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ORIGINAL ARTICLE

Correlation of anthropogenic activities with soil characteristics.

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ABSTRACT
Textile industries are well known for dyeing and printing fabrics with exquisite colors and designs.The development of synthetic dyes has therefore become massive and a profitable industry. The usefulness of synthetic dyes is the robustness of shades and their flexibility over natural dyes. But it has deleterious effects. Pali district in Rajasthan, famous for its textile industries, is now under the threat of severe environmental pollution. Air, water, and soil have been adversely affected by the textile industries of this area. Our present study aims at the analysis of soil samples collected from the industrial area of Pali. The area selected was from the close vicinity of Bandi River which is the main influx of industrial waste discharges. Samples were also collected from field areas that are irrigated by the water of the Bandi River, transported through pipes. It was found that the soil samples are highly alkaline, electrical conductivity and total dissolved salt values are high. Percent nitrogen and percentage organic matter of soil samples are found to be very low suggesting it to be highly unsuitable for agriculture purposes. BOD and COD values are much higher than the standard values indicating large soil pollution. The samples were also analyzed for heavy metal concentration. Results showed high levels of heavy metals which impart toxicity to agricultural products and thus adversely affect human health.
Keywords: Dyes, toxicity, textile industries, soil pollution, heavy metals.

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INTRODUCTION

Color imparts grit and glamour to fabrics. Whatever be the composition of a textile, a dazzling, vibrant color augments its commercial value. The dyeing industry has therefore been blooming for the past few decades. But the grey side of this industry is the carcinogenic nature of dyes leading to huge environmental degradation. The effluents from these industries adversely affect the water and soil quality where it is disposed [1-7]. Figure 1 is a graphical representation of the disposal of wastes.

Pali district of Rajasthan has many industries producing chemical dyes, paints, and a few marble factories. But over the years this place has become a hub for textile manufacturing, designing, and coloring. Now over 800 textile industries (small and big), are known in this region. Though they contribute substantially to the state economy in terms of income and employment with over fifty percent of the city's population being employed in these industries, the discharge from these textile industries into river Bandi has highly polluted the river and neighboring soil area, making it deeply contaminated. Synthetic dyes are highly colorful, bright, and colorfast. These dyes commonly contain carcinogenic organic and inorganic substances including azo dyes, naphthol, anthraquinones, vat dyes, arylamines, rhodamines, carbazoles, thiophenes, Sulphur, nitrates, chromium compounds (as mordants), and other heavy metals like arsenic, cadmium, copper, lead, cobalt. Besides these other harmful substances used in these factories include formaldehyde-based dye fixing agents, organic softeners, chlorinated stain removers, and other non-biodegradable chemicals. Many of these give rise to various kinds of allergies and diseases [8-12]. The grave concern for the environmentalist is the carcinogenic nature ofthe dyes. The effluents from these mills include oily scums and colored colloidal solutions. Through drainpipes, these are discharged into neighboring water bodies which adds a foul smell and turbidity to it. This decreases the sunlight penetration in water affecting the flora and fauna of aquatic bodies as well as the neighboring region.

When these discharges seep into the neighboring fields, it blocks the pores of the soil, affecting irrigation in the area.

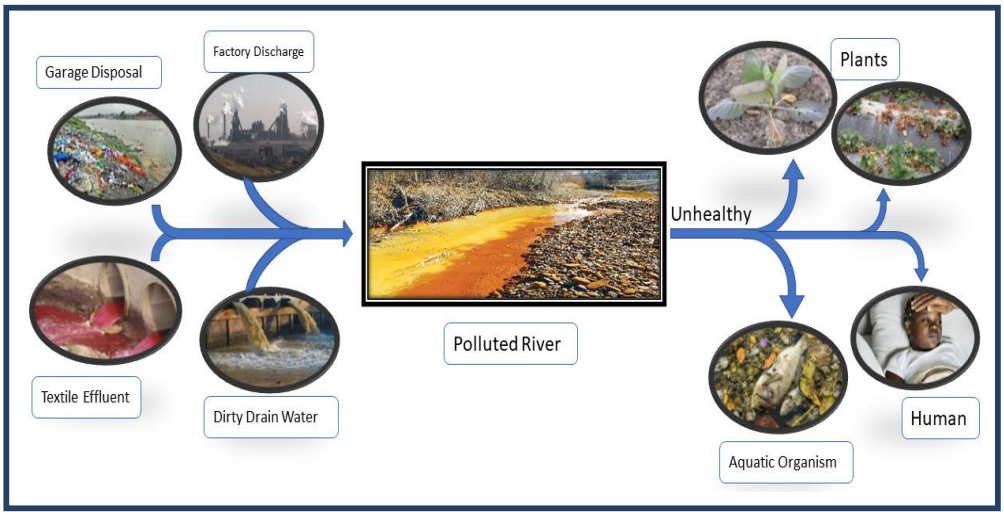

Figure:1 Disposal of wastes into river water and adjoining soil and its after-effects
(factory discharge, garbage discharge, textile effluents) into river water resulting in contamination of water and soil leading to unhealthy plants, aquatic animals, and humans.

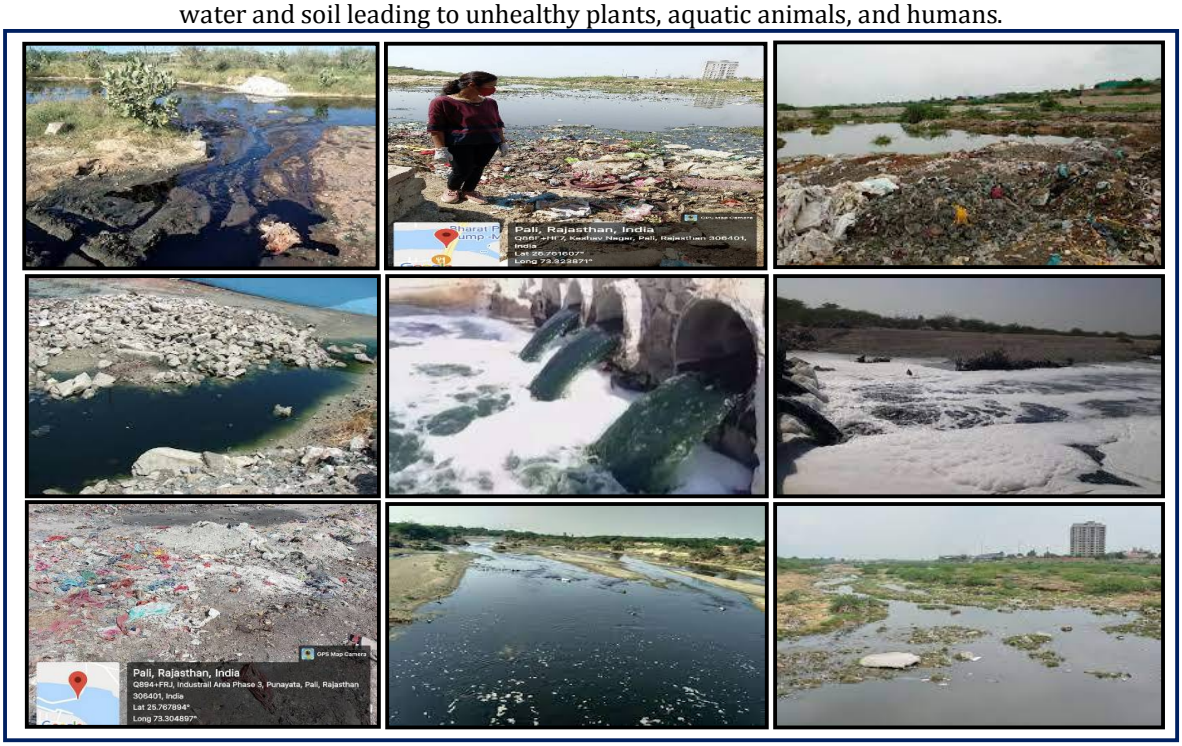

Figure: 2 Photo grid depicting pollution due to textile effluents & garbage disposal

In 1982, India's first common effluent treatment plant (CETP) was set up in Pali to treat industrial effluents. But over the years, many new mills have developed, so the situation has not changed much. Out of 800 units, around 600 textile mills are under the Red category of the Central Pollution Control Board (CPCB) indicating that the situation is grim.
The water quality of the Bandi river is very poor and soil in this region is adversely affected. The present study includes analysis of soil quality by measuring Physico-chemical parameters as well as heavy metal detection and their impact on plant and human health [13-14].

MATERIAL AND METHODS

Location: The study location is the Pali district of Rajasthan located between 24^0 45' to 26^0 29' North Latitudes and 72^0 47' to 74^0 18' East Longitudes. With over 800 textile industries in this region,few areas were selected for sample collection. Figure 2 gives the geographical area and site of sample collection

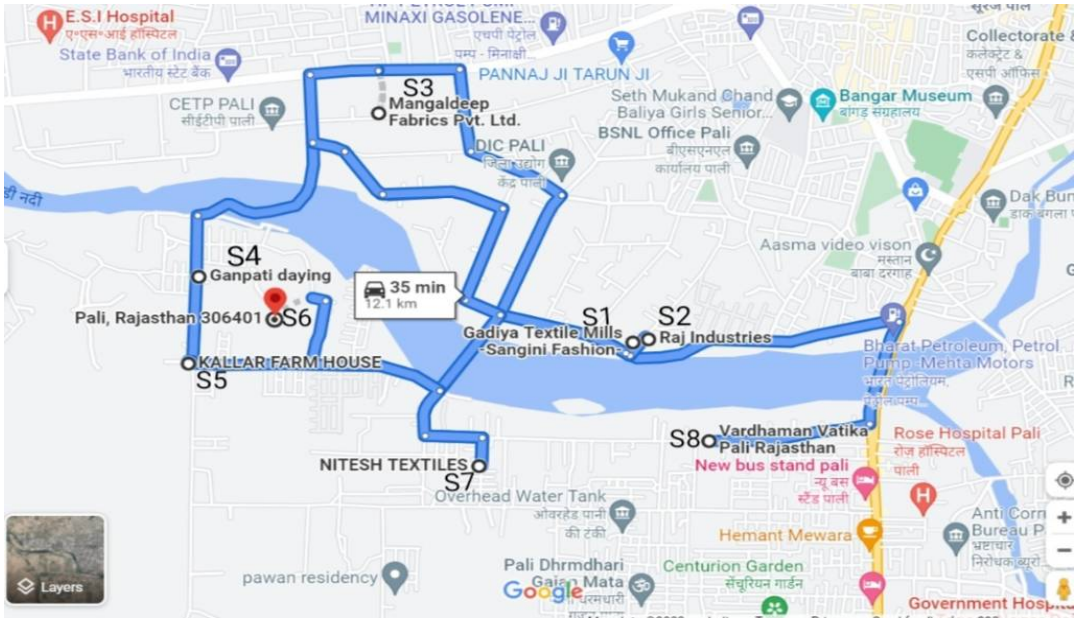

Figure: 3 Geographical area and site of samples

Sampling:

Sampling was done from the targeted areas by first removing the surface vegetation, followed by digging 6 to 8 inches deep with the help of shovel and spade. These were collected in transparent plastic zip pouches and labeled properly. Immediately these were taken to the laboratories. It was then air-dried in the tray for 2-4 days at room temperature.

The dried soil is grounded and sieved through 2-10 mm mesh. Few of the tests were done early, like pH and Nitrogen analysis. For Physico-chemical analysis, 10 g of soil sample was mixed with 50 mL distilled water(1:5 W/V), stirred thoroughly, and kept undisturbed for 5 minutes. The suspension is then filtered through Whatman filter paper, and the filtrate was used for conducting analysis. Tableno.1 shows the sample labeling with geographical mapping.

Table: 1 Labelling of samples and geographical mapping.

S.no	Sample no.	Distance from Bandi River	Geographical area
1	S_1	Factory Soil- Approximately 50 m from Bandi River	Gadiya Textile Mills, Mandiya Bypass Road,
2	S_2	River Soil- 100 m from Bandi River	Raj industries
3	S_3	Near Factory-700 m from Bandi river	Mangaldeep Fabrics pvt ltd
4	S_4	Barren land soil-400 m from Bandi river	Near Ganpati dyeing
5	S_5	Field Soil- Approximately 1 Km from Bandi River	Near Kallar Farmhouse
6	S_6	Field Soil- 550 m from Bandi River	Field Soil
7	S_7	Field Soil- 600 m from Bandi River	Nitesh Textiles
8	S_8	Field Soil- 200 m from Bandi river	Vardhaman vatika

Instrumentation

Atomic Absorption spectrometer AA500, Pg instrument, was used to determine the heavy metal concentration of the selected soil samples. It is equipped with Flame Atomizer as well as Graphite Atomizer which can be switched by a simple selection in the software. It is a high-performance automated instrument useful in various fields including Agriculture, Environmental, Pharmaceutical, clinical, Geological, petrochemical, etc. pH was determined by Digital pH-Meter Model-152-R and conductivity by Conductivity meter Model NDC-736.Other Physico-chemical properties were analyzed using different volumetric and instrumental analytical procedures according to BIS, ASTM standards.

RESULTS AND DISCUSSION

The samples collected from different regions were analyzed for various parameters to access the extent of pollution in soil due to contamination from textile industries. Table 2 gives the summary of the Physico-chemical data as well as Heavy metal concentration of various soil samples. The Physico-chemical

parameters of the polluted soil samples suggest that textile industries have brought about a major deterioration in the soil quality of Pali. All the parameters have highly deviated from the blank soil.
pH is the most fundamental property to analyze the soil. It is indicative of the acidity, neutrality, or alkalinity of the soil. The pH value shows the alkaline nature of soil having values ranging between 7.82 to 10.81. This is due to the leaching action of waste materials and disposal of alkaline dyes from the textile industries into the BandiRiver from where the polluted water seeps into the soil. The same water is transported to neighboring fields for agriculture also making it highly alkaline.

Table:2Physicochemical and Heavy metal concentration of soil samples

	Sample1	Sample2	Sample3	Sample4	Sample5	Sample6	Sample7	Sample8
Colour	Reddish	Orange	Dirty Green	Blue Green	Green	Dark Brown	Blue	Green
pH	10.3	7.82	9.25	10.0	8.23	10.81	9.31	10.18
EC (µmhos/cm)	100	125	142	107	34	133	182	125
TDS (mg/L)	3200	1600	1180	4200	1800	1705	3200	5780
BOD (mg/L)	852	373	243	233	563	650	420	300
COD (mg/L)	1248	350	680	1289	800	784	993	760
% Nitrogen	0.016	0.020	0.030	0.025	0.014	0.028	0.035	0.029
% Organic Matter	0.24	0.39	0.42	0.22	0.34	0.19	0.44	0.29
Cr (ppm)	25.827	4.285	12.79	0.810	6.100	6.702	4.701	1.676
Cu (ppm)	3.029	1.372	3.178	0.106	1.314	2.516	1.580	1.932
Pb (ppm)	0.467	0.400	0.667	0.400	0.333	0.533	0.792	0.264
Cd (ppm)	0.031	0.037	0.115	0.019	0.043	0.073	0.026	0.096

EC- Electrical Conductivity, TDS- Total Dissolved Salts, BOD-Biological oxygen demand,
COD-Chemical oxygen demand.

Electrical Conductivity is indicative of the ionized components (cationsand anions) present in the aqueous environment. The values of EC of various soil samples lie between 34 to 182µmhos/cm.
Total Dissolved Solids (TDS) of soil samples are high. A large number of salts are dissolved in water viz. Chlorides, sulfates, phosphates, nitrates, carbonates, and bicarbonates of sodium, potassium, magnesium, calcium, Iron, Manganese, etc. An increase in the concentration of any of these ions greatly affects the water quality and alters the population of aquatic animals and plants in it. A high value of TDS indicates an increase in the density of water and decreases the solubility of gases,
particularly oxygen and makes it unsuitable for drinking or irrigation purposes.
The TDS values of the eight samples were found to lie between 1180 to 5780 ppm. The TDS values as obtained on analysis of various samples are suggestive of the high degree of contamination in the soil. The extremely high values of 3200,4200 and 5780 ppm are an alarming signal for the nature of the soil.

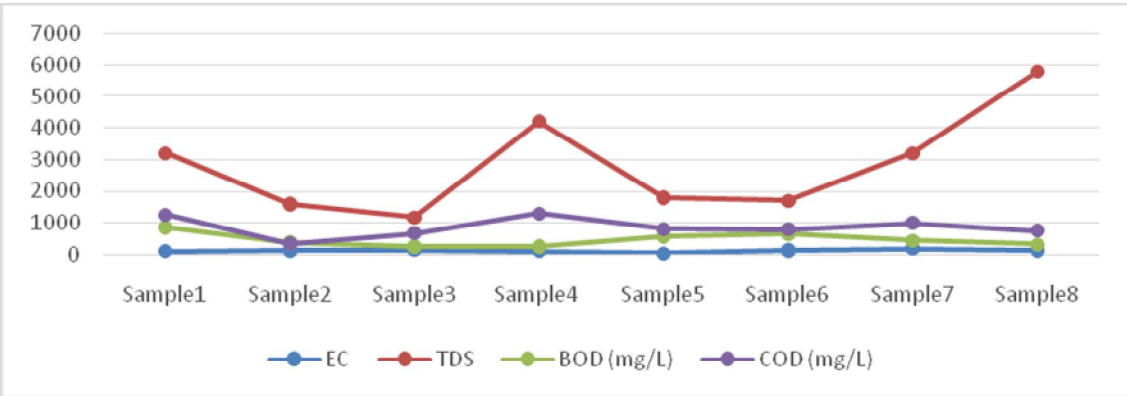

Figure: 4 Physico-Chemical properties (EC, TDS, BOD, COD) of different soil sample

Soil health is also determined by its BOD value. Biological oxygen demand tells about aerobic biodegradation of organic matter in the soil by measuring the oxygen needed by the aerobic biological organisms for the complete breakdown of organic matter into carbon dioxide and water. The BOD values of soil samples are also low, ranging between 233 to 852. Low values of BOD indicate a low amount of

organic matter and hence low suitability for agriculture. Like BOD, COD is yet another parameter to characterize the soil. It measures chemically the amount of oxygen required to oxidize the organic contaminants into inorganic end products. A greater value of COD means a larger amount of oxidizable organic matter which ultimately reduces the dissolved oxygen levels. The analyzed soil samples have high COD values ranging between 350 to 1289 signifying extremely high pollutant levels in the soil.
% Organic matter is indicative of soil health. Soil should contain at least 2 to 8 percent of organic matter as it provides nutrients to the organisms residing in soil and reduces pests by increasing soil's microbial activity. Organic matter helps in binding soil particles and improves water holding capacity. Overall, it provides physical, chemical, and biological benefits to the soil. The soil samples analyzed have a very low content of organic matter in them. Figure 5 showsthe value ranges between 0.19 to 0.44 which indicates large depletion of organic matter in the soil thereby making it unfertile and hence inappropriate for crop production.

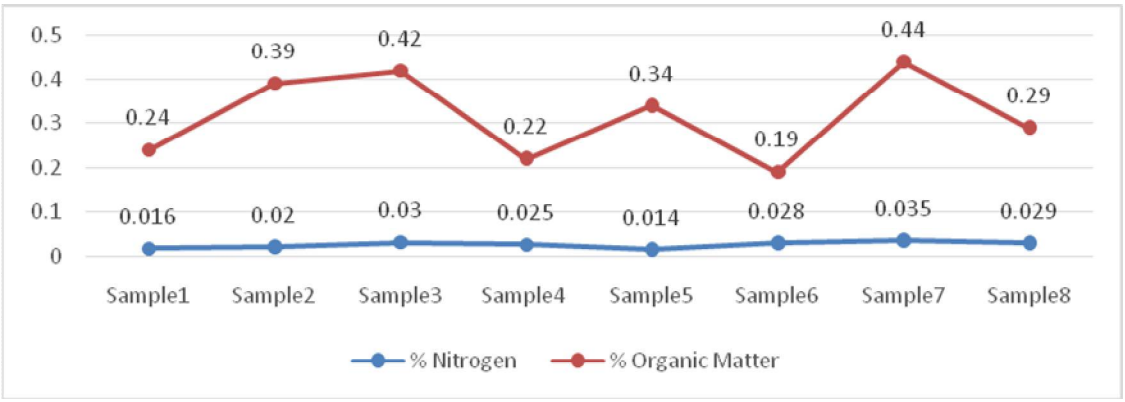

Figure:5 % Organic Matter and % N of different soil samples

Figure 5 shows the variationof % N in different soil samples. Available Nitrogen is a measure of the amount of nitrogen in the soil (present as nitrate, nitrite, or ammonium ion/ salt that can be taken up by plants instantaneously. For healthy soil, the amount of available nitrogen should vary between 10mg/kg to 50 mg/kg. But the data shows a very low amount of nitrogen present in the soil indicating them to be unsuitable for agricultural purposes. Fertilizers containing nitrogen should be added to increase the soil quality.

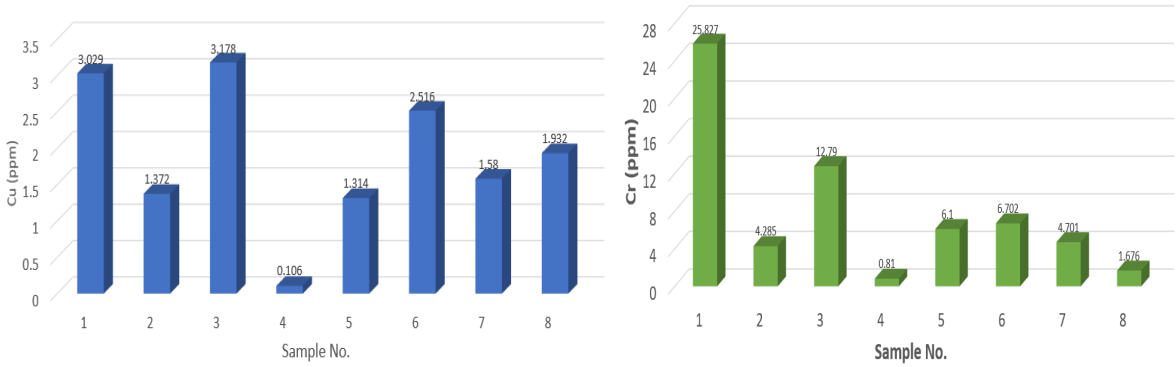

Figure:6 Conc of Cu and Cr in various soil samples

Heavy metals are naturally present in the environment. They are also required by organisms in trace amounts (essential metals). Metals like iron, copper, zinc are required at low concentrations for various physiological activities of living organisms. But when their density increases, they are classified as toxic[15-22]. Higher concentrations of heavy metals are very harmful and pose a serious threat to life Table No.2 also summarizes the heavy metal concentrations in different soil samples. All the samples were analyzed for copper, chromium, lead, and cadmium. The data reveals significantly high values for all the metals analyzed. Figure 6 shows Copper concentrations ranging from 0.106 to 3.029 ppm in different soil samples. A lower concentration of Cu was seen in a sample of barren land, around 500 m away from Bandi River, while the highest Cu concentration was observed in sample no. 1 (from Gadiya textile mills), 50 m from Bandi River. Though copper is known to be an essential micronutrient for the growth and

development of plants, a large concentration of Cu causes leaf discoloration, stunting, chlorosis, and necrosis in plants. In humans too, an increased amount of copper causes diarrhea, abdominal pain, nausea, and even damages liver.[23]

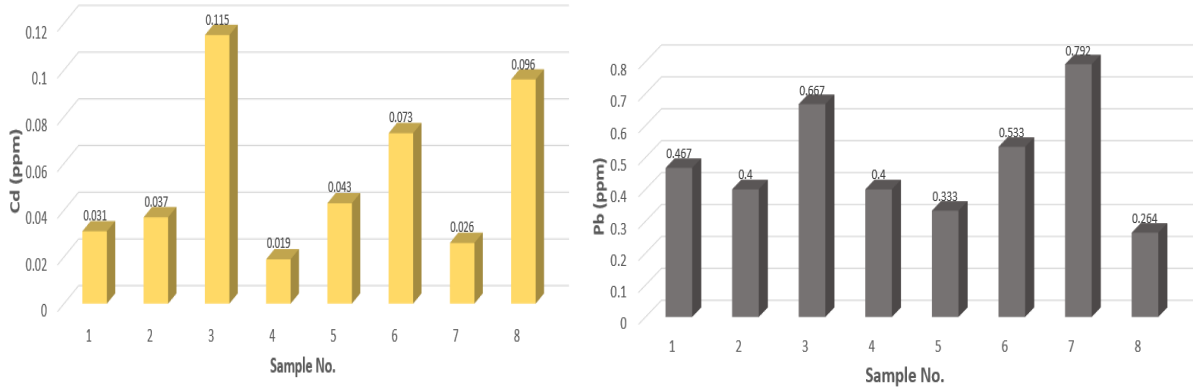

Figure:8 Conc of Cd and Pb in various soil samples

It was observed that Cr concentration in different samples showed great variation (Figure 7). Sample no:4 gave a concentration of 0.810 while sample no.1 had a maximum value of 25.827 mg/L indicating a high level of toxicity. A large amount of Cr causes coughing, sneezing, running nose, itching and burning sensation in humans, while in plants its high concentration alters germination process, photosynthesis etc. [24]

With the help of AAS, the concentration of lead was found to lie between 0.333 to 0.792 ppm [Figure 8)A large amount of lead is extremely toxic to the flora and fauna.[25] Its high concentration causes hindrance in ATP production, seed germination, chlorophyll production as well as root elongation and decreases enzymatic action of biota. In humans, its increased concentration (called lead poisoning) causes symptoms like headache, constipation, memory loss, infertility, developmental delay in children, numbness in hands and legs, etc. It hinders hemoglobin synthesis and its accumulation in RBC causes anemia.

Cadmium is a heavy metal that does not assist in any known biological action. But its presence in plants and animals can cause intense deleterious effects in them. The analysis of soil samples for cadmium concentration showed a range from 0.032 to 0.115ppm (Figure 9). Its adsorption increases due to high concentration of hydrous oxides, organic matter, and clay minerals. It is known for its high mobility in the environment. Its mobility is affected by ionic strength, redox state, and pH of the solution. Cd complexes with dissolved organic matter as well as anions such as chlorides and sulphates to form water-soluble complexes. It, therefore, gets easily transported and is one of the most mobile heavy metals. Cd toxicity in plants causes alteration in enzymatic activity, mineral nutrition, photosynthesis, and seed germination[26]. In humans, it reaches through the food chain cycle and causes diseases like itai-itai, Cancer, and damage to the kidney, bone, liver, and reproductive parts of the body.

Table:3 shows the analysis by Pearson's correlation coefficient depicting the relationship between various Physico-chemical properties and heavy metal concentrations. This is used to determine the strength of the relationship between two variables. The values lie in the range of +1 to -1. A value of +1 signifies a strong positive relationship between the two variables while the value of -1 indicates a strong negative relationship. Zero signifies no relationship between the variables.

Table:3 Pearson's Correlation coefficient of Soil parameters with heavy metal concentrations

	pH	EC	TDS	%N	%OM	BOD	COD	Cr	Cu	Pb	Cd
pH	-	-	-	-	-	-	-	-	-	-	-
EC	0.2639	-	-	-	-	-	-	-	-	-	-
TDS	0.4546	0.0944	-	-	-	-	-	-	-	-	-
%N	0.3486	0.8701	0.2229	-	-	-	-	-	-	-	-
%OM	-0.7121	0.3289	-0.3188	0.2714	-	-	-	-	-	-	-
BOD	0.2618	-0.3073	-0.2105	-0.5179	-0.4063	-	-	-	-	-	-
COD	0.5832	-0.0867	0.4579	-0.0298	-0.4854	0.2727	-	-	-	-	-
Cr	0.2148	-0.1113	-0.2568	-0.3829	-0.1046	0.6926	0.301	-	-	-	-
Cu	0.2975	0.2152	-0.322	0.0772	0.0709	0.4391	-0.1594	0.731	-	-	-
Pb	0.0682	0.7046	-0.3888	0.6088	0.4792	-0.0129	0.094	0.209	0.338	-	-
Cd	0.1944	0.1767	-0.0837	0.3665	0.1225	-0.2938	-0.458	0.0105	0.6047	0.0153	-

CONCLUSION

The analysis of various soil samples from pali district of Rajasthan shows large contamination in soil with increasing heavy metal concentration beyond the permissible limits. Apart from sewage disposal, non-degradable plastic discards, and electronic good scraps, the major threat to the water and soil environment is the effluent discharge from over 800 textile units situated here. This greatly pollutes the Bandi river as all the discharge from the industries, is finally poured here. The irony is that the farmers of this region use the same polluted water for irrigation and other purposes. Pollutes from the river water enter the soil. Plants are adversely affected as well as the fauna of the region. Therefore, it is concluded that anthropogenic activity has greatly contributed to enhancing the toxicity of the environment.

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