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An Evaluation of Heavy Metals Concentration at an Open Dumpsite in Borno and Remediation Techniques

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Abstract: *Dumps item leachate is known to contain several heavy metals which are detrimental to human health and the environment. Heavy metals constitute an ill-defined group of inorganic chemicals that are hazardous at certain levels of concentration. There is abundant evidence to show that heavy metal concentration can contaminate groundwater and soil and may pose hazards to humans and the ecosystem through direct ingestion or contact with contaminated groundwater and soil and ultimately results in a reduction in food quality (safety and marketability) via phytotoxicity, reduction in Land usability for agricultural production causing food insecurity and land tenure problems. Lead (Pb)and Zinc with an average value of 1.38mg/L and 2.398mg / L respectively, are the two heavy metals whose concentrations are elevated and beyond the recommended level by NESREA, FedMinEn, and the WHO in the study undertaken and adequate remediation are proffered to curtail their detrimental effects on human and the environment. The average ranking of the heavy metal concentration in the leachate Lead(Pb)(2.198mg/L)>Zinc(Zn)(1.38mg/L)>Iron(Fe)(0.58mg/L)>Chromuim(Cr)(0.23mg/L)>Copper(Cu)(0.12mg/L).*

Key words: *Concentration, Environment, Heavy Metals, and Leachate*

INTRODUCTIONS

Leachate is a complex mixture of organic, inorganic, and many unidentified toxicants which may pose a lot of risks of unknown magnitude to aquatic and human life. There are numerous health implications due to illegal waste dumping in public places and a lack of proper solid waste management.

Dumpsite leachate contains high levels of Heavy metal which ultimately contaminate either groundwater, soil, surface water, or both owning to infiltration and surface runoff. These heavy metals have no usefulness to human life and may be toxic even at trace concentrations and ultimately cause serious health concerns. Heavy metals constitute an ill-defined group of inorganic chemical hazards. Heavy metals contamination of groundwater and soil may pose risks and hazards to humans and the ecosystems through direct ingestion or contact with contaminated groundwater, reduction in food quality

(safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity and land tenure problems. The ranking of the average concentration for Bulumkutu open dumpsites shows Lead(Pb)1.798mg/L> Iron (Fe)0.784mg/L>Zinc(Zn)>chromium(Cr)0.23mg/L>Copper(Cu)0.12mg/L. Based on the ranking, Lead(Pb) is the most important trace metal of concern at Bulumkutu open Dumpsites

RESULTS AND DISCUSSIONS

Heavy metals accumulations in wastes at dumpsites affect soil and groundwater and release concentrated leachate into the environment which further affects the food chain resulting in causing detrimental health consequences to human and aquatic life. Heavy metals when accumulated may cause serious health hazards and environmental problems because of the poisonous effects of these metals on plants and the potential health implications to humans and animals consuming such vegetables from those dumpsites.

Heavy metals elevated concentrations existed in most dumpsites at an environmentally dangerous level. According to Abbas et al (2019), municipal solid wastes may increase the concentration of heavy metals in soil and groundwater. This may have consequences on human health, host soil, and crops. This clearly shows that the environmental impacts of municipal solid wastes are influenced by their heavy metals content. The damage to the environment with regards to heavy metals comes from various sources which can be classified as urban industrial aerosol liquid and solid wastes from man and animals. mining industries and agricultural chemicals. Heavy metals (HMs) are mostly present in electronic wastes especially copper from wires Cr, Ni, Zn. Cd and Pb, including other metals and elements that are rare on the earth's crust.

Table 1.0 Measured Heavy metals at the Bulumkutu open Dumpsites

DISTANCE(m)	5	10	15	20	25
Zinc (Mg/l)	2.96	2.1	0.88	0.48	0.48
Chromium (Mg/l)	0.62	0.1	0.1	0.12	0.21
Iron (Mg/l)	0.42	0.44	0.34	1.47	1.25
Copper (Mg/l)	0.24	.17	0.02	0.09	0.08
Lead (Mg/l)	3	2.94	3	1.2	2.85

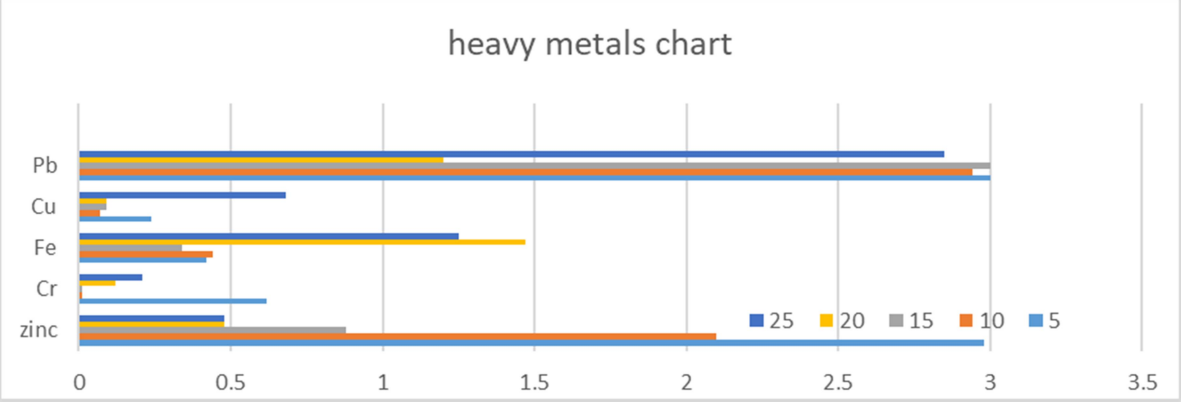

Table 1.2 NESREA LIMITS FOR LEACHATE PARAMETERS AT DUMPSITE

PARAMETERS	Pb	Cd	Cu	Fe	Na+	Cl	Arsenic	BOD	COD
MAX.LIMITS	0.1	0.01	0.01	0.5	2	250	0.05	6	30

The concentrations of Zinc(Zn) at 5,10,15,20, and 25m are 2.96 mg/L, 2.10 mg/L, and 0.88mg/L. 0.48mg/l, and 0.48mg/L respectively which is an indication that distance does not significantly affect the level of concentration of Zinc at the Bulumkutu open Dumpsite while the presence of such metals can be attributed to the presence of old scraps of metals and other Zinc element related materials at the dump site.

The observed concentrations of chromium of 0.62mg/L, 0.1mg/L, 0.1mg/L, 0.12mg/L and 0.21mg/L at a distance of 5, 10, 15, 20, and 25m at the dumpsite show evidence of the presence of wastes from the nearby leather tanneries workshops, local textile industries, and some electroplating and steel moulding activities within the vicinity of the dumpsite. The observed concentration of lead(Pb), is 3.0mg/L 2.94, mg/L 3mg/L,1.2 mg/Land 1.85mg/L at 5,10,15,20 and 25m away from the dumpsite can be attributed to lead acid-batteries, plastics, and rubber remnants, lead foil such as bottle closures, used motor oil and discarded electronic gadgets.
The observed concentration of copper (Cu) in the leachate sample at distances of 5,10,15,20 and 25m are 0.24mg/L,0.17mg/L,0.02mg/L,0.09mg/Land0.08mg/L respectively, the presence of copper in the dumpsite leachate can be attributed primarily to the products of photovoltaic solar cells. discarded old plumbing pipes and electrical cables.

High concentration of copper is a health threat as it is established that elevated levels can cause metal fumes fever with flu-like symptoms, hair and skin decolonization, dermatitis, irritation of the upper respiratory tract, metallic taste in the mouth, and nausea. Iron was observed to be of less concentration at a distance of up to 15m before it raises at 20m and slightly decreases. This can be attributed to the timespan required by its sources to decompose and contaminate the leachate. Primary sources can be discarded rods, metal scraps, etc which are reported to increase the presence of a high concentration of iron in leachate.

High concentrations of iron in leachate samples have been reported to increase the odor and color of the leachate solution thereby increasing its detrimental effects on the receptor where its taste, odor, and color are greatly distorted as reported by Moore et al,2007, Longe and Emekwohie,2017.
The observed average value for the iron in the leachate sample is 0.784mg/L which is higher than the prescribed permissible limits by NESRE of 0.5mg/L and less than the FedminEnv standard of 1.0mg/L. However, the average observed value is within the limit of the FedminEnv for discharge and may not be a cause of concern for its discharge NESREA and the FEDMinEnv are having similar and near-equal maximum limits for leachate parameters at dumpsites to be discharged to receiving bodies as stipulated in the constitution. Environmental experts are concerned about the unhealthy proliferation of dumpsites in the country without commensurable measures to curtail the effects of such on human health and the environment.

DECREASE OF LEACHATE STRENGTH WITH TIME

The degradation of the MSW over time and space results in the production of leachate that easily migrates within the water table underground, Leachate is a liquid that has seeped through solid wastes in a landfill/Dumpsite and has attracted soluble dissolved /suspended materials in the processes.

The volume of leachate generated is expected to be very high in humid regions with high rainfall or run-off and shallow water table. Any movement of the potential impacts of a landfill on groundwater quality requires consideration of the components of the leachate most likely to cause an environmental impact as well as the sources of concentration of those components. Leachate characteristics are expected to evolve over time, increasing from initial values to a peak (i.e. maximum value) and then subsequently decreasing as the potential contaminants are either flushed out of the systems (i.e. collected as leachate), biodegraded or precipitated. There is considerable evidence to suggest that the strength of leachate decreases with time. This decrease may be attributed to the biological breakdown of organic compounds to simpler compounds /elements .it can also be due to dilution effects .it has been recognized that the decline in concentration C with time T can often be empirically approximated by the first-order equation of the form

$$C=Co \exp\{-kt\}$$

Where
Co =is the representative peak source concentration
K= the 1st order constant =ln2/ (half-life)

Based on empirical observations relating to a collection of Dumpsite leachate data establish values of Co and K as shown in the table for ease of reference.

Parameters	Co mg/L	K (a¯1)	Inferred biological/ chemical half –life)(years)
BOD	35000	0.225	4.3
COD	89,000	0.192	5.5
TOC	14,000	0.260	3.6
NH3-N	12,000	0.100	19.8
CL	2,470	0.065	∞
SO4	15,000	0.079	49.5
Cd	0.160	0.125	11.6
Cu	10	0.200	5.1
Cr	0.33	0.900	0.800

The following factors are to be considered in choosing any remediation technique (s) so as to maximize the benefits of the exercise.

a) The most critical factors that will determine the appropriate and effective remediation must include the level of toxicity to reduce, mobility of the toxicity, and volume reduction.

b) Cost, long-term effectiveness /performance
c)commercial availability and general acceptance

Table 2.1 HEAVY METALS IMMOBILIZATION AT CONTAMINATED SITES USING LOCAL AVAILABLE MATERIALS

HMS IMMOBILIZES	**LOCAL MATERIALS**
Cd	Sewage sludge
Cd	Cattle manure
Cd,Cr,Pb	Rice hulls
Cr,Cd	Leaves
Cu.Pb,Zn,and Cd	Poutry manure
Pb	Bagase(from sugar cane)
Cd,Cr,Pb	straw

CONCLUSION

Dumpsites leachates contain a high level of heavy metals which ultimately contaminate either groundwater, surface water, or both owning to infiltration and surface runoff. These heavy metals have no known usefulness to human life and may be toxic even at trace concentrations and can cause serious health concerns to the environment, the presence of heavy metals at the dumpsite is responsible for the toxicity of leachate. The various level of concentration of the selected observed heavy metals at the dumpsite in the leachate sample is capable of having detrimental effects on the health of human and the environment because of the level of concentration of the Lead(Pb)and the Zinc.

Heavy metal accumulation consistently exists at waste dumpsites at an environmentally dangerous level. Municipal waste may increase the concentration of heavy metals. Adequate knowledge of the various sources of contamination and potential risks of the toxic heavy metals in contaminated soil, surface water, and groundwater is essential to enable one to choose some appropriate remediation techniques. It is, therefore, necessary to ensure that the leachate from this dumpsite is treated using any cost-effective and universally acceptable method as advocated here to curtail the effects of the heavy metals on humans and the environment. These advocated labor-based technology is recommended for developing countries in Africa like Nigeria where there is an abundance of such recommended remediation materials for field applicability and commercialization

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