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The Analysis of Concentration of Heavy Metals Detected in Contaminated Non-fertile Soil from Roadsides and Waste Dumping Sites of Kannad City

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ABSTRACT

The study comprises the sampling of contaminated soil from landfill (dumping ground) and roadside sites as well as the analysis of its heavy metal content. Solid waste management is a significant task for both urban and rural places around the world. The main obstacles to managing it are financial limitations and a lack of societal knowledge of trash management. Nowadays, every city, town and municipalities struggles with how to manage the enormous amounts of solid garbage that are produced. The purpose of the current study was to evaluate the soil quality at various roadside locations and open Landfill (dumping grounds). The total of 150 soil samples from six sites were collected from various locations and with top layer and having depths between 15-20 cm. Analysis was carried out for the study of seven heavy metals and the study examines their minimum to maximum values in μg/g from all types of sites are as Pb 5.6-96.3, Fe 1.22-28.65, Zn 11.6- 68.9, Cr 14.6- 154.3, Cu 118.4-268.4, Co 4.22- 69.28, Ni 5.45- 38.3 as pollutants in a soil sample by atomic absorption analysis from Kannad City in the Aurangabad District lies in Marathwada region of Maharashtra. Most of the observed values in the soil samples of dumping sites were above the acceptable ranges.

Keywords : Dumping Grounds, Environmental Toxicity, Heavy Metals, Pollutants , Soil Analysis, Soil Contamination

I. INTRODUCTION

When considering the effects of environmental pollution concern, heavy metals and the majority of organic pollutants are believed to be the most hazardous. The metals are neither perishable nor biodegradable. Heavy metals that are transmitted into the soil will eventually build up and enter the ecosystem or the food chain, harming human health. (Xing and Ching, 2004). Heavy metal soil contamination, particularly with Mn, Cu, Ni, Fe, and Zn, is a risk in high-density, intensively populated places such dumping sites for waste and sludge disposal, with high concentrations of traffic and automotive combustion (Maharaju, 2010). The soil from residential areas is moderately contaminated with Cr, Ni, and Pb, according to the Index of Geo-accumulation, Enrichment, and Contamination Factor

Invariable (Cu to some extent). The agricultural soil showed considerably lower contamination indices, and it is assumed that the removal of hazardous metals from the soil through plant/crop uptake of these nutrients together with some other macro and micro nutrients throughout its growth (Dasaram et al., 2011)

In the majority of Indian cities, open dumping of municipal solid wastes is a common thing, which is detrimental to the ecological aspect and citizens' health. Open dumping is represented as a land clearing area where heavy waste is set off in a manner that doesn't protect the earth. Such areas are exposed to the weather, pests, and foragers and are susceptible to open consumption. Open dumping includes of solid waste disposal facilities or an acts that generates adverse effects on public health or the nearby environment. The physico-chemical characteristics of the soils near dumping sites have a significant impact about how vegetation grows there. The ability of plants to absorb minerals, for instance, is influenced by the soil's structure and acidity, which has a significant impact on the establishment and growth of vegetation in such locations.

Eventually, toxic substances from runoff at open dumping sites cause leachate to penetrate, which causes water contamination. The ecosystem and all adjacent living beings are negatively impacted by soil that contains a high concentration of heavy metals. As they go through their different life cycles, plants raised in these environments are susceptible to absorbing heavy metals from the soil. Because heavy metals have the potential to accumulate in biosystems through contaminated water, soil, and air, their potential contamination of food chains has become a hot topic in recent years. Therefore, it appears that current research on risk assessments places a special emphasis on understanding heavy metal sources, their accumulation in the soil, and the impact of their presence in both water and soil. In 2004 (Sharma et al.) Numerous factors, including geo-climatic conditions, the rate of urbanisation, ineffective waste management, additional anthropogenic causes, etc., are to blame for the type of pollution. Nearly all of these contaminants that contaminated the ecosystem are easily taken by plants, which in turn absorb them into animals. At levels only a little over what's necessary for the body's normal metabolic processes to continue, these contaminants become relatively toxic (Chakraborthy et al., 2004). These heavy metals have the potential to seep into the groundwater table through leachate and have detrimental impacts on groundwater. In this study, the metals Zn (zinc), Pb (lead), Ni (nickel), Fe (iron), Cr (chromium), and Cu are taken into consideration (Copper).

The aim of this study is to raise public awareness of the harmness that heavy metal contamination causes to people. Heavy metal pollution is a significant environmental issue that poses a hazard to biological systems but is hardly ever researched in locations of Kannad City in Aurangabad District from the Marathwada region.

II. MATERIALS AND METHOD

The Study area is located at an elevation of around 633 metres (2077 feet) above sea level, almost in the middle of the State's geographic region. The Kannad city, which has 15 dams and 7 lakes, has the most dams in Maharashtra. The town is located in Aurangabad district which lies in Marathwada region of Maharashtra with precise coordinates are 20° 27' North and 75° 13' East as shown in Fig. A. In the Gautala Sanctuary region in Kannnad, teak and sandalwood are primarily found. From Kannad, there are 211 km of the Mumbai-Nagpur State Highway and the Dhule-Solapur National Highway.

The samples are collected from various prime locations of city having wastes on open ground, nearby roads and residential areas. The neighborhood was troubled by a number of issues, including unpleasant smell, insects, vermin, rats, and mosquitoes. Residents were affected with numerous diseases as a direct consequence. Total 150 samples are collected out of which 50 are from roadside sites and 50 are from dumping ground sites and 50 are from residential area sites in April 2022.

Using the appropriate digging instrument, half of each type of site's sample is taken from the top layer (0–5 cm) and half from the subsurface (15–20 cm). About 500gm of soil sample was collected from each location. The samples were organized with proper labels (Sample ID, Sampling time and location) and kept in polyethylene bags carefully. All soil samples were air dried and were kept in oven for 20 min at 100°C. The soil sample were thoroughly dried before being sieved through a stainless-steel sieve with size of about 2 mm, placed in clean plastic bags, and once more correctly numbered. The samples are prepared for additional examination.

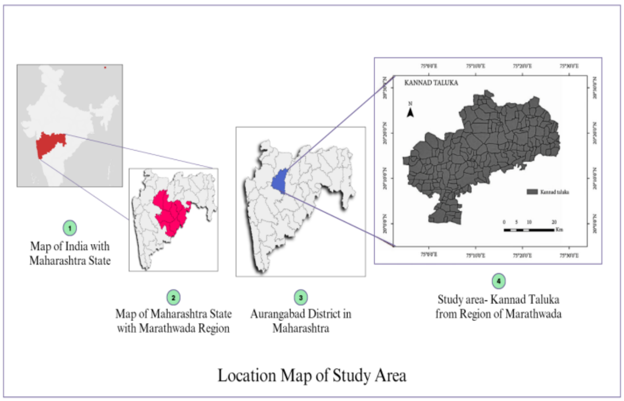


Figure A: Location Map of Study Area

III. HEAVY MATERIAL ANALYSIS METHOD

Using a Perkin Elmer ICP-OES (Inductively coupled plasma-optical emission spectrophotometer), heavy metal analysis was carried out (Model: Optima 8000). Argon (at 120 psi pressure) and nitrogen were the gases employed in the analysis (At 80 psi pressure). The "S10" Auto Sampler and the "Syngistix ICP continuous" software were both used. When implementing the DTPA (Diethylene Triamine Pentaacetic Acid) extracted heavy metal analysis method, the device was first calibrated using standards prior to sample insertion and was then fed into the instrument using an autosampler.

IV. RESULTS AND DISCUSSION

The discussion here will be limited to six selected heavy metals namely lead (Pb), cadmium (Cd), zinc (Zn), ferrous (Fe), chromium (Cr), copper (Cu) and cobalt (Co).

Table 1(i-vii). Minimum, Maximum and Mean Levels (μg/g) of Metals of Various Study Areas

Table 1(i)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
Pb	Min	11.7	12.4	46.4	54.6	6.5	5.6
	Max	84.2	42.5	96.3	77.5	20.4	17.6
	Mean	47.95	27.45	71.35	66.05	13.45	11.6

Table 1(ii)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
Fe		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
	Min	3.32	4.63	3.45	5.68	1.22	2.12
	Max	12.62	18.48	16.44	28.65	10.34	12.33
	Mean	**7.97**	11.555	9.945	17.165	5.78	7.225

Table 1(iii)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
Zn		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
	Min	12.2	13.6	24.6	34.7	11.6	12.4
	Max	22.3	24.8	59.2	68.9	16.7	19.3
	Mean	17.25	19.2	41.9	51.8	14.15	15.85

Table 1(iv)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
Cr		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
	Min	54.5	55.3	78.3	99.2	14.6	52.3
	Max	90.2	116.6	127.9	154.3	119.4	92.7
	Mean	72.35	85.95	103.1	126.75	67	72.5

Table 1(v)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
Cu		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
	Min	128.2	148.5	178.4	208.3	118.4	123
	Max	169.7	218.4	234.6	268.4	144.5	216
	Mean	148.95	183.45	206.5	238.35	131.45	169.5

Table 1(vi)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
Co	Min	32.6	32.5	38.23	42.10	4.22	11.53
	Max	46.4	49.6	62.56	69.28	32.12	40.43
	Mean	39.5	41.05	50.39	55.69	18.17	25.98

Table 1(vii)

Heavy Metal and its Range		Road side Site		Dumping Ground Site		Residential Areas Site	
		Top Layer	Sub-Layer	Top Layer	Sub-Layer	Top Layer	Sub-Layer
Ni	Min	12.3	13.5	17.8	19.2	5.45	7.67
	Max	22.7	34.2	28.4	38.3	16.87	18.44
	Mean	17.5	23.85	23.1	28.75	11.16	13.055

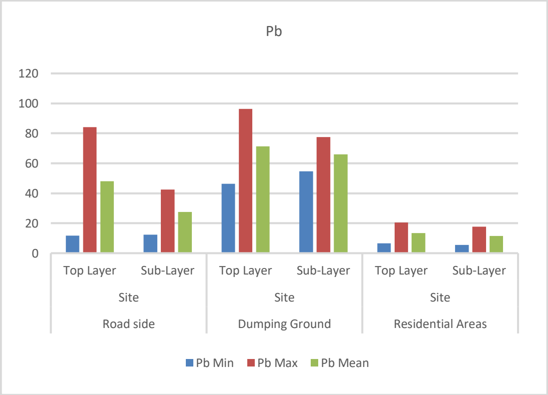
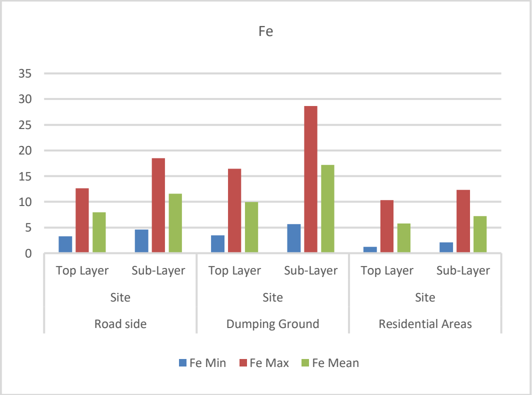


Figure 1



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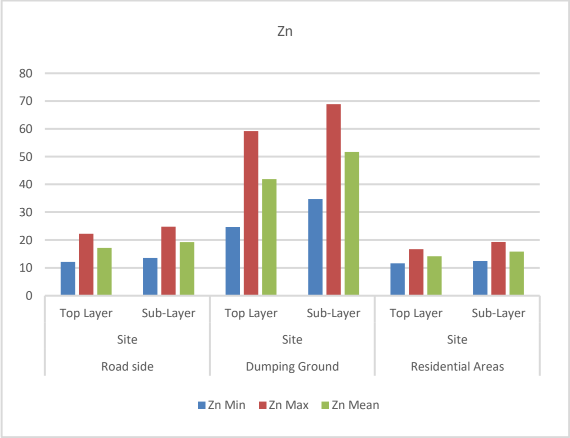

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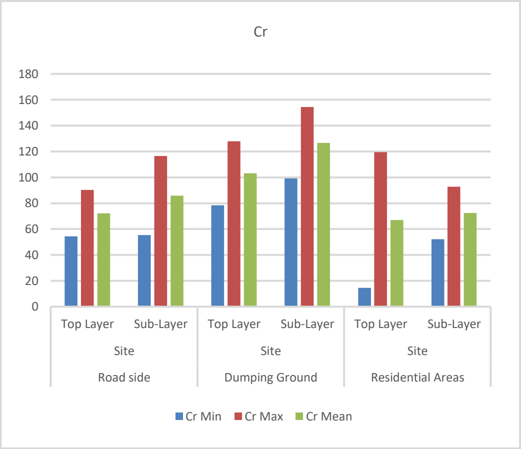

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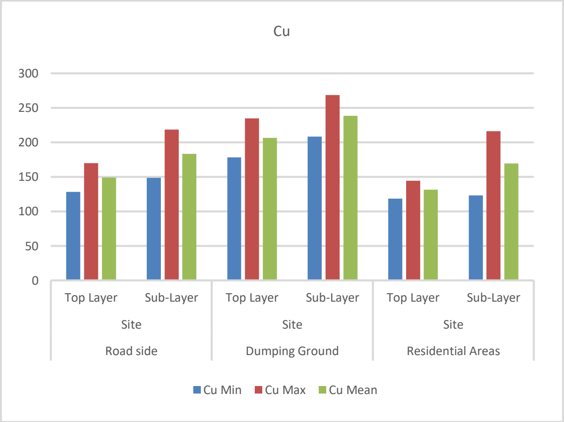

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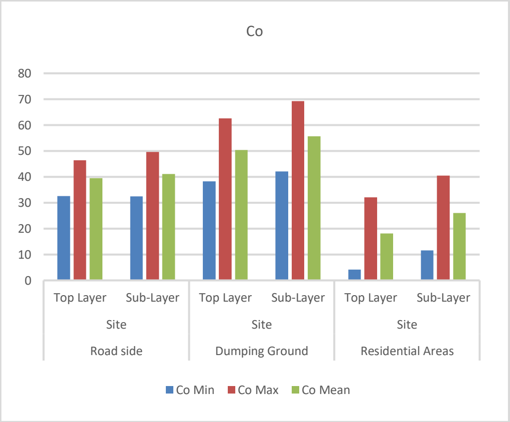

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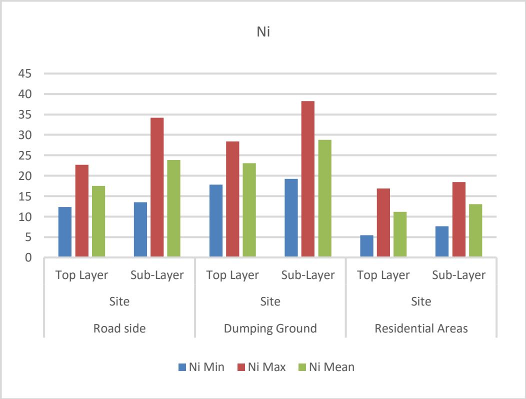

Figure 7

V. CONCLUSION

The results have shown that the use of machine learning algo- rithms, specifically the Random Forest and Support Vector Machine models, can achieve high accuracy rates in detecting fake news articles. This suggests that machine learning can be a useful tool in the fight against the spread of fake news. However, it is important to note that the accuracy of the models may be affected by the qualityof the data set used for training and testing, as well as the features selected for input. Additionally, the models may not be able to detect all instances of fake news, as the definition of what constitutes”fake” news can be subjective and may vary across different contexts.

Lead

Over than 95% of the lead that is currently circulating in the biosphere is human-made. Lead enters the biological system and harms all living things, including people, because it is less mobile and persists for a long time (Fig.1). Lead is mostly released into the soil through the automotive, paints & dyes, batteries, pesticides, fertilisers, explosives, and metallurgical sectors. The highest level of lead was recorded (190.7μg/g) in soil sample from Agro-chemical and Engineering work Industries. Here, there is severe lead pollution as a result of mechanical work with metals, unscientific motor vehicle approaches or procedures, the use of gasoline and diesel, and their emission. Automotive emissions and metal businesses that release lead into the environment affect agricultural areas close to major cities. Studies of a pastoral agroecosystem close to Adelaide revealed that up to around 50 km from the city limit, lead concentrations in surface soils had noticeably increased (Tiller et al., 1987).

Lead pollution's natural targets are the roadside habitats. In comparison to other soils, the roadside soils typically have higher concentrations of heavy metals. Pb concentrations are higher in samples taken from the neighboring oil refinery's soil and main highways (Smith and Flegal, 1995). In the residential area though the value showed is little high most of the area is not polluted. In this study the range of lead is between 5.6 - 96.3 μg/g given in Table-1(i). The highest concentration is observed in dumping ground sites then in roadside sites and least in newly formed residential area sites as per Fig. 1.

Ferrous

Though it results in severe morphological and physiological abnormalities, such as lower germination percentage, interference with enzyme activities, nutritional imbalance, membrane damage, and chloroplast ultrastructure, Fe toxicity is rarely studied in the field of plant science. Exogenous Fe addition decreases soil respiration rate and DOC concentration. There are toxic effects of Fe on seed germination, carbon assimilation, water relations, nutrient uptake, oxidative damages, enzymatic activities, and overall plant growth and development. In this study the range of Fe is between 1.22- 28.65 μg/g given in Table-1(ii). The highest concentration is observed in dumping ground sites then in roadside sites and least in newly formed residential area sites as per Fig. 2.

Zinc

Residential areas were shown to be less likely to have high zinc concentrations than dumping ground places (Claramma and Joseph, 2008). An increasing concentration of zinc in subsurface soil samples implies ongoing metal leakage, even though there were no samples that showed zinc pollution. These samples never, however, reached the lower limit or lowest level that is advised for zinc concentration in soil, as shown in Fig. 3.

The area with the highest concentration of zinc is the dumping ground. Pesticides, fungicides, and bio-solids are widely used in agriculture and farming, along with fertilisers. Heavy metals like zinc, lead, chromium, cobalt, cadmium, and copper are abundant in these materials. The presence of heavy metals in soil is a result of processes that form the soil as well as agricultural and human activities. The observed the range of Zn is between 11.6-68.9 μg/g given in Table-1(iii). The highest concentration is observed in dumping ground sites then in roadside sites and least in newly formed residential area sites as per figure 3.

Chromium

Chromium is more abundant in subsurface soil samples, which suggests that the metal is mobile and leaking. Symptoms of Cr toxicity appear as wilting of tops and root injury; also chlorosis in young leaves, chlorotic bands on cereals and brownish-red leaves are typical features. Cr can be source of illnesses such as severe and prolonged allergic dermatitis (Fregert, 1981) and potentially carcinogenecity (Hyodo et al., 1980). Cr has also been shown to be mutagenic in microorganisms, causing infidelity (mis-reading) during synthesis of DNA copies. (Theshelasvili et al., 1980). The range of Cr is observed in between 14.6-154.3 μg/g given in Table-1(iv). Chromium was found in high concentrations in a subsurface soil sample from an industrial area. The amount of chromium in the residential and agricultural areas is nearly in equal range as shown in Fig. 4.

Copper

The average level in the roadside and residential areas is similar, as shown in Fig. 5, but the roadside area has a higher concentration of copper, which is likely the result of continuous deposition and leaching. The area by the road is drier. For Cu retention, the soil's moisture content was crucial. Cu concentration was higher in dry soil than in humid soil. When agricultural land is divided into different plantations, one significant oddity in the Cu distribution is that the mean concentration of Cu in the upper and subsurface soils is nearly equal, or that the ratio of Cu in the surface to subsurface soil is one. Higher concentrations of Cu in the soil were caused by extensive use of pesticides, fungicides, biosolids, and certain fertilisers in agriculture and farming. Copper is concentrated in the soil as a result of repeated applications of pesticides containing copper as well as the spread of animal manure and urban waste on farmland (Van der Watt et al., 1994). In this study the range of Cu is between 118.4- 268.4 given in Table-1(v). As per Fig. 5 the highest concentration is observed in dumping ground sites then in roadside sites and least in newly formed residential areas.

Cobalt

Cobalt was identified in high concentrations in a subsurface soil sample taken from an industrial region. In soils around the world, cobalt is present in an average quantity of 8 parts per million (ppm) (MOEE 1993). The cobalt concentration is higher in samples of subsurface soil, indicating the metal's mobility and leakage. The range of Co is observed in between 4.22-69.28 μg/g given in Table-1(vi). Co was found in high concentrations in a subsurface soil sample from an industrial area in Fig. 6.

The concentration of cobalt is found in the following ascending order:

Dumping Area > Road Side Area > Residential Area > Agricultural Area.

Nickel

The most common symptoms of Ni phytotoxicity is interveinal chlorosis in new leaves, grey-green leaves and brown and stunted roots. Nickel carcinogenecity has been reported in both animals (Furst et al., 1971). In this study the range of Ni is between 5.45- 38.3 μg/g given in Table-1(v). The highest concentration is observed in dumping ground sites then in roadside sites and least in newly formed residential area sites as per Fig. 7.

CONCLUSION

As the amount of organic matter in the soil rises, so do the concentrations of heavy metals like lead, cadmium, copper, chromium, zinc, and cobalt. The samples with high levels of heavy metals contained a lot of organic matter. Heavy metals are retained in the soil as a result of a complicated process involving organic carbon and heavy metals. The soils near dumping grounds are where the samples with the highest concentrations of heavy metals were taken.

It is observed that the analysis of heavy metals performed in the various 6 zones with 150 samples which includes sites from Residential area, Roadside Sites and Dumping ground sites among these dumping ground has the higher content all most of Heavy metals than Roadside Sites. The least amount of concentrations of heavy metals are observed in the newly developed residential area sites which were previously a fertile land.

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