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Environmental and Agronomic Implication of the Levels of Heavy Metals Contamination of the Soils along Enugu-Abakaliki Major Highway in Southeastern Nigeria

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ABSTRACT

Studies on levels of micronutrients and heavy metal concentration in soils provide vital information for best management options at all times. The study investigated levels of concentration of some heavy metals (Lead-Pb, Iron-Fe, Copper-Cu, Zinc-Zn and Manganese-Mn) on soils along Enugu-Abakaliki major express way in southeastern Nigeria in relation to the environmental and agronomic implication. Forty soil samples were collected at 0-40 cm depth from two environments (A and B). Results showed highly significant ($P<0.01$) mean lead (Pb) (16.37 mgkg^{-1}) on the soils of Environment A than B (9.5 mgkg^{-1}). Mean Pb in Ishieke I soil was significantly higher ($P<0.05$) than those of Boundary point II, Ezzamgbo II, and Ezzamgbo. Except Zn that was statistically similar, other metal mean values varied in concentration. Deficiency symptoms of macro- and micro-nutrients were observed on maize and tomato crops. Lime fertilizer was recommended. Continuous evaluation of soils for heavy metals should be an integral part of land use planning for long-term sustainability of farming systems and environmental stability.

Introduction

Oil boom and the favorable economic climate of the late seventies gave rise to the heavy construction of highways and major expressways as a way of enhancing infrastructural development in Nigeria. It is also worthy of mention that these expressways or highways connect major cities, state headquarters and traverse major food producing lands to which southeastern Nigeria is no exception.

There has been little study on the concentration levels of heavy metals on highway soils of Enugu and Ebonyi states, Nigeria. Studies elsewhere have shown that roadside soil became enriched with lead (Pb) and some other heavy metals emanating from vehicle emission (Turer and Maynard, 2003). Contaminated roadside soils may constitute a health hazard if the metals are transferred to other reservoirs or absorbed by plants (Ano *et al*, 2007). Studies of roadside soils in Manoa Basin of Oalu, Hawaii have shown that Cu, Pb and Zn are due to significant anthropogenic enrichments and that these potential soil pollutants can be washed into nearby water bodies, where they can form a major source for bioaccumulation (Sutherland and Tolosa, 2001).

Studies of heavy metals in ecosystem have indicated that many areas near urban complexes, metalliferious mines or major express road system contain anomalously high concentrations of heavy metal and trace elements (Alloway, 1995). Ojanuga *et al. (*1996) have shown that heavy metals are naturally present in soils but anthropogenic activities have resulted in high concentrations in Nigerian environment. Nriagu (1979) reported that soils could be polluted from a wide range of heavy metal sources. Apart from high density of cars and the resulting motor exhaust fumes, motor vehicle servicing centres popularly called 'mechanic villages' along urban and peri-urban highways could be major sources of automobile wastes laden with pollutants. In such locations, according to Onweremadu *et al.* (2007), fossil fuel products are used resulting to excess accumulation of various forms of heavy metals. These accumulations deteriorate nearby farms and cause non-point-source pollution.

According to Barret (1987), the scale and intensity of human impacts along urban and peri-urban ways due to continuing cycle of construction, use and re-use of structures leads to a higher rate of change. The physical and chemical environment is profoundly affected by every kind of human activity, from deliberate acts of construction, management or vandalism to accidental or incidental pollution. Craul (1985) pointed out that soils along urban and rural areas are frequently disturbed and subjected to mixing, filling and contamination with heavy metals, pesticides and herbicide residues. An attempt to produce an inventory of world-wide emissions from industrial and domestic sources suggest that soils are major sinks receiving large quantities of trace metals from a variety of industrial and general wastage of commercial products on land (Nriagu and Pacyna, 1988). It was estimated that if the total metal inputs were dispersed uniformy, annual rates of deposition would vary from 1g/ha for cadmium and antimony to about 50g/ha for lead, copper and chromium, and over 65g/ha for zinc and manganese.

Changes in the chemical nature of the soil brought about by addition of pollutants may present a hazard and toxicity to soil flora and fauna including cultivated crops, or may lead to the accumulation of toxic substances in vegetables making them unsuitable for human consumption. This is in tandem with

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earlier report by Ezeaku (2012). Flux of heavy metals between surface soils and dusts may influence exposure of the population and particularly young children to toxic substances and present a hazard to human health. However, different types of exposed land units are subjected to varying degrees of contamination depending on location, the past and present land use and the proximity to pollution (Xian, 1989).

Heavy metal concentration excess of critical limits could have agronomic and environmental implications and this could be a major source of concern to environmentalists and particularly farmers who put the roadside lands into intensive crop production as is the case in the study location. Incidentally, there is scarcity of information related to levels of contamination by heavy metals on soils along the urban-peri-urban-rural interface in Enugu and Ebonyi States of Nigeria. This study demonstrates a need to provide empirical depictions of relationships between heavy metals load on soils close and far away from expressways along Enugu-Abakaliki in southeastern Nigeria.

The major objective of this study was to determine the concentration levels of trace elements and heavy metal of roadside soils along Enugu-Abakaliki expressway in southeastern Nigeria in relation to the environmental and agronomic implication.

The expected output aims to fill gaps in knowledge, and especially to help relevant stakeholders in environmental and agricultural land use planning and sustainable land management to optimize soil productivity.

Materials and method

Site description

Enugu and Abakaliki is respective capital city of Enugu state and Ebonyi state in southeastern Nigeria. Both states lie within the transitional zone between humid and sub-humid tropical climate. The constructed Enugu-Abakaliki Expressway is one of the busiest highways in Southeastern Nigeria. It connects Enugu (capital of Enugu State) through Nkalagu (a town known for cement production) to Abakaliki (a highly agrarian area and a university town).

In both states, rainfall is fairly distributed throughout the year with minimum annual rainfall of 1800 mm and maximum of 2000 mm. Bi-modal pattern of rainfall is experienced between April and July as well as September and November with a break in August. At the beginning of rainfall it is violent and torrential lasting for 1 to 2 hours (Okonkwo and Ogu, 2002). The highest relative humidity is 80% and occurs in the rainy season, while the lowest (60%) is obtained in the dry season (ODNRI, 1989). The minimum temperature is $27^{O}C$ while the maximum temperature is $31^{O}C$, which is experienced during dry season. The dry season corresponds to the period of high evapotranspiration and high temperature regime (Ezeaku, 2006).

Geology and geomorphology

Geologically, the Abakaliki area is underlain by sedimentary rock derived from successive marine deposit from cretaceous and tertiary period and belongs to ASU river group, which consists of olive brown shales, fine-grained sand stones and mudstones. The land surface is more of flat plains. Enugu state soils are derived from sandy deposits of false bedded sandstone popularly called 'Acid sands'. A greater proportion of the land surface is undulating to undulating plains.

Soils/Vegetation and land use

The soil of Abakaliki belongs to the order Ultisol and classified as T*ypic Haplustult* (FDALR, 1985), while that of Enugu is well-drained ferallitic sandy clay loam classified at the order level as Ultisol and sub-order of Typic kandiusult (Ezeaku 2010). Generally, the soils are acidic, have low CEC, base saturation, and low fertility status, usually suffering from multiple nutrient deficiencies. Soil fertility is maintained by fallow, whose length is fast reducing due to anthropogenic activities in urbanization process.

Vegetation and land use

Both Enugu and Abakaliki are within the northern fringe of the tropical rainforest and belong to Derived savannah agroecology of Nigeria. However, the general vegetation on the lands of southeastern Nigeria stretches through its undulating hills of grasslands to the semitropical rainforest type. Land uses include low land traditional rice farming; multiple (annual) cropping (cassava, plantain, cocoyam, maize, vegetables, pepper, melon seed and beans); citrus and oil palm plantations, herbaceous plants, grasses as bush fallow, and natural forest through the crest to lowlands of the upland-inland continuum.

Soil sampling

Two environments (50 m and 500 m away from expressway) were studied. 50 m and 500 m away from expressway is, respectively, represented as Environment A and B. Five (5) towns were chosen to constitute the sampling points for each of Environment A and B. For the Environment A, the sampling towns (points) were Ishieke 1, Ezzamgbo 1, Ezillo 1, Boundary point 1 and Amechi-Idodo 1. They are situated at close proximity (50 m away) to the expressway. On the other hand, Ishieke II, Ezzamgbo II, Ezillo II, Boundary Point II and Amechi- Idodo II, constitute the remote sampling point as Environment B. In other words, each sampling point on the soils of Environment A had a corresponding point in Environment B.

The ten sites in both Environment A and B were chosen along the expressway for soil sample collection. At each site, random sampling was employed using an auger of 86 mm internal diameter at the soil depth of 0-40 cm. The depth is where most arable and vegetable crops as surface feeders extract water and nutrients and, also zone where most changes are expected to occur (Ezeaku, 2010). Four replicate samples each were taken and bulked as composite sample for the depth. A total of forty composite soil samples were collected, 20 of which were from 50 m away from the expressway (Environment A) affected soils, while the rest 20 samples were from the environment of 500 m away from expressway (Environment B). The soil samples were air-dried and crushed by hand to facilitate drying. Further crushing was done using mortar and pestle, sieved through a 2-mm aperture. Soil particles <2-mm were re-bagged for chemical analysis.

Laboratory methods

The micronutrients determined were Fe, Cu, Zn and Mn, while Pb was the only heavy metal. The method of determination was by digestion method (Algeria *et al.*, 1991; Lacatusu, 2000). Digestion of soil sample for the heavy metals was carried out with a mixture of concentrated $HCl0_4$ and $HN0_3$ at a ratio of 2:1 and heavy metals were extracted using 0.5M HCl. The heavy metal concentrations in the supernatant were determined using Atomic Adsorption Spectrometer (AAS) Alpha 4 model. Statistics. Data generated was subjected to analysis using SAS (2000).

Results and discussion

Occurrence and distribution of heavy metals (Pb, Fe, Zn, Cu and Mn) on the soils of the study locations are shown in Tables 1 and 2.

Lead (Pb): The result shows that the highest mean value of lead (Pb) (16.37 mgkg^{-1}) was obtained on the soils of Environment A (Table 2), while Environment B had lower mean value of 9.5 mgkg^{-1}, suggesting lower reception of Pb by the soils of the latter.

Comparing the concentration of Pb in the sampling points of both environments, it was observed that the mean Pb value (33.7 mgkg^{-1}) obtained in Ishieke I soil was significantly ($P<0.05$) higher than the least values obtained on the soils of Boundary point II (5.4 mgkg^{-1}), Ezzamgbo II (5.6 mgkg^{-1}), and Ezzamgbo I (7.0 mgkg^{-1}) (Tables 1 and 2), suggesting minimal reception of Pb by these soils. Except mean Pb value of 33.7 mgkg^{-1} obtained in Ishieke I, all other values (Tables 1 and 2) were within the range (24.0 to 66.1 mgkg^{-1}) of Pb reported for polluted soils of Spain (Algeria *et al*., 1991). The relative high values of Pb in Amechi-Idodo II (14.0 mgkg^{-1}), Ezillo II (11.6 mgkg^{-1}) and Ishieke II (10.7 mgkg^{-1}) (Table 2) could be due to air transport of Pb from point of emission. Ehosiem (2004) reported that air transfer Pb very far away through air borne to the point of release. Run-off water along the expressway gutters after rainfall events could also contribute heavy metal of Pb offsite.

The high values of Pb obtained on the soils of Environment A could be associated to the proximity of the soils to the expressway where vehicular movements and emissions from motor exhaust are pronounced due to high density of car. This is in line with the report by Ademoroti (1986) that vehicular emissions are known to contain Pb, which is deposited on both soils and vegetation as the vehicles pass on the road. Lead is also listed as one of the major air pollutants whose sources include motor-vehicle exhaust, lead smelters and battery plants (Redmond, 2007). Furthermore, lead (Pb) is used in enormous quantities in storage batteries and in sheathing electric cables. These corroborate Gulson e*t al*., (1981) observation.

On this basis, it sounds convincing that these are sources of Pb concentration on the soils of Environment A because of activities of motor mechanics and other artisans who trade on and use these articles for motor car and motor bike maintenance.

Iron (Fe): The result of iron (Fe) (Table 2) shows that almost all the soils on Environment B had higher values (Fe range: 32.5 to 46.3 mgkg-^{1}) with mean (Fe) value of 41.0 mgkg-^{1} than those of Environment A (Fe range: 17.2 to 42.7 mgkg-^{1}, mean: 29.4 mgkg-^{1}). Iron (Fe) values obtained in Environment B are statistically similar, while Ezillo I (42.7 mgkg-^{1} Fe) and Ishieke I (36.9 mgkg-^{1} Fe) were, respectively, significantly ($P<0.01$) and ($P<0.05$) higher relative to others (Table 1).

Even though Fe ranks fourth in abundance (about 5%) among the chemical elements in the earth's crust or lithosphere, after oxygen, silicon, and Aluminum (Turer and Maynard, 2003), the high concentrations of Iron (Fe) on the soils of Environment B (Table 2) could be explained to higher organic wastes from domestic and commercial ventures as the population density in these areas appears higher. The concentrations of Fe obtained on the soils of Environment A are within the normal tolerable level (38 mg/kg, Davies 1986) of Fe in the soil, while those of Environment B are above normal, indicating contamination level.

Zinc (Zn): The result of Zinc (Zn) concentration on the soils of Environment A ranges from 12.0 to 24.0 mgkg-^{1} with a mean of 16.9 mgkg-^{1}. Those of Environment B ranges from 12.1 to 29.8 mgkg-^{1} with a mean of 18.8 mgkg-^{1}. The values of Zn in both Environment A and B are not significantly different. Major possible sources of Zn on the soils could be improvised toilets with faecal deposits as well as fruits and vegetable markets along the expressway. Also vehicle tyres that undergo wear and tear as well as refuse dump from residents and commercial ventures could contribute to Zn concentration on the soils. Doss *et al*. (1995) observed that Zn is normally released as the tyres undergo wear on motion, and that Zn is a component of vehicle tyres. Other possible sources of Zn to the soils could be application of sludges and composted materials and applications of fertilizers and pesticides (agro-chemicals) by farmers who cultivate the soils for arable, cereal and vegetable crops. Turer *et al*. (2003) reported that sludges exhibit a wide range of Zn concentrations which are generally higher than the background levels found in soils.

Alloway (1990) reported soil concentration range of 70-400 mg/kg total Zn as critical, above which toxicity is likely. From this range, the level of Zn obtained on both soils of Environment A and B is still very low. Presently there is no cause for alarm.

Copper (Cu): Result of copper (Cu) concentration on the soils of both environments is presented in Tables 1and 2. Generally, the concentrations of Cu on the soils of Environment B are higher than those obtained on soils of Environment A. The mean value of Cu on soils of Environment B was 43.11 mgkg-^{1} with a range from 35.4 to 49.1 mgkg-^{1}, while those of Environment A range from 5.4 to 10.1 mgkg-^{1} and a mean of 8.4 mgkg-^{1}. The mean Zn value of 43.1 mgkg-^{1} is significantly ($P<0.01$) higher than 8.4 mgkg-^{1} (Tables 1 and 2).

The high concentration levels of Cu on the soils of Environment B relative to A can be associated to sewage sludge. Sludges are usually applied by the farmers to the soil as a source of added soil organic matter for cultivated crops. Atmospheric deposition is another one possible source of Cu to the soils. Nriagu (1979) has shown that the atmosphere is the important medium for the transmission of pollutant Cu to most remote areas. Since the communities in remote areas of Enugu and Abakaliki are agrarian areas with cattle rearing, the possibility of high concentration of Cu and Zn could be from the sewage sludges. Brady and Weil (2002) reported high concentration level of Cu, Zn and Cd on sewage sludges relative to soils and plants.

Contamination for Cu can only be declared when its concentration is above 130mg/kg (ICRCL, 1987). Ano (1994) reported that the amount of Cu in soils varies but normal agricultural soil is estimated to contain 1 to over 50 mgkg-^{1} of Cu. From these two reports, the concentration levels of Cu on the soils of Environment A and B are normal, and thus the probability of experiencing Cu contamination of the soils is still very low.

Managanese (Mn): The concentration levels of manganese (Mn) on both Environment A and B soils range from 6.1 to 15.5 mgkg-^{1} (Tables 1 and 2). Mean value of Mn for Environment A (17.8 mgkg-^{1}) was higher than that of Environment B (11.3 mgkg-^{1}) even though there is no statistical difference between them. Both Environment A and B mean values are lower than the mean obtained in Ishieke I (35.4 mgkg-^{1}). High concentration of Mn in Ishieke I could be due to the presence of car wash outfits that has the potential of continual release of effluents containing oil, paint and vanish oils, petrols, diesel, detergents and dissolved dust particles resulting from anthropogenic activities around Environment A. Possible sources of Mn on the soils of Environment B could be through application of sewage sludge and inorganic fertilizers containing

Mn in the form of $MnSO_4$, MnO or as an addition to micronutrient fertilizers.

Davies (1986) showed that the normal level of Mn in the soil is about 3 mg/kg and full contamination is declared when a value above 50 mg/kg is obtained. The foregoing indicates that the concentration level of Mn on the soils of Environment A and B is above normal but below the level to declare contamination. Manganese (Mn) therefore is not a threat in both environments.

Agronomic and Environmental Implication of the Concentration Levels of Heavy Metals on the Soils

Agronomic implication

Previous studies have shown that heavy metals are potentially toxic to crops, animals and humans when contaminated soils are used for crop production (Xian, 1989). Heavy metals may enter the human body through inhalation of dust, consumption of contaminated drinking water, direct ingestion of soil and consumption of food plants grown in metal-contaminated soil (Cambra *et al*., 1999; Dudka and Miller, 1999).

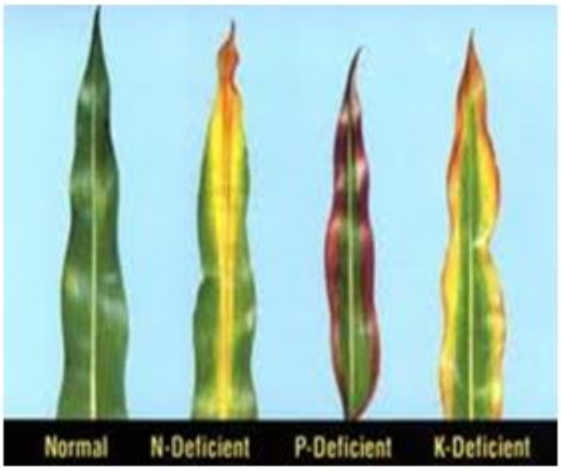

Figure 1: Macro nutrients (N, P, and K) deficiency in maize

Figure 2: Pottasuim (K) deficiency in tomato

Figure 3: Magnesium deficiency in tomato

Even though most crops may not tolerate wide variability in the availability of essential nutrients in the growth and developmental stage, the problem is compounded when there is presence of heavy metals, which has potentials of truncating crop demands. Figures 1 to 3 show deficiency symptoms of macro nutrients (N, P, K, Mg) on cultivated maize and tomato crops.

The deficiencies could be due to heavy metal truncation of the crops' demand for these nutrients. Deficiency symptoms of Zn and Cu on the cultivated maize crops are shown in figures 5 and 6. Low concentration levels of Zn on the soils (Tables 1 and 2) may have caused the observed deficiency symptom. Furthermore, it could be that the quantity of Zn in the soils are not sufficiently available for the crop root absorption, hence the symptom (Figure 4).

Figure 4: Zinc deficiency in maize plant.

Figure 5: Copper (Cu) deficiency in maize plant

Similarly, low concentration levels of Cu on the soils of Environment A (Table 1) may have caused the deficiency symptom seen on the maize crop (Figure 5) planted along the expressway. This is surprising because the values of Cu obtained on the soils of both Environment A and B (Tables 1 and 2) were normal and uncritical. A plausible excuse for the observed deficiency symptom of Cu, however, could be partly that the concentration is not available in the right quantity for the crops use or that Cu was strongly adsorbed in the soil colloidal complex that the crop roots cannot extract it. The relatively lower values of heavy metals obtained in both Environment A and B may not be unconnected with dilution by rainwater, which is of high intensity and duration in southeastern Nigeria. Rain water influences concentration and heavy metal dynamics in soil. The values are within the tolerable levels that may not pose toxicity to cultivated crops.

The study showed that Iron (Fe) concentration levels on soils of Environment A are within tolerable level, an indication that cultivated crops on the soils are at safe level of toxicity. Environment B presents contamination of Fe above the tolerable limit and this could limit crop production. Even though concentration of heavy metals in crops depend on availability in the soil and crop uptake, Brady and Weil (1999) reported that certain plants have been found to accommodate more than 20,000 mgkg-^{1} Ni, 40,000 mgkg-^{1} Zn and 1000 mgkg-^{1} Cd, hence referred to as hyper-accumulating plants. Such plants pose serious health hazards to humans and animals.

The high values of heavy metals on some of the soils have the potential to kill and/or inactivate soil organisms in the soils; hence they pile up as autochthonous decomposers that have been rendered extinct. Reduced activities of microorganism suggest lower bio-activities, particularly reduced biodegradation of organic materials that could lead to soil infertility and productivity loss. Foth (1984) suggested cultivation activities for proper oxidation of the soil for prolonged and pronounced activities of soil organisms in soil fertility restoration.

Environmental implication

The sites under investigation are areas that are subjected to various land use/land cover types that have the potential to predispose the soils to heavy metal (Pb) and micronutrient contaminations. Many highways close to urban cities have witnessed increase in commercial activities and some rural places have grown to be peri-urban cities. The population engage in different land uses ranging from farming (cropping and livestock production) to trading. Wastes from domestic and commercial ventures are sources of trace elements (Fe, Zn, Cu, Mn, etc) and heavy metal (Pb) that have environmental implication of polluting surface and underground water bodies if the soils become transported to these water bodies by erosion or leaching. Heavy metal contamination of the underground water bodies is synonymous with earlier report by Ano *et al.* (2007) that heavy metal pollutants contaminate underground aquifer system through its transmission into the soil body.

A detailed report on heavy metal contamination of surface water bodies such as river and stream was shown in the study of the influence of open cast mining of solid minerals on soil, landuse and livelihood systems in selected areas of Nasarawa State, North-Central Nigeria (Ezeaku, 2012). The study revealed that high levels of heavy metals above critical levels result in human health hazards but as He *et al.* (2004) have shown mobility of heavy metals depends not only on the total concentration in the soil but also on the soil properties, and environmental factors.

Conclusion

The result revealed that highest mean lead (Pb) was obtained on the soils of Environment A than Environment B, suggesting lower reception of Pb by the soils of latter. Mean Pb in Ishieke I soil was significantly ($P<0.05$) higher than the least values obtained on the soils of Boundary point, Ezzamgbo II, and Ezzamgbo I.

The concentration of Fe obtained on the soils of Environment A was within the normal tolerable level (38 mg/kg, Davies 1986) of Fe in the soil, while those of Environment B were above normal, indicating contamination level. The level of Zn obtained on both soils of Environment A and B was very low considering critical range of 70-400 mg/kg total Zn above which toxicity is likely. The concentration levels of Cu on the soils of Environment A and B was found normal. The concentration level of Mn on the soils of Environment A and B was above normal but below the level to declare contamination. Manganese (Mn) therefore was not a threat in both environments.

From the foregoing, it is recommended that crop production activities can be commercially embarked upon with minimal cost involvement and efforts in reclaiming those soils with toxicity levels, especially Fe. Based on observed toxicity levels of Fe on the studied soils of Environment B (communities situated 500 m away from the expressway), it is recommended that the farmers in these areas should source and use lime fertilizers which could decrease uptake of heavy metals by crop plants.

Heavy metal monitoring and evaluation should be an integral part of land use planning for long-term sustainability of farming systems and environmental stability.

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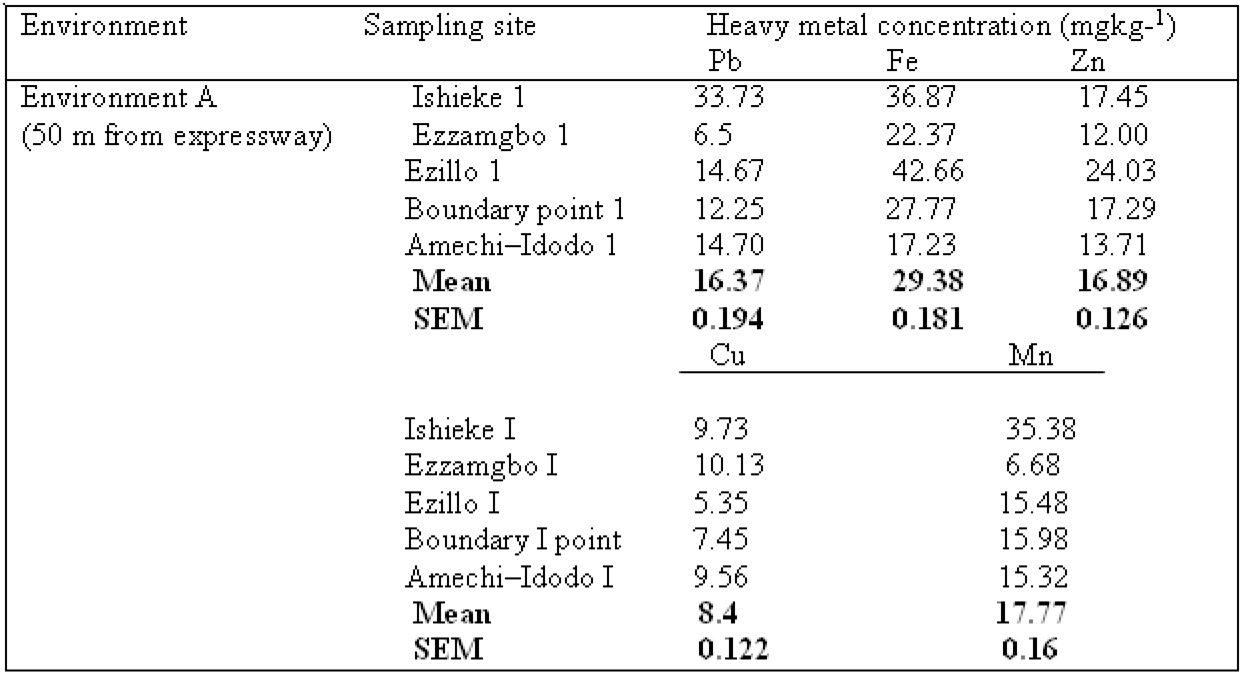
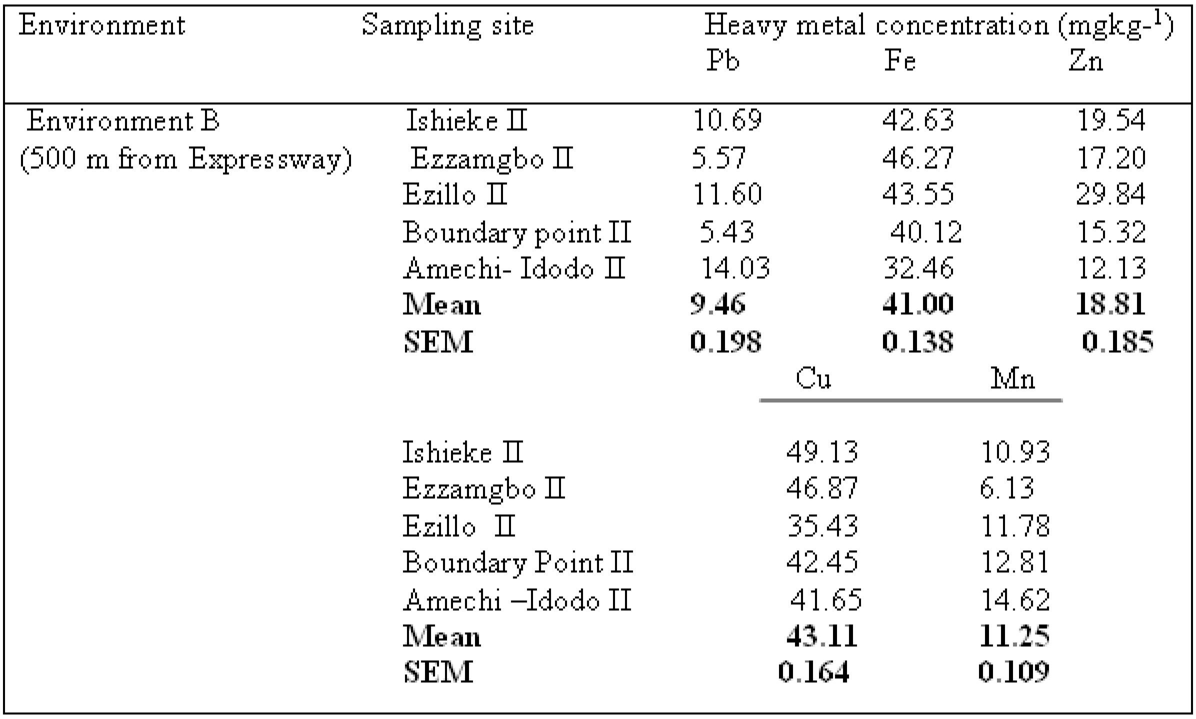
Table 1: Mean values of Pb, Fe, Zn, Cu and Mn levels on soils of Environment A



Environment	Sampling site	Heavy metal concentration (mgkg-^{1}) Pb	Fe	Zn
Environment A (50 m from expressway)	Ishieke 1	33.73	36.87	17.45
	Ezzamgbo 1	6.5	22.37	12.00
	Ezillo 1	14.67	42.66	24.03
	Boundary point 1	12.25	27.77	17.29
	Amechi–Idodo 1	14.70	17.23	13.71
	Mean	**16.37**	**29.38**	**16.89**
	SEM	**0.194**	**0.181**	**0.126**
		Cu	Mn	
	Ishieke I	9.73	35.38	
	Ezzamgbo I	10.13	6.68	
	Ezillo I	5.35	15.48	
	Boundary I point	7.45	15.98	
	Amechi–Idodo I	9.56	15.32	
	Mean	**8.4**	**17.77**	
	SEM	**0.122**	**0.16**	

SEM = standard error mean

Table 2: Mean values of Pb, Fe, Zn, Cu and Mn levels on soils of Environment B



Environment	Sampling site	Heavy metal concentration (mgkg-^{1}) Pb	Fe	Zn
Environment B (500 m from Expressway)	Ishieke II	10.69	42.63	19.54
	Ezzamgbo II	5.57	46.27	17.20
	Ezillo II	11.60	43.55	29.84
	Boundary point II	5.43	40.12	15.32
	Amechi- Idodo II	14.03	32.46	12.13
	Mean	**9.46**	**41.00**	**18.81**
	SEM	**0.198**	**0.138**	**0.185**
		Cu	Mn	
	Ishieke II	49.13	10.93	
	Ezzamgbo II	46.87	6.13	
	Ezillo II	35.43	11.78	
	Boundary Point II	42.45	12.81	
	Amechi –Idodo II	41.65	14.62	
	Mean	**43.11**	**11.25**	
	SEM	**0.164**	**0.109**	

SEM = standard error mean

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