrated sulfuric acid, which produced ammonium sulphate from the bound nitrogen. By adding excess concentrated sodium hydroxide, the sulfuric acid was neutralized, turning the solution alkaline. The ammonia that has been released during this process was then distilled into a solution of boric acid, and the amount of nitrogen was measured by titration with a standard acid.

Determination of Phosphorus

The phosphorus content in the soil samples was determined by a spectrophotometric method as described by Estefan (2013) earlier. It involves collection of representative sample from grab samples which are air-dried, ground, sieved to 2mm followed by acid digestion and a spectrophotometric analytical method adopted (Hach 3900DR spectrophotometer). Phosphate concentrations of the soils were also in tandem with the method adopted by Amos et al., (2023) in Lafia, Nigeria. The extracted phosphorus is measured colourimetrically based on the reaction with ammonium molybdate and development of the 'Molybdenum Blue' colour. The absorbance of the compound is measured at 880 nm in a spectrophotometer and is directly proportional to the amount of phosphorus extracted from the soil. Usually, 1-gram scoop of air-dried soil and 10 milliliters of extractant are shaken for 5 minutes. The amount of phosphorus extracted is determined by measuring the intensity of the blue colour developed through the Murphy-Riley Method. The colour is measured with a Brinkman PC 900 probe colorimeter at 880 nm.

Determination of Particle Size Distribution

The soil particle size analysis was achieved in line with the method adopted by Iyama et al. (2023). 50 ml of “cagon solution” (sodium hexametaphosphate solution) was used to soak 50 g of the previously sieved soil

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sample overnight. The already prepared mixture was put into a 1000-ml volume in a measuring cylinder. The mixture was then added to the 1000-ml mark, stirred, and allowed to settle for about 40 seconds before a hydrometer was inserted into it for the sandy content analysis. The clay and silt contents were analysed after a 3-hour interval (when the mixture had settled down) following the same procedure. The temperature at 3 hours and 40-second intervals was obtained simultaneously with the readings of the hydrometer and then designated as T1 and T2, H1 and H2, respectively. The following computations were used to determine the particle size:

% Sand = 100 – [H1 + 0.2 (T1 – 68) – 2.0]2

% Clay = [H2 + 0.2 (T2 – 68) – 2.0]2

% Silt = 100 – (% sand + % clay)

RESULTS AND DISCUSSION

Tables 2 through 4 present the findings from the two-monthly assessments of the physicochemical characteristics of the soils surrounding selected automobile shops between November 2021 and September 2022 in Bori (Station 1), Kaani (Station 2), and Wiiyaakara (Station 3), all in Khana Local Government Area during the sample period. Table 5 presents the mean levels of physicochemical properties of soils from the three different selected automobile repair garages in Khana, their ranges, the mean values across the three impacted sites, as well as the results of the control site.

Results

The mean results for pH , EC (µs/cm), Phosphorus (mg/kg), TOC(%), TN(%), Silt(%), sand (%) and clay(%) across the three study stations 1,2, 3 are respectively with corresponding control stations are 6.10±0.58, 6.74±0.42, 6.34±0.31 and 7.40±2.01; 81.65±9.10, 84.80±8.18, 87.47±9.29 and 65.50±2.32; 9.00±1.02, 7.80±0.83, 10.40±1.76 and 43.76±3.32; 14.14±0.71, 13.31±0.48, 13.24±0.74 and 5.93±0.12; 1.72±0.20, 1.46±0.40, 1.60±0.38 and 23.41±2.20; 17.57±1.24, 18.51±1.37, 18.54±1.16 and 19.70±2.34; 54.78±1.71, 57.34±1.51, 55.13±1.25 and 52.20±3.87 and 27.65±1.46, 24.15±2.18, 26.33±1.39 and 28.10±1.65. Using ANOVA to determine the difference amongst the 3 stations, the f-ratio value was 0.00171 while the p-value is 0.998291. The result is not significant at $p < .05$ but from the Tukey's HSD test showed a slight significant difference between stations 1 and 2 for the spatial dimension. Similarly, there was no significant temporal variation from the month of March to September as the f-ratio value was 0.01983 while p-value was 0.999193 showing result is not significant at $p < .05$.for the station 1 which was corroborated by the Tukey HSD test. For station 2, the f-ratio value is 0.01377 while p-value is .999607 showing that the result is not significant at $p < .05$. The Tukey's HSD test showed slight significance between January and March and also for March and July. In a similar trend the F-ratio value is 1.29531 for station 3 while the p-value was 0.295783. The result is not significant at $p < .05$ as the Tukey HSD recorded no significance also. The mean of the stations when compared to the control using t-test showed that of the 7 parameters studied in the different stations (M= 26.91, SD=825) compared to those of the control group (M=30.75, SD=454) showed no serious significant effect though there is a gradual increase in the concentrations, t (14)= -0.3, p= .382978.

Table 2: Mean levels of two-monthly determinations of physicochemical properties of soil around an automobile repair garage in Bori, Khana (Station 1)

Physicochemical properties	Months					
	November	January	March	May	July	September	Mean ± S.D
pH	6.10±1.00	6.90±2.01	6.17±1.57	5.01±1.20	5.90±2.11	6.50±1.20	6.10±0.58
EC (µs/cm)	70.01±3.01	74.01±4.12	89.45±8.02	75.60±3.30	95.50±5.05	85.35±6.07	81.65±9.10

Phosphorus (mg/kg)	8.81±1.01	9.94±2.10	7.82±0.06	9.81±0.10	10.08±2.45	7.53±1.01	9.00±1.02
TOC (%)	14.07±1.11	13.07±1.21	15.01±1.30	15.06±2.22	13.67±1.20	13.98±1.21	14.14±0.71
TN (%)	1.38±0.11	1.93±0.10	1.73±0.19	1.88±0.28	1.85±0.21	1.55±0.55	1.72±0.20
Silt (%)	17.10±1.12	15.96±1.18	19.15±1.22	18.90±2.25	18.10±1.10	16.20±1.70	17.57±1.24
Sand (%)	54.50±2.21	54.24±2.00	54.45±3.30	53.50±7.02	53.50±5.11	58.50±3.12	54.78±1.71
Clay (%)	28.40±1.13	29.80±1.18	26.40±2.11	27.60±1.24	28.40±1.00	25.30±1.21	27.65±1.46

Table 3: Mean levels of two-monthly determinations of physicochemical properties of soil around an automobile repair garage in Kaani, Khana (Station 2)

Physicochemical properties	Months						
	November	January	March	May	July	September	Mean ± S.D
pH	6.30±1.11	7.06±1.43	7.33±1.01	6.80±1.10	6.85±1.02	6.10±2.01	6.74±0.42
EC (µs/cm)	80.00±3.10	83.03±3.11	101.00±9.12	88.30±7.30	80.90±7.00	75.55±3.85	84.80±8.18
Phosphorus (mg/kg)	6.23±0.31	7.90±0.60	8.21±1.80	7.33±0.45	8.28±0.75	8.84±0.59	7.80±0.83
TOC (%)	12.68±1.00	12.98±1.09	13.62±1.77	13.58±1.21	12.95±1.01	14.07±1.12	13.31±0.48
TN (%)	0.95±0.00	1.56±0.10	1.95±0.89	0.98±0.08	1.92±0.02	1.38±0.85	1.46±0.40
Silt (%)	19.50±1.40	16.98±1.35	17.50±1.10	19.50±0.10	20.50±1.19	17.10±0.30	18.51±1.37
Sand (%)	56.90±1.11	57.91±1.12	58.90±1.23	58.90±1.23	56.90±1.20	54.50±1.21	57.34±1.51
Clay (%)	23.60±2.05	25.11±1.89	23.60±2.21	21.60±2.00	22.60±2.30	28.40±2.23	24.15±2.18

Table 4: Mean levels of two-monthly determinations of physicochemical properties of soil around an automobile repair garage in Wiiyaakara, Khana (Station 3)

Physicochemical properties	Months						
	November	January	March	May	July	September	Mean ± S.D
pH	6.20±2.00	6.99±2.11	6.67±2.12	6.40±1.02	6.05±2.11	6.30±1.11	6.34±0.31
EC (µs/cm)	75.01±2.92	81.12±3.12	97.87±6.20	90.20±6.11	100.05±9.34	80.54±4.21	87.47±9.29
Phosphorus (mg/kg)	9.25±1.10	10.04±2.01	9.72±0.56	10.24±0.20	14.21±2.12	8.96±1.03	10.40±1.76

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TOC (%)	12.85±1.02	13.21±1.01	12.92±1.50	12.95±1.22	14.85±1.09	12.68±1.25	13.24±0.74
TN (%)	1.76±0.11	1.75±0.11	1.86±0.12	2.04±0.55	1.24±0.45	0.95±0.06	1.60±0.38
Silt (%)	18.20±1.00	19.25±1.54	20.10±2.00	17.00±1.20	17.20±1.55	19.50±0.21	18.54±1.16
Sand (%)	55.70±1.21	54.70±1.90	52.80±3.40	55.00±2.55	55.70±4.01	56.90±3.10	55.13±1.25
Clay (%)	26.10±1.06	26.05±1.12	27.10±1.17	28.00±2.01	27.10±2.00	23.60±1.08	26.33±1.39

Table 5: Mean levels of physicochemical properties of soils across the three selected automobile repair garages in Khana

Physicochemical properties	Stations			Range	Mean ± S.D	Control
	1	2	3			
pH	6.10±0.58	6.74±0.42	6.34±0.31	6.10 – 6.74	6.39±2.26	7.40±2.01
EC (µs/cm)	81.65±9.10	84.80±8.18	87.47±9.29	81.65 – 87.47	84.64±2.38	65.50±2.32
Phosphorus (mg/kg)	9.00±1.02	7.80±0.83	10.40±1.76	7.80 – 10.40	9.07±1.06	43.76±3.32
TOC (%)	14.14±0.71	13.31±0.48	13.24±0.74	13.24 – 14.14	13.56±0.41	5.93±0.12
TN (%)	1.72±0.20	1.46±0.40	1.60±0.38	1.46 – 1.72	1.59±0.11	23.41±2.20
Silt (%)	17.57±1.24	18.51±1.37	18.54±1.16	17.57 – 18.54	18.21±0.45	19.70±2.34
Sand (%)	54.78±1.71	57.34±1.51	55.13±1.25	54.78 – 57.34	55.75±1.13	52.20±3.87
Clay (%)	27.65±1.46	24.15±2.18	26.33±1.39	24.15 – 27.65	26.04±1.44	28.10±1.65

Discussions

The pH

The results obtained across the three studied stations (Table 5) for pH had a value that ranged from 6.10–6.74 with a mean value of 6.39±2.26. The soil tend to be less acidic during the wet seasons of May and July due to dilution factor during reversed in the month of September probably due to anthropogenic inputs. The pH of the soil from the auto-mechanic workshop ranged from 5.87 to 6.20 which was more acidic in the study results of Amos et al. (2023) around the automobile workshops in Lafia, northern Nigeria probably due to their different soil compositions. These values were, however, lower than the value obtained from the control site. This increase in the acidity of the soils above the background level is an indication that the operations of the automobile garages, such as spilled electrolytes from discharged motor batteries into the soils, may be responsible. According to Akan et al. (2013), organic matter decomposition releases carbon (IV) oxide, which reacts with water to produce carbonic acid and lower soil pH and could be the source of low pH in anthropogenic locations. The values of pH obtained in this study were in the same range as the values published by Amukali and Bariweni (2020), Jolaoso et al. (2019), Osakwe (2014), Pam et al. (2013), Sadick et al. (2015), but were lower than those reported by Ezigbo (2014) and higher than those reported by Okeke et al.

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(2020). Conversely, Iyama et al (2022) in their study of soil fertility status of aged and abandoned dumpsites in Port Harcourt recorded a range of 2.62±0.00 -6.52±0.00 showing very highly acidic soil in the lower range while the upper range was in agreement with this study .The mobility of chemical components in the soil can be estimated using the pH parameter. It affects how easily heavy metals move through soil and concentration factors during the creation of complex compounds. Metallic elements become more soluble when soil pH falls. Low pH levels will cause the release of heavy metals, which will increase mobility. Metals usually create scarcely soluble carbonates and phosphates at high pH values. Conversely, they may exist in more bioavailable, free ionic forms at low pH (Sintorini et al., 2021). It makes them more available, mobile, and redistributable, which improves their accessibility to plants. These areas usually have acidic soils, and heavy metal mobility and availability are greatly facilitated by low soil pH (Osakwe, 2014). Consequently, the availability of nutrients and heavy metals in relation to the degree of toxicity and soil contamination can be measured using the pH values.

Electrical Conductivity

The results obtained across the three studied stations (Table 5) for EC had a value that varied from 81.65–87.47 with a mean value of 84.64±2.38. This was relatively lower compared to those observed in Lafia, Nigeria of range 77.59-126 s/m (Amos et al., 2023).When comparing the results of the soils around the three auto repair shops with those at the control site, it was observed that the EC values at the impacted sites were all higher than those at the control site. Consequently, this increase in the EC values of the soils above the background level is an indication that there is a reasonable and significant presence of ions caused by the operations of the automobile garages. The components of various workshop materials, such as motor oil, brake oil, other petroleum products, spilled electrolytes from discharged motor batteries, and some metal vehicle scraps, lead to the formation of some soluble and insoluble salts, which could account for the extraordinarily high conductivity of these sites (Timothy et al., 2021). The values of EC obtained in this study were lower than those published by Amukali and Bariweni (2020), Ezigbo (2014), Iyama et al., (2022), Jolaoso et al. (2019), Osakwe (2013), Peter et al. (2017) earlier. The soluble salt concentration in soil is measured using electrical conductivity, a common metric of salinity. While soluble nutrients can also be ascertained using it, soil salinity is the most typical application. The electrical conductivity of soil is influenced by the amount of moisture that soil particles can hold. It is useful for monitoring the mineralization of soil organic matter. It is a metric for the number of ions in a solution. With an increase in ion concentration, the electrical conductivity of a soil solution increases. Electrical conductivity changes with depth, although the range of variation is smaller in the upland profile, owing to the slope of the land surface, high permeability, and high rainfall, which cause alkali and alkaline bases to leach away. It's a metric that relates to soil features such as texture, cation exchange capacity, drainage, organic matter content, salinity, and subsoil characteristics.

Percentage Phosphorus

The mean concentration of phosphorus recorded across the three studied stations had a value that ranged from 7.80±0.83–10.40±1.76 with a mean value of 9.07±1.06 (Table 5). These values were considerably lower than those at the control site. The fact that the soil around the auto repair shops has less phosphorus than the background level suggests that the operations of the auto repair shops, such as the discharge of used motor oil, gasoline, and diesel, have an impact on the soil's hydrocarbon content and microbial activity, such as heterotrophic bacteria. The values of the available phosphorus obtained in this study were within the range reported by Adewole and Uchegbu (2010) and Nwosu (2016); lower than the results published by Anegbe et al. (2018); Ezigbo (2014); Jolaoso et al. (2019); Maleki et al. (2014); and higher than the value reported by Iyama et al. (2022) and Osakwe & Okolie (2015) in similar studies probably due to soil types and likely possible human and natural activities prevalent in the areas.

According to a related study, Tiku et al. (2016) speculate that the higher hydrocarbon content may have contributed to the higher mean heterotrophic bacteria count found in the soil samples from the auto-mechanic workshop. In comparison to non-petroleum-polluted soil, soil contaminated with spent petroleum products has a higher concentration of heterotrophic bacteria. Each and every living cell in a plant contains phosphorus. It is among the most essential macronutrients for plant development. For plants to develop fibrous root systems and seeds, phosphorus is essential. In soils, phosphorus encourages plant growth. Plants will suffer seriously in soils with insufficient phosphorus levels. Crop growth may be inhibited, leaves may become purple, and the timing of flowering and the formation of new shoots will be delayed (Edori & Iyama, 2017; Osakwe & Okolie, 2015; Tale & Ingole, 2015).

Percentage Total Nitrogen and Total Organic Carbon

Across the three studied stations, the value varied from 1.46 to 1.72 with a mean value of 1.59±0.11 (%) as shown in Table 5. Compared to the control site, these mean values were significantly lower. The lower relative levels of total nitrogen (%) in the soils at the study locations compared to the control site were a sign of comparatively stronger anthropogenic influences on the soils. These values were found to be higher than the mean values realised by Amukali and Bariweni (2020), Anegbe et al. (2018), Farombi et al. (2013), Iyama et al.(2022), Nwosu (2016), Osakwe and Okolie (2015), Sadick et al. (2015) and Tiku et al. (2016) but lower than the results published by Adewole and Uchegbu (2010), Nebo et al. (2018), Osakwe (2014), and Jalaoso et al. (2019) in earlier studies.

According to Osakwe (2014), the presence of nitrogen in the soil could be explained by organic components in the soil that may have led to nitrogen mineralization, the process by which inorganic nitrogen is obtained by the decomposition of dead organisms and the degradation of organic nitrogenous compounds. But the lower levels observed in the soils were a sign of stronger anthropogenic influences, such as the leaking of spent oil, which slows nitrification—the biological oxidation of ammonia to nitrite followed by the oxidation of the nitrite to nitrate occurring through separate organisms or direct ammonia oxidation to nitrate in comammox bacteria. Chemicals that require the presence of nitrogen to be metabolically active include amino acids, proteins, enzymes, and other non-proteinous materials.

Jolaoso et al. (2019) stated that it has been established that petroleum-based contamination in soil leads to a reduction in two major organic nutrients: nitrate (nitrogen) and phosphate (phosphorus). These nutrients were much lower in the oil-affected soils than in the control soils. There is also strong evidence that chemical pollutants, like heavy metals, have an impact on the N and P cycles. This is mostly because the pollutants interfere with the microbial functions that are essential to these processes.

Nitrogen is the most important fertilizer element. It promotes the growth of plants and gives the leaves a rich green hue. Plant roots absorb nitrogen as NO_3^- and NH_4^+. It is a component of all living cells and is the most crucial primary nutrient needed by plants for healthy growth and development. All proteins, enzymes, and metabolic processes involved in the creation and transfer of energy depend on it. It is a component of nucleic acid, plant protein, and chlorophyll, all of which are necessary for plant growth. In addition, nitrogen directly connected to soil organic carbon. Nitrogen affects how well plants produce fruit and raises the fruit's protein content. For total organic carbon TOC, the values mean concentrations and control were 13.56±0.41and 5.93±0.12 which were higher than those recorded in soils of three selected universities in Port Harcourt where similar activities may have occurred (Iyama & Edori, 2021).

Particle size distribution

The results of soil particle size distribution for the studied stations are displayed in Tables 2–5. From the results obtained across the three studied stations (Table 5), % silt ranged from 17.57–18.54 with a mean of 18.21±0.45; % sand ranged from 54.78–57.34 with a mean value of 55.75±1.13; and % clay ranged from 24.15–27.65 with a mean value of 26.04±1.44. In comparison of the results from the impacted sites with those from the background, it was revealed that, except for sand, the levels of silt and clay were higher in the impacted sites than in the control. The soils' textural class was generally sandy-clay-loam, which follows the order sand>clay>silt. The particle size distribution of the soil showed that the soil contained a higher proportion of sand than clay and silt at all the sampling sites. This conforms to the results obtained by Odueze et al. (2017) and Osakwe and Okolie (2015) in separate studies.

This soil therefore has the potential to hold more water and has a high sorption capacity for metal ions within the particles due to the presence of a relatively high percentage of clay and its loamy texture (Sadick et al., 2015). The size of the soil's particles has a significant impact on its texture. Aeration and root penetration are

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impacted by the texture of the soil. It has an impact on the soil's nutritional status as well. Electrical conductivity can convey considerable information about soil texture (Kekane et al., 2015). In contrast to clayey soils, which keep water from percolating and act as a natural filter for pollutants and contaminants in water, sandy soils retain little water and have a high rate of percolation, which encourages groundwater contamination. The clay and silt components of soil are where trace metals accumulate most frequently. The content of heavy metals in soil often rises as soil particle size decreases (Edori & Iyama, 2017). The spatial variations of the study parameters are shown in Figures 2 and 3 below.

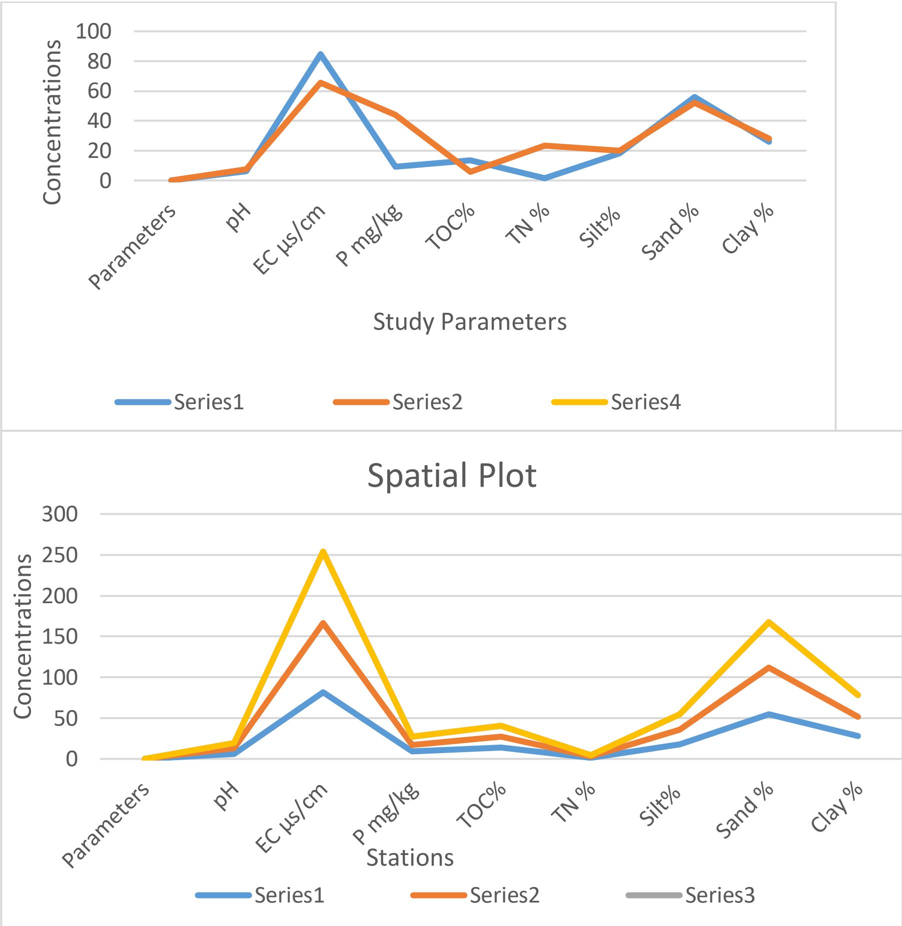

Figure 2: Distribution of Concentrations for Study Parameters, Stations and Control

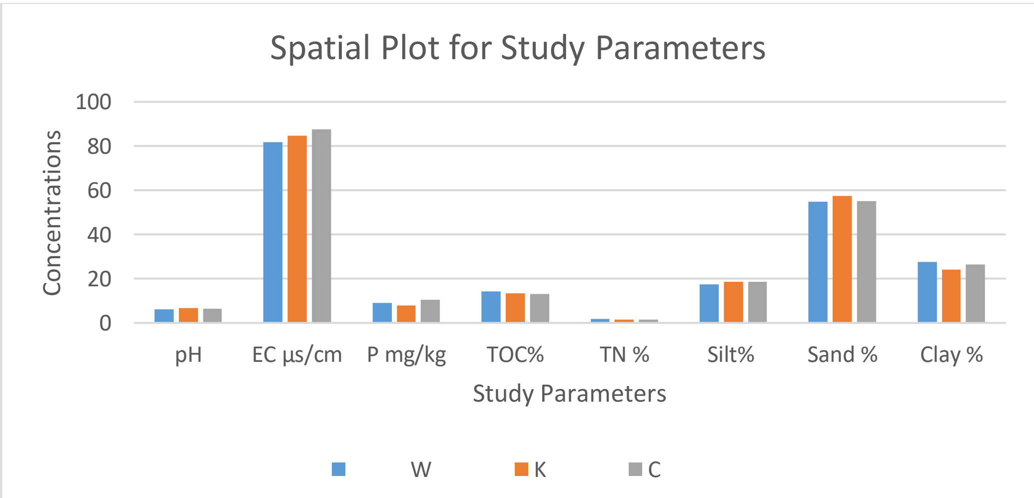

Figure 3: Spatial Plot of Parameters and Concentration Levels

The indiscriminate dumping of waste around the study area sterns from the weak enforcement of environmental laws by the Khana local government council since sanitation is domiciled in the concurrent list of the federal republic of Nigeria. Similarly, the federal agency lacks the manpower needs to go into local supervision of the environment. National environmental standards regulation and enforcement agency (NESREA) supposedly is expected to monitor the effluent discharges of waste into the environment to protect public health and safety but the distance of KHANA from the capital city where the agency resides is a big challenge to oversight functions. In addition, the siting of auto-mechanic workshops should be controlled especially its distance from farm lands and residential buildings owing to the carcinogenic impacts of dioxins and polycyclic aromatic hydrocarbons (PAHs) predominant in these spent oils (Abhulihmen, 2016). Polycyclic aromatic hydrocarbons (PAHs) are globally found contaminants and introduced naturally into the environment by oil seeps or anthropogenically by spills of crude or refined petroleum product (petrogenic) while Pyrogenic PAHs are formed from the incomplete combustion of fossil fuel or biomass and are commonly distributed by atmospheric deposition and urban runoff (Abhulihmen, 2016; Gupta & Gupta, 1998).

The persistence of oil products in soils is of great concern as this can last several decades causing damage and be lethal to soil microorganisms useful and friendly to the farmer at burrowing the soil for proper aeration. Most importantly, virgin forests are destroyed including shrubs which serve as vegetative cover causing severe ecological damage and indirect health consequences. It is important to note that the auto-mechanics found in this region of the world are considered poor, low class and dirty giving those issues of low class social esteem hence do not care about the environment even with enlightenments done by waste management society of Nigeria, Rivers State Council (WAMASON).

CONCLUSION

The study on the surrounding soil of selected automobile repair garages in Khana shows that the physicochemical parameters of the soils were all altered by the activities of the automobile repair workshops, as the computed results were markedly different from those of the control site. The mean results of pH, EC, and TN, as well as percentage sand, were all higher in soil sampled from the impacted locations than the control site, while phosphorus, TOC, percentage silt, and percentage clay were lower in contrast to the control. This could be attributed to the volume and nature of work carried out in these localities. The controlled samples ranked better in terms of the soil quality of the parameters investigated when compared to the auto-mechanic workshop and its environs. The observed pattern of the physicochemical parameters suggests that gradual changes are taken place in the soil especially around the mechanic workshop due to increasing activities of automobile repairs and indiscriminate dumps of spent oils and grease (hydrocarbons). Thus, the change of soil properties observed is a strong indication of growing pollution level that requires remediation strategies such as bioremediation, air sparging and thermal treatment of scraped surfaces.

The use of farmland as a dumping ground by artisans should be prohibited forthwith while laws restricting the establishment of automobile repair workshops inappropriately should be enacted, followed by implementation and enforcement to check the level of compliance; furthermore, auto mechanics (artisans) should be educated on the health consequences associated with the unsuitable dumping of waste; proper waste disposal methods should be encouraged; and modern waste disposal facilities should be provided in all auto mechanic workshops or mechanic villages. It is hence advisable to posit that auto-mechanic workshops should be sited far from residential areas; prompt soil remediation of polluted sites using automated and modern technologies be encouraged and continuous education and training should be provided for the automobile workers, emphasizing on the environmental implications of their poor occupational waste management. It will also be necessary for punitive measures to be enforced by relevant regulatory agencies such as the national environmental standards regulation and enforcement agency (NESREA). More efforts be made by government to enforce policies and regulations by NESREA and relevant agencies. Similarly, this work should be extended to heavy metals, oil and grease, human risk assessment to be more holistic and comprehensive.

REFERENCES

1. Abhulimhen, B. (2016). Physico-Chemical Properties of Soil Sourced from Automobile Mechanic Workshop in Ikoku Mechanic Village, Mile 3 Diobu, Port Harcourt, Rivers State, Nigeria. Published B.Tech project of the Department of Science Laboratory Technology (Geology and Mining

Technology Option), Faculty of Science, University of Port Harcourt, Nigeria. SSRN: https://ssrn.com/abstract=3490585 or http://dx.doi.org/10.2139/ssrn.3490585
2. Adewole, M. B. & Uchegbu, L. U. (2010). Properties of soils and plants uptake within the vicinity of selected Automobile workshops in Ile-Ife Southwestern, Nigeria. Ethiopian Journal of Environmental Studies and Management, 3(3), 31-35.
3. Akan, J. C., Audu, S., Audu, Z. & Ogugbuaja, V. (2013). Assessment of heavy metals, pH, organic matter and organic carbon in roadside soil in Makurdi metropolis, Benue State, Nigeria. Journal of Environmental Protection, 4, 618-628.
4. Amos, I.A., Edward, B.A. & Maryam, I. (2023). Quality assessment of the physicochemical properties of soils from automobile workshops and transformer installations site in Lafia, Nasarawa State. Science World Journal, 18(1), 20-25.
5. Amukali, O., & Bariweni, P. A. (2020). Distribution of Physicochemical Parameters through Soil Profiles around Auto-Mechanic Workshop Clusters in Yenagoa Metropolis, Nigeria. European Journal of Biology and Biotechnology, 1(4), 1-8. http://dx.doi.org/10.24018/ejbio.2020.1.4.47.
6. Amusan, A.A., Ayobami, T.S. and Babatunde, S.B. (2003). Effect of traffic density on heavy metal content of soil and vegetation along roadsides in Osun state, Nigeria. West African Journal of Applied Ecology, 4,107- 114
7. Anegbe, B., Okuo, J. M., Atenaga, M., Ighodaro, A., Emina, A., & Oladejo, N.A. (2018). Distribution and Speciation of Heavy Metals in Soils around Some Selected Auto Repair Workshops in Oghara, Delta State, Nigeria. International Journal of Environment, Agriculture and Biotechnology (IJEAB), 3(2), 574 – 584.
8. Durak, A., Buyukguner, E. & Dogan, H.M. (2010). Determination of physical and chemical properties of soils under different land managements. Asian journal of chemistry, 22 (8), 6375-6386.
9. Edori, O. S., & Iyama, W. A. (2017). Assessment of physicochemical parameters of soils from selected abattoirs in Port Harcourt, Rivers State, Nigeria. Journal of Environmental & Analytical Chemistry, 4(3), 191-196.
10. Elum, Z. A. & Tigiri, H. D. (2018). Socio-economic factors influencing plantain production in Khana Local Government Area of Rivers State. Journal of Agriculture and Food Sciences, 16(2), 107-116.
11. Eneji, I. S., Vesuwe, R. N., & Oloruntoba, S. O. (2017). Analysis of polyaromatic hydrocarbons in soil around auto-mechanic workshops in major towns in Benue State, Nigeria. FUW Trends in Science & Technology Journal, 2(1), 79-84.
12. Ezigbo, V. O. (2014). Physiochemical characteristics and heavy metal levels of soils associated with maize processing mill effluent in nise and its environs, Anambra State Nigeria. African Journal of Education science and Technology (AJEST), 1(4) 113-119. https://www.ajest.info/index.php/ajest/article/view/236
13. Farombi, A. G., Adebayo, O. R., & Oyekanm, I. A. M. (2013). Impact of Petroleum Product on the Soil around Automobile Workshops in Osun State. Journal of Applied Chemistry, 4, (1), 13-15. https://www.iosrjournals.org https://doi.org/10.14738/aivp.103.12175.
14. Gupta, U.C., & Gupta, S.C. (1998).Trace Element Toxicity Relationship to Crop Production, Livestock and Human Health. Comm. Soil Science, Plant Anal.,29 (11-12),1491-1522.
15. Iyama, W. A., & Edori, O. S. (2021). Comparative Study of Organic Parameters of Soils from Three Selected Universities in Port Harcourt Metropolis, Nigeria. European Journal of Applied Sciences, 9(1), 21-34. https://doi.org/10.14738/aivp.91.9114.
16. Iyama, W. A., Edori, E. S., Edori, O. S., Nimame, P., Egbunefu, C. N., Timothy, N., Emejuru, S. W., Gbode, Y. L. & Samuel-Harry, F. (2023). Assessment of physicochemical properties of soils around fruit garden market in Port Harcourt, Rivers State, Nigeria. European Journal of Applied Sciences, 11(1), 675-689.
17. Iyama, W. A., Timothy, M. N., Egbunefu, C. O., Emejuru, W. S., Samuel-Harry, F., & Edori, O. S. (2022). Comparative Assessment of Soil Fertility Status of Aged and Abandoned Rumuolumeni Dumpsite, Port Harcourt, Nigeria. European Journal of Applied Sciences, 10(6), 266–278. https://doi.org/10.14738/aivp.106.13362.
18. Johnbosco, U. (2020). Impact of used motor oil on the soil qualities of Orji mechanic Village Owerri, Nigeria. International Journal of Engineering Technologies and Management Research, 7(2), 1-12. https://www.10.29121/ijetmr.v7.i2.2020.524

19. Jolaoso, A. O., Njoku, L. K., Adedokun, A. H., & Adesuyi, A. A. (2019). Assessment of Automobile Mechanic Workshop Soils in Lagos and the Genotoxic Potential of the Simulated Leachate using Allium Cepa L. EQA–Environmental quality, 34(2019) 48-62. https://www.eqa.unibo.it/article/view/8933/9113
20. Kalambe, N. A. (2021). Determination of nitrogen in soil samples of tiwasa region in Amravati District. International Journal of Scientific Research in Science and Technology, 5(4), 109 – 116.
21. Kawo, A.H., Yahaya, S., Olawore, Y.A., Ogidi J.A. (2018). Bacteriological and Physicochemical Properties of Petroleum-Contaminated Soil Collected from a Mechanic Site in Abuja, North-Central Nigeria. International Journal of Microbiology and Biotechnology, 3(1), 1-6.
22. Kekane, S. S., Chavan, R. P., Shinde, D. N., Patil, C. L., & Sagar, S. S. (2015). A review on physico-chemical properties of soil. International Journal of Chemical Society, 3(4), 29-32.
23. Maha, A. A. (2022). Evaluation of heavy metals in soil wastewater stream. International Journal of Analytical Chemistry, 2522840,11.
24. Maleki, A., Amini, H., Nazmara, S., Zandi, S., & Mahvi, A. H. (2014). Spatial distribution of heavy metals in soil, water, and vegetables of farms in Sanandaj, Kurdistan, Iran. Journal of Environmental Health Science and Engineering, 12, 1-10.
25. Marcus, A. C., Nwineewii, J. D., & Edori, O. S. (2017). Heavy metals assessment of leachate contaminated soil from selected dumpsites in Port Harcourt, Rivers State, Nigeria. International Journal of Chemical Studies, 5(6), 1507-1511.
26. Mohiuddin, K.M, Ogawa, Y., Zakir, H.M. & Kanna, O. (2011). Heavy metals contamination in water and sediments of an urban river in developing country. International Journal of Environmental Science Technology, 8(4), 245-268.
27. Nebo, C. U., Udom, G.J., & Echirim, C. N. (2018). Contamination impact assessment of automobile mechanic workshop on soil and groundwater resource in Port Harcourt, Nigeria. International Journal of Science Inventions Today, 7(3), 451-463.
28. NPC (2009). National Population Commission. Nigerian Population Census
29. Nwosu, A. E. (2016). Variability of physicochemical characteristics of degraded soils at Iwofe waste dumpsite & Ikoku mechanic village in Rivers State. Unpublished Doctoral dissertation, Federal University of Technology, Owerri. https://www.academia.edu/36428984/NWOSU_AMARACHUKWU_THESIS
30. Odueze, J. C., Nwakonobi, T. U., & Itodo, I. N. (2017). Influence of physico-chemical characteristics of soils on heavy metal contamination in Makurdi, Benue state. Journal Environmental Science Toxicology and Food Technology, 11(5), 84-92.
31. Oguntimehin, I., & Ipinmoroti, K. O. (2008). Profile of heavy metals from automobile workshops in Akure, Nigeria. Journal of Environmental Science Technology, 1(7), 19-21.
32. Okeke, O., Ezeh, E., Okeke, H. C., Aniobi, C. C., & Akagha, C. I. (2020). Comparison of Soil Samples from Selected Anthropogenic Sites within Enugu Metropolis for Physicochemical Parameters and Heavy Metal Levels Determination. Journal of Environmental Protection, 11(10), 848-861. https://www.scirp.org/html/7-6704311_103525.htm.
33. Okonokhua, B.O., Ikhajiagbe, B., Anoliefo, G.O. & Emede, T. O. (2007). The Effects of Spent Engine Oil on Soil Properties and Growth of Maize (Zea mays L.). Journal Applied Science and Environmental Management, 11(3), 147-152.
34. Osakwe, S. A. (2014). Heavy metal contamination and physicochemical characteristics of soils from automobile workshops in Abraka, Delta State, Nigeria. International Journal of Natural Sciences Research, 2(4), 48-58.
35. Osakwe, S. A., & Okolie, L. P. (2015). Physicochemical characteristics and heavy metals contents in soils and cassava plants from farmlands along a major highway in Delta State, Nigeria. Journal of Applied Sciences and Environmental Management, 19(4), 695-704. https://www.dx.doi.org/10.4314/jasem.v19i4.18
36. Pam, A. A., Sha'Ato, R., & Offem, J. O. (2013). Evaluation of heavy metal in soil around auto mechanic workshop clusters in Gboko and Makurdi, central Nigeria. Journal of Environmental Chemistry and Ecotoxicology, 5(11), 298-306.

37. Peter, A. M., Ajayi, O. O., Abata, E. O., Solomon, A., & Oluwalope, M. T. (2017). Chemical fractionation of heavy metals in the soil of auto-mechanic workshops in Akure, Ondo State, Nigeria. Chemical Science International Journal, 21(2), 1-16. https://www.10.9734/CSJI/2017/38088
38. Sadick, A., Amofo-Out, R., Acquah, S. J., Nketia, K. A, Asamoah, E., & Adjei, E. O. (2015). Assessment of heavy metal contamination in soil around auto mechanic workshop clusters in central agricultural station, Kumasi-Ghana. Applied Research Journal, 1(2), 12-19.
39. Sintorini, M. M., Widyatmoko, H., Sinaga, E., & Aliyah, N. (2021). Effect of pH on metal mobility in the soil. In IOP Conference Series: Earth and Environmental Science, 737(1), 012071. IOP Publishing. https://doi.org/10.1088/1755-1315/737/1/012071
40. Tale, K. S., & Ingole, S. (2015). A review on role of physico-chemical properties in soil quality. Chemical Science Review and Letters, 4(13), 57-66.
41. Tiku, D. R., Asikong, B. E., & Idire, S. O. (2016). A study of bacteriological and physicochemical characteristics in soils of auto-mechanic and none auto-mechanic workshop soils from selected areas in Calabar metropolis. Microbiology Research Journal International, 16(2), 1-14. https://www.10.9734/BMRJ/2016/23596
42. Timothy M. N., Iyama W.A., & Chidi, O. N. (2021). Evaluation of physicochemical characteristics of soils at auto mechanic workshops in Bori and environs, Rivers State, Nigeria. Journal of Health, Applied Sciences and Management, 5(2), 178-186. https://doi.org/10.5281/zenodo.5747298
43. Timothy, M. N., Iyama W.A., Egbunefu, C.O., Aalonee, E. B. & Edori, E. S. (2022). Heavy metal contamination of top soil at auto-repair workshops in Wiiyaakara Town, Khana, River State, Nigeria. Nigeria Journal of Oil and Gas Technology, 4(2), 162-183.
44. Udousoro, I., Ini, U.U. & Edidiong, A. (2010). Survey of some heavy metal concentrations in selected soils in south eastern parts of Nigeria. Composites Part A. Applied Science and Manufacturing, 2(2), 139-149.