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Heavy Metal Concentrations in Road Side Soils from Selected Locations in the Lagos Metropolis, Nigeria

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ABSTRACT

Assessing the concentration of potentially harmful heavy metals in road side soils in Lagos metropolis is imperative in order to evaluate the potential risks to people and the environment. This is due to rapid increase in the use of vehicles for day to day transportation coupled with lack of emission standards which has raised serious concern about vehicular pollution. This paper reports the results of the investigation of heavy metal concentration in road side soils of selected areas in Lagos metropolis as a result of vehicular pollution. Locations considered were motor parks, garages and roadsides in Alimosho-, Agege-, Ikeja-, and Oshodi/Isolo-LGA of Lagos State. Seven locations that spans across the four local governments were selected on the basis of their high concentration of vehicular traffic. Three sites with low traffic concentration were also selected outside the seven locations to act as control sites. Soil samples were collected at each location for a period of three months in the dry season. The concentrations of six heavy metals (manganese, nickel, lead, chromium, zinc, and iron) in the samples were determined with an atomic absorption spectrometer (AAS). All the monitored heavy metal pollutants where compared with European Union (EU) regulatory standard. Results show that the concentrations of heavy metals in the soil samples from the seven locations were within safe limits though higher than in the control sites. It is evident that as time goes on, these heavy metals may pose health hazards. The study reveals that vehicular-related pollution in Lagos metropolis is indeed significant with possible severe health consequences.

Keywords: *Vehicular pollution, Lagos, heavy metals, AAS, EU standard, Health Hazards*

1. INTRODUCTION

In recent years, advancement in technology has led to high levels of industrialization leading to the discharge of effluents and emissions containing heavy metals into the environment. Sources of heavy metals in soils in urbanized areas mainly include natural occurrence derived from parent materials and human activities which are associated with activities such as atmospheric deposition, industrial discharges, waste disposal, waste incineration, urban effluent, long-term application of sewage sludge, fertilizer application in soil, and vehicle exhausts (Bilos et al., 2001; Hlavay et al., 2001; Koch and Rotard, 2001). Soil has long been recognized as a repository for pollutants due to the adsorption processes which binds inorganic and organic pollutants to it (Popoola et al., 2012). It has been reported that topsoil and roadside soil near heavy traffic in urban areas are indicators of heavy metal contamination from atmospheric deposition (Arowolo et al., 2000; Xiangdong et al., 2001). Metals such as Cd, Cu, Pd and Zn are good indicators of contamination in soils because they appear in gasoline, car component, oil lubricants and industrial incinerator emissions (Popoola et al., 2012).

It has been estimated that over 600 million people globally are exposed to hazardous level of vehicular pollution which remains a threat to environmental health problem and is expected to increase reasonably as vehicle ownership increases in the world (Cacciola et al., 2002) in Han and Naeher (2006). In many cities in the developing world, lack of access to land make many places to be converted to garages, parks, including places such as road verges, and any other spot that motorist could occupy. All setbacks along major highways are occupied by motorist and the alarming rate at which this is going is unprecedented. Emissions from the heavy traffic on these roads contain lead (Pb), cadmium (Cd), zinc (Zn), and nickel (Ni), which are present in fuel as anti-knock agents and have also led to the contamination of air and soils. Excessive accumulation of heavy metal on land through traffic emission and subsequently finding its way into the soil may results in elevating heavy metal contamination and thus pose health hazards to people.

Vehicular pollution in most developing countries of the world has not been checked properly by environmental regulating authorities leading to increase levels of pollution. This situation is alarming and is predicated on the poor economic disposition of developing countries, poor vehicle maintenance culture and importation of old vehicles which culminate to an automobile fleet dominated by a class of vehicles with high emission of harmful pollutants (Brunekeef, 2005; Abam and Unachukwu, 2009). In Nigeria, for instance, the State Environmental Protection Agency (SEPA) and the

Federal Environmental Protection Agency (FEPA), now the National Environmental Standards and Regulations Enforcement Agency (NESREA) are charged with the responsibility of enforcing environmental laws, regulations and standards in order to deter people, industries and organizations from polluting and degrading the environment. However, these responsibilities were restricted to the control of air, water, and noise pollution, waste disposal and oil spillage. No consideration was given to soil pollution, especially the major threats to environmental health (Olukanni and Adebiyi, 2012).

Despite the change in petrol specification by the Standards Organization of Nigeria (SON) on zero lead and the input of the Department of Petroleum Resources (DPR) to ensure that all petrol coming into Nigeria to be unleaded since June 2002, the situation of increased pollution from mobile transportation source is on the increase in per capital vehicle ownership. The increase in vehicle ownership has resulted in high congestion on Nigerian roads with consequent increase in the concentration of pollutants in the air and soil, thereby increasing health risk on human population. Human exposure to these pollutants due to traffic is believed to have constituted severe health problems especially in urban areas where pollution levels are on the increase (Han and Naeher, 2006). Presently, there is neither a legislative framework nor a set standard in the State to monitor emission from mobile sources. Although Ministry of Transport is working with the Ministry of Environment to set guidelines on vehicular emissions, but this has not come to fruition. As a consequent of various observations, different arms of the government environmental controlling agencies are interested in the effects of vehicular emissions on the soil and on the environment as a whole. The objective of this paper is to investigate the level of heavy metal concentration in road side soils of selected areas in Lagos metropolis as a result of vehicular pollution. It is believed that the knowledge from this investigation would assist authority in planning adequate pollution control measures. It is equally hoped that the study would generate interest on further research on the impact of vehicle emission quality and health implications particularly in Lagos and Nigeria in general for effective guidelines on vehicular emissions and traffic management.

1.1 Contributing Factors of Vehicular Pollution

Among the numerous factors that influence the vehicular emissions includes, traffic-, roadway, vehicle-factor etc. Each of these factors significantly affects the pollution levels.

1.1.1 Traffic Factor

Traffic factor such as traffic volume, traffic composition, average speed of the flow etc. come under this category. As the traffic volume increases the amount of total pollutants will be increased. Traffic composition also contributes significantly to the pollution levels because emission rate varies for different types of vehicle (Nirjar et al, 2002). Hence, the same amount of traffic volume with different vehicular composition produces different amounts of pollutants. Speed limits also affect the amount of pollution because faster drive consequently increases fuel burning. Therefore, introducing lower speed limits on motorways is expected to cut both fuel consumption and pollutant emissions (EEA, 2011).

1.1.2 Roadway Factor

Roadway factor affecting the pollution levels are carriageway width, lateral clearance, medians, and shoulder width etc. As the road width increases, the maneuverability to movement of the vehicles will be increased, which results in the reduction of pollutants. Medians reduce the obstruction caused by the opposing vehicles, which results in the reduction of number of accelerations and decelerations. So the fuel consumption will be minimized thus reducing the emission levels (Nirjar et al, 2002).

1.1.3 Vehicle Factor

The age of the vehicle, its condition and servicing frequency, type of engine (2- stroke, 4- stroke), and vehicle miles traveled come under this category. The older vehicles will emit more pollutant than a newer one, if they are not maintained properly. Vehicles with 4-stroke engine would produce lesser emissions than 2-stroke engine. Similarly, vehicles with catalytic converter will emit less pollutant (Nirjar et al, 2002). Most of the by-products of automobiles comprise of different fraction particles. These fractions include the ultrafine particles which are formed in the engines and tailpipes, fine particles produced mainly by chemical reactions, and coarse particles which are formed mechanically by the abrasion of road materials, tyres and brake linings (Palmgren et al., 2003, Olukanni and Adebiyi, 2012).

2. MATERIALS AND METHODS

2.1 Study Area

Figure 1 shows the map of Lagos State with the Local Governments where samples were taken while Figure 2 shows the traffic congestion in some of the study area. State lies between the sedimentary belt of South-Western Nigeria on longitude 20^{o} 42' E and 3^{o} 22' E and between latitude 60^{o} 22' N and 60^{o} 22' N. The metropolis has an estimated landmass of 3577 km^2 (22% of which consist of lagoon and creeks), inhabited by about 80% of the population of Lagos State making it the most urbanized state in Nigeria and regarded as a megacity (Mabogunje, 2002). Lagos is a major industrial and commercial hub in

Nigeria with a population density of 2,578 person/Km^2 which is responsible for about 70% of the nations industries and commercial activities. About 40% of all new vehicle registration in Nigeria is also in Lagos accounting for about 40% of the total national fuel consumption (Baumbach et al., 1995). The average temperature in Lagos is 27 °C and the annual average rainfall 1532 mm (Aina, 1994; Peil, 1991).

Figure 1 Map of Lagos State showing the local government areas

Table 1 shows the seven sampling locations that were identified as a case study for this project to show the level of heavy metal contamination in soils in the Lagos Metropolis. A common characteristic of these areas is the presence of heavy flow of transportation. The samples were collected from seven locations. Other locations within the local government areas which are characterized by low traffic densities were used as the control sites. The location labeled C1 (Fig. 1) was the control for sites A2, B1 and B2; the location labeled C2 was the control for sites D1 and D2; while the location labeled C3 was the control for the sites E1 and E2. These locations are sparsely populated and basically residential with no industrial activity taking place.

Table 1. Sampling locations in 4 Local Governments

S/No	LGA	Main Sample Location	Designation	Control sample location
1	Agege	Agege motor park	A2	Residential Area (C1)
2	Alimosho	Iyana Ipaja garage	B1	
		Abule-egba motor park	B2	
3	Oshodi/Isolo	Oshodi park	D1	
		Jakande Estate	D2	Residential Area (C2)
4	Ikeja	Ikeja Park	E1	
		Oba-Akran Road	E2	Residential Area (C3)

2 a 2 b

Figure 2 View of vehicular congestion releasing pollutants in the Lagos metropolis

2.2 Samples and Sampling Locations

A sample each was collected in each of the seven selected locations monthly over a period of 3 months (December - February) and one sample each were taken from each of the control sites making it a total of 24 samples. Areas with obvious signs of disturbance, such as animal burrowing, engine oil spillage and landfills, were avoided. Sampling spots were cleared of debris before actual sampling started (Chimuka et al., 2005; Mmolawa et al., 2011). 500 g of composite soil samples were collected within a distance of 0-5 meters from the edge of the main road at each location. All soils collected were sampled at the surface (0 to 10 cm in depth) using a hand-driven stainless steel auger. The soil samples were kept in labeled polythene bags and taken to the laboratory for analysis (Awofolu, 2005; Mmolawa et al., 2011; Olukanni and Adebiyi, 2012).

2.3 Methods of Laboratory Analysis

The data used in this assessment were obtained by analyzing the soil samples with a Perkin Elmer 3300 atomic absorption spectrometer. The size of each large clod was first reduced and the sample was spread on a tray in a layer not thicker than 15 mm. Thereafter, the various samples were placed in a drying oven at a temperature of 40°C. They were left in the oven for 24 hours to remove the moisture in the samples. Each oven-dried sample was crushed into particles and passed through a 2 mm sieve (EPA method 3052) (USEPA, 1995). However, before crushing commenced, stones, fragments of glass and other noticeable impurities were removed by hand. 1g of each soil sample was accurately weighed and treated with 10 ml of high purity of concentrated HNO_3. The mixture was placed on a hot plate until it became dry. It was then cooled. This procedure was repeated with another 10 ml aliquot of concentrated HNO_3 followed by 10 ml of 2 M HCl. Each digested soil sample was then warmed in 20 ml of 2 M HCl to redissolve the metal salts. The extract was filtered with filter papers and the volume was then adjusted to 25 ml with double distilled water. The concentrations of manganese, nickel, lead, chromium, zinc, and iron in each sample were determined on a Perkin Elmer 3300 Atomic Absorption Spectrometer equipped with AA Winlab software.

3. RESULTS AND DISCUSSION

Table 2 shows the concentrations of heavy metals (manganese, nickel, lead, chromium, zinc and iron) in the soil samples at various locations with their controls while Table 3 shows comparisons of the results of this study with results from other studies and the European Union regulatory standards. The heavy metal contents in the soils varied significantly from location to location. Mn content in soils ranged from 3.72- 953.52 mg/kg, Ni ranged from 0.94-42.73 mg/kg, Pb ranged from 5.57-69.20 mg/kg, Cr ranged from 1.58-347 mg/kg, Zn ranged from 25.87-198.32 mg/kg and Fe ranged from 403 – 1528.30 mg/kg.

Table 2 Variation in concentration of heavy metals in the study area

Location	Month	Mn (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Zn (mg/kg)	Fe (mg/kg)
A2	DEC	651.80	10.24	69.20	26.53	69.80	1133.54
	JAN	38.79	33.75	23.08	347.19	105.56	1333.10
	FEB	45.98	24.91	25.84	285.61	120.57	701.57
	Control C1	16.94	20.62	17.69	58.20	45.36	744.20
B1	DEC	57.20	3.29	11.26	11.56	87.72	247.62
	JAN	36.48	40.59	30.77	234.10	117.60	1404.80
	FEB	30.69	42.73	31.23	275.06	108.86	1528.30
	Control C1	16.94	20.62	17.69	58.20	45.36	744.20
B2	DEC	953.52	22.74	44.83	58.22	74.66	952.51
	JAN	5.82	0.94	15.38	32.88	45.37	561.30
	FEB	7.11	2.48	9.41	34.99	60.92	271.85
	Control C1	16.94	20.62	17.69	58.20	45.36	744.20
D1	DEC	51.30	4.55	17.05	14.05	65.28	236.14
	JAN	66.51	23.66	36.20	295.44	84.26	1230.90
	FEB	60.80	25.89	41.63	311.20	83.45	976.93
	Control C2	5.51	32.77	8.54	1.58	56.24	661.50
D2	DEC	61.27	5.85	79.21	15.24	32.60	359.66
	JAN	4.99	1.31	5.57	18.34	41.66	290.40
	FEB	7.74	2.65	5.96	23.44	48.31	403.74
	Control C2	5.51	32.77	8.54	1.58	56.24	661.50
E1	DEC	113.50	9.04	52.03	14.01	128.94	666.37
	JAN	74.16	42.61	23.91	247.96	126.85	1152.90
	FEB	75.15	40.37	25.32	186.73	155.04	116.26
	Control C3	3.72	8.93	10.24	3.66	25.87	378.35
E2	DEC	130.41	6.87	28.51	8.31	201.70	1108.34
	JAN	65.07	37.62	30.92	12.90	176.60	1245.60
	FEB	63.26	36.47	37.61	10.89	198.32	1076.87
	Control C3	3.72	8.93	10.24	3.66	25.87	378.35
	EU Standard	1500	50.0	90-300	100	300	1500

In this study, the levels of Mn, Ni, Pb and Cr concentrations were lower than European Commission (EC) limit of 1500 mg/kg, 50 mg/kg, 300 mg/kg and 100 mg/kg respectively (EC, 1986) and were at lower concentrations than the maximum tolerable levels proposed for agricultural soils, (Kabata-Pendias and Dudka, 1984). The levels of manganese in soils were relatively low. The highest level of manganese obtained was higher than 408 mg/kg reported by Ho and Tai (1988). Soil generally contains 200 – 3000 mg/kg of manganese with an average value of 600 mg/kg (Lindsay and Norvell, 1979). The concentration of manganese obtained in this study is lower compared to results of other studies in Nigeria except for locations A2 (651.80 mg/kg) and B2 (953.52 mg/kg) in the month of December which are higher than the concentration recorded for those conducted in Yauri (608.11 mg/kg) and Kaduna (132 mg/kg) (Yahaya et al., 2009; Okunola et al., 2007). This high concentration might be connected to high traffic within the period when many people travel for end of year festivities since both are motor parks. When the highest manganese concentration obtained from this study was compared with the levels in similar studies elsewhere, the concentration of manganese obtained is lower than the concentration recorded from those conducted in the United States (2532 mg/kg), China (1740 mg/kg), and Poland (1122 mg/kg) (Abida et al., 2009; Bradford et al., 1996; Dudka, 1992). Mn and Ni are associated with traffic related sources such as corrosion of metallic part, concrete materials, reentrained dust from roads and tear and wear of tyres and engine parts (Fergusson and Kim, 1991).

Table 3 comparing the values of this experiment with values of other studies

Metals	This study	[a] Study in USA	[b] Study in China	[c] Study in Poland	[d] Study in India	[e] Study in Ethiopia	[f] EU Reg. Standard
Mn	3.72- 953.52	43-2532	134-1740	83-1122	NA	NA	1500
Ni	0.94 - 42.73	2.44-69.4	7.73-70.9	2.0-27.0	343-1409	47.3 - 200.6	50.0
Pb	5.57 - 69.20	4.62-55.4	9.95-56.0	7.1-50.1	ND-623.95	20.3 - 325.4	90-300
Cr	1.58 - 347	6.59 - 208	19.3 -150	3.7 - 75.3	ND - 145.45	86.3 - 15790	100
Zn	25.87-198.32	12.6 -183	28.5 -161	10.5 – 1547	ND	140.9 - 302.8	NA
Fe	403 – 1528.30	NA	NA	NA	676 –16234	NA	NA

Source: A = Shacklette and Boerngen (1984), b = Bradford et al. (1996), c = Dudka (1992), d = Abida et al. (2009), e = Melaku et al. (2005), f = (EC, 1986); Yahaya et al., (2010). ND = not detected, NA = not available.

The highest concentration of nickel (42.73 mg/kg) obtained from this study is lower than the highest concentration recorded for Yauri (107.13 mg/kg) (Yahaya et al., 2009) but was higher than the concentration recorded in Iwo (7.55 mg/kg) (Ayodele and Dawodu, 2002). When the concentration obtained from this study were compared with the levels in similar studies elsewhere, the lowest concentration of nickel (0.94 mg/kg) obtained is lower than the least concentration recorded for those conducted in the United States (2.44 mg/kg), China (7.73 mg/kg), Poland (2.0 mg/kg), Ethiopia (47.3 mg/kg) and India (343 mg/kg) (Shacklette and Boerngen, 1984; Dudka, 1992; Bradford et al., 1996); Melaku et al., 2005; Abida et al., 2009) respectively. The highest concentration of nickel (42.73 mg/kg) obtained in this study is lower than the highest concentration recorded for those conducted in the United States (69.4 mg/kg), China (70.9 mg/kg), Ethiopia (200.6 mg/kg) and India (1409 mg/kg) except for Poland where the highest concentration recorded was 27.0 mg/kg (Dudka, 1992; Bradford et al., 1996; Melaku et al., 2005; Abida et al., 2009). Natural concentration of Nickel in soil is less than 100mg/kg, though it can be exceptionally high in some cases especially the soil formed from ultra-basic rocks (Allen et al., 1974). Diseases related to high level of heavy metal in the system include lung tissue damage, respiratory illness, liver and kidney failure and others (Popescu, 2011).

Pb concentrations from the seven locations ranging from 5.57-69.20 mg/kg are lower than the limit of 90 – 300 mg/kg recommended by EU standard. The range of Pb concentrations in all the soil samples in this study is also lower than what is obtained in some studies carried out in India and Ethiopia. The results of lead concentrations in soils of old industrial cities like Uppsala (in northern Europe) have the mean Pb level in playground soil to be 26 mg/kg (Ljung et al., 2006) while cities such as Hong Kong which have their mean Pb level in playground soils to be 77.3 mg/kg (Sai et al., 2002) in (Popoola et al., 2012). These levels may reflect the long history of industrial contamination coupled with traffic emissions because Pb in gasoline has been phased out in most of these countries (Popoola et al., 2012). The mean concentration obtained in this present study is higher than the range of 30-50 mg/kg reported by Nriagu (1992) as the typical concentration of lead in urban soils of African cities which gives cause for concern. However, the sources of Pb in the urban areas could be more from metal plating and lubricating oils. It could also be due to rough surfaces of the roads which increase the wearing of tyres, and run-offs from the roadsides (Hewitt and Rashed, 1988). It was revealed by Atuanya and Oseghe (2006) that higher lead concentration in soils has toxic effect on microorganisms inhabiting the soil which consequently alters the flora and fauna of a location. lead has been found to be the major cause of hypertension, impairment of central nervous system and other respiratory problems in adult (Olade, 1987).

The upper limit Cr in this study (347 mg/kg) is higher than the limit of 100 mg/kg recommended by EU while the least concentration of chromium (1.58 mg/kg) was lower compared to the studies in USA which had (6.59mg/kg), China (19.3 mg/kg), Poland (3.7mg/kg) and Ethiopia (86.3mg/kg) respectively (Dudka, 1992; Bradford et al., 1996; Melaku et al., 2005; Abida et al., 2009; Yahaya et al., 2010). The highest value for chromium was higher than other studies as shown in Table 3. The months of January and February are the peak period for the concentration of Cr in all the locations except for location B2. These might be connected to high level of industrial activities in those areas couple with their population densities. Source of chromium emissions into soils are automobile brake lining, catalytic converters and chrome pigment for automobiles. Trace amount of metal such as trivalent chromium entering the body through various routes is capable of inducing genetic and epigenetic alteration in different cancer related genes of somatic and stem cells, thus involving in cancer stem cell formation and increasing the incidence of cancer (Popoola et al., 2012).

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The concentration of Zn ranged from 25.87 mg/kg – 198.32 mg/kg in all the locations. In this study, the levels of zinc in soils were relatively high. The upper limit concentration of zinc obtained from this study, when compared with those conducted in the United States (183 mg/kg), China (161 mg/kg), and Poland (154.7 mg/kg) is relatively higher (Melaku et al., 2005; Abida et al., 2009; Yahaya et al., 2010). The prevalence of Zn, though the least toxic among all heavy metals (Ladipo and Doherty, 2011) in the study area is indicative of the significance of zinc in the ecosystems. Concentration of metals in soil vary in dry season and wet season due to the run off effect that is capable of removing high metals from the road side soil and the effect of rain may also facilitate the leaching of the soil and contributes to the dilution of the soil solution (Yahaya et al, 2009). Zn is a good indicator of contamination in soils because it appears in gasoline, car component, oil lubricants and industrial incinerator emissions.

The concentration of Fe for this study ranging from 403 mg/kg – 1528.30 mg/kg is lower than what was obtained in a related study in India. The concentration for USA, China, Poland and Ethiopia were not available. Fe has been found to occur at high concentrations in Nigeria soil (Adefemi et al., 2007). The high concentrations of these metals in the soil samples may also be due to the natural lithogenic and pedogenic processes (Woolhouse, 1983), as well as anthropogenic factors which result in environmental pollution (Knezevic et al., 2009). The concentrations of iron are significantly higher in relation to other elements. Vanmechelen et al. (1997) state that iron in the mineral of soil layers varies within a wide range of 100 to 100,000 mg/kg. Knezevic et al. (2009) noted that iron concentration in the mineral of forest soils layer in Serbia amounts to a minimum value of 10,442 mg/kg, and a maximum value of 80 mg/kg. The recorded iron concentration values in the soil in this study may be considered as "regular".

Various studies have shown that heavy metals such as Pb, Cd, Ni, amongst others are responsible for certain diseases that have lethal effects on man and animals, and due to their accumulation and long time retention by plants and animals, these metals are very dangerous (Popescu, 2011). Therefore, to reduce metal concentration of food chain and ecosystem from vehicular emissions, an appropriate land use policy which prohibits the use of road side lands, especially within 30 m either side of the road, for farming, sun-drying of food stuff, grazing or as a source of pasture to feed livestock is required (Amusan et al., 2003).

4. CONCLUSION

Physiochemical properties and levels of heavy metals- Mn, Ni, Pb, Cr, Zn, and Fe in road side soils in some selected locations in Lagos Metropolis and their potential effects on human were determine in this study. Heavy metal concentrations in road side soil samples are mostly higher than those in the soil for control due to metals emitted from vehicle exhaust and other sources. The analytical results indicated that most of the heavy metals were above the natural heavy metals concentration of surface soil and can accumulate to constitute health hazards. The results shows that iron had the highest concentration in the soil for each month and can be represented in the following order: for site A2; Fe > Mn > Cr > Zn >Pb > Ni, For Site B1; Fe > Cr > Zn > Mn >Ni > Pb, For Site B2; Fe > Mn > Pb > Zn > Cr > Ni, For Site D1; Fe > Cr > Zn > Mn >Pb > Ni, For Site D2; Fe > Zn > Pb > Zn >Cr > Ni, For Site E1; Fe > Cr > Zn > Mn >Pb > Ni and Site E2; Fe > Zn > Mn > Pb >Ni > Cr. The concentration of all the heavy metals in the seven locations was below that of the European Union regulatory standard.

5. RECOMMENDATIONS

There should be extensive awareness campaign on the need for enhanced fuel quality and the emplacement of emission standards to reduce the impact of vehicle emissions. It is also imperative that a technical committee should be established to develop emission standards for Nigeria and should be well implemented. The government should come up with vehicle inspection and maintenance facilities in order to ensure the roadworthiness of vehicles and impound vehicles that violate emission standards in the country.

REFERENCES

[1] Abam F. I. and Unachukwu G. O. (2009), “Vehicular emissions and air quality standards in Nigeria” European Journal of Scientific Research, Vol. 34, No.4, pp. 550-560

[2] Amusan A. A., Bada S. B. and Salami A. T. (2003). “Effect of Traffic Density on Heavy Metal Content of Soil and Vegetation along Roadsides in Osun State”. West African Journal of Applied Ecology, Vol. 4.

[3] Abida B., Ramaih M., Harikrishma I. K. and Veena K. (2009), “Analysis of heavy metals concentrations in soils and litchens from various localities of Hosur road, Bangalore, India”. EJournal of Chemistry, 2009, Vol. 1, pp. 13-22.

[4] Adefemi O.S., Olaofe, D and Asaolu, S. S. (2007), “Seasonal variation in heavy metal distribution in the sediment of major dams in Ekiti-State”. Pakistan J. Nutrition, Vol. 6, No. 6, pp. 705-707.

[5] Aina T. A., Etta F. E. and Obi C. I. (1994). “The search for sustainable urban development in Metropolitan Lagos, Nigeria: Prospects and

problems". Third World Planning Review, Vol.16, pp. 201-219.

[6] Allen S. E., Grinshaw H. M., Parkinson J. A and Quarmby C. (1974). "Chemical analysis of ecological Materials". Blackwell Scientific Publications, Oxford. 565 p.

[7] Atuanya E. I., Obuekwe C.O. and Ehigie S. O. (1999). "Microbial studies and lead tolerance levels of microbes in lead accumulator dumps". Jour. Env. Sci. and Health, Vol. 2, No. 1, pp. 8 – 13.

[8] Arowolo T.A., Bamgbose O. and Odukoya O. O. (2000). "The chemical forms of lead in roadside dust of metropolitan Lagos, Nigeria". Global J. Pure Appl. Sci., Vol. 6, No. 3, pp. 483-487.

[9] Atuanya E. I. and Oseghe E.O. (2006). "Lead Contamination and Microbial Lead Tolerance in Soils at Major Road Junctions in Benin City". J. Appl. Sci. Environ. Mgt. Vol. 10, No. 2, pp 99 – 104.

[10] Awofolu O. R. (2005). "A survey of Trace metals in vegetation, soil and lower animals along some selected major and Roads in metropolitan city of Lagos". Environmental monitoring and Assessment. Vol. 105, pp. 431-447.

[11] Ayodele R. I. and Dawodu M. (2008). "Heavy metals contamination of topsoil and dispersion in the vicinities of reclaimed auto-repair workshops in Iwo, Nigeria". Bull. Chem. Soc. Ethiop. Vol. 22, No. 3, pp. 339-348.

[12] Baumbach G., Vogt U., Hein K. R., Oluwole A. F., Ogunsola O. J., Olaniyi H. B. and Akeredolu F. A. (1995). "Air pollution in a large tropical city with a high traffic density – results of measurements in Lagos, Nigeria". The Science of the Total Environment. Vol. 169, pp. 25-31.

[13] Bilos C., Colombo J. C., Skorupka C. N., Rodriguez P. M. (2001). "Sources, distribution and variability of airborne trace metals in La Plata City area, Argentina". Environmental Pollution. Vol. 111, pp. 149-58.

[14] Bradford G. R., Chang A. C. and Page A. L. (1996). "Background concentrations of trace and major elements in California soils". Kearney Foundation Special Report, University of California, Riverside, pp. 1–52.

[15] Brunekreef B. (2005). "Out of Africa, Occupation and Environmental Medicine". Vol. 62, pp. 351-352.

[16] Cacciola R. R., Sarva M. and Polosa R. (2002). "Adverse respiratory effects and allergic susceptibility in relation to particulate air pollution: flirting with disaster". Allergy Vol. 57, No. 28, pp. 1–6.

[17] Chimuka L., Mugwedi R., Moboladisoro B. H., Odiyo O. J. (2005). "Metals in environmental media: A study of trace and platinum group metals in Thohoyandou, South Africa". Water SA, Vol. 31, No. 4. Pp. 581-588.

[18] Dudka S. (1992). "Factor analysis of total element concentrations in surface soils of Poland". Sci. Total Environ, Vol. 121, pp. 39–52.

[19] European Environmental Agency (2011). "Do lower speed limits on motorways reduces fuel consumption and pollutant emissions?" http://www.eea.europa.eu/themes/transport/speed-limits Assessed on 16/08/2012.

[20] Fergusson J. E. and Kim N. D. (1991). "Trace elements in street and house dusts: sources and speciation". Sci. Total Environ. Vol. 100, pp. 125–150.

[21] Han X. and Naeher L. P. (2006). "A review of traffic-related air pollution exposure assessment studies in the developing world". Environment International, Vol. 32, pp. 106 – 120

[22] Hewitt C. N. and Rashed M. (1988). Proc. Int. Conf. Chemicals in the Environment.

[23] Hlavay J., Polyak K., Weisz M. (2001). "Monitoring of the natural environment by chemical speciation of elements in aerosol and sediment samples". Journal of Environmental Monitoring Vol. 3, pp. 74-80.

[24] Ho I. B. and Tai K. M. (1988). "Elevated levels of lead and other Metals in Roadside Soil and Grass and their use to monitor Aerial metal Depositions in Hong Kong. Environ Pollut. Vol. 49, pp. 37-51.

[25] Kabata-Pendias, A. and Dudka, H. (1984). "Trace elements in Soils and Plants". CRC Press, Boca Raton, USA.

[26] Knezevic M., Stankovic D., Krstic B., Nikolic M. S. and Dragica V. (2009)." Concentrations of heavy metals in soil and leaves of plant species Paulownia elongate S.Y.Hu and Paulownia fortunei Hemsl". African Journal of Biotechnology Vol. 8, No. 20, pp. 5422-5429.

[27] Koch M. and Rotard W. (2001). "On the contribution of background sources to the heavy metal content of municipal sewage sludge". Water Science and Technology. Vol. 43, pp. 67-74.

[28] Ladipo M. K. and Doherty V. F. (2011). "Heavy metal levels in vegetables from selected markets in Lagos, Nigeria". African Journal of Food Science and Technology. Vol. 2, No. 1, pp. 18-21.

[29] Lindsay W. K. and Norvell W. A. (1979). "Development of a DTPA soils test for zinc, iron, manganese and copper". J. Soil Sci. Soc. Am., Vol. 42, pp. 421-428.

[30] Ljung K., Selinus O., Otabbong E. and Berglund M. (2006). "Metal and arsenic distribution in soil particle sizes relevant to soil ingestion by children". Appl. Geochem., Vol. 21, pp. 1613-1624.

[31] Mabogunje A. and Akin L. L. (2002). "Management in Nigeria: Issues, Opportunities and Threats", Paper presented at the National Conference on Land Management and Taxation, Department of Estate Management, University of Lagos.

[32] Melaku S., Wondimu T., Dams R. and Moens L. (2005). "Multi-element analysis of Tinishu Akaki River Sediment, Ethiopia, by ICP-MS after microwave assisted Digestion". Can. J. Anal. Sci. Spec. Vol. 50, pp. 1.

[33] Mmolawa K. B., Likuku A. S., Gaboutloeloe G. K. (2011). "Assessment of heavy metal pollution in soils along major road sides in Botswana". African Journal of Environmental Science and Technology. Vol. 5, No. 3, pp. 186-196.

[34] Niirjar R. S., Jain S. S. and Parida M. (2002). "Development of transport related air pollutants modeling for an urban area." Journal of Indian Road Congress, No. 487.

[35] Nriagu J. O. (1992). "Toxic metal pollution in Africa". Sci. Total Environ., Vol. 121, pp 1-37.

[36] Okunola O. J., Uzairu A., and Ndukwe G. (207). "Levels of trace metals in soil and vegetation along major and minor roads in metropolitan city of Kaduna, Nigeria", African journal of Biotechnology. Vol. 6, No. 14, pp. 1703-1709.

[37] Olade M. A. (1987). "Lead Mercury, Cadmium and Arsenic in the environment". Edited by T.C. Hutchinson and K.M. Meema. John Wiley and Sons Ltd. Chapter 20, pp. 335-341.

[38] Olukanni D. O. and Adebiyi S. A. (2012). "Assessment of vehicular pollution of road side soils in Ota Metropolis, Ogun State, Nigeria". IJCEE-IJENS, Vol. 12, No. 4, pp. 40-46.

[39] Palmgren F., Waahlin P., Kildesó J., Afshari A., and Fogh C. L. (2003). "Characterisation of particle emissions from the driving car fleet and the contribution to ambient and indoor particle concentrations". Phys. Chem. Earth. Vol.28, pp. 327-334.

[40] Peil M. (1991). "Lagos: The City Is the People". Belhaven Press, London.

[41] Popescu C. G. (2011). "Relation between vehicle traffic and heavy metals from the particulate matters". Romanian Reports in Physics. Vol. 63, No. 2, pp. 471-482.

[42] Popoola O. E., Bamgbose O., Okonkwo O. J., Arowolo T. A., Odukoya O. and Popoola A.O. (2012). "Heavy metals content in playground topsoil of some public primary schools in metropolitan Lagos, Nigeria". Research Journal of Environmental and Earth Sciences. Vol. 4, No. 4, pp. 434-439.

[43] Sai L. N., Lung S. C., Kin C. L. and Wing K. C. (2002). "Heavy metal contents and magnetic properties of playground dust in Hong Kong". Environ. Monit. Assess. Vol. 89, pp. 221-232.

[44] Shacklette H. T. and Boerngen J. G. (1984). "Element concentrations in soils and other surficial materials of the conterminous United States". U.S. Geological Survey Professional Paper. Vol. 1270, 105 p.

[45] U.S – Environmental Protection Agency. (1995). "Test Methods for evaluating solid waste". Vol. 1A: Laboratory manual physical/ chemical methods, SW 846, 3rd ed. U.S Gov. Print, Office, Washington D.C.

[46] Vanmechelen L., Groenemens R. and van Raust E. (1997). "Forest soil condition in Europe. Results of a large scale soil survey". Tehnical report. EC, UN/ECE,

[47] Woolhouse H. W. (1983). "Toxicity and tolerance in the response of plants to metals". In: Encyclopedia of Plant Phisiol, New Series, Vol. 12 C, Springer-Verlag, New York, Heidelberg, Berlin, pp. 246-289.

[48] Xiangdong L., Chi-Sun P. and Pui Sum L. (2001). "Heavy metal contamination of urban soils and street dusts in Hong Kong". Appl. Geochem. Vol. 16, pp. 1361-1368.

[49] Yahaya M. I., Ezeh G. C., Musa Y. F. and Mohammad S. Y. (2009). “Analysis of heavy metals concentration in road side soils in Yauri, Nigeria”. African Journal of Pure and Applied Chemistry. Vol. 4, No. 3, pp. 22-30.