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Research Article

THE INVESTIGATION OF SOIL POLLUTION TO CD AND CR ELEMENTS ON THE AROUND OF LOUSHAN CEMENT FACTORY, GUILAN PROVINCE, IRAN

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ABSTRACT
Soil contamination and accumulation of heavy metals in agricultural products is one of the most important environmental issues that have threatened living plants, animals and human. The purpose of this study was to monitor the status of heavy metals in soils around the cement factory of Loushan. In this study, soil samples in three directions of north-west, south-west and south-east of cement factory and at intervals of 500 meters to 5 km distance from the plant were sampled in three replicates. Concentrations of DTPA-extractable cadmium and EDTA extractable chromium concentrations in soil samples were measured. Results showed that the maximum concentration of DTPA-extractable cadmium in the northwest of the plant within 1000 meters (1.4 mg/kg), within 1500 meters in the southwest of the plant (2.16 mg/kg) and within 1000 meters in the southeast of the plant (1.92 mg/kg) was observed. Since the concentration of cadmium in non-polluted soils is less than one mg/kg, soil of the studied area had cadmium contamination.

Key Words*: Cement Factory, Heavy Metals, Soil Contamination*

INTRODUCTION
Though, soil is considered as the main platform for food production and other raw materials for humans, yet today it is also being considered as a place to municipal and industrial waste disposal, particularly in industrialized countries. Soil contamination has increasingly risks to human health and the environment. Heavy elements are considered as the most important pollutants in the environment that sharply in recent decades have been considered. Accumulation of heavy metals in soil, especially in agricultural lands is gradual and concentration can reach to levels that threaten the human food security. Annually, thousands of these elements from the activities of municipal, industrial and agricultural imported into the soils. For example, annually, more than 38 thousands tons of cadmium and one million tons lead from various sources is added to soil (Amini *et al.*, 2005).
Soil pollution is a threat to human health and the environment. In recent decades, heavy metals as environmental pollutants and the soil receive more attention (Fransen *et al.*, 1997). Part of the heavy elements that has been added by environmental pollutants to the soil is absorbed by plants. Solid particles in air can put a negative impact on air quality that the cement factory is one of the producers of aerosols. However, the cement factory to be built away from downtown, the factory dust by wind, rain and other factors are distributed and accumulates in plant, animal and soil context that cause negative effects of heavy elements on human health (Yvaz, 1992). Cement factory is considered as an important source of contamination of both organic and inorganic chemicals and input materials and semimetals such as As, Cd, Co, Cr, Ni, Pb, and Zn. Various types of heavy elements has been studied and these elements are very dangerous because they are toxic (Adrino, 2001).
Accumulation of heavy metals in soils reduces crop yield. This reduces the quality of the environment, human health and soil fertility (Kabata Pendiaz, 2001 and Nicolson, 2003). Plant tolerance to Cd varies from 0.2 to 9 mg kg^{-1} soil, but the amount of 3 mg kg^{-1} of cadmium in soil stopped plant growth and makes serious damage to the human body (Silvira *et al.*, 1977). Soil contamination at the plant will cause pollution and pollutants are transferred to humans through edible plants and domestic animals (Kabata

Pendiaz *et al.,* 2001). Soil, is a place for particles that are deposited by air (Alkhashman and Shavabke, 2006). Isikili *et al.,* (2003) investigated the chromium concentration in 258 samples of soil and plants around and away from the cement factory of Cocorhesyar, Turkey and concluded that the concentration of this element in the plant was more than the control area. Heavy metal toxicity in humans, animals and plants are important factors that should be paying more attention to it. Heavy metals such as cadmium, mercury, lead, chromium and aluminum have a role in environmental pollution. Present study investigated status of Cd and Cr concentration of soil around cement factory of Loushan Township, Guilan, Iran.

MATERIALS AND METHODS

Loushan is one of the central cities of Rudbar in the Guilan province and the neighboring city of Qazvin province. The study area is located at 49° 31′ east longitude and 49° 39′ of North latitude. According to the latest figures, it seems that definitive population of Loushan Township is over 22,000. Loushan position is located at 100 km from Rasht and it is arid weather. Cement factory of Loushan is located within the city that due to increased pollution levels, it has been repeatedly criticized by city officials and people.

Measurement of Available Heavy Elements in the Soil

With regard to the satellite image of area, three geographically directions were considered to take soil samples. To evaluate the dispersion of heavy metals around the cement factory of Loushan, 30 soil samples from a depth of 0-30cm region in the Northwest, Southeast and Southwest of cement factory was prepared and was transported to the laboratory. Soil samples were taken every 500 meters and were transferred to the laboratory. At first, Soil samples become air-dried and then sieve in mm 2. Five grams of dried soil was poured in 250 ml Erlenmeyer flask. 20 cc was added to the DTPA and was shacked in 380 rpm for 2 hours and then, samples were centrifuged. And later the samples were filtered and soil extracts was prepared. The concentration of cadmium in soil extracts was measured using DTPA (Lindsay and Norvell, 1978). Measurement of the element concentration was performed using Flame Atomic Absorption Spectrometry (Brooks, 2002).

Measurement of Available Cr in the Soil

One gram of dried soil from each sample was extracted with 10 ml EDTA extracts soluble. Chromium concentration measured by Flame Atomic Absorption Spectrometry (Brooks, 2002). Soil sample pH by extract 2:1 water to soil, lime soil by (titration method), soil texture by (hydrometer method), soil organic matter by (walky and black method) was measured. Statistical analysis was performed using SPSS software.

RESULTS AND DISCUSSION

Table 1 show that the effect of distance from cement factory on soil heavy metal concentration in all three directions, northwest, southwest and southeast was significant at 1% level.

Table 1: Variance analysis of heavy metal concentration in soil at different distances from the cement factory of Loushan in three directions towards the northwest, southwest and south-east

Source	Geographic vector	df	Element	
			Cd	Cr
Distance of factory	NW	9	0.875**	0.024**
	SW	9	1.016**	0.146**
	SE	9	0.858**	0.012**
Error	NW	18	0.006	0.003
	SW	18	0.097	0.031
	SE	18	0.098	0.001

*** Signficant at 1% level*

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DTPA-Extractable Soil Cadmium Concentrations

According to the results in Table 2, the highest concentration of cadmium was observed in northwest in comparison with other intervals in 1000 and 3500-meter distance from the plant (1.40, 1.36mg/kg). Cadmium in most non-contaminated soils has concentrations less than 1 mg /kg and critical concentration in the soil is 1.5 to 2.5 mg/kg (Gilmore *et al.,* 1979). Concentration was not significant difference in the two distances from the factory. At 500, 2000 and 3000 meters, lacking of cadmium in soil was observed. Within 2500 meters, reducing the concentration of extractable Cd had significant difference between 1000 and 3500 meters. The highest concentration of DTPA-extractable Cadmium in the southwest within 1500 meters of cement with concentration of 2.16 mg/kg was observed. The concerned heavy metal concentration at 500, 1000, 2000 and 2500 meters with no significant difference, but was significantly lower than 1500 meters distance. The highest concentration of DTPA-extractable Cadmium in the Southeast within 1000 meters of cement was observed. And at intervals of 500, 1500, 3500 and 4500 meters the highest concentration of the heavy element was visible from within 1000 meters. A significant difference in the concentrations of heavy elements was not observed in the intervals listed, but the difference in the concentration in these intervals was significant compared to other distance.

Table 2: Cd and Cr concentrations in soil (mg / kg) at different distances from the cement factory of Loushan for three geographic directions

Distance	North West		South West		South East	
	Cd	Cr	Cd	Cr	Cd	Cr
500	0.00	0.28 bc	1.23 bc	0.91 bc	1.32 b	0.36 b
1000	1.40 a	0.52 a	1.46 b	1.26 a	1.92 a	0.45 a
1500	0.21 c	0.37 b	2.16 a	1.13 ab	1.26 b	0.36 b
2000	0.00	0.29 bc	1.50 b	0.96 bc	0.58 c	0.34 bc
2500	0.75 b	0.24 c	1.40 b	0.84 cd	0.48 c	0.26 de
3000	0.00	0.21 c	0.66 d	0.76 cde	0.18 c	0.34 bc
3500	1.36 a	0.31 bc	0.83 cd	0.50 e	1.23 b	0.30 cd
4000	0.23 c	0.26 c	0.30 d	1.39 a	0.61 c	0.29 cde
4500	0.29 c	0.27 bc	0.46 d	0.71 cde	1.37 b	0.28 cde
5000	0.23 c	0.23 c	0.63 d	0.23 c	0.66 c	0.23 e

EDTA-Extractable Soil Chromium Concentrations

According to Table 2, the highest concentration of Chromium in all three geographic distance was observed at 1000 meters from the cement factory. At distances greater than one kilometer, Chromium concentrations significantly decreased compared to 1000 meters away from the cement factory. Isikli *et al.,* (2003) examined the Chromium concentrations in 258 soil and plant samples at different distances from the cement plants, Cocorhesyar, in Turkey and concluded that Chromium concentrations at distances closer to the plant was more than from further distances from the cement factory and by a gradual distancing from the factory, the heavy metal concentration declined compared to distances closer to the factory.

Conclusion

Cadmium is one of the heavy elements studied in the area around Loushan cement factory. In directions northwest, southwest and southeast, maximum DTPA-extractable Cd concentration within 1000 meters of cement, respectively, 1.4, 2.16, 1.92 mg kg was observed. A cadmium concentration in soils around the cement factory of Loushan especially within 1000 meters in three geographical in the extent of contamination was observed. Concentration of this element in both the southwest and southeast was more than the northwest. Wind direction can be effective in the scattering this element.

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