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Evaluation of State of Soil Contamination in Pali, Rajasthan due to Textiles Industries using Heavy Metal Pollution Index

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ABSTRACT

Heavy metal contamination in the soil severely threatens human life as plants grown in the contaminated soil accumulate these toxic metals, which reach living organisms through agro products and cause severe health issues. Pali city is famous for the textile,paints, and some marble-based industries and has been in the news for the very high degree of pollution, which led NGT to impose a ban on thousands of textile industries. We have conducted our research mainly to assess the state of heavy metal pollution due to the textile industries in Pali city after the NGT ban, focusing primarily on soil pollution. A detailed analysis was conducted in or around the Bandi River and Pali industrial zone of Rajasthan in 2021-2022. Soil samples were taken near the Pali industrial region for Physico-chemical and heavy metal content analysis. Heavy metal concentrations in soils near the industrial area were more contaminated than the typical metal distribution in the soil collected from non-industrial sites.The concentration of heavy metals present in the soil samples was very high. Zn-is 454.751 mg/kg, Cd- 454.751 mg/kg, Cr- 232.312 mg/kg, Ni- 7.173 mg/kg, Co- 209.682 mg/kg, Fe-3162.642 mg/kg, Cu- 279.430 mg/kg, and Pb- 294.140 mg/kg. All the toxic metals were observed in very high concentrations than the prescribed limits by the WHO.The Heavy Metal Pollution indexes for all samplesalso suggest a very high degree of soil pollution even after the NGT ban and urgently need to be addressed.

Keywords: *Toxic metals, soil pollution, HPI, Pali.*

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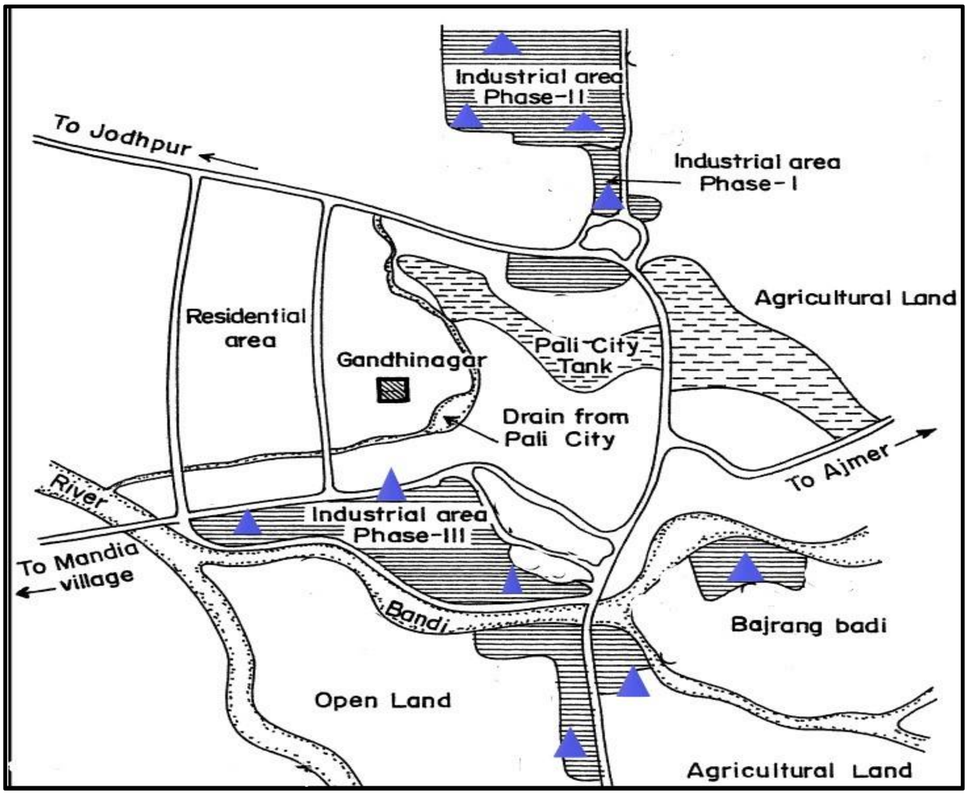
INTRODUCTION

Soil is an essential component of the environment, and its health is closely linked to agriculture, health, and the economy of many countries, particularly India. When detected in large concentrations in the environment, a number of heavy metals have already been considered to be dangerous to the health of both people and wildlife. [1,2]. Many industrial complexes' surrounding areas are particularly vulnerable to high levels of harmful heavy metals resulting from the release of improperly treated wastewater discharges to land[3,4]. The accumulation of toxic metals in such high amounts above their usual dispersion in soil generally indicates that the soil in the research region has been contaminated. Heavy metals deposited on the soil surface undergo downhill transportation, according to McLean and Bledsoe (1992), which does not increase until the soil's ability to hold metal is exhausted or metal interacts with related waste Metrix to encourage mobility[5]. Because of their toxicity and accumulation, heavy metals have a significant ecological impact today[6]. These substances, which have an effect on human health, can leak into groundwater or surface water be absorbed by plants, release gases into the air or bond moderately with soil components including clay or organic matter.[7,8].This research aims to examine heavy metal content in the Pali zone soils and investigate their likely sources and health impacts on humans.

RESOURCES AND TECHNIQUES

THE STUDY AREA'S DETAILS - Pali is one of Rajasthan's most prominent trial cities, with numerous large and small-scale enterprises precariously of cotton textile industries, goods and services[9]. The water and chemicals used in the textile, dyeing, and printing industries and the water and chemicals used in these industries are discharged directly into the Bandi River[10]. The Central Pollution Control Board (CPCB) in New Delhi has named Pali industrial sector one ofthe most polluted locations[11]. Six districts of Rajasthan share a border with the Pali district. The Bandi River, a tributary of the Luni River, basically the only important river that recharges groundwater after and during monsoons, is located within the watershed of the research region. About 300 enterprises produce chemicals, dyes, textiles, paints, and some marble-based industries in this industrial region. In the studied area, the average annual rainfall is 490 mm. In the Bandi River and other bodies of water, rainfall is the only raw water supply. Groundwater can be used for industrial applications and is the primary supply of home and agricultural water[12]. Near the industrial sector, there seems to be a Common Effluent Treatment Plant (CETP) where treated effluents are mixed with municipal sewage sludge and dumped into the Bandi River, eventually joining the Luni River[13,14].



MAP OF SAMPLING SITE

MATERIAL AND METHODS

Sampling

The most crucial stage of any soil analysis is the collection of a soil sample. Samples of the soil were obtained from the Pali Industrial zone (shown on the map). After digging 15 to 20 cm below the surface, soil samples were obtained. To obtain soil samples, a tubular auger and khhurpi were used[15]. Samples were collected in polythene bags and labelled with a permanent marker (site name). Soil material was dried at 60°C for two days. With a mortar and pestle, the dry soil specimen was disaggregated. The material was finely pulverised to a fineness of –250 mesh. As a guide, the soil samples were evaluated using the Encyclopaedia of Methodology in Environmental Science Vol. 2 sources of information [16].

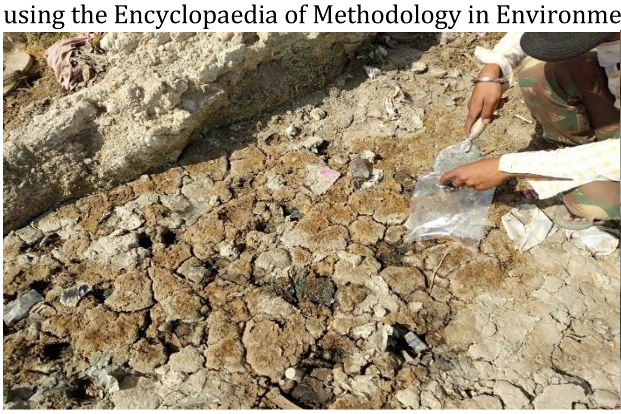


Fig 1: **SAMPLE COLLECTION AND SAMPLE PREPARATION**

Working method based on analysis: -

Using standard techniques, soil samples were analysed for pH, electrical conductivity (EC), alkalinity, and total dissolved solids (TDS). The specimen were oven-dried for 48 hours at 70 ° Centigrade to test their heavy metal concentration. The sieved material was then digested on a sand bath for 2 hours using a 15 ml triacid combination (70% HNO_3, 65%$HClO_4$ and 70% H_2SO_4). Filtered the solution through Whatman No.42 filter paper, placed the residue in a volumetric flask and made it up to 50 mL with distilled water[17]. The heavy metal was then examined using a Flame Atomic Absorption Spectrophotometer[18,19,20].

RESULTS AND DISCUSSION-

Physicochemical Analysis of Soil Samples

pH- The pH range for soil was between 6.5 and 8.5. Table 1's observations make it abundantly evident that ten soil samples have pH from 8.7 to 10.1arealkaline.

TDS &Electric conductivity-TDS should not exceed 500–2000 mg/L; according to WHO guidelines, electric conductivity shouldn't be higher than 450 S/cm. All ten samples had total dissolved solids and electrical conductivity readings more elevated than the recommended limits. According to Table 1, TDS values ranged from 4210.01 to 5406.86 mg/l, while EC values ranged from 2210 to 3930 S/cm.

Cadmium-Cadmium levels in the samples ranged from 9.012 to 16.312 mg/kg, much higher than the reference value.

Chromium: Chromium concentrations between 165.601 and 232.312 mg/kg were discovered, exceeding the 100 mg/kg WHO acceptable limit.

Nickel: Its concentration was slightly higher than the average value, ranging from 2.032 to 7.173 mg/kg.

Cobalt: Its content in samples was more significant than the recommended range of 50–70 mg/kg, ranging from 174.637 to 209.682 mg/kg.

Iron:The iron content in the samples ranged from 3101.631 to 3162.642 mg/kg, which is exceptionally high.

zinc: The zinc content of the samples ranges from 240.310 to 454.731 mg/kg, which is higher than the recommended range of 150-250 mg/kg.

Copper: The copper concentration was slightly higher than recommended, ranging from 172.462 to 279.430 mg/kg.

Lead: Lead concentrations in samples ranged from 242.432 to 294.140 mg/kg, exceeding the recommended range of 45-100 mg/kg.

Table No. 1- Heavy metal and Physicochemical Analysis of Soil Samples

	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10
pH	9.1	8.7	9.7	9.9	10.1	9.2	9.4	9.6	9.2	9.7
EC	2700	2236	3120	3310	2210	3930	3920	3120	2620	2780
TDS	4900	4710.12	5300	5110.72	4210.01	5100	4340.20	4748.02	5406.86	4887.07
Alkalinity	262	370	390	325	294	470	240	280	340	310
Cd	10.783	11.132	9.012	15.967	16.312	12.061	14.161	15.673	10.863	11.737
Cr	165.601	170.310	232.312	210.670	208.632	192.030	169.621	204.632	210.118	180.370
Ni	3.014	5.412	2.032	7.173	4.673	6.001	4.732	3.173	4.920	6.310
Co	182.060	190.780	207.187	206.543	174.637	196.632	209.682	201.807	184.880	194.032
Fe	3147.933	3101.631	3162.642	3119.366	3104.143	3112.612	3125.321	3119.776	3130.630	3141.840
Zn	286.432	274.467	310.473	240.310	401.387	388.320	298.840	390.617	454.751	406.736
Cu	177.310	264.348	262.840	255.630	259.340	279.430	172.462	193.731	210.630	270.476
Pb	247.173	262.867	267.487	242.432	247.863	277.669	280.403	294.140	251.632	267.432

Table2: PHYSICO-CHEMICAL AND HEAVY METALS PARAMETERS

metals	max allowed conc. (Sn)	1/Sn	Σ 1/Sn	K = 1/(Σ1/Sn)	Wn = K/Sn	Ideal value (Vo)	Mean Conc. Value (Vn)	Vn/Sn	Qn = Vn/Sn*100	WnQn
Cd	10	0.1	0.4	2.5	0.25	0	10.783	1.0783	107.83	26.9575
Cr	100	0.01	0.4	2.5	0.025	0	165.601	1.65601	165.601	4.140025
Ni	4	0.25	0.4	2.5	0.625	0	3.014	0.7535	75.35	47.09375
Co	60	0.016667	0.4	2.5	0.041666667	0	182.06	3.034333	303.4333	12.64306
Fe	3119	0.000321	0.4	2.5	0.000801539	0	3147.93	1.009276	100.9276	0.080897
Zn	200	0.005	0.4	2.5	0.0125	0	286.432	1.43216	143.216	1.7902
Cu	200	0.005	0.4	2.5	0.0125	0	177.31	0.88655	88.655	1.108188
Pb	60	0.016667	0.4	2.5	0.041666667	0	247.173	4.11955	411.955	17.16479
Σ		0.403654			1.009134872					110.9784
					HPI = 109.9738					

Evaluation of the "Heavy Metal Pollution Index" (HPI) for Pali area soil samples- The "Heavy Metal Pollution Index" (HPI) displays the heavy metal soil quality [21]. We estimated HPI for various sampling locations, and by comparing these results, we could assess the soil quality and pollution load at multiple locations Table-3.

For the data obtained from all the other sites, comparable computations are made, and the results are compared for additional analysis. These are the results: -

TABLE 3:- STANDARD PARAMETERS AND HEAVY METAL POLLUTION INDEX (HPI) CALCULATION FOR SS1

Sr. No.	Sample	HPI
1	SS1	109.97
2	SS2	150.23
3	SS3	95.84
4	SS4	189.88
5	SS5	151.18
6	SS6	164.41
7	SS7	149.28
8	SS8	130.85
9	SS9	142.54
10	SS10	167.28

CONCLUSION

The study's conclusions imply that alarmingly high heavy metal contamination of soils near the Pali industrial sector has occurred. Although NGT has banned many industries, many sectors still throw effluents without treatment to the ground and Bandi River areas, potentially posing health hazards [22]. High levels of HPI are also indicating that all the sites under our study are highly polluted with heavy metals. Before dumping harmful metals containing industrial effluents, they should be sent to the CETP for treatment. Inspecting the CETP's output water after treatment is also a good idea to ensure that no dangerous chemicals are released into the nearby river or ground. The soils in the area need to be remedied to meet environmental quality standards. In addition, regular monitoring of all the industries is also required for heavy metal ions concentration.

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