Heavy Metal Toxicity In Traffic Interchange At T-Junction Epe Lagos State

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Abstract- This study provides an overview of the current level of heavy metal toxicity at the T-junction traffic interchange, including its origins, chemical properties, enrichment factors, and health effects. The Deposition Gauge method was employed to conduct this experiment, and three deposition gauges were planted at the sampling site and the control unit being Lagos State University Epe Campus for duration of 1 month, between December 2022 and January 2023 (Dry Season). The gauges were harvested and taken to the analytical laboratory of Chemical Engineering Department in order to determine the deposition Fluxes. Prepared samples were taken the Central Research Laboratory, Tanke in Ilorin where the samples were characterized using X-ray Fluorescence (XRF) spectrometer multi elements detector equipment. Mean and standard deviations were determined after which the Enrichment Factors (EF) were calculated. Twelve elements were characterized from the samples collected at the sampling site, and twenty-one elements at the control experiment unit respectively. EF was determined and elements such as Fe, Ag, Rh, Ru, In, Sn, Ti, Cd, Pd, Mn and Au were moderately enriched, with the exception of S, Cl, V, and Zn, highly enriched. This shows that anthropogenic activities affect the concentrations of some heavy metals at the sampling site as well as the control unit. Hence, a clean-up of the study area is recommended.

Indexed Terms— Toxicity, Health Effects, Enrichment Factor, XRF, Anthropogenic

I. INTRODUCTION

Metals are materials that are malleable, lustrous, and have excellent electrical conductivity. They freely shed their electrons to produce cations. Heavy metals are significant environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons [1] [2]. Arsenic, cadmium, chromium, copper, lead, nickel, and zinc are the heavy metals most frequently detected in wastewater, and they all pose threats to both human health and the environment [3]. In Nigeria, within the cities, atmospheric Zn and Cu concentrations were reported to be a function of traffic density [4]. [5] noted that organometallics such as tetraethyl lead $[(C_2.H_5)_4Pb]$, an additive to gasoline (petrol) is an important source of Pb in automobile roadways exhaust emission. The study observed that 58.3-143.5ug pb/g plant was obtained in areas of very high traffic volume (greater than 1000 vehicles/h) as against 15.2-15.8ug pb/g plant in low traffic volume (<200 vehicles/h).

According to common definitions, heavy metals are defined as metals with a particular density of greater than 5 g/cm3 that have a negative impact on the environment and living things. [6][7][8]. When present in extremely low quantities, these metals are needed for maintaining a variety of biochemical and physiological processes in living things, but when their concentrations rise over a certain threshold, they become toxic. Heavy metal exposure persists and is rising in many regions of the world despite the fact that heavy metals are known to have several negative health impacts and that these effects can endure for a very long time. Based on the above, roadside soil, street dust, and plants can be exposed to significant levels of metals, owing to both vehicle emissions and carried harmful chemicals, Metal levels in the environment are influenced by the combustion of fossil fuels, vehicle wear (tires, body, and brakes), and automotive fluids.

It has been observed that roadside soil is highly contaminated with various heavy metals, namely Ni, Cd, Zn, Cu and Pb [9]. Despite the fact that many heavy metals are present in nature, certain of them have been demonstrated to pose a risk to health, particularly when present in high quantities in plant and human cells. Even at minute amounts, heavy metals including cadmium, lead, copper, and zinc are potentially poisonous and represent a serious threat to both food safety and human health [10]. Environmental management issues with transportation-related heavy metal discharge into the environment vary with respect to time, place, human activity intensity, traffic volume, mobility, and metal bioavailability [11]. It has been demonstrated that dangerous metals including Cd, Cr, Cu, Fe, Mn, Pb, and Zn are linked to ambient particles produced by roadside dust and can induce the respiratory tract epithelium to produce and release inflammatory mediators [1]. These emphasized the need to respond to the continuous deposition of heavy metals on urban soils in order to achieve sustainable environmental management. The goal of this study is to evaluate the impact of heavy metal pollution from traffic on roadside along T-junction in Epe Local Government Area, Lagos State, Nigeria.

II. MATERIALS AND METHODS

2.1 Study Area

Lagos is the largest in Nigeria, as well as on the African continent. It is one of the fastest growing in the world, and also one of the most populous urban agglomerations with GPS coordinates of 6° 31' 27.7644" N and 3° 22' 45.1416" E. Epe is a town and local government Area (LGA) in Lagos State, Nigeria located on the north side of Lekki Lagoon with coordinate of 6° 34' 59.99" N and 3° 58' 59.99" E

Epe is a town and Local Government Area (LGA) in Lagos State, Nigeria located on the north side of the Lekki Lagoon and about 90 km from Ibadan. Epe has a latitude of 6°35'40.54"N and a longitude of 3°58'39.5"E or 6.594595 and 3.977639 respectively. During the 2006 Census, the population of Epe was approximately 181,409. A road junction at the entrance into Epe from the Lekki-Epe Expressway features a sculpture of two giant fish, erected by the Lagos State Government (T-junction).

2.2 SAMPLING PROCEDURE

The samples was carried out between December 2022 to January 2023 (Dry Season) at T- Junction Epe in the above study area shown in Fig 3.1. In the research region, deposition gauges were positioned for 30 days. In the interim, a deposition gauge was set up for 30 days on the Lagos State University Epe Campus to act as our experiment's control. After 30 days, the deposition gauges were harvested, and the deposition fluxes were ascertained at the analytical laboratory of the Chemical Engineering Department at Lagos State University in order to determine the deposition fluxes. A dry, pre-measured Whatman membrane filter paper (3.0 m) was used to filter the dry deposition in the deposition gauges after it had been washed with water and weighed on a digital weighing scale. To stop particles from settling out again until they are fully dried, the wet filter sheets were stored in desiccators. To evaluate the deposition fluxes, the filter paper and particles were reweighed after drying.

Fig.1: Geographical map of T-Junction interchange Epe, Lagos State.

The X-ray Fluorescence (XRF) spectrometer was used to characterize the particles in private own laboratory, the Central Research Laboratory, Tanke in Ilorin. The observed heavy metals' enrichment factor was calculated.

Deposition Fluxes was calculated using the equation below

$$Deposition\ Flux = \frac{w_2 - w_1}{At} \qquad 1$$

Where;
W_1 is the weight of the filter paper (g), W_2 is the weight of filter paper and sample (g), A is Area of the deposition gauge (m^2), and t is the time (measure in days).

2.3 ENRICHMENT FACTOR(EF)

This was necessary in order to evaluate the concentration of the elements characterized as well as to ascertain that they are within the threshold limits and that they in line with the acceptable standard. The EF of each element was determined using the equation below;

$$EF=(C_x/C_{Al})\ aerosol/(C_x/C_{Al})\ crust \qquad 2$$

Where C_x and C_{Al} are the concentrations of the element x and the reference element, while $(C_x/C_{Al})_{aerosol}$ and $(C_x/C_{Al})_{crust}$ are the proportions of the element concentrations in the particulate matter and in the Earth's crust' respectively.

III. RESULTS AND DISCUSION OF RESULTS

3.1 CHARACTERIZATION OF THE SAMPLES FROM THE DRY DEPOSITION

Deposition fluxes were calculated as shown in Tables 1 and 2 which reveal that the fluxes at the control site are more than that of the selected interchange. This may be due to other activities going on within the Lagos State University Epe campus. The PM samples obtained at the sampling locations during the dry season were characterized for possible heavy metals. Twelve elements are detected at T-Juntion which is the sampling point while twenty one elements were detected at control experiment site (Lagos State University, Epe Campus)

3.2.MEAN AND STANDARD DEVIATION

The daily averaging of the detected elements was calculated with the mean and error bar for both the sampling site and the control experiment location. The mean and standard deviation (the error bar) were calculated as presented in shown in Fig. 2 and 3 respectively. Fe has the highest mean concentration value of 0.105 as well as highest standard error bar of

Table 1: Dry Deposition Flux of T-Junction Epe

SITE	W1 (g)	W2 (g)	ΔW (g)	A (sq m)	T (month)	AT (Sq m. month)	ΔW (mg)	F (g/sq m/month)
S1	1.4911	2.7202	1.2291	0.03142	1	0.03142	1229.1	39.1184
S2	1.5204	2.4331	0.9127	0.03142	1	0.03142	912.7	29.0484
S3	1.5202	2.7333	1.2131	0.03142	1	0.03142	1213.1	38.6092

Table 2: Dry Deposition Flux for Control Experiment LASU Epe Campus

SITE	W1 (g)	W2 (g)	ΔW (g)	A (sq m)	T(month)	AT (sq m. month)	ΔW (mg)	F (g/sq m/month)
S1	1.6001	3.2043	1.6042	0.03142	1	0.03142	1604.2	51.05665
S2	1.6201	2.9521	1.332	0.03142	1	0.03142	1332	42.3934
								93.4500

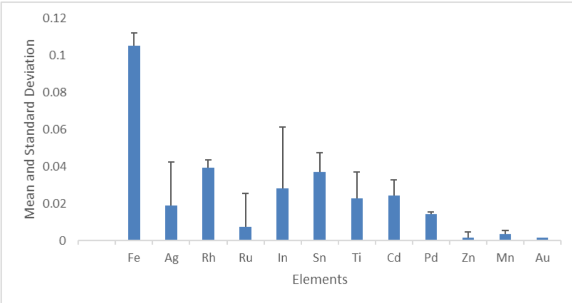

Fig 2: Mean and standard deviation of the characterized Elements at study area.

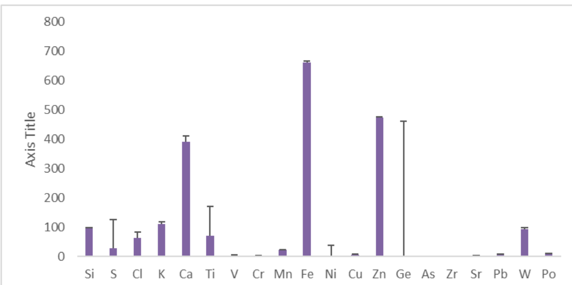

Fig 3: Mean and standard deviation of the samples in the dry season at control unit.

0.056. while Zn has the lowest mean concentration of 0.014 and error bar of 0.011 at the sampling site T-Junction. At the control experiment site, Fe also has the highest mean concentration value of 661.680 and error bar value of 34.526 while Zr has the mean concentration value of 0.740 with no error bar value. Zn has the highest error bar value of 459.80. the daily averaging all detected elements show that they are beyond the limits of 35 μg/m^3 and 25 μg/m^3 set by both [12] and [13] respectively.

3.3 Enrichment Factor Analysis (EF).

Element such as Al, Si, Ti, and Fe are frequently used as a point of reference for the calculation of factors because they are abundant in crustal material and are not significantly impacted by pollution [14] [15]. For this study, iron (Fe) was used as the reference element, the enrichment factor of the analysis for each element in the sample was calculated based on the average elemental concentration data of the upper continental crust. At T-Junction, only one element Sn was highly enriched, when EF >10, it indicates that a large fraction of the element can be attributed to non-crustal or anthropogenic sources trace metal in the atmosphere AEEs while all others are < 10 and that a large fraction of the element can be attributed to crustal derived trace metals sources in the atmosphere NEEs [16] [17] [18]

The EF of the control experiment shows that Zn was AEEs element having 497.3394 this may not unconnected with fact that sampling site was the busiest interchange at Epe and tat several activities are going on within and around the location. The high Iron (Fe) concentration detected in dry deposition indicates the ubiquity of this toxic metal in the environment and shows that the areas are Fe enriched. According to [13], the recommended atmospheric limit for Fe is 0.003μg/m^3 and 0.02μg/m^3 respectively and these values are far below the concentrations got in the study areas.

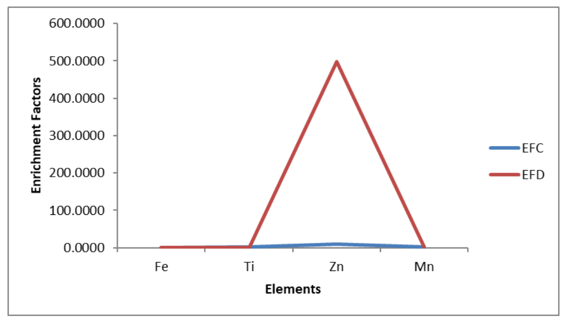

Fig 4: Plot for Enrichment factors of both T-Junction and Control Experiment

CONCLUSION

The current study has shown that the dry deposition of the defined samples at T-junction do not only indicate anthropogenic activities in the study region but also demonstrate that the environment needs immediate clean-up as one element each have enrichment factors greater than 10 [19] [20]. The increased in anthropogenic activities around the sampling site as well as control experiment unit during the during working hours is likely the cause of the heightened amounts of pollutants recorded. Poor vehicle maintenance and lack of implementation of traffic rules and laws by the regulated bodies may also have contributed to the increase in concentrations characterized heavy metals. This study discovered that most of the toxic heavy metals were, Silver (Ag), Indium (In), Tin (Sn) and Zinc (Zn) and Gold (Au), are ubiquitous in the ambient environment. These atmospheric pollutants pose the greater negative effects on the environment.

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