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Assessment of Automobile Workshops and Heavy Metal Pollution in a Typical Urban Environment in Sub-Saharan Africa

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Automobile workshops (AW) are pervasive across many cities in Sub-Saharan Africa (SSA), often existing close to residential and commercial land use. Activities within these enterprises use and release many heavy metals with serious consequences for human health. This study examined soil and water samples to quantify the load of heavy metals within these enterprises. In soil, means of 3.073, 91.033 and 5.630 mg kg^{-1} were observed for Hg, Pb and Cd, respectively, and only Hg mean was below the benchmark. The means of 0.063, 0.114 and 0.131 mg/l were observed for water samples across the AW. On average, the soil of the AWs had about 99, 68 and 34% more Hg, Cd and Pb, respectively, compared to the background samples. Similarly, water samples around the workshops were also 82, 89 and 93% higher in Hg, Pb and Cd, respectively. Nemerow Pollution Index (NPI) shows that all the water samples from the workshop site are heavily polluted while 88% of the soil is between *slightly polluted* and *heavily polluted*. 55% of the background samples (water) are heavily polluted, while 30% of soil samples fall within the safety domain class of NPI. This shows that AWs pose a significant risk to human health, and there is an indication that increased concentration of heavy metals in soil could be linked to the content in the groundwater. There is a need to clearly identify and quantify the pool of heavy metals in soil influencing the level of heavy metals in the groundwater in order to design effective control measures.

Keywords: *heavy metal, automobile workshop, pollution index, Sub-Saharan Africa, environmental monitoring.*

1 Introduction

Urban environments and their landscapes are a reflection of social, economic, political, environmental and technological processes taking place within them (Lawal, 2009). Urban forms create one of the most intense interactions between man and the environment (Lawal, 2009). This interaction has led to the description of urban soils as "created soils" (Wong, Li, & Thornton, 2006). This is as a result of heavy modification and the influence of humans. An example of this modification is the impact of AWs evident in many parts of SSA. These are usually found along major roads, streets and markets across this region. Waste from these enterprises is usually dumped indiscriminately across the environment. This often leads to soil contamination, alteration of chemical and physical properties of the soils (Aelion, Davis, McDermott, & Lawson, 2009). These contaminants may find their way directly to humans through inhalation of dust from contaminated soils, ingestion or skin contact or indirectly through the consumption of plants/animals in these contaminated environments. Plants have been found to absorb heavy metals via foliar uptake (Feng et al., 2011).

Heavy metals are present in many items of daily use by human; moreover, we can argue that the level of such will be considerably higher within and

around AWs across SSA due to lack of proper waste disposal mechanisms and infrastructure. Urban soils have been reported to have elevated concentrations of Pb, Cd, Cu, and Zn in comparison to rural, agricultural or forest soils (Pilgrim & Schroeder, 1997; Chen, Wong, Zhou, & Wong, 1997). Furthermore, newer segments of the city were also found to a have lesser concentration in comparison to the older regions (Guo, Wu, Xie, & Zhang, 2012). Various studies have identified the sources and impacts of heavy metals, for example, Maria-Ema, Gabriel, & Valentin (2012); Poggio & Vrscaj (2009); Hossain (2006). Calderon, Ortiz-Perez, Yanez, & Diaz-Barriga (2003) reported that pregnant women and children are the most susceptible to the negative health impacts of heavy metals. Pb, for example, has a wide range of sources of exposure especially, through human activities such as mining, burning fuels and industrial processes (World Health Organisation (WHO), n.d.-b). It is also found in petrol, paints, battery production, solders, stained glass making, some cosmetics and traditional medicines and when lead pipes are being used for water delivery (WHO, n.d.-b). Attendant environmental and health issues in many parts of the world affects many body systems – neurologic, hematologic, gastrointestinal, cardiovascular and renal systems (WHO, n.d.-a). There have been efforts at the international level to eliminate these heavy metals in products and processes, for example, Global Alliance to Eliminate Lead Paint, Global Mercury Partnership, Bamako Convention, Basel Convention. In many developing countries because of the economic situation, latest technologies designed to reduce exposure to these heavy metals are not affordable or available. Furthermore, deficiencies in enforcement as in the case across SSA and Nigeria have led to importation and usage of obsolete technologies and even banned (across many high income countries) products/chemicals. This has further exacerbated exposure to heavy metals and other contaminants across the region. For example, in the City of Port Harcourt in Nigeria, annual precipitation is about 2,500 mm (between March and October) and water table between 0.6 m (wet season) and 1.2 m (dry season) below ground surface (Nwankwoala & Omunguye, 2013). With this level of water table in the study area (Port Harcourt region) most people dig shallow wells as a source of portable water with the implication that runoff and percolation could contaminate such wells (liquid and solid wastes discharged directly into the environment). Moreover, most citizens do not benefit from pipe borne water utility with just about 10 km useable out of the 190 km pipe network (Water and Sanitation Department, 2014). They also reported that waterborne diseases such as cholera, typhoid and dysentery are common.

From the foregoing, it is pertinent that sources and loads of heavy metals across many cities in SSA need to be characterised. This example will help inform decision making on identification, quantification of risk and management of the human health issue related to heavy metals across the region. To this end, this study seeks to quantify heavy metals' load in one of the important sources (automobile workshop) across many cities in SSA. In order to do this, soil and water around AWs were tested for heavy metals, the relationship among them were examined as well as the level of pollution based on the excess of established guidelines.

2 Materials and methods

2.1 Study area

The study area is the Obio/Akpor local government area in Rivers State, Nigeria. The study area is located within the Niger Delta region of Nigeria. Rivers States has three ecological zones – Mangrove forest and coastal vegetation, fresh water swamp and lowland rainforest and the Mangrove forest and coastal vegetation are the most dominant (Niger Delta Development Commission, 2006). The area is within a coastal plain belonging to sedimentary formation of the Niger Delta (Short and Stauble, 1967). The study area is poorly drained, due to low relief and gentle slopes which makes river flow very low.

The report by NDDC (Niger Delta Development Commission, 2006) provides extensive details about the land and the people of the regions and it serves as a guide for the description of the study area. Pattern of settlement is dominated by the availability of dry land and the nature of the terrain, which has led to the low number of large settlement across the Niger Delta region. However, a big city like Port Harcourt in mangrove swamp developed on islands of dry lands in the interior parts of the Delta with relatively better drainage conditions and accessibility. The region is dominated by agriculture and industries, and across many rural communities, fish and subsistence farming is common. Industries such as food manufacturing, oil servicing, oil and gas, construction and marine industries are also common. AWs are quite common as well and are sited across many parts of the study area located within other land use types such as residential, commercial, etc.

2.2 Sample collection, preparation and analysis

Samples were collected across the study area for 33 out of the 58 AWs identified around the study area. Purposive sampling was adopted based on available resources to conduct the work and the spread of the workshops across the study area. Furthermore, samples of topsoil and water were also collected 100 m away from AWs. These samples were used as background status of heavy metals across the area. From the foregoing, a total of 66 samples (each) for soil and water were collected from the study area.

Samples collected include top soils and water from nearby boreholes. Top soil samples were collected randomly from the AWs selected and

placed in labelled polythene bags. For water sample collection, taps around the boreholes identified (close proximity to the workshops) were allowed to run for 2 minutes before the samples were collected in 2 litres bottles (pre-cleansed with distilled water) and labelled.

Soil samples were air dried and grounded mechanically. The grounded samples were then sieved through a 2 mm mesh sieve, 30 g were taken from this fraction and re-grounded using mortar and pestle. Digestion and heavy metal analysis were carried out following the procedure described by Skoog, West, Holler, & Crouch (2013). Water samples were filtered and stored at 4 ^{o}C until heavy metal analyses were carried. Solutions of water and soil were diluted to 100 ml with distilled water, and concentration of Hg, Pb and Cd in this filtrates were tested using the Atomic Absorption Spectrophotometer (AAS).

2.3 Data analysis

Statistical analysis was carried out using the statistical software (Statsoft Incorporated, 2006). Descriptive statistics were computed for each of the samples (soil and water). An independent sample t-test was also carried out to examine the difference between the content of heavy metals in soil and water. Furthermore, a pollution index (PI) was computed, this index was computed as the ratio between the observed values and the national benchmarks. An integrated indicator of pollution was also computed. This provided a value, which could sum up the level of pollution of the three metal species evaluated in this study. The Nemerow pollution index – NPI (Cheng, Shi, & Zhu, 2007; Liu, Xie, & Chen, 2004) was adopted as the integrated pollution measure. This indicator was computed (Eq. 1) and modified using the pollution index explained above.

$$NPI = \sqrt{\frac{\left(\frac{1}{m}\sum_{i=1}^{m} P_i\right)^2 + P_{imax}^2}{2}} \quad (1)$$

where m is the number of metal species evaluated; P_i – the pollution index computed; P_{imax} – maximum value obtained for P_i. NPI was computed for all the sites as well as the background samples collected. NPI classes ranges from < 0.7 (Safety domain); $0.7 \leq NPI < 1.0$ (precaution domain); $1.0 \leq NPI < 2.0$ (Slightly polluted); $2.0 \leq NPI < 3.0$ (Moderately polluted) and $NPI > 3.0$ (Heavily polluted).

3 Results and discussion

3.1 Descriptive statistics and comparative analysis

Across the selected the AW, the mean Hg content in the soil is below the benchmark set by the DPR (Table 1). The highest frequency was observed for values ranging between 2 and 3 mg kg^{-1} (9 sites), 8 sites were found to have between 1 and 2 mg kg^{-1} of Hg in their soil and there were 3 sites with means between 4 and 5 mg kg^{-1}. At the extreme – between 5 and 6 mg kg^{-1} – there are 4 sites, similarly there are 4 sites found with Hg ranging between 3 and 4 mg kg^{-1}.

Table 1. Descriptive statistics of heavy metal content in soil and water samples.

Metal Species / **Statistics**	**Mercury**		**Lead**		**Cadmium**	
	Soil	**Water**	**Soil**	**Water**	**Soil**	**Water**
	(mg kg^{-1})	**(mg/l)**	**(mg kg^{-1})**	**(mg/l)**	**(mg kg^{-1})**	**(mg/l)**
Mean	3.073±1.609	0.063±0.126	91.033±47.620	0.114±0.219	5.630±3.690	0.131±0.245
Minimum	0.500	0.010	4.900	0.010	1.100	0.010
Maximum	6.000	0.710	205.500	1.050	14.000	1.200
Guideline values	12/50b	0.006a 0.001b	70/600b	0.01ab	3.8/22b	0.003a 0.005b

[a] – WHO Guidelines for Drinking Water Quality, 4th Edition (2011); [b] – Department of Petroleum Resources of Nigeria (DPR) Maximum allowable concentration of metals in soils – natural/industrial land use (2002).

For Pb, the mean value is considerably higher (91 mg kg^{-1}) than the DPR benchmark of 70 mg kg^{-1}. This is attributable to the high values obtained in 28 out of the 33 sites (with values ranging from 50 mg kg^{-1} to 205 mg kg^{-1}). The remaining 5 sites have Pb content lower than 50 mg kg^{-1}. In the case of Cd, the mean value also exceeded the DPR benchmark. Soils across the sites have values ranging between 1 and 14 mg kg^{-1}, while 19 sites have values between 4 and 14 mg kg^{-1} of Cd.

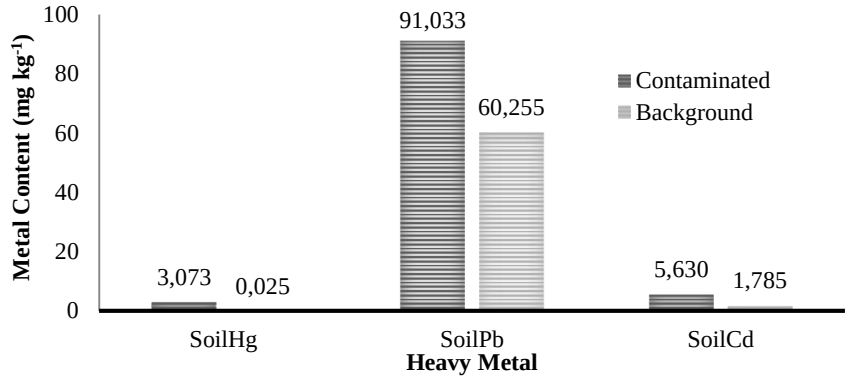

Figure 1. Comparative bar chart of heavy metal content in background and contaminated top soils.

A comparison of the mean heavy metal contents of the contaminated soils at the AW with that of the background soil (Fig. 1) shows considerable differences. For example, average Hg content of contaminated soils of the AW is about 99% higher than that of the background soil while Cd content is about 68% higher in the contaminated soils. The average Pb content of background soils is lower than the benchmark value. However, average Pb content of contaminated soils shows an elevation of about 34% compared to the background soils.

The levels of Hg in the soil are within tolerable limits, however, with all the AWs around residential and commercial areas where access is not restricted, there is a risk that prolonged exposure as predicated by this scenario could have a considerable human health impact (for tradesmen and local communities). The same could be said of Pb and Cd, but the situation is even more precarious with very high Pb values across most sites.

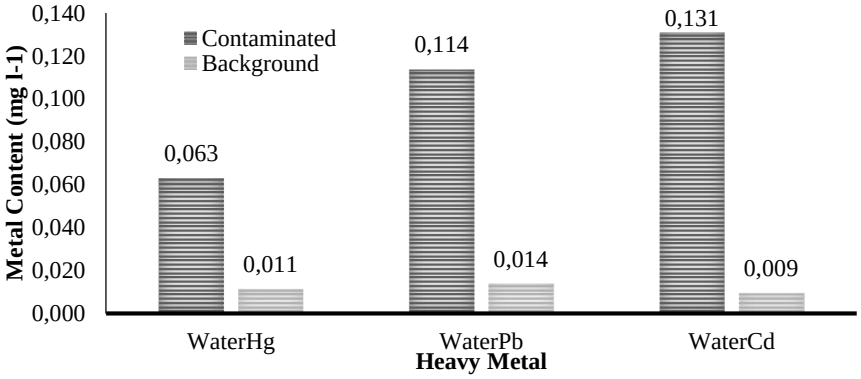

Figure 2. Comparative bar chart of mean heavy metal content in background and contaminated borehole water samples.

Heavy metals load in these soils could be attributed to sources and activities taking place at most of the AWs. For example, Cd is usually present in the pigments in paints for the car body works, plastics, glass, welding electrodes used by "panel beaters" (body works specialists), combustion of petroleum products, etc. Battery specialists, "battery chargers" as they are called across Nigeria, are usually present around AWs, and they are a major source of Pb. Other sources is gas exhaust of most automobiles under service at these AWs (use of leaded petrol and additives are still common). Hg is relatively lower across the site, and this could be attributed to its limited use compared to Cd and Pb. However, Hg sources in automobiles include safety switches and relays in trunk/hood light switches, relays to control power to pumps and heaters, relays (with mercury switches) to control airbags, anti-lock brakes, some seat belt and suspension systems and suspension system (Green, n.d.). The elevation of these heavy metals in comparison to background level gave an indication that activities within the AWs are responsible for this. With the enumeration of likely sources at the workshops mentioned above it is no surprise that such elevated level of heavy metals content in the soils was observed.

Heavy metal contents in the water samples from nearby boreholes (Table 1) show that average values exceeded the DPR benchmark for all the metal species measured. Hg contents of water samples across the 33 sites fell under three ranges with 27 sites having values between 0.010 mg l^{-1} and 0.100 mg l^{-1}, 5 sites have values between 0.100 mg l^{-1} and 0.200 mg l^{-1} and one site has the value of 0.710 mg l^{-1}. In the case of Pb, 30 have values between 0.010 mg l^{-1} and 0.200 mg l^{-1} (with 4 having the same value as the benchmark) and there is one site each in the range of 0.400–0.600 mg l^{-1}, 0.600–0.800 mg l^{-1} and 1.000–1.200 mg l^{-1}. None of the sites have Cd content within the limits specified by the DPR, 28 sites have values between 0.010 mg l^{-1} and 0.200 mg l^{-1}, 4 within 0.400 mg l^{-1} and 0.600 mg l^{-1} and one site with 1.2 mg l^{-1}.

Comparison of the average background and contaminated water samples show that there are marked differences between the water samples in relation to their heavy metal content (Fig. 2). Mean Hg content of the contaminated water sample is about 82% higher than that of the background level. There were elevations of about 89 and 93% respectively for Pb and Cd when background values were compared to the contaminated sites (AW).

These marked differences between the background values and the samples of contaminated soils and water gave an indication that activities at the AWs are responsible for these differences. Furthermore, t-test analysis shows that the means of metal contents in the water sample (for all the metal species) statistically differ from the means of the metal contents in soil. This could be attributed to the behaviour of these metals in the soils. According to Shuman & Luxmoore (1991) metals could enter into one or more of the seven pools in the soil. They could (a) dissolve in the soil solution, (b) occupy exchange sites on inorganic matter of soil, (c) associate with insoluble soil organic matter (SOM), (d) be adsorbed on organic soil matter, (e) precipitate as mixed or pure solids, (f) enter into the secondary mineral structure and/or (g) enter into the primary mineral structure. Most of human activities will probably lead to the metal entering into any of the first five pools. The content of heavy metals in these pools is dynamic and will depend on various factors. Consequently, the amount that reaches the groundwater will also varies accordingly, but will not be directly related to the total amount available in the soil. SOM, pH, clay mineral content affect the adsorption and mobility of Cd, which could consequently affect the quantity of the total Cd got into the groundwater (McLean & Bledsoe, 1996).

3.2 Analysis of Integrated Pollution Measure

NPI values show (Table 2) that all the water samples from and around the AWs are heavily contaminated (i.e. NPI values > 3). In the case of the background samples, about 55% of the samples are seriously polluted while about 21% of them are in the precaution domain or slightly polluted domain, and one site is moderately polluted.

Table 2. NPI values and classification across water samples collected.

S. N.	AWs Water Samples		Backgroundwater Samples	
	NPI	**NPI Description**	**NPI**	**NPI Description**
1	81.417	Seriously Polluted Domain	11.113	Seriously Polluted Domain
2	91.982	Seriously Polluted Domain	9.416	Seriously Polluted Domain
3	115.765	Seriously Polluted Domain	7.765	Seriously Polluted Domain
4	25.577	Seriously Polluted Domain	0.884	Precaution Domain
5	9.354	Seriously Polluted Domain	1.143	Slightly Polluted
6	230.203	Seriously Polluted Domain	90.852	Seriously Polluted Domain
7	95.143	Seriously Polluted Domain	1.844	Slightly Polluted
8	11.431	Seriously Polluted Domain	1.208	Slightly Polluted
9	584.464	Seriously Polluted Domain	114.948	Seriously Polluted Domain
10	101.181	Seriously Polluted Domain	16.433	Seriously Polluted Domain
11	19.816	Seriously Polluted Domain	8.421	Seriously Polluted Domain
12	44.952	Seriously Polluted Domain	0.991	Precaution Domain
13	86.727	Seriously Polluted Domain	8.510	Seriously Polluted Domain
14	11.754	Seriously Polluted Domain	0.991	Precaution Domain
15	9.626	Seriously Polluted Domain	0.909	Precaution Domain
16	25.351	Seriously Polluted Domain	8.227	Seriously Polluted Domain
17	15.237	Seriously Polluted Domain	1.824	Slightly Polluted
18	10.198	Seriously Polluted Domain	0.909	Precaution Domain
19	20.396	Seriously Polluted Domain	0.991	Precaution Domain
20	18.225	Seriously Polluted Domain	2.160	Moderately Polluted
21	166.231	Seriously Polluted Domain	4.050	Seriously Polluted Domain
22	66.151	Seriously Polluted Domain	3.329	Seriously Polluted Domain
23	18.708	Seriously Polluted Domain	5.161	Seriously Polluted Domain
24	12.754	Seriously Polluted Domain	1.898	Slightly Polluted
25	69.296	Seriously Polluted Domain	5.715	Seriously Polluted Domain
26	9.908	Seriously Polluted Domain	0.997	Precaution Domain
27	19.253	Seriously Polluted Domain	1.080	Slightly Polluted
28	19.816	Seriously Polluted Domain	3.512	Seriously Polluted Domain
29	99.439	Seriously Polluted Domain	7.812	Seriously Polluted Domain
30	44.452	Seriously Polluted Domain	1.818	Slightly Polluted
31	86.282	Seriously Polluted Domain	4.224	Seriously Polluted Domain
32	85.561	Seriously Polluted Domain	3.561	Seriously Polluted Domain
33	21.602	Seriously Polluted Domain	20.261	Seriously Polluted Domain

In the case of soils of the AWs sites, about 48% of the sites are found to be slightly polluted, 30% are moderately polluted while 12% are in the precaution domain and 9% are seriously polluted. For the background soils, the NPI values indicate that only three classes can be found. About 33 of the sites were

in the precaution domain, 37% were slightly polluted and about 30% were in the safety domain.

These results indicate that water around the AWs is seriously affected across the study area with all the water samples showing heavy pollution. This could be a result of the sandy nature of the soils across the region as well as the high water table, which made it possible and considerably easier for runoff and percolation of heavy metals into the groundwater. Furthermore, 100 m away from the AWs sites (background sample sites) water samples are also considerably polluted with more than half of the water samples showing moderate to heavy pollution. Thus, this indicates that there are other sources of pollution across the region. Exhaust from combustion engines (automobiles and power generating sets), burning of refuse, indiscriminate dumping of refuse, extensive industrial activities (metal construction, welding, metallurgy, etc.) taking place across the study could be responsible for this level of pollution.

Table 3. NPI values and classification across soil samples collected.

S. N.	AWs Soil Samples		Background Soil Samples	
	NPI	**NPI value description**	**NPI**	**NPI value description**
1	1.266	Slightly Polluted	0.965	Precaution Domain
2	2.250	Moderately Polluted	1.065	Slightly Polluted
3	1.477	Slightly Polluted	0.965	Precaution Domain
4	1.257	Slightly Polluted	0.604	Safety Domain
5	0.892	Precaution Domain	0.583	Safety Domain
6	2.074	Moderately Polluted	0.964	Precaution Domain
7	2.838	Moderately Polluted	1.155	Slightly Polluted
8	1.347	Slightly Polluted	0.666	Safety Domain
9	1.190	Slightly Polluted	0.789	Precaution Domain
10	0.721	Precaution Domain	0.292	Safety Domain
11	0.957	Precaution Domain	0.642	Safety Domain
12	1.648	Slightly Polluted	1.016	Slightly Polluted
13	1.596	Slightly Polluted	0.742	Precaution Domain
14	3.313	Seriously Polluted Domain	1.177	Slightly Polluted
15	2.275	Moderately Polluted	0.738	Precaution Domain
16	1.276	Slightly Polluted	0.499	Safety Domain
17	1.378	Slightly Polluted	0.967	Precaution Domain
18	2.983	Moderately Polluted	1.427	Slightly Polluted
19	2.455	Moderately Polluted	1.095	Slightly Polluted
20	3.054	Seriously Polluted Domain	0.920	Precaution Domain
21	2.052	Moderately Polluted	1.032	Slightly Polluted
22	2.488	Moderately Polluted	1.169	Slightly Polluted
23	1.218	Slightly Polluted	0.207	Safety Domain
24	1.734	Slightly Polluted	0.618	Safety Domain
25	1.463	Slightly Polluted	0.839	Precaution Domain
26	2.223	Moderately Polluted	0.869	Precaution Domain
27	1.884	Slightly Polluted	1.184	Slightly Polluted
28	1.490	Slightly Polluted	0.849	Precaution Domain
29	2.414	Moderately Polluted	1.073	Slightly Polluted
30	0.733	Precaution Domain	0.267	Safety Domain
31	1.507	Slightly Polluted	1.038	Slightly Polluted
32	3.290	Seriously Polluted Domain	1.490	Slightly Polluted
33	1.293	Slightly Polluted	0.512	Safety Domain

The level of pollution observed in the soils of the contaminated sites (88% of the site have NPI classes ranging between slightly and heavily polluted) shows (Table 3) that there is a need for concern. This and the level of access to these sites pose serious risk to human health. This is an alarming trend due to the pervasiveness and the interconnection between these AWs and local communities. People and domestic animals have access to these AWs, which increase their exposure to consumption or inhalation of these contaminants.

There is a contrast in the level of pollution in the background soils, where most of the soil has NPI classes ranging between the safety domain and the slightly polluted domains. Thus, it is evident that there is an influence of the AWs on the level of pollution with heavy metals, and this impact decreases as we move away from the AWs, but other activities further contribute to heavy pollution at these sites.

4 Conclusions

From the analysis of the samples across the study area, it is evident that soil and water around the AWs are more polluted than the surrounding/background soil and water. This is an indication of the impact of AWs as a major source of heavy metals into the soil and water in the study area. Average concentration of heavy metals in soil across the AWs sites is considerably higher than that of the

background site, i.e. 3.073 mg kg^{-1} vs 0.025 mg kg^{-1} (Hg) and 91.033 mg kg^{-1} vs 60.255 mg kg^{-1} (Pb). Mean water with Hg (0.063 mg l^{-1}), Pb (0.114 mg l^{-1}) and Cd (0.131 mg l^{-1}) for AW sites when compared to 0.011 mg l^{-1}, 0.014 mg l^{-1} and 0.009 mg l^{-1} for Hg, Pb and Cd respectively across the background sites shows a clear indication that AWs contribute to water pollution across the study area. Thus, we can conclude that groundwater and soils were considerably impacted by pollution. This implies that there is a high risk of groundwater pollution as a result of heavy metal contamination from AWs.

The average content of Pb, Hg and Cd were found to be considerably above the benchmark values in soil as well as water. Although AW samples had elevated heavy metal content, background samples were also found to be considerably polluted. Across the study area and across the two sample sets, Hg is comparatively low across the study area (Soil mean = 3.073 mg kg^{-1} and Water mean = 0.063 mg/l); this could be attributed to a lower number of sources and uses across the study. However, Pb and Cd were higher compared to the benchmark value, and this could be attributed to the presence of this metal across many materials and articles handled within the AWs. The average concentration of all the heavy metals is found to be multiple of that found in the background areas. With these very high values (Fig. 1 and Fig. 2) it is possible to conclude that AWs are a contributor of note to heavy metal contamination across the sample sets (soil and water) of the study area.

The pollution index adopted (NPI) showed that all the soils across AWs can be classified as heavily polluted because all soil samples analysed showed high concentration of heavy metals. This index also showed that there is a considerably high level of pollution in the background areas (soils). Thus, with about 88% of the sample area (soil) falling between slightly polluted and heavily polluted, we could conclude that there is an extensive risk of exposure and consequently significant impact on human health. Furthermore, there is no direct relationship between the total content of heavy metals in soil and that of heavy metals in groundwater. This is an indication that there is a need to identify and quantify which pool ends up in the groundwater and which factors influence this dynamics.

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Tipinėje Užsachario Afrikos aplinkoje esančių automobilių dirbtuvių tyrimas taršos sunkiaisiais metalais atžvilgiu

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Daugelyje Užsachario Afrikos miestų sparčiai didėja automobilių dirbtuvių skaičius. Dažnai tokios dirbtuvės įsikuria netoli gyvenamosios ar komercinės paskirties žemės. Šių įmonių veikloje naudojama ir į aplinką išmetama daug sunkiųjų metalų, o šie kelia riziką žmonių sveikatai. Siekiant ištirti įmonių sukeliamą taršą sunkiaisiais metalais, šiame tyrime buvo analizuojami automobilių dirbtuvių teritorijose paimti dirvožemio ir vandens mėginiai.

Nustatyta, kad dirvožemio mėginiuose vidutinė Hg, Pb ir Cd koncentracija buvo atitinkamai 3,073, 91,033 ir 5,630 mg kg^{-1}, ir tik Hg koncentracija buvo mažesnė už leistiną normą. Vandens mėginiuose vidutinė Hg, Pb ir Cd koncentracija buvo atitinkamai 0,063, 0,114 ir 0,131 mg/l. Dirvožemio mėginiuose Hg, Cd ir Pb koncentracija buvo vidutiniškai 99, 68 ir 34 % didesnė negu etaloniniuose mėginiuose, o vandens mėginiuose – atitinkamai 82, 89 ir 93 % didesnė. Nemerovo taršos indeksas (NTI) parodė, kad visi paimti vandens mėginiai buvo smarkiai užteršti sunkiaisiais metalais, nes 88 % dirvožemio mėginių pateko į *lengvai* arba *smarkiai užterštο* dirvožemio ribas. 55 % etaloninių vandens mėginių buvo smarkiai užteršti, ir tik 30 % dirvožemio mėginių pateko į saugiomis laikomas NTI ribas. Tyrimas parodė, kad automobilių dirbtuvės kelia rimtą pavojų žmonių sveikatai, ir tai yra požymis, kad padidėjusi sunkiųjų metalų koncentracija dirvožemyje gali turėti įtakos gruntinio vandens sudėčiai. Kad būtų galima sukurti efektyvias taršos kontrolės priemones, reikia aiškiai identifikuoti ir kiekybiškai išreikšti dirvožemyje esančius sunkiuosius metalus, lemiančius požeminiame vandenyje esančių sunkiųjų metalų lygį.

Raktažodžiai: *sunkieji metalai, automobilių dirbtuvės, taršos indeksas, Užsacharės Afrika, aplinkos monitoringas.*