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Effect of industries on heavy metal content in soils of adjoining area

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Abstract
Due to rapid industrialization, urbanization and intensive agriculture in India increasing contamination of heavy metals in soil has become a major concern. A geochemical investigation was carried out in and around the industrial development area of district Rohtak to determine the effect of contamination in the study area. Soil samples collected near the industrial area were analyzed for Zn, Cu, Fe, Mn, Ni, Cd, Cr, Co and Pb contents. Samples were collected from the industrial area of Rohtak from the top to 15 cm layer of the soil. The samples were collected from industrial areas, and far away from industrial area. Levels of the metals in soils around the industrial area were found to be higher than their normal distribution in soil that is away from industries such as Pb – 2.13 ppm, Cr – 0.06 ppm, Cu – 2.12 ppm, Zn – 2.07 ppm, Co – 0.03 ppm and Cd– 0.15 ppm. High concentration of these toxic elements in soil is responsible for the development of toxicity in agriculture products, which in turn affects human life.

Keywords: Heavy metals, cadmium, distribution, concentration, industry

Introduction
Various heavy metals have been reported to be dangerous to the health of humans and wildlife when they occur in the environment at some high concentrations (Martin 1997; Onianwa 2001) [10, 12]. The vicinities of many industrial complexes are particularly liable to such high levels of toxic heavy metals that are derived from the discharge of poorly treated liquid effluents to land (Fakoyade and Onianwa 2002) [7]. The presence of heavy metals in such high concentrations above their normal distribution in soil generally reflects the contamination of soil in the study area. According to McLean and Bledsoe (1992) [11], heavy metals introduced on the soil surface, undergo downward transportation, which does not occur to any greater extent unless the metal retention capacity of the soil is overloaded or metal interaction with associated waste matrix enhances mobility. There are many different sources of heavy metal contaminants including deposition, wastewater lechate and surface runoff. Heavy metals today have a great ecological significance due to their toxicity and accumulation. These elements, can be leached into the surface water or groundwater, taken up by plants, released as gases into the atmosphere, or bond semi-permanently by soil components such as clay or organic matter, which later effect human health (Saether *et al.* 1997; Acero *et al.* 2003) [13, 2]. The present study aims to assess heavy metal contamination in soils of the district Rohtak (Haryana) industrial area and to study their possible sources. Raw sewage and sludge depending upon their source may contain an appreciable amount of metallic micronutrients and heavy toxic metals. Long- term application of these materials to land may cause accumulation of heavy metals in soil and may become toxic to plants. (Adhikari *et al.* 1993) [3] In most of the cities disposal of effluent is carried out by using it for irrigation. This kind of land application of the industrial effluent results in direct addition of trace metals to the soils, resulting in its degradation and also adding of toxic metals in the food chain (Lark *et al.* 2002) [8].

Materials and Methods
The study area Rohtak is one of the districts of Haryana where industrial growth is at good pace. The soil samples (0-15 cm) were collected from the fields near the industries and also from the fields those are far away from industries. Numbers of soil samples collected were five from the field that is near to industries and another five from the field that are far away from industries. Before analysis samples were air dried and grinding was done with pestle mortar and pass through 2mm sieve. Zn, Mn, Co, Cu, Ni, Cr, Pb, Cd and Fe were determined by DTPA extractable method.

DTPA, a chelating agent, extracts the easily soluble Zn, Mn, Co, Cu, Ni, Cr, Pb, Cd and Fe by forming soluble complexes. The extracting solution is buffered at pH 7.3 by triethanolamine (TEA) and also includes $CaCl_2$ to prevent dissolution of $CaCO_3$. These conditions permit the right amount of Zn, Fe, Cu and Mn to be extracted and $CaCl_2$ to stabilize the pH of the extractant. DTPA extractant has the ability to chelate Zn, Cu, Fe and Mn in competition with Ca^{2+} and Mg^{2+}. The elements in the DTPA extract are determined by atomic absorption spectrophotometer.

Results and Discussion

Micronutrient status of soil adjoining and away from industries

The DTPA-extractable micronutrients concentration in the soil samples collected away from industries and adjoining to industries are shown in Table 1 and Table 2. It indicates that the higher content of Zn, Cu, Fe, Mn and Ni were recorded in the soil samples collected from adjoining field to industries. Higher concentration of these micronutrients (Zn, Cu, Fe, Mn and Ni) under industrial land use may be due to application of wastewater. Generally, it seems that heavy metals tend to accumulate in the surface soil layers (Chang *et al.*, 1984) [5], and has strong binding force with clay minerals and also the organic matter limit their movement in soil. The results were in good agreement with those reported by Al-Lahham *et al.* (2003) [4], Soumare *et al.* (2003) [14] and Madrid *et al.* (2007) [9].

Table 1: Micronutrient of soils away from industries

	Zn	Cu	Fe	Mn	Ni
Site A	0.97	1.54	11.23	6.98	0.24
Site B	0.87	1.25	15.12	6.89	0.74
Site C	1.23	1.06	9.8	7.65	0.12
Site D	0.88	1.32	7.26	6.87	0.34
Site E	1.09	1.1	9.34	7.68	0.14

Table 2: Micronutrient of soil adjoining to industries

	Zn	Cu	Fe	Mn	Ni
Site A	2.63	1.9	19.24	11.25	0.45
Site B	2.06	2.5	18.53	11.45	0.87
Site C	1.75	1.85	17.34	10.14	0.64
Site D	2.12	1.97	16.23	9.45	0.42
Site E	1.81	2.4	18.45	8.56	0.64

Heavy metal status of soil adjoining and away from industries

The Heavy metal content of in soil away from industries and adjoining to industries is given in Table 3 and Table 4 respectively. The results indicate that the concentration of DTPA extractable Cobalt in soil away from industries varied from 0.01 to 0.02 ppm and in soil adjoining to industries it varies between 0.02 to 0.05 ppm. Concentration of Cd was found higher in soil that is adjoining to industries. The DTPA extractable Cr varies from 0.04 to 0.07 ppm in soil away from industries. The content of Pb were also found higher in soil of field that are near to industries.

Table 3: Heavy metal content of soil away from industries

	Co	Cd	Cr	Pb
Site A	0.02	0.04	0.07	1.38
Site B	0.01	0.07	0.04	1.24
Site C	0.02	0.05	0.06	1.75
Site D	0.01	0.07	0.03	1.64
Site E	0.01	0.03	0.04	2.01

Table 4: Heavy metal content of soil adjoining to industries

	Co	Cd	Cr	Pb
Site A	0.02	0.2	0.07	3.05
Site B	0.03	0.13	0.04	1.78
Site C	0.03	0.1	0.06	2.15
Site D	0.04	0.19	0.08	1.89
Site E	0.05	0.11	0.04	1.78

Comparison of micronutrient status of soils in the adjoining areas and at distance from industries

The higher mean value i.e. 2.07, 2.12, 17.96, 10.17, 0.60, 0.03, 0.15, 0.06 and 2.13 ppm of DTPA extractable Zn, Cu, Fe, Mn, Ni, Co, Cd, Cr and Pb (Fig 1 and Fig 2) were found in samples collected from field adjoining to industries. Higher concentration of these heavy metals, some of which are essential plant micronutrients (Zn, Cu, Fe, Mn and Ni) under industrial land use may be due to application of wastewater. Generally, it seems that heavy metals tend to accumulate in the surface soil layers (Chang *et al.*, 1984) [5], and has strong binding force with clay minerals and also the organic matter limit their movement in soil. The results were in good agreement with those reported by Al-Lahham *et al.* (2003) [4], Soumare *et al.* (2003) [14] and Madrid *et al.* (2007) [9].

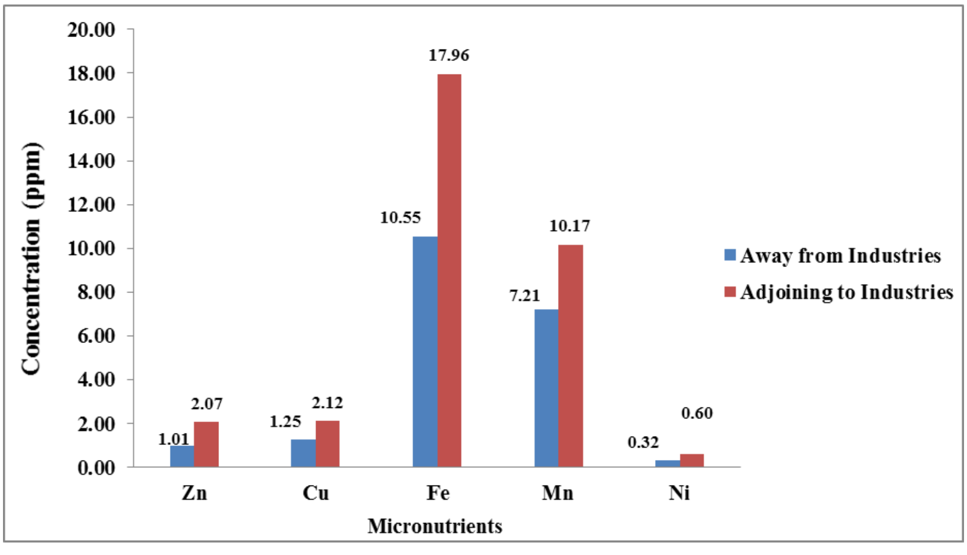

Fig 1: Comparison of micronutrient status of soil in the adjoining areas and away from industries

Comparison of heavy status of soils in the adjoining areas and at distance from industries

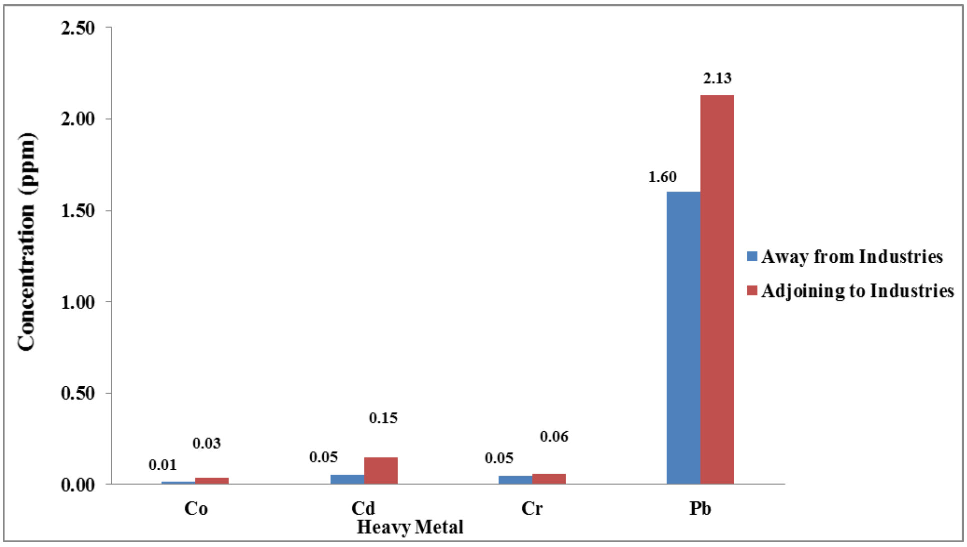

Fig 2: Comparison of heavy metal status of soil in the adjoining areas and away from industries

Conclusion

The results of the study generally show that soils in the vicinity of the industries area have been contaminated with higher heavy metals at levels than the soil away from industries, which may give rise to various health hazards. There should be a provision to measure toxic metals in industrial effluents before dumping them in nearby fields or canal. It is also desirable to check the outlet water of industries after treatment to ensure that these toxic pollutants are not released into the adjoining field.

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