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RESEARCH ARTICLE

CORRELATION INVESTIGATION OF HEAVY METALS COMPOSITION OF CLASSROOMS' DUST: A CASE STUDY OF DODOMA MUNICIPAL PRIMARY SCHOOLS

Miraji Hossein[1]* and Ladislausi Patricia[1] and Ngassapa FN[2]

[1]Department of Chemistry, School of Physical Sciences, College of Natural and Mathematical Sciences, University of Dodoma, P. O. BOX 338, Dodoma, Tanzania
[2]Department of Chemistry, College of Natural and Applied Sciences, University of Dares Salaam, P.O.BOX 35061, Dares Salaam, Tanzania

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A B S T R A C T

Exposure to heavy metals has been a source of many unexpected health effects. Toddlers are even more prone to heavy metals contamination based on childhood behaviors, high absorption rate and rapid organs development. In order to establish toddler exposure risks, dust samples obtained from three Primary Schools were analyzed by using GF-AAS. High amounts of Zn, 126.12 and 95.33 ppm found at Mazengo and Mlezi respectively. Amani Primary School observed to have high amounts of Cr,53.23 ppm while Cd was the least, 0.85 ppm. There were no significant differences among the schools since the computed t-test values, ≤ 1.0 were smaller than critical value, 2.571.High positive correlation for Zn with respect to other metal observed at Amani while Mazengo had mostly negative correlation. The same high correlation for Zn/Metal observed among most classrooms. These findings indicated uniform and similar pollution patterns for these schools. Presence of these heavy metals in the classroom dust implicated high risks and vulnerability that was descending from nursery to upper classes.

INTRODUCTION

General Introduction

Dust contains several particulate materials in the atmosphere that originates from soil, weathering and pollution. Its solid particulates matters are in the form of fine powder with less than 100 µm which may be on the ground, surface of objects or blown about by natural forces Mohd *et al*. (2014), Adekola and Dosumu(2001). Apart from presence of pollen, hairs, woods, fibers, papers, minerals and seeds in the dust, road dust contains vehicle exhausts, tire and break wares as well as dust from construction or paved roads Gunawardana *et al*.(2012). Effects of dusts include transport of airborne pathogens, allergic reactions, cardiovascular system diseases, asthma, sneezing, coughing, irritation of the eyes, pneumonia, poor visibility, reduction of agriculture productivity and increasing maintaining costs for mechanical tools Bo *et al*.(2013). Luilo and Othman (2006) reported the presence of lead in the soil and grasses along the main roads of Dar es Salaam. Since heavy metals undergo bio-accumulation/concentration, long-term exposure is related to renal failure, cancer cases, liver and nerve tissue damage, anemia, stomach and intestinal irritation, tremors, gingivitis and/or minor psychological changes, together with spontaneous abortion and congenital malformation. Extreme conditions lead into chronic diseases Sampson *et al*.(2012).Other reported composition of dust is heavy metals Al-Khashman (2007). Heavy metals like Cu, Se, and Zn are essential for metabolic activities at very low concentration, however in the elevated amounts result into toxicity Richard *et al*. (2014).

Enclosed building like classrooms get dusts though infiltration from outdoor sources, smokes, building and furniture materials, consumer products and occupants activities Al-Rahji and Seaward(1996). As these classrooms being a concentration point of dusts, heavy metals are unavoidable. Thus toddler can easily ingest these dusts since much of their time is spent in contact with floors, engaging in mouthing of hands, toys and other objects or consumption of contaminated food Zongmin (2013). Hence this manuscript addresses the extent to which toddlers are exposed into heavy metals from indoor classroom dusts of the three selected primary schools.

METHODOLOGY AND MATERIALS

Study Area

Mazengo, Amani and Mlezi Primary Schools located at Dodoma Municipal were selectedas sampling areas as shown in the Figure 1. Theseschools arelocated in the residential areas near by main roads. Fifteen composite dust samples were collected during the wet season of February 2013. Samples were collected from windowsills, bookshelves and at corners of each five classrooms of the three schools; namely Nursery (NU), STD I, STD II, STD III and STD IV. Samples collected by careful sweeping an area, mixed together to form composite sample then packed into polyethylene bags for transport.

All samples were air-dried at Geological Survey of Tanzania laboratories for 24 hours, then homogenized with mortar and pestle. Digestion of 1 g of the samplein 20 mL of acid involved heating at 180 ˚C and 120 psi for 10 min. Digests were filtered through Whatman 125 filter paper into 100 mL volumetric flasks. Each filtrate filled with distilled water to the mark, to give a final sample solution containing 20% (v/v) aqua regia.

Stock solution standards were prepared from certified standard solutions. Shimadzu AA-6300 Graphite Furnace Atomic Absorption Spectrophotometer (GFA-EX7) fitted with an auto-sampler used for determination of the heavy metals contentAdachi and Tainosho (2004). Quality assurance was observed by using standard sampling protocol, certified standards and furthermore analytical grade reagents were used.

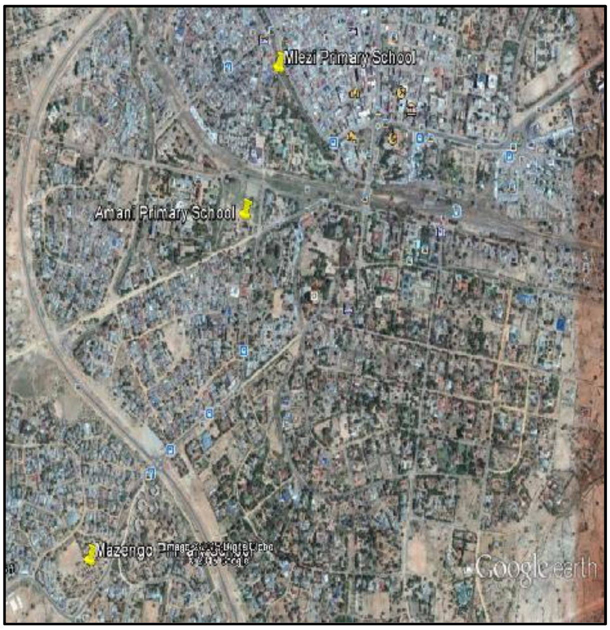
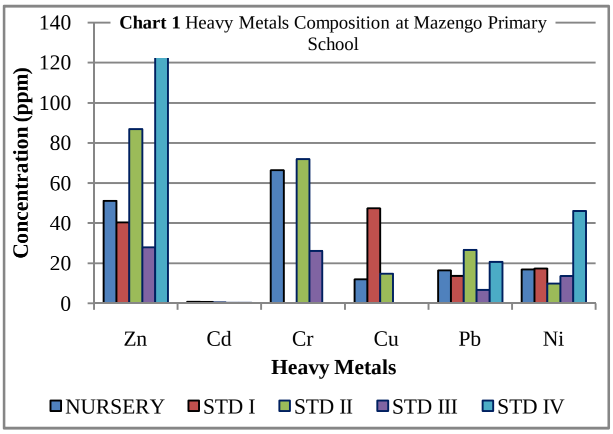


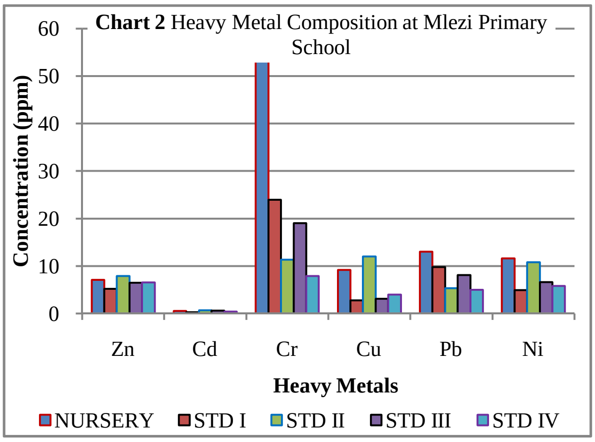
Figure 1 Map of Dodoma Municipal Showing Sampling Areas

RESULTS AND DISCUSSION

All collected data in this case have been presented in Charts 1-3 which show amounts of heavy metals and their variations from each school and each classroom. Chart 4 indicates t-test values for each type of metals among the three schools. T-test determines if two sets of data are significantly different from each other. If the difference is small they come from the same population and if the difference is large then they come from two different populations. Chart 5 shows the existing correlations between classes of each three schools. Chart 6 shows the existing correlation between metals with high concentrations. Correlation analysis indicates the effects of changing one parameter against the other, and/or existing relationship between the parameters.

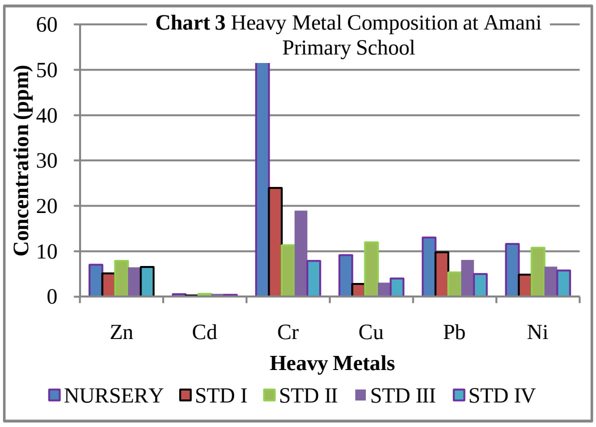
Significant amounts of heavy metals were found at Mazengo primary school as indicated in Chart 1. Zinc was the highest





followed by Cr, Cu, Pb, Ni and then Cd which was the least. Nursery classroom had large amounts of these metals compared to other classrooms.

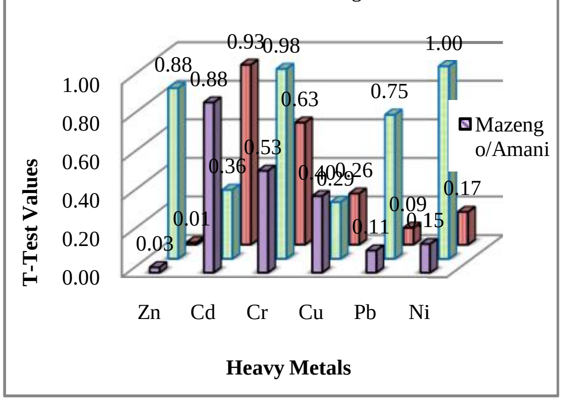
The high amount of Zn found in Mazengo as well as other primary schools (Chart 1-3) were the results of zinc released in tiny particulates of rubber tires on road surfaces which is also reported by Nur *et al*. (2014). Their small size allowed easy blown by winds. The concentration of Cd for all investigated classrooms was above the average concentration in the earth's crust which is about 0.2 g/g. The Cd concentration was higher in nursery classroom due to the fact that these classrooms are closer to the roads than others. In addition nursery students are very active, always playing on the soil and transported dusts which accumulate in their classrooms.



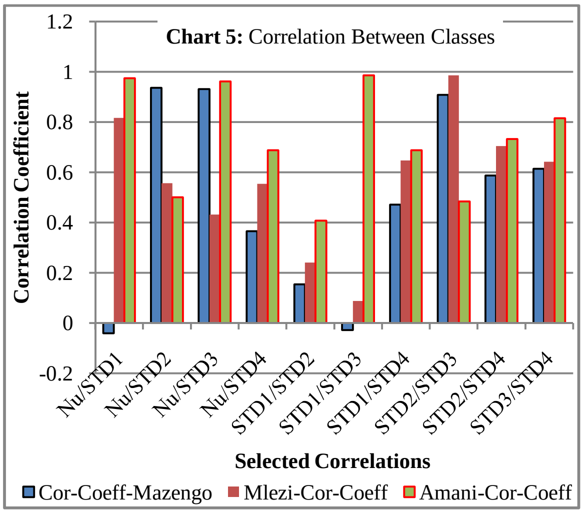
The quantity of Cr in classroom dusts was higher than what obtained for Pb. Cr was detected in most classroom dust, having the highest concentration of 33.258 ppm at Mlezi primary school. This was because its classrooms were surrounded by roads as well as garages. Near by garage activities might be responsible for the high obtained values. Copper contents were fairly different for all schools because its occurrence in the environment is by both natural and anthropogenic based. Examples of natural sources are wind-blown dust, decaying vegetation and forest fires. A few examples of human activities that contributed to copper release are waste disposal. Copper concentration at Amani primary school was lower than Mazengo while at Mlezi primary school was higher than Mazengo and Amani primary schools due to the waste disposal from the garage near to Mlezi. The high levels of lead were found at Mlezi primary school due to the results of paint chippings from old peeled paints. The contents of nickel were higher than what obtained for Cu because nickel is a natural element of the earth's crust, thus its presence is common.

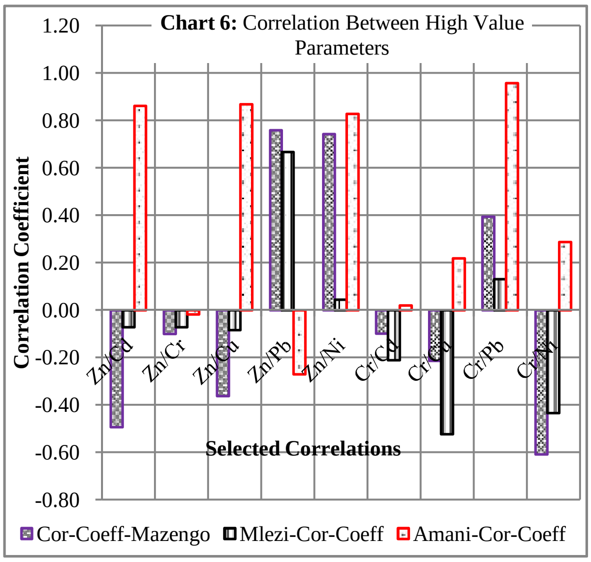
The t-test computational output is presented in Chart 4.The computation involved each particular type of metal in the respective school in order to establish the existing relationships between the schools. The degree of freedom was 5, 2 tailed sample at a probability of 0.05. It was observed that all computed t-test values were less than 1.0 compared to critical value of 2.571. Moreover computed values were less than critical value even at different probability levels. Since the compute values were less than critical values hence null-hypothesis is retained. This means that there was no significant difference among the collected data in the three schools.

Chart 4: T-test evaluation among the Schools



Correlations between classrooms are presented in Chart 5. Apart from very small negative correlations observed between NU/STD1 and STD1/STD3 the rest classes had positive correlations. A small negative correlation (< - 0.1) suggested that the relationship between compared classrooms were weak. The obvious reason is that these classes were not under the same building hence behaved differently. There were no a perfect correlation, however some of them in Chart 5 had high correlation coefficient ≥ 0.7. It was an indication that changing from one class to another resulted in the changing of heavy metals content. Amani primary school was leading in high values of positive correlation, followed by Mlezi then Mazengo. Further observations in Chart 6 were the correlation between metals with high recorded concentrations. Fewer had positive correlations while most of them had negative correlations. This was evidence that there was no relationship between the concentrations of one metal to another.





CONCLUSION AND RECOMMENDATIONS

Dusts have been proven being the causative agent of many diseases. Its presence in the studied areas and the presence of heavy metals implicated potential health risks. Thus to overcome dust sources use of wet processes is encouraged, inclosing of dust-producing processes, treatment of exhaust before getting into atmosphere, using vacuum instead of brooms, adopting effective storage and transport, good housekeeping and controlled disposal of toxic materials. Use of personal protection equipment is highly encouraged particularly in the indoor processes. Good indoor keeping practice such as frequent wet mopping and good maintenance of the ventilation system by closing those windows facing major roads should be taken into consideration in order to reduce exposure to dust. Also the use of marker pens should be taken into consideration in order to reduce the amount of dusts from chalks. Adaptation of planting more threes in our areas which apart from other advantages trap dusts is suggested being a long term plan.

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