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## ASSESSMENT OF SOME HEAVY METALS IN SOILS ASSOCIATED WITH AUTOMOBILE ACTIVITIES IN SELECTED AREAS OF GOMBE, NIGERIA

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### ABSTRACT

*This study determined the levels of heavy metals in soils associated with automobile activities in three different sites within Gombe metropolis. Top soil samples were collected from two locations at each sampling site using standard method. The samples were digested and analysed for heavy metals (As, Cr and Ni) using Atomic Absorption Spectrophotometer. The concentration of heavy metals ranged from 0.96 - 1.95 mg/kg at A site, 0.89 - 2.11 mg/kg at B and 0.98 - 2.0 mg/kg at C for Cr, and 1.06 - 2.11 mg/kg at A site, 0.98 - 1.89 mg/kg at B and 0.95 - 0.98 mg/kg at C for Ni while the concentration of As was below detectable limit in all the study sites. The mean concentrations of the metals were compared with that of Department of Petroleum Resources (DPR, 2002) Standard values for Nigerian soil and that of World Health Organization (WHO, 1996). All the concentration of the metals studied were found to be below the DPR and WHO target values. Results of contamination factor (Cf) showed that all the studied sites fall under class 1 low contaminated one with Cr and Ni being found with values greater than one. The values of Pollution Load Index obtained from these three sites (PLI <1) were less than 1 in all the studied sites, thus indicating perfection.*

**Keywords; Assessment, Automobile, Digestion, Heavy metal, Site**

### INTRODUCTION

Soil is a critical environmental medium, which is subjected to a number of pollutants due to different human activities (Al-Khashman and Shawabkeh, 2006). Public motor roads affect natural environment to a large extent because automobile act as line sources of heavy metal pollutants (Poszyler-Adamska and Czemiak, 2007). The pollution of soils by heavy metals from automobile sources is a serious environmental issue. These metals are released during different operations of the road transport such as combustion, component wear, fluid leakage and corrosion of metals. The major metal pollutants of the roadside environments are released from fuel burning, wear out of tyres, leakage of oils, and corrosion of batteries and metallic parts such as radiators etc. (Dolan *et al.*, 2006). Soils are critical in assessing the potential environmental impacts of automobile emissions and several researchers have indicated the need for a better understanding of heavy metal pollution of roadside soils (De Kimple and Morel, 2000; Manta *et al.*, 2002). Heavy metals are among the most important pollutants in the environment, which are introduced as a result of both

anthropogenic and natural activities (Chibuiké and Obiora, 2014).

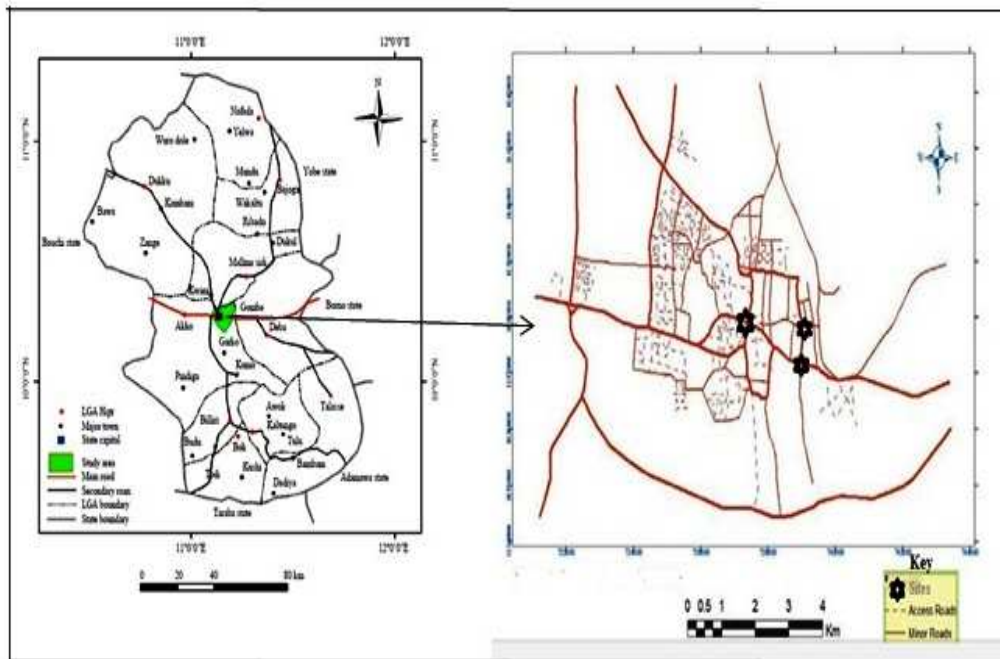
The anthropogenic fractions contain high concentrations of heavy metals and have a potential to contaminate soils, which can be dispersed and inhaled by humans which can cause serious threat to their health. The pollution caused by heavy metals in agricultural soil can also affect food quality and safety. To date, various potentially toxic elements (PTEs) have been identified, such as arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn), which are known to influence human disease by their respective deficiency or toxicity (McKinley *et al.*, 2013). So heavy metal contamination has been a worldwide environmental concern with its potential ecological effect (Hu *et al.*, 2017). Therefore, it is necessary to monitor heavy metals contamination in the soil to determine their levels due to the hazards they posed to the soil, and showed it is anthropogenic impact to the local environment. This current study aimed at determining some selected levels some heavy metals, contamination factor and pollution load index in soil associated with automobile activities in three different sites within Gombe metropolis.

**MATERIALS AND METHODS**

**Study Area**

The study area consists of three traffic circles in Gombe metropolis, the capital of Gombe State, situated in the Northern Nigeria. It is located between latitude 10°17'05.88"N and 11°10'36.78"E with an area coverage of about 52 km<sup>2</sup> and about 399,531 population (Figure 1). The study area falls into Sudan

savanna climate. The climate of the area is tropical with dry/harmattan season (November-April) and rainy season (May-October) with temperature ranging from 18 °C to 39 °C and an average annual rainfall of 850-954 mm (Iloje, 2001). The relative humidity ranged from 70% to 80% in August and decreases to 15 to 20% in December (Sulaiman *et al.*, 2016).



**Fig. 1:** Map of Gombe Road Network Showing the Study Area

**Soil Sample Collection and Processing**

Soil samples were collected from top soil (0 - 10 cm) using stainless steel trowel at three different traffic circles (Town, Market and Union Bank) from edge and 50 m away from the roadside. At each sampling location, four subsamples were randomly collected to make a composite sample. One hundred grams of each composite sample were collected into zip mouthed polyethylene bags and transported to Geology laboratory at Gombe State University, stored at room temperature for pre-treatment and analyses.

**Sample Preparation and Digestion of Soil**

The air dried soil samples were grinded with an agate mortar and sieved through 1mm mesh standard sieve. Zero point five gram of each of the sample were digested in 20 mL freshly prepared aqua-regia (1:3 HNO<sub>3</sub>:HCl) on a hot plate for 3hrs, then evaporated

and diluted with 50 mL of distilled water to determine the concentration of As, Cr and Ni, with atomic absorption spectrophotometer (AAS) (AA6300, Shimadzu, Japan). All the sample analyses were done in three replicates.

**Contamination Factor (CF)**

The level of contamination of the roadside soil by the heavy metal was expressed in terms of a Contamination Factor (CF) and determined by employing the model by Lacatusu, (2000).

$$CF = \frac{\text{Concentration of the metal in soil}}{\text{Target (Background) value}} \dots\dots\dots \text{Equation 1}$$

The background values used were reference values of metals by DPR (2002), for maximum allowable concentration of the metals in Nigeria soil (As = 1, Cr = 100, Ni = 35) in mg/kg.

The following contamination classes were used to define the contamination factor;  $CF < 1$  refers to low contamination;  $1 \leq CF < 3$  means moderate contamination;  $3 \leq CF \leq 6$  indicates considerable contamination and  $CF > 6$  indicates very high contamination (Mafuyai *et al.*, 2015).

**Pollution Load Index (PLI)**

Pollution Load Index (PLI) can be defined as the sum of contamination factor. The pollution load index (PLI) was developed by Thomilson *et al.* (1980), as follows:  $PLI = (Cf_1 \times Cf_2 \times Cf_3 \times Cf_4 \dots Cf_n)^{1/n}$  ..... Equation 2  
 Where n is the number of metals studied and Cf is the contamination factor calculated as described in Equation 1. The PLI gives an estimate of the metal concentration status. The ranks of values of  $PLI < 1$  denote perfection:  $PLI = 1$  present that only baseline levels of the pollutants are present and  $PLI > 1$  would indicate deterioration of site quality Thomilson *et al.* (1980).

**RESULTS AND DISCUSSION**

The mean values obtained for the heavy metals at different sampling sites were shown in figure 2. All the studied metals were detected in the three sites except As. Arsenic (As) is widely known for its adverse effects on human health. In this study Arsenic was

below the detectable limit in all the studied sites. The mean concentration of Cr ranged from 0.96 - 1.95 mg/kg at A site, 0.89 - 2.11 mg/kg at B and 0.98 - 2.0 mg/kg at C, and Ni ranged from 1.06 - 2.11 mg/kg at A site, 0.98 - 1.89 mg/kg at B and 0.95 - 0.98 mg/kg at C in all the studies sites. The soil sample from at site B was observed to have the highest concentration of Cr (2.11 mg/kg) while the lowest concentration of Cr (0.89mg/kg) was observed at A, 50 m away. The general trend in all the studied sites in respect to Cr was; site B >C>A > C 50 m >A 50 m> B 50 m. This variation in concentration of the metals may be due to traffic density. Taofeek and Tolulope (2012) reported the mean concentration of Cr (mg/kg) in roadside soil at Ogbomoso was higher than the Cr concentration recorded at the study. The lowest concentration of nickel was observed at C 50 m away Ni (0.95mg/kg) and highest level of Ni (2.01 mg/kg) was observed at site A. The rate of high corrosion and wear from old vehicle (as a result of high patronage in imported used cars) plying the roads could have accounted for the significant levels of anthropogenic contributions of Ni in roadside dust (Mafuyai *et al.*, 2015). However, the mean concentrations of all the studied metals were below the permissible limit set both by Department of Petroleum Resources (DPR, 2002) and World Health Organization (WHO, 1996).

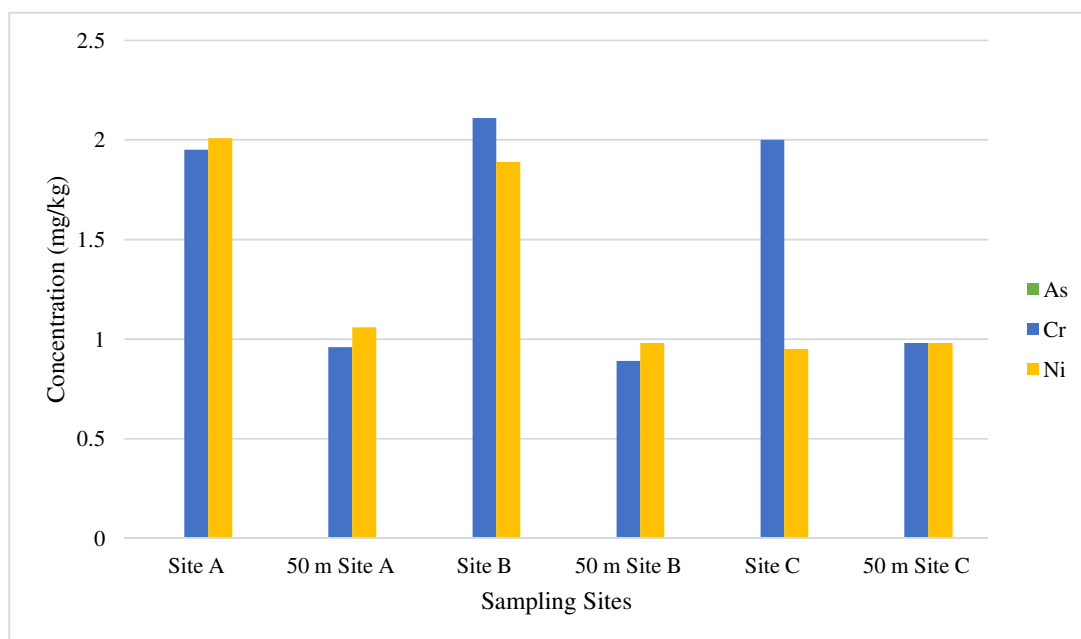


Figure 2: Heavy Metals Content at Different Sampling Sites

The assessment of the overall contamination of all the studied sites was based on Contamination Factor (Cf) Figure 3. The values obtained for contamination factor (Cf) shows that all the studied sites fall under class 1

(low contaminated) with Cr and Ni being found with values greater than one. This indicates very low anthropogenic pollution in all the studied sites.

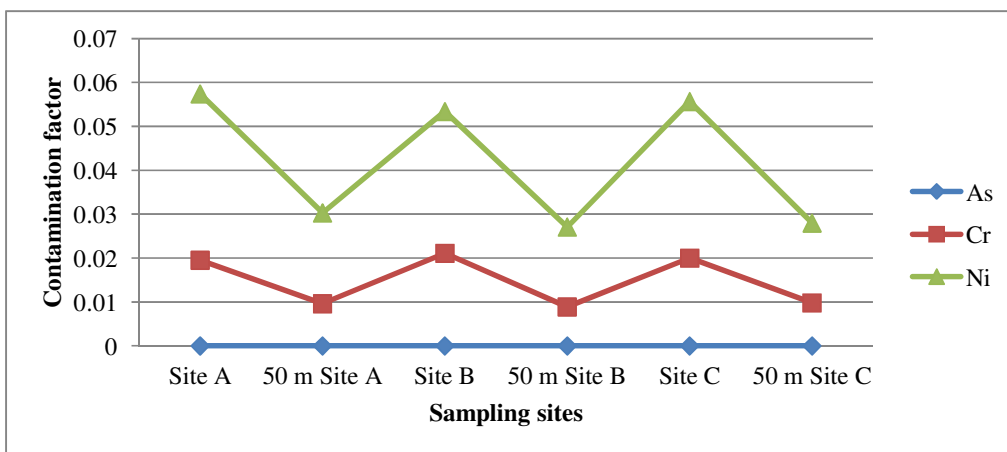


Figure 3: Contamination factor (Cf) for Arsenic, Chromium and Nickel at Different Sampling Sites of Gombe, Metropolis, Nigeria

The Pollution Load Index (PLI) was extensively used for soil pollution assessment; it is used to measure the degree of overall contamination of the study sites.

The pollution load index in this study(Figure 4) was less than 1 in all the studied sites, thus indicating perfection.

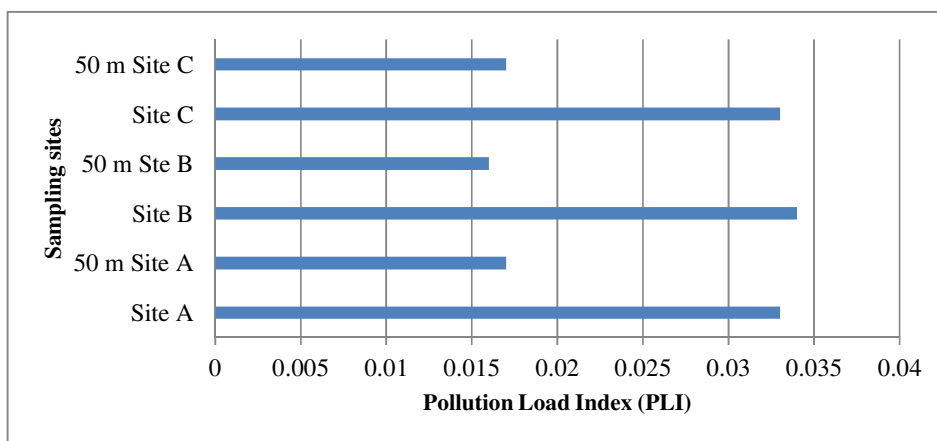


Figure 3: Pollution Load Index (PLI)for Arsenic, Chromium and Nickel at Different Sampling Sites of Gombe, Metropolis, Nigeria

**CONCLUSION**

The results of this study showed that As is the only metal below detectable limit, while the others metals Cr and Ni were below DPR and WHO target values. The result generally revealed that the concentration of the metals were higher at edge roadside soil and decrease with increase in roadside distance due to traffic volume. All the pollution indices carried out revealed that contamination factor (Cf) of all the

studied sites fall under class 1 (low contaminated) with Cr and Ni and pollution load index obtained from these three sites (PLI >1) were less than 1 in all the studied sites, thus indicating perfection. Regular monitoring is recommended to be conducted to ensure suitable management of the urban environment and reduction of automobile related contamination of soils, which can cause health hazard on the surrounding population.

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