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Daily Exposure of Roadside Topsoil to Lead at Olaiya Roundabout, Osogbo, Nigeria

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ABSTRACT: *The daily concentration of lead in roadside topsoil at Olaiya roundabout in Osogbo, Nigeria was investigated. Lead was found to be most significant on Monday around the old motor park and accounts for 25% of lead for the day. It was found to be most significant along government secretariat on tuesday and wednesday with 28% and 29% contribution to daily lead exposure respectively. Lead was found to be most significant along government house, Okefia, beside the market on thursday and friday with 27% and 22% contribution to lead contamination respectively. Most significant lead concentration on saturday and sunday was obtained beside the market. The highest lead level for the study was obtained on wednesday along government secretariat. However, the level of lead in this study was low compared to other studies elsewhere. Automobile exhausts emissions is likely to be the major source of lead in addition to waste deposition and railway. Statistical analysis showed significant difference in the levels of lead with a positive correlation at $p< 0.05$. Lead is an important toxicant that can exert adverse effects in humans, given sufficient exposure and accumulations in the body.*

Keywords: *Contamination, correlation, lead, roadside topsoil, vehicular exhausts,*

I. INTRODUCTION

Lead is used as minor additives to gasoline and various auto-lubricants and is always released during combustion. Other sources of lead in urban area include from tyres and engines, during abrasion and wears. Heavy metal contamination of urban topsoil is usually derived anthropogenically from sources such as emissions from car-exhausts, refuse dumpsite, waste incineration, agricultural inputs and from emissions from industrial activities. Roadside in many cities have been studied for topsoil traffic-related metal pollution [1]. Lead compounds have been used in a wide variety of products such as paints, ceramic, pipes, solders, gasoline batteries and cosmetics [2]. Despite years of intensive research, educational efforts and remedial measures, lead continues to receive as much attention as any modern environmental health is concerned. Lead is an important toxicant that can exert adverse effects in humans, given sufficient exposure and accumulations in the body. Body systems known to be susceptible to adverse effects of high exposure include; neurological, reproductive, renal and hermatological. Children are more sensitive than adults to the effects of lead and precaution should be taken to limit childhood exposure and keep blood lead levels (BLL) below the recommended level. According to USEPA [3], soil lead level of 1000 ppm correlates with a critical blood lead level of $7\mu gdL^{-1}$ in children. In Nigeria, [4,5,6] have reported various forms of polluting activities (such as soil pollution from various petroleum products) of heavy metals including lead which result in metal contamination of topsoil.
The aim of this study was to determine the day of the week when the contamination of lead in roadside topsoil will be most significant around a popular roundabout in a typical Nigerian city.

II. METHODOLOGY

The study was carried out at Ola-Iya round-about in Osogbo, Nigeria. Topsoil samples at selected points at the junction were used for the study. Eight topsoil samples were collected on a daily basis at eight locations for seven days of the week [Monday (MOS), Tuesday (TUS), Wednesday (WES), Thursday (THS), Friday (FRS), Saturday (SAS) and Sunday (SUS)]. A total of fifty-six topsoil samples were used for the study. At each of the fifty-six locations, the top 0-5 cm soil was scooped with a stainless steel shovel from several points and pooled together to form composite for that location. The collected samples were air-dried for six days, crushed, sieved and then kept for lead determination.

Fig. 1 shows the map of sampling locations where the samples were collected.
Extraction of lead was carried out by weighing 5.0g of the sieved soil in a 150 mL Pyrex beaker and 50 mL of 2M HNO_3 was added and placed on a water bath for 2 hours with occasional shaking according to [7]. The extract obtained was then filtered and made up to 50mL with distilled water and analysed for lead with atomic absorption spectrophotometer. Stock standard solution of lead was prepared and working standard solutions were prepared for the purpose of calibration. Blank reading was subtracted from sample reading and resulting lead concentration was extrapolated from the calibration graph. A blank was always included for every ten samples analysed. Reagents used were of analytical grade. Statistical analysis of data was carried out by the use of STATISTICA 7.

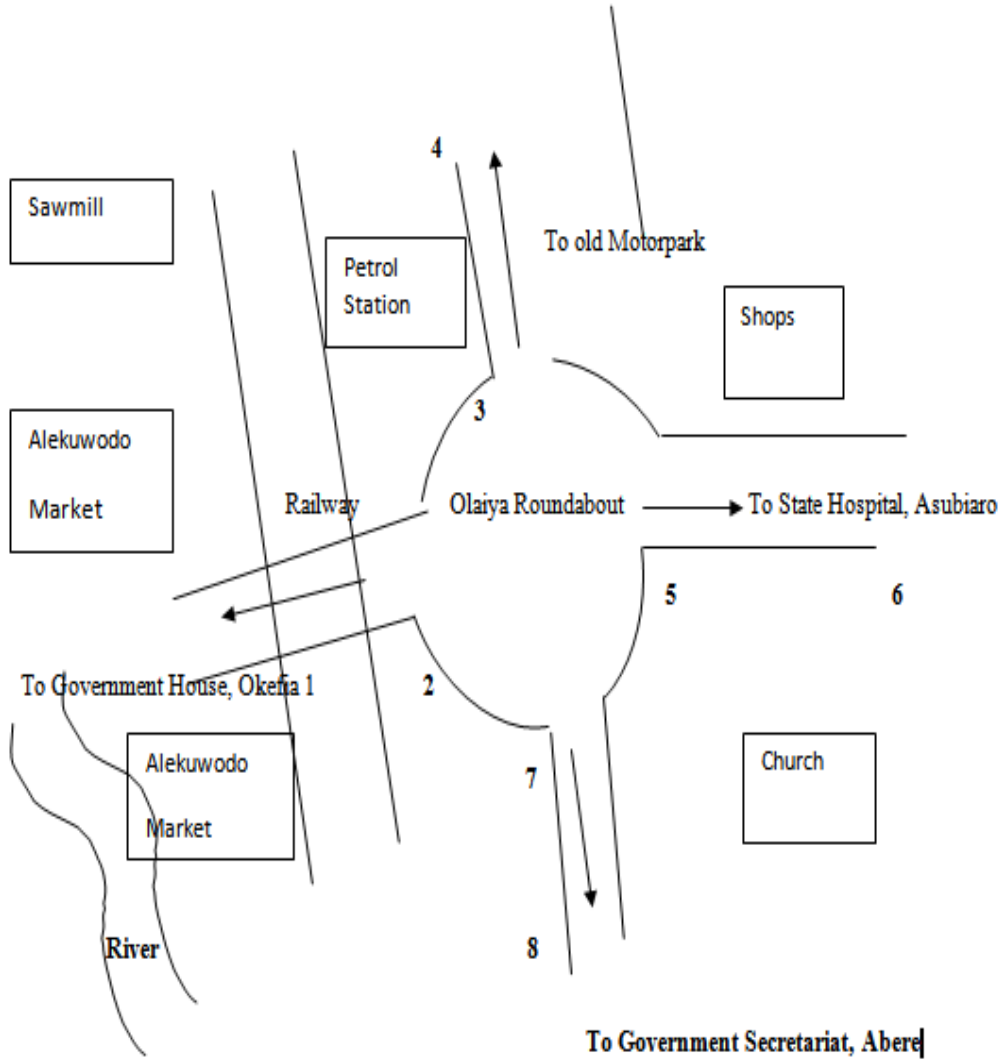

Figure 1: Map of the sampling area

III. RESULTS AND DISCUSSION

The results of the exposure of roadside soil to lead on daily basis are as shown in Figures 2 to 8. Figure 2 shows the distribution of lead on monday. Lead concentration at point MOS 3 had the highest concentration (72.7 mg/kg) which accounts for 25% of the total lead experienced on monday. These could be as a result of some civil servants that are going to their respective places of work on monday and could involve those having personal vehicles and those that use public vehicles where there is vehicular exhaust of lead, because this direction is towards the motor park direction as shown in Figure 1. More than 70% of the citizens in Osogbo are civil servants that work at various ministries. This round-about is always very busy because every ministry staff will always want to get to work on time and also this route leads to other major towns and states such as Lagos, Ibadan, Akure, Ife, Ede. This observation was within the level of lead obtained by [1] around motor parks in Ibadan, Nigeria (21.0 -1090 mg/kg). MOS 8 was also noticed to contribute 20% of the total lead for Monday (58.4 mg/kg).

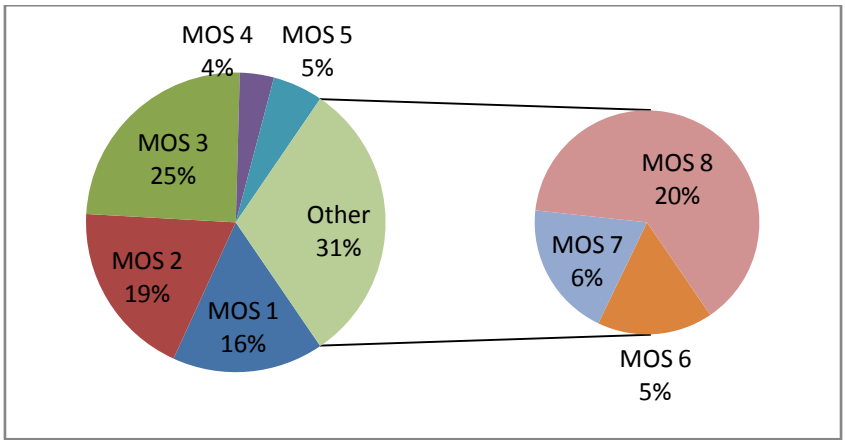

Figure 2: Exposure of roadside soil to lead on Monday

The variation of lead in all the sampling points on tuesday is as illustrated in Figure 3. TUS 8 had the highest lead concentration (73.7 mg/kg) and accounts for 28% of the total lead on tuesday. This direction was towards the government secretariat, Abere and could be due to the high lead discharge from exhaust of motor vehicles going to the government secretariat in the morning and when coming back from the secretariat. The reason could also be due to runoff from polluted areas high in lead and get deposited at this sampling site. Some of the civil servants living in Osogbo or working in Osun State do not reside in the state, and come from other neighbouring states to report to their various offices, the exhausts from their car can add to the soil lead concentration.

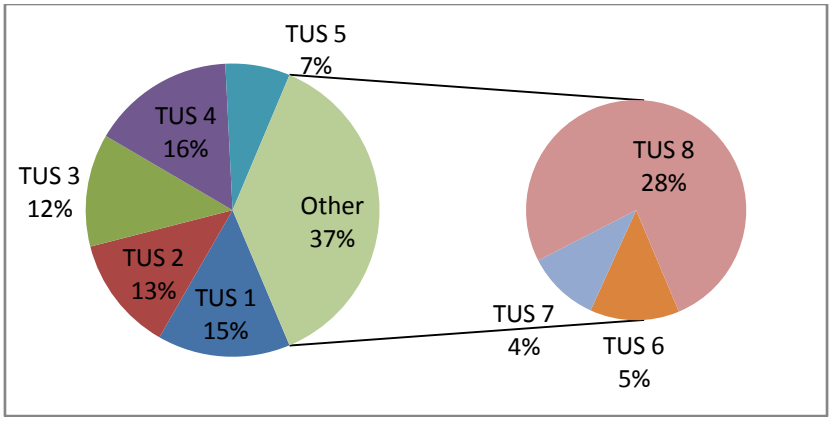

Figure 3: Exposure of roadside soil to lead on Tuesday

The highest level of lead in soil on wednesday was obtained at WES 8 again (83.9 mg/kg) and accounts for 29% of the total lead concentration for this day as shown in Figure 4. The result of the high level is as explained for tuesday due to discharge of lead from vehicle exhausts. The high level of lead obtained in this study could be primarily due to anthropogenic sources. It is estimated that about 2800 metric tons of vehicular gaseous lead emission is deposited to urban areas in Nigeria annually [8].

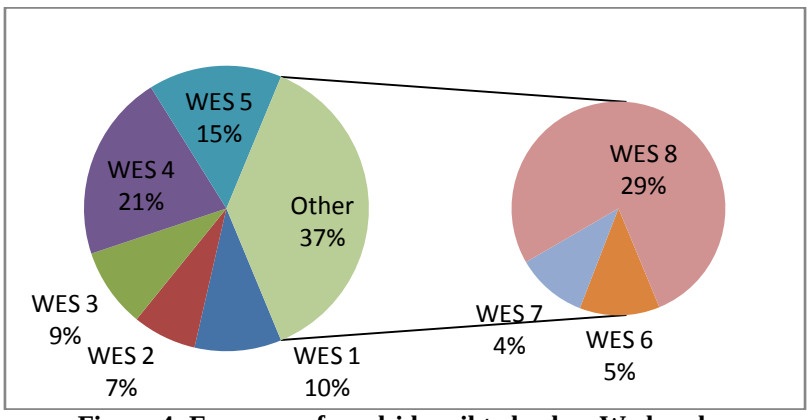

Figure 4: Exposure of roadside soil to lead on Wednesday

The exposure of the roadside top soil on thursday is as shown in Figure 5. The highest lead level was obtained in THS 2 (68.1 mg/kg) and accounts for 27% of the total lead experienced on thursday followed by THS 3 (65.9 mg/kg) which accounted for 26% of lead on thursday.

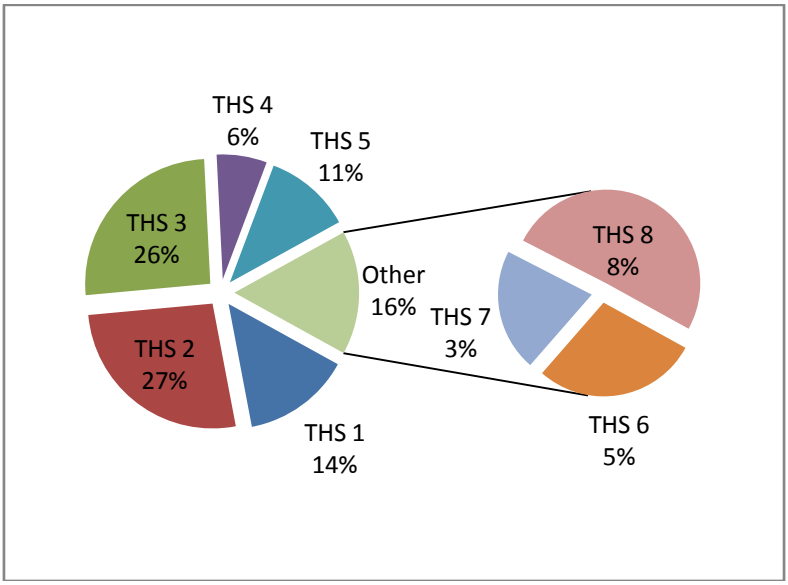

Figure 5: Exposure of roadside soil to lead on Thursday

The two points signify that most workers in the state are fully in town and the exhausts from their cars can lead to lead level in soil. These two points are towards residential houses of these workers and other people residing in the town of Osogbo and one will expect more lead deposition as they drive to their various offices and back to their various destinations. It could also be attributed to the deposition by runoff water carrying soil particles containing lead which get deposited in the soil at this point.

Figure 6 showed the highest lead concentration to be at FRS 2 (40.6 mg/kg) and accounts for 22% of the daily lead level for Friday. It would be noticed that the level of lead was also high for FRS 1 (30.2 mg/kg) and accounts for 16% of the daily lead exposure to topsoil. The level of lead in soil here shows that these two areas

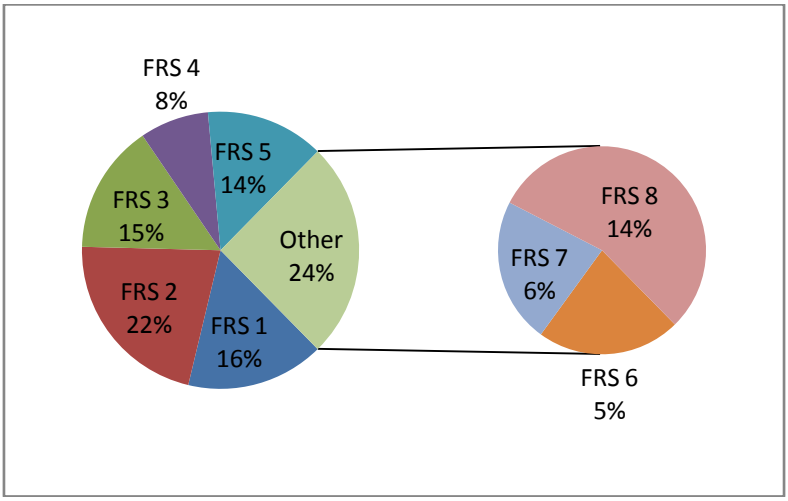

Figure 6: Exposure of roadside soil to lead on Friday

Are always exposed to lead compared to other locations used in the study. Apart from vehicle exhausts which contribute to lead contaminant in the soil, the soil around Olaiya roundabout could also be exposed to lead as a result of the railway crossing at FRS 2/FRS 8 and also the petrol station at FRS 3. The reason could also be due to aerial deposition on soil as a result of wind.

The level of lead in soil on saturday is illustrated in Figure 7. The highest lead concentration was obtained in SAS 1 (40.1 mg/kg) and contributes about 22% of lead. This area is around the popular Alekuwodo market. This could be due to the number of buyers that visited the

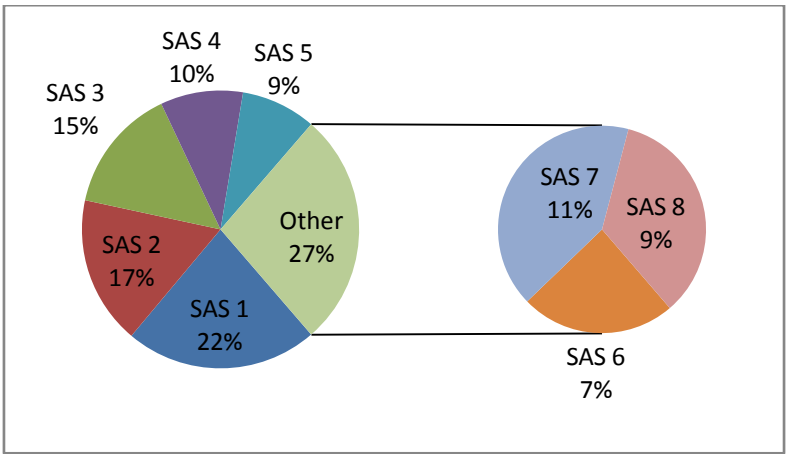

Figure 7: Exposure of roadside soil to lead on Saturday

Market on saturday, since they don't have the chance of visiting the market on working days. It could also be attributed to runoff from polluting sources. There is also a supermarket along this side of the market that makes use of a generator. The exhaust from this supermarket can add to soil lead level. This explanation could also be used to explain the phenomenon observed on sunday as in Figure8.

The level of lead in this sampling site is as a result of automobile exhausts from cars passing through the market which get deposited on the soil. It could also be due to some geological background of the soil and the deposition of soil from other contaminated areas during runoff when it rains.

The level of lead in this study was compared to lead level in some other countries as shown in Table 1. Comparison of the average value of lead in this study with other places as shown in Table 1 reveals that lead concentration for all locations in the study area was still low, but needs monitoring.

The dietary exposure that results in blood levels of concern has been estimated to be 60 micrograms of lead per day for children less than 6 years. Given a soil level of 100 ppm (100 µg/g) eating approximately two teaspoons

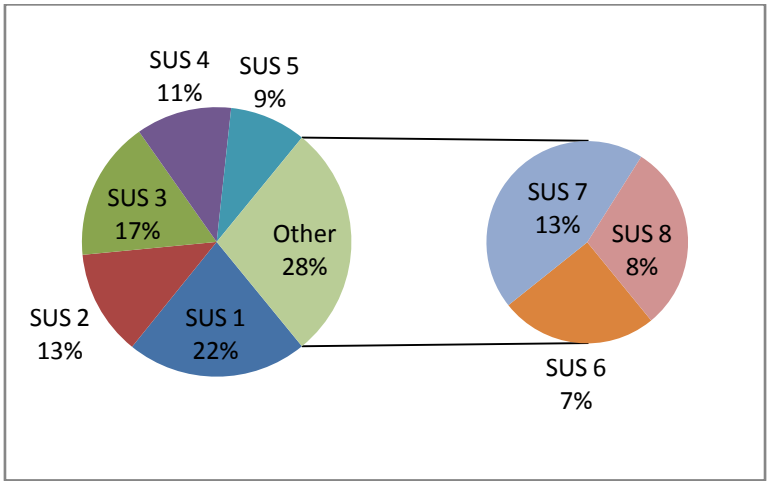

Figure 8: Exposure of roadside soil to lead on Sunday

Table 1: Soil quality criteria for some countries compared to levels obtained in this study (mg/kg)

Country	Pb	Reference
Netherlands (action level)	**530**	**[9]**
Netherlands (further investigation)	**310**	**[9]**
Canada (residential)	**140**	**[10]**
Canada (commercial)	**260**	**[10]**
Nigeria (Motor parks)	**266±330**	**[1]**
Nigeria (Olaiya junction)	**28.8±18.9**	**This study**

Of the soil per week be required to give the same amount of lead (Pb) found in diet that can cause elevated blood levels of concern. This calculation is based on the assumption that half of the lead in soil eaten

by children is absorbed. For a soil that has a lead level of 300 ppm, eating about three quarters of a teaspoon per week could cause elevated blood levels of concern [11]. One way analysis of variance showed that there was no significant difference in the means of lead obtained for the days of the week. Table 2 illustrates the Pearson matrix and showed positive correlations for TUS/WES (r = +0.84), MOS/THS (r = +0.77), MOS/FRS (r =+0.74),

Table 2: Pearson matrix for daily lead exposure in topsoil

	MOS	TUS	WES	THS	FRS	SAS	SUS
MOS	**1.00**						
TUS	**0.54**	**1.00**					
WES	**0.10**	**0.84**	**1.00**				
THS	**0.77**	**0.12**	**- 0.20**	**1.00**			
FRS	**0.74**	**0.39**	**0.10**	**0.85**	**1.00**		
SAS	**0.58**	**0.14**	**-.027**	**0.60**	**0.66**	**1.00**	
SUS	**0.47**	**0.04**	**- 0.28**	**0.46**	**0.41**	**0.91**	**1.00**

THS/FRS (r = +0.85) and SAS/SUS (r = +0.91). This implies that the contamination of lead in the topsoil for these locations is from the same polluting sources.

The findings from this study will help to bring awareness to some market women and customers patronizing this market to some of the hazards they are likely to come across in terms of lead pollution. An advice for the government is to site markets at places free of heavy metal pollution by creating a park for car users to reduce pollution from this source.

IV. CONCLUSION AND RECOMMENDATION

The study showed that lead at roadside topsoil was most significantly contaminated on tuesday and wednesday along the route to the government secretariat. The disposal of waste along these route containing lead, lead from railway, pollution due to runoff as a result of rain and exhausts from generating sets are suspected to be major sources of lead contamination of topsoil in all these days studied, in addition to that derived from motor vehicular exhaust. The market is of major concern because people buy foodstuffs from here and this metal can get deposited on some or all of the food items sold here which is dangerous to human health. The adverse effect of this could be chronic or acute.

Recommendation made include:

1. The marketers around this study site should be educated on the effect of this metal on their health and to the health of buyers patronizing this market.
2. The river beside this market should be investigated for its lead level.
3. Blood lead level of marketers should be analysed to know the level of this metal in their blood stream so as to give advice on the risk of exposure.

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