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Evaluation of Heavy Metals' Concentrations in Sand Deposits along Heavy Traffic Areas in Port Harcourt Metropolis, Nigeria

Christian Mathew, Chinda Worokwu
Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria

ABSTRACT

Roadside sand deposits are common menaces on our roads within the cities of Nigeria, especially as they become air-borne due to heavy human and vehicular traffic as well as natural factors such as wild wind. Ten heavy locations were identified and samples collected and analyzed for 9 heavy metals: Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb) and Zinc (Zn) in Port Harcourt City. Analysis was done using atomic absorption spectrophotometer and data generated were analyzed using descriptive statistics with Microsoft excel 2010. Results from the analyses show that all identified sample points are loaded with significant amounts of all the metals investigated at environmentally unacceptable levels. Iron was identified in triple digits in all sample points. Cadmium and lead were found to be significantly high so are other metals with respect to Who (1984) and FEPA (2003) regulations. These concentrations may be directly translated to the bioavailability of these metals which have very strong toxicological implications of these metals in the environment. Therefore, the present practice of sweeping roadside of sand deposits is obviously not effective especially at the junctions which are hardly attended due the heavy vehicular and human traffic.

Keywords: Heavy Metals, Heavy Traffic, Sand deposits, Port Harcourt

I. INTRODUCTION

Studies involving environmental levels of heavy metals have been extensively carried out by individual researchers and bodies in the different components of the environment all around the globe. Port Harcourt city in this study is comprised of two local government areas (Port Harcourt City and Obio/Akpor). The city is not just one of the many in the world, it is a city according to the 2006 Nigerian census of 1 382 592 people from 235 098 in 1963. This astronomical rise now stands at 1.5 million (Greater Port Harcourt City Development Authority, [1], approximately between 2.7 million and 3.7 million including the greater Port Harcourt areas [2].

Port Harcourt in Nigeria is the hub of the oil and gas and allied industries amidst other servicing economic activities such as food processing, transportation, paint manufacturing, paper and plastic manufacturing, etc. The city like every civilized society hosts corporate professional firm like the legal, accounting, engineering, real estate, medical, hospitality, banks, education (3 universities, 2 health colleges, 1 monotechnic-type college, over 300 public and private primary and secondary schools, a reasonable number of non-formal educational institutions, etc), etc. All of these come with some form of pressures on the city and its environs by of population inflow and congestions and corresponding pollution of same which include metals through the known channels of wear and tear, fossil fuel combustion emissions. This study therefore, aims to analyze the concentrations of some selected metals in some selected locations in the city prone to the challenges of the city status.

In Nigeria, the release of these metals and other pollutants into the environment has been implicated on high population density and industrialization [3] and specifically for roadside sand deposits [4]. Heavy metal concentration on roadside sand samples collected between 50cm-1m distance along Abakaliki–Enugu–Okigwe expressway in south eastern Nigeria was

reported with a mean values of 5205.11 (Fe), 247.97 (Cu), 74.11 (Zn) 100.19 (Pb) and 18.8 (Cd) mg/kg while means values at 100m away from the roadside for Fe, Cu, Zn, Pb and Cd were 4890, 217.86, 64.08, 87.13 and 3.05 mg/kg, respectively [5]. In Adogo, levels of heavy metals in soil and cassava leaves have been reported in roadside soil at ranges from <0.01-0.07±0.01 µg/g for Cd, 0.05±0.02-0.89±0.25 µg/g for Cu, 0.09±0.004-0.18±0.03 µg/g for Ni, 0.06±0.001-0.44±0.16 µg/g for Pb and 0.04±0.003-0.05±0.001µg/g for Zn [6].

Elsewhere in Africa such as in Ghana, Ketu-South District, increasing air pollution levels due to rapid urbanization and growth in vehicular emission was reported in roadside dust samples collected and analyzed for heavy metals which ranged from 0.4-18.2 µg/g for As; 284-9106 µg/g for Cr; 18.4-144.1 µg/g for Cu; 233-1240 µg/g for Mn; 12.3-493.2 for Ni; 3.1-67.8 µg/g for Pb; and 18.2-406.5 µg/g for Zn [7]. Beyond the shores of Africa such as in England, concentration levels of metals as high as 25.0-1198.0 µg/g for Pb, 56.7-480.0 µg/g for Zn, 0.3-3.8 µg/g for Cd and 15.5-240.0 µg/g for Cu have been reported in roadside soils which were higher than natural background levels reported for British soils [8]. In Nepal, roadside dust samples collected along Kathmandu-Bhaktapur road section of Arniko Highway, Kathmandu valley showed elevated levels of the heavy metals which ranged from 69.09-471.40 mg/kg for Pb, 1.56-6.15 mg/kg for Cd and 0.59-1.89 mg/kg for Hg with the average concentrations 245.36 mg/kg for Pb, 2.89 mg/kg Cd and 1.04 mg/kg Hg for the same elements [9].

II. METHODS AND MATERIAL

A. Sample Collection

10 sample points were purposively selected on the basis of the objective of this study which is the evaluation of concentrations of metals most likely to be released due commercial activities in such busy locations in the city. Grab samples of sand deposits were collected using plastic scrapers along each adjoining roads/streets to a given sampling points (SP) at a sampling distance of 4ft were collected. All samples collected from the designated SPs were combined into a composite sample for that SP. Each composite sample was stored in a tight polythene bag [10]. 10 composite samples were collected from the 10 selected sampling points for this study. The samples were designated as follows: Eleme junction (SP01EJ), Rumuokoro junction (SP02R1), Rumuokwuta junction (SP03R2), Rumuepirikom junction (SP04R3), Agip junction (SP05AJ), Mile3 Park area (SP06M3), Mile1 Market area (SP07M1), Mile1 Flyover (SP08FO), Waterlines junction (SP09WJ) and Rumuola junction (SP10R4).

B. Sample preparation and analysis

Samples were air-dried. 1 g of each of all the dry samples was digested in a 250 mL conical flask using a mixture 10 mL each of 40% HF and 70% $HClO_4$ in a fume chamber. The resultant clear colourless solution was allowed to cool down, filtered and made up to 100 mL with deionized waster and finally stored in plastic containers in readiness for analysis.

9 metals were analyzed using the 200A model Buck Atomic Absorption Spectrophotometer.

C. Data Analysis

Data generated was subjected to descriptive statistical analysis, mean and standard deviation using Microsoft excel 2007 package.

III. RESULT AND DISCUSSION

A. Results

The result of the study shown in table 1 reveals that all 9 metals are significantly loaded in the roadside sand collections at all the sample points evaluated in this study. Mean concentration of Cd was found to be 0.11±0.03 mg/kg with highest concentration of 0.14 mg/kg and 0.15 mg/kg at SP03R2 and SP07M1 respectively and lowest of 0.08 mg/kg at SP04R3, SP08FO and SP09WJ. Mean concentration of Pb was 1.25±0.71 mg/kg with the highest of 2.64 mg/kg at SP01EJ and lowest of 0.77 mg/kg at SP02R1 and SP10R4. Fe concentration was found in 3 digits with a mean of 305.0±83.8 mg/kg and highest of 463.0 mg/kg at SP07M1 and lowest of 199.0 mg/kg at SP06M3. The results also portray some degree of uniformity in distribution in concentration of the metals especially with Cr and Ni with mean levels approximately between 1.0-2.0 mg/kg respectively whereas Cu, Mn and Zn portray non-uniform distributions with mean levels at

0.50±8.37 mg/kg, 8.32±2.49 mg/kg and 5.03±0.61 mg/kg respectively. The pattern of distribution of these metals is depicted in figure 1 below. Findings of this study are presented in table 1 below.

Table 1: Metals Concentrations in Port Harcourt City (mg/kg)

Samples	Cd	Co	Cr	Cu	Fe(x10)	Mn	Ni	Pb	Zn
SP01_EJ	0.10	1.10	0.55	26.91	33.86	11.07	1.76	2.64	4.74
SP02_R1	0.09	1.03	1.75	0.35	21.45	13.59	1.03	0.77	5.48
SP03_R2	0.14	1.14	1.80	11.82	30.65	9.25	2.32	0.92	4.96
SP04_R3	0.08	0.86	1.43	0.51	24.06	6.11	1.64	0.92	6.01
SP05_AJ	0.10	0.80	1.95	0.05	38.76	8.76	1.50	0.98	5.49
SP06_M3	0.09	0.65	1.09	0.57	19.90	5.84	1.34	0.92	4.59
SP07_M1	0.15	0.82	1.18	0.43	46.30	6.58	1.56	1.98	5.68
SP08_FO	0.08	0.78	1.30	0.46	24.81	8.20	1.30	1.27	4.08
SP09_WJ	0.08	0.83	1.27	1.83	36.16	7.69	1.32	1.33	4.52
SP10_R4	0.09	0.66	1.32	0.41	29.08	6.07	1.36	0.77	4.77
Mean	**0.11**	**0.87**	**1.36**	**0.50**	**30.50**	**8.32**	**1.51**	**1.25**	**5.03**
SD	**0.03**	**0.17**	**0.40**	**8.37**	**8.38**	**2.49**	**0.33**	**0.71**	**0.61**
FEPA (2003)	**0.003**	**0.05**	**0.05**	**0.50**	**0.30**	**0.10**	**0.02**	**0.01**	**0.30**
WHO (1984)	**0.003**	**0.05**	**0.05**	**0.50**	**0.30**	**0.10**	**0.02**	**0.01**	**0.30**

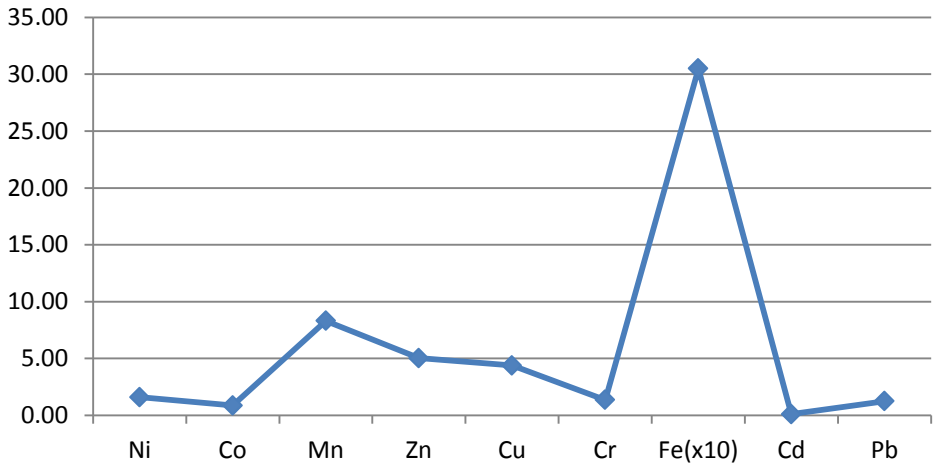

Figure 1: Mean Metal Distribution in mg/kg

All locations have reasonable levels of all the metals evaluated, enough to provoke curiosity into how much of these and other metals are in the sand deposits along the roads evaluated and how much are airborne in the immediate vicinity and even beyond. These figures depict the very nature of our roads within the metropolis in the present, recent and immediate past.

B. Discussion

From the findings of this study, all metals investigated were found to way beyond environmentally permissible limits. Finding may not be directly unconnected with busy heavy traffic and commercial activities of the selected sample points. These points in the city are beehives of commercial activities which directly relate the heavy vehicular movements associated with these points of the city. The findings also corroborate all known findings in similar studies along the Abaliki-Enugu-Okigwe expressway study **[5]**; Adogo study in Nigeria [**6];** Ketu-South in Ghana study **[7];** England study **[8];** Nepal roadside dust study **[9]**.

These levels detected are not friendly values especially during the dry season when the likelihood of suspending the soil deposits and other particulate materials in the air

by moving automobiles is highest. Foodstuffs sold along such affected roads/streets can readily take up these metals; direct inhalation is also a sure possibility.

IV. CONCLUSION

From the detected values of all the metals investigated, heavy traffic areas can be said to be polluted of these land- and air-borne heavy metals pollutants.

Further investigation into the levels of these pollutants and other metals in other areas within the city and the outskirts need to be carried out to ascertain the pollution level and devise remedial measured to check or control emissions, from fuel, corrosion and other sources in such heavy traffic areas.

This study is geared towards establishing the fact that a much more detailed study could be conducted especially, because of the sudden hike in commercial activities in the city which is also a beehive of major industries in the delta region of Nigeria.

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