International Journal of Science and Technology Volume 6 No. 8, August, 2017

Determination of Heavy Metals (Cd and Ni) In Soils of Auto Mechanic Village, Suburb of the Yenagoa City, Bayelsa State, Nigeria

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ABSTRACT

Soil samples were collected at a depth of 0-5cm, 5-10cm and 10-15cm from auto mechanic village, suburb of the Yenagoa city, South-South, Nigeria and analyzed for cadmium and nickel to understand their levels and potential ecological risk. The concentrations of heavy metals were determined using a ANALYST 400 Perkin-Elmer AAS. The concentrations of Cd ranged from 0.13 - 0.15 with a mean of 0.14 ±0.01 mg/kg and the control site ranged from 0.12 - 0.13 with a mean of (0.13±0.10mg/kg), while the concentration of Ni ranged from 0.38 - 0.49, with a mean of (0.44±0.06 mg/kg), and ranged from 0.30-0.35 with a mean of (0.32±0.03 mg/kg) for the control site. Compared to the heavy metals permissible limit in agricultural, residential, commercial and industrial soils standards, Cd and Ni showed lower concentration, possibly indicating that the origin of these heavy metals is natural. The concentrations of Cd and Ni in this study were below the Department of Petroleum Resources target value, the metal contamination / pollution index place the auto mechanic village under slight contamination (<0.1) and do not pose a threat to the soil dwelling fauna and human health.

Keywords: *Auto Mechanic Village, Heavy Metal, Contamination, Pollution Index, Suburb*

1. INTRODUCTION

The activities of an auto mechanic workshop, among others, involves panel beating, vulcanizing, auto electrical repairs, brakes and steering, automatic or standard transmission engine, spray painting etc.,are identified as potential source of heavy metals.

Heavy metals in effluents are poorly soluble in water, and cannot be degraded; they tend to accumulate in soils and subsequently accumulate in plants. In addition, heavy metals persist in soil which then leach down into the groundwater and may induce enhanced antioxidant enzymatic activities in plants or become adsorbed with solid soil particles (Iannelli et al., 2002; Ghoneim et al., 2014; Mahmoud and Ghoneim, 2016).

As population increased and technology improved and expanded, more significant and wide spread problems arose causing a continuing and accelerating decline in the quality of the environment and its ability to sustain life. However, level of these metals in the environment has increased tremendously in the past decades as a result of human inputs and activities. Some of the input of these metals result from activities related to industrialization, including combustion of fuels, or other temperature driven reactions associated with motor vehicle performance (Sawyer, 1998; Odoh *et al*., 2011).

Soils, weather in urban or agricultural areas represent a media and sink for the release of metals into the environment and also a media on which agricultural crops are produced and the possibility of these crops to take up these metals becomes obvious. Heavy metals once in soil, some would be persistent because of their immobile nature, while other metals however would be more mobile therefore the potential of transfer through soil infiltration down to ground water aquifer or plant – root uptake and subsequent transfer into the food chain, to cause biochemical defects in body organs like liver, kidney, spleen and lungs is highly likely to occur (Haliru et al., 2014).
Unchecked industrial and human activities have contributed significantly to elevated levels of these metals, in surface and subsurface soils when compared to those contributed from geogenic or natural processes (Dasaram *et al*., 2011; Pam *et al*.,2013).

Cadmium is very bio-persistent but has few toxicological properties and, once absorbed by an organism, remains resident for many years (Campbell, 2006; Wuana and Okieimen**,** 2011).
Nickel is an element that occurs in the environment only at very low levels and is essential in small doses, but it can be dangerous when the maximum tolerable amounts are exceeded. The most common application of Ni is an ingredient of steel and other metal products. The major sources of nickel contamination in the soil are metal plating industries, combustion of fossil fuels, and nickel mining and electroplating (Khodadoust *et al*., 2004).

Many biogeochemical properties / parameters have been proposed and applied to indicate soil contamination with heavy metals. However, the most commonly used indicator for soil heavy metal pollution is still total/recoverable content, though extractable amount is often more closely related to plant uptake or availability. Regulatory standards for heavy metal levels have

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been established for agricultural soils but wide discrepancy exists among different countries regarding the critical value of each contaminant (He *et al*., 2015).

The heavy metals most frequently encountered in auto mechanic workshop waste include cadmium, nickel, etc., all of these pose ecological and public health risk. Therefore become indispensible to institute a study to check the levels of these metals in soils of the auto mechanic village, Yenagoa city, Bayelsa State, Nigeria. The main objectives of this work are: (1) to evaluate the contents of two metals; Cd and Ni in soil of auto mechanic village (2) to provide scientific based information on the overall ecological risk and public health concerns.

2. MATERIALS AND METHODS

2.1. Description of study area

Bayelsa state mechanic village is a suburb at Etegwe along Imirigi road of the Yenagoa metropolis, Nigeria. The study area lies between the coordinates of latitudes 04o15" North and latitude 05o23' South and longitude 05o22"West and 06o45" East (Fig 1).

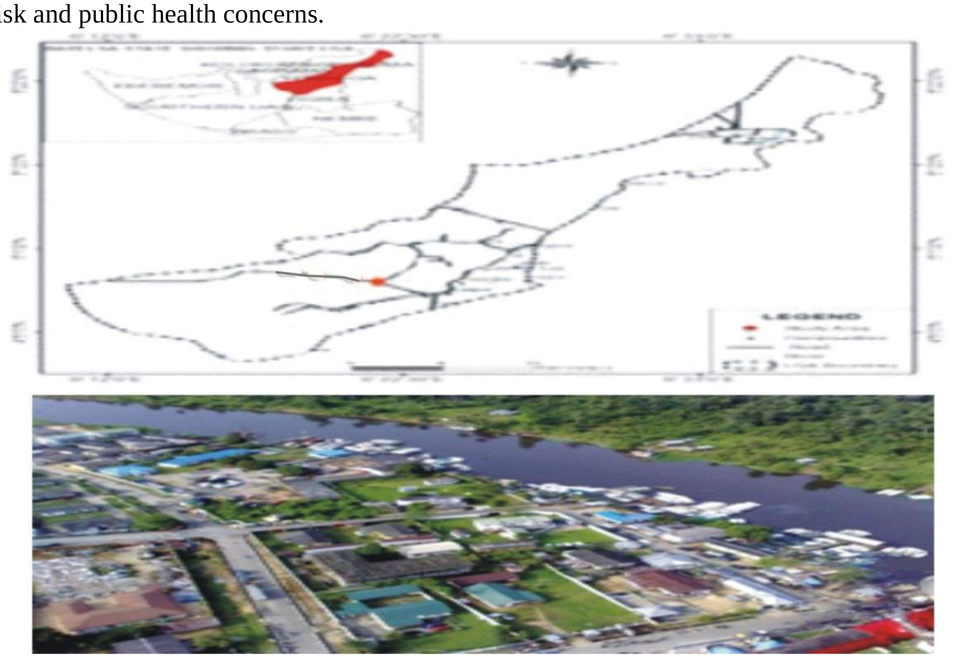

Fig.1 Map of the study area showing sampling site and Image of Yenagoa city

2.2. Reagents Used, Sampling and analysis

The reagents used are HCl, HNO_3 de-ionized water etc. All glass wares used (conical flask, measuring cylinder, volumetric flask, and watch glass) were washed with liquid detergent and rinsed thrice followed by oven drying.

Surface soil samples were collected from auto mechanic village using hand auger at a depths of 0-5cm, 5-10cm and 10-15cm respectively. One control sample was also collected about 100 m away where neither car repairs, industrial nor commercial activities are carried out. The samples were placed in labeled polythene bags and transported to the laboratory. In order to get a representative sample, several sub-samples were collected and mixed together.

The soil samples were homogenized, made lump free by gently crushing repeatedly using an acid pre-washed mortar and pestle, and passed through a 2 mm plastic sieve prior to analysis.

2.3. Aqua-regia digestion method (NH) was applied.

1.0 g of each sample was treated with 15 ml HCl and 5 ml HNO_3 in a (ratio 3:1). The sample was then heated on a hot plate with the temperature gradually increased until decomposition was complete and volume reduced by evaporation to about 5ml. The samples were filtered, washed with de-ionized and double-distilled water, transferred quantitatively to a 50 ml volumetric flask for the analysis of heavy metals (Quevauviller *et al.*,1998; Idera *et al*., 2014).

2.3. Instrumentation

An ANALYST 400 Perkin-Elmer Atomic absorption Spectrophotometer fitted with deuterium lamp for background correction was used for the determination of all the elements after successive dissolution, decomposition and made up to the 50ml mark in a volumetric flask.

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3. RESULTS AND DISCUSSION

Table 1-2 summaries the concentrations of heavy metals in (range, minimum, maximum, mean ± standard deviation) expressed as milligram / Kilogram (mg/Kg) of dried soils of the auto mechanic village and a control sample collected about 100 m away from where neither car repairs nor commercial activities are carried out. The percentages of the heavy metals in the soils are represented graphically in Fig. 2-3.

Table 1 Concentration (range, mean ± standard deviation (mg/kg) for cadmium and nickel

	AMVS		CSS	
Depth	Cd	Ni	Cd	Ni
0 - 5	0.15	0.46	0.12	0.30
5 -10	0.13	0.38	0.13	0.31
10 - 15	0.15	0.49	0.13	0.35
range	0.13-0.15	0.38-0.49	0.12-0.13	0.30-0.35
mean±std	0.14±0.01	0.44±0.06	0.13±0.01	0.32±0.03

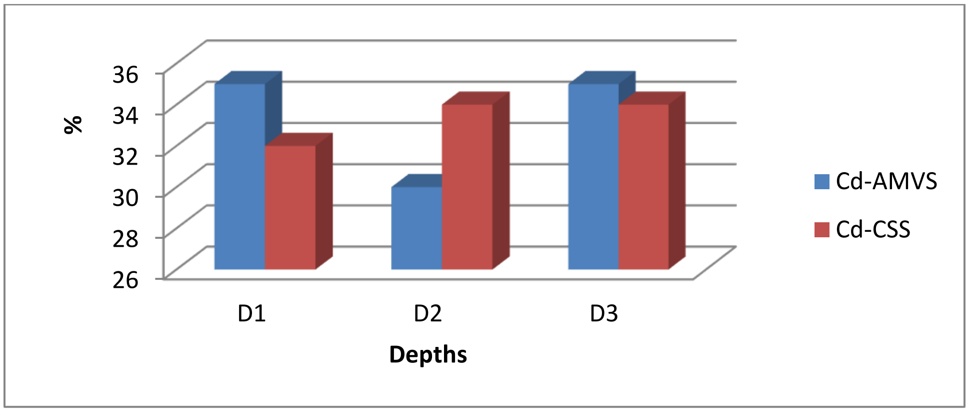
AMVS = auto mechanic village soil, CSS = control site soil

Cadmium

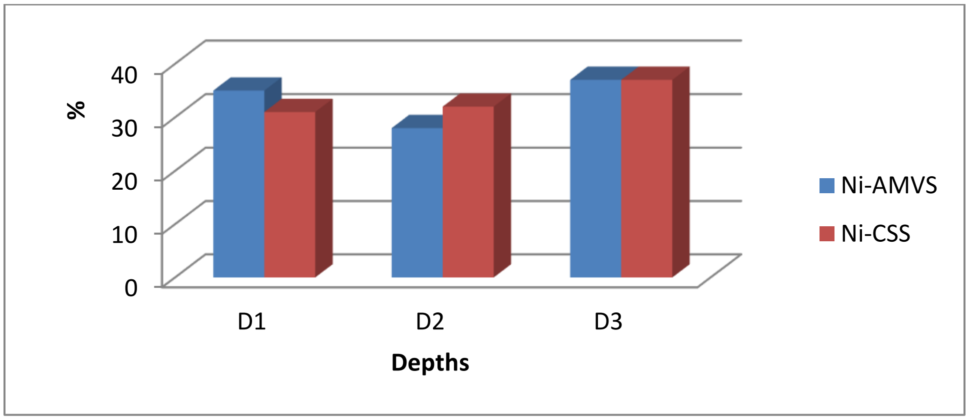
The mean concentrations of Cd in this study ranged from 0.13 - 0.15 with a mean of 0.14 ±0.01 mg/kg and the control site ranged from 0.12 - 0.13 with a mean of 0.13±0.10mg/kg(Table 1-2).. Kabata-Pendias and Pendias (1984) reported that the background concentrations of cadmium in the surface soils in Britain are 1.05 µg/g. The mean cadmium concentrations for urban roadside soils and rural roadside soils near Bradford as 2.44 µg/g and 1.04 µg/g, respectively (Aksoy1996; Khalid *et al*.,2006). The values of cadmium concentrations obtained are all far below the maximum tolerable levels proposed for agricultural soil and comparable to levels in natural environment (Lee and Lee, 2011; Engler, R.M.,1980; Leizou et al., 2015).

Nickel

Concentration (range, mean ± standard deviation, mg/kg) for nickel was 0.38 – 0.49, (0.44±0.06mg/kg) in auto mechanic village and in control site 0.30-0.35, 0.32±0.03 (Table 1-2). Lenntech (2009) emphasis that the nickel content in soil can be as low as 0.2 mg/kg or as high as 450 mg/kg although the average is about 20 mg/kg. Global input of nickel to the ecosystem 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 (Kasprzak *et al*., 2003).



Cd-AMVS=Auto mechanic village soil, Cd-CSS=Control site soil, D1=0-5cm, D2=5-10cm,D3=10-15cm
Fig.2 A comparison of Cd values in auto mechanic village soil and control site



Ni-AMVS=Auto mechanic village soil, Ni-CSS=Control site soil, D1=0-5cm, D2=5-10cm,D3=10-15cm
Fig.3 A comparison of Ni values in auto mechanic village soil and control site

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Duda-Chodak and Blaszczyk, 2008; Lenntech, 2009 reported that there are higher chances of the usual cause of medical problems; developing cancers of the lung, nose, larynx and prostrate as well as respiratory failures, birth defects and heart disorders from large intake of nickel from plants grown on nickel rich soils (such as tea, beans, vegetables). The values of nickel concentrations obtained are far below the maximum tolerable levels proposed for agricultural soil and comparable to levels in natural environment (Lee and Lee, 2011; Engler, R.M.1980; Leizou et al., 2015).

Table 2: Total mean concentrations (mg/kg) of heavy metals in soils of auto mechanic village and control site

.02.3		N	Range	Minimum	Maximum	mean		Std. Deviation	variance	skewness	
sites	metals	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
AMVS	Cd	3	.01	.13	.15	.14	.01	.01	.00	-1.70	1.22
	Ni	3	.11	.38	.49	.44	.03	.06	.00	-1.38	1.22
CSS	Cd	3	.01	.12	.13	.13	.00	.01	.00	-1.65	1.22
	Ni	3	.05	.30	.35	.32	.02	.03	.00	1.51	1.22

AMVS=auto mechanic village soil, CSS=control site soil

Metal Contamination/pollution index:

The metal contamination/pollution index (MCPI) was introduced by Lacutusu (2000) for determining the extent of metal accumulation in soils and has been used by various workers in their studies (Ololade 2014**;** Iwegbue *et al.*, 2013; Haliru *et al.*, 2014).

$$MCPI = \frac{Concentration\ of\ metal\ in\ soil}{Target\ value\ from\ reference\ table}$$

The contamination / pollution index scale consists of ten grades ranging from Slight contamination to Excessive pollution (<0.1 – 16.0). Cadmium was found to have a pollution index of 0.01 and nickel 0.18. The values for Cd and Ni were in the range that fall within contamination range (less than 1). Following the categorization of the contamination/pollution index, all the metals were in the range that showed very slight contamination (<0.1).

Comparison with heavy metals permissible limit in soils

Table 3 Allowable limits of heavy metals concentration in soil (mg/kg)

HMs	Austria	Germany	France	Luxembourg	Netherlands	Sweden	U K	FEPA, Nigeria	This Study
Cd	1 to 2	1	2	1 to 3	0.5	0.4	3	2.0	0.14±0.01
Ni	50 to 70	50	50	30 to 75	15	30	75	0.5	0.44±0.06

Source: ECDGE (2010; Adelekan and Abegunde, 2011). Lee and Lee, 2011; Imasuen and Omorogieva, 2013; He *et al*., 2015

Comparison with some countries heavy metals permissible limit in agricultural, residential, commercial and industrial soils (ECDGE (2010 ; Adelekan and Abegunde, 2011;. Lee and Lee, 2011; Imasuen and Omorogieva, 2013; He *et al*., 2015; FEPA, 2003), the results of this study were found to be lower (Table 3): and do not pose a threat to the soil dwelling fauna and human health.

4. CONCLUSION

This study is the first to assess the levels of heavy metals in soils of the auto mechanic village, suburb of the Yenagoa city, Bayelsa State, Nigeria. The results revealed that the concentrations of the Cd and Ni in soils of the auto mechanic village were considerably accumulating. Comparison with reference standards, and studies from other environments showed that the results of this study were lower. The indices of contamination, such as metal contamination/pollution index attempted place the auto mechanic village very slight contaminated. The auto mechanic village and its environment are likely to face threat of metal pollution in the coming years with the present levels unless stringent pollution control policies are adopted, involves prohibiting unauthorized and unplanned sitting of auto mechanic workshops and effluent disposal should be in a manner that optimizes protection of the ecosystem.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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