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Determination of Heavy Metal Levels of Kondok Soils-Haftgel

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Abstract: The objective of the present investigation was to evaluate some total heavy metal content such as Cd, Pb, Cr, Ni and Cu in kondok soils and to determine the relationships between the contaminants and other physico-chemical soil properties. Currently, Cd, Pb, Cr, Ni and Cu do not seem in toxic levels. Also, the relationship between total heavy metal contents and some soils properties that was investigated on 69 disturbed soil samples. Significant relations between total heavy metal contents and some soil properties were determined at $p<0.01$.

Key words: Heavy metals, cadmium, nickel, cobalt, lead

INTRODUCTION

Heavy metals are well known to be toxic to most organisms when present in high concentration in the environment (Giller *et al*., 1988). In the last decades, human activities have continuously increased the levels of heavy metals circulating in the environment (Ma and Rao, 1997). Anthropogenic activities such as agriculture, industry and urban life increase content of these elements in soils and waters (Algeria *et al*., 1991). Heavy metals can be also found in the parent rock from which soils have developed. The anthropogenic heavy metals are believed to be easily accumulated in the top soil (Baker, 1990; Samsoe-Petersen *et al*., 2002), causes in potential problems such as toxicity to plants and animals (Ma *et al*., 2002; Berti and Jacobs, 1996), accumulation in food chain, perturbation of ecosystem and adverse health effects (Forstener, 1985; Stalikas *et al*., 1997). Of all the natural compartments, soil is perhaps the most important because it receives heavy metals coming from different sources and simultaneously acts as a buffer to control the movement of these elements to other compartments (Gil *et al*., 2004).

Kondok Season River passes from Haftgel City in Khuzestan Province. In order to agriculture extension in this area, construction of a dam on this river was suggested by Khuzestan water and power authority. To prediction of dam storage water quality after construction, some studies was done on physical-chemical soils properties and heavy metals contents such as Cd, Pb, Ni, Cr and Co in soils by Sazabpardazan Consulting Engineering (2007).

The purposes of this study are: (1) to determine the heavy metal content of Kondoke soils and (2) to determine the relationships between the contaminants and other physico-chemical soil properties.

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MATERIALS AND METHODS

Study Site

The study was carried out in Kondok area (Fig. 1) South of Iran (49°18'-49°35'N, 31°25'-31°40'E) and has semi-arid climate with temperatures ranging from 25.7 to 37.6 and annual mean precipitation is 300 mm based on 30 year period.

Soil Sampling and Preparation for Analysis

Soil samples were taken from 20 points, taking into considers different soil depths (0-150 cm). Plant residues and roots were removed by hand and soils were transferred to laboratory. Samples were kept at room temperature and the analyzed.

Soil Characterization

The following basic soil characteristics were determined: Soil reaction (pH) was measured in a suspension at a soil/water ratio of 1:2 according to McLean (1982). $CaCO_3$ was determined according to the calcimeter method of Nelson (1982) and total soluble salt was analyzed measuring the electrical conductivity of an extract of the same mixture (Rhoades, 1982). The texture of the soil samples was determined by the hydrometer method (Day, 1982). Organic matter was determined by the Walkley-Black procedure (Nelson and Sommers, 1982).

Determination of Heavy Metals

The soil sample were dried at 105-110°C for a total period of one day soil samples were sieved using 0.074 mm for the sake of homogeneity. Weighted samples were transferred into acid baths. The acid volumes used were 15 mL HCl and 5 mL HNO_3 for each sample. On a hot plate, the samples were heated at 115-120°C. After observing reddish gas exit from the heated samples and making sure that the prepared samples are dry, the samples were

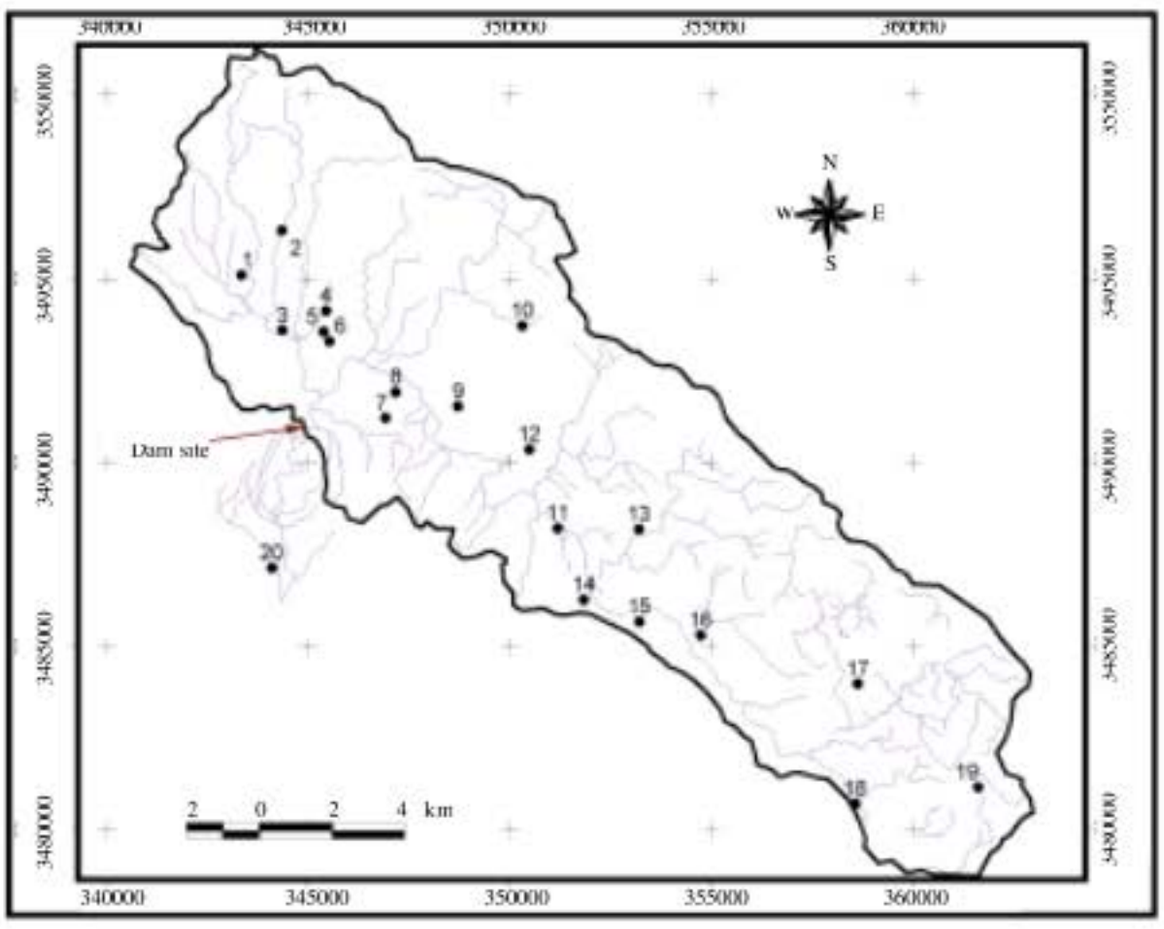

Fig. 1: Location map of the sampling site

removed from the hot plate. A 10 mL HCL and HNO_3 mixture was added to each sample. Finally concentrations of each sample were measured by atomic absorption spectrophotometer.

Statistical Analysis

Statistical analysis were performed using the statistical package for social science (version 15, SPSS Ins., Chicago, IL, USA) program. Pearson's correlation coefficients and p-values were calculated for all possible variable pairs.

RESULTS

Soil Properties

Some physico-chemical properties of soil sample obtain from 65 sampling point at 0-150 cm depths in the total of 20000 ha study area is shown in Table 1.

Soil texture was not similar for all samples and also clay, silt and sand contents of the 65 samples were 14-43, 35.3-65.3 and 2.4-42.4, respectively. Value of soil pH was in range from 7 to 8 which related to value of soil salinity. $CaCO_3$ content was high in all samples due to their origin from lime parent material. The organic matter content ranged was low, 0.07-1.29% (Table 1).

Heavy Metal Concentrations

Cd content of the samples soils were 0.23-2 mg kg^{-1}, soil toxic limit is around 2.5-3.0 mg $kg^{-1}$for Cd (Fabis, 1987). Toxic limit of Pb, Ni and Cu in soil is 50 mg kg^{-1} (Fabis, 1987). Pb was 1.67-8.34 mg kg^{-1}, Ni, 1-9 mg kg^{-1} and Cu 1.83-9.2 mg kg^{-1}; Toxic limit of Cr is 75 mg kg^{-1} in soil (Fabis, 1987). Cr content was 0.83-7.50 mg kg^{-1}. The descriptive statistics on the heavy metal concentrations of the soil are shown in Table 2.

The Relationships Between Soil Heavy Metal Concentration and Some Soil Properties

Correlations analysis was used to establish relationships between total concentrations of heavy metals and soils physicochemical parameters. Table 3 shows the relationship between Cd, Ni, Pb, Cr and Co concentrations correlations coefficient and some soils properties.

Cd, Ni, Pb and Cr contents were positively correlated with the soil depth. Cd, Ni and Cr contents were positively correlated with the soil silt content. Visa versa, sand was negatively correlated with Cd, Ni and Cr. Clay content was not significantly related except Cd. Organic

Table 1: Descriptive statistics on selected soil physical and chemical properties (n = 65)

Soil property (%)	Min.	Max.	Mean
Clay	14.00	43.00	24.70
Silt	35.30	65.30	46.30
Sand	2.40	42.40	28.40
Organic matter	0.07	1.29	0.40
pH	7.40	8.10	7.76
$CaCO_3$	31.20	39.90	31.84

Table 2: Heavy metal concentration of soil samples (mg kg^{-1})

Heavy metal	Min.	Max.	Mean
Cd	0.23	2.00	0.90
Pb	1.67	8.34	5.20
Ni	1.00	9.00	4.32
Cr	0.83	7.50	3.50
Co	1.83	9.20	4.80

Table 3: Correlation coefficients of relations between heavy metal contents (dependent variable) and soil depth, clay, loam, sand, organic matter, $CaCO_3$, pH and calcium content of the soils (independent variable) (n = 17)

	Pb	Ni	Cr	Cd	Co
Soils properties	----------	----------	(mg kg^{-1})	----------	----------
Soil depth (cm)	-0.700**	-0.700**	-0.620**	-0.310*	-0.210
Clay (%)	0.012	0.110	0.140	0.310*	0.210
Silt (%)	0.003	0.380**	0.462**	0.334**	0.079
Sand (%)	-0.026	-0.322**	-0.393**	-0.471**	-0.186
Organic matter (%)	0.102	0.451**	0.465**	0.084	0.141
$CaCO_3$ (%)	-0.265*	0.053	0.119	-0.170	-0.150
pH	0.290*	0.187	-0.036	0.250*	0.263*

**Significant at the %1 level, *Significant at the %5 level

matter was correlated with the Ni and Cr. $CaCO_3$ was found significant only for Pb. Although, pH limitation alterations, Cd, Pb and Co contents was negatively correlated with it.

DISCUSSION

Soil texture in this area was generally medium to heavy. It is strongly affected by parent soil material. The organic matter content was low due to soil high temperature and decomposition high ratio of this matter. The pH was in range 7-8 in soil different levels and when salinity is low, it is more than 8. $CaCo_3$ content was high due to more content $CaCO_3$ in soil parent material.

In all samples concentrations of heavy metal do not seem in toxic levels. Therefore these materials won't be caused pollution in water reservoir in future.

According to correlations analysis Cd, Ni, Pb and Cr contents were positively correlated with the soil depth. This probably may be due to high organic matters contents in top soil. Clay content was not significantly related except Cd. This probably is due to kind of clays.

CONCLUSION

The results from this study showed that Cd, Ni, Pb, Cr and Co concentrations do not seem in toxic levels. Extractable contents of heavy metals are highly correlated to physico-chemical characteristics of the soils. Compared to other elements Cd were more significantly and correlated with soils properties. Accumulation of these elements increased in the upper soil layers. Probably, higher organic matter contents of the upper layers tended to this tendency. Sand was significantly and negatively correlated with Cd, Ni and Cr. This observation concurs with the findings in other studies (Aydin, 2004; Tarackgtoglu *et al*., 2006). Except Cd, none of the other heavy metal was not correlated with clay content. This is not according to other studies (Aydin, 2004; Tarackgtoglu *et al*., 2006) may be due to the kind of clay. Soil stability was low in various soil moisture conditions. This related to exist of clays such as chlorite and polygorscite and etc. The approved of this subject need to mineralogy by X-Ray. But, by attention to low soils CEC this subject may be approved. In most of the time soils CEC were lower than half soil's clay percent and this approved the presence of minerals with low CEC.

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