



RESEARCH PAPER

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Environmental effects of land use change on TIC, CEC and clay mineral species

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Abstract

This research studied the Environmental Effects of land use changes on clay mineral types in the region of Aghcheh (with an area of 2000 hectares) of Faridan in Isfahan Province. Samples were taken at depths of 0-30 centimeters in soils of four types of land use: rangeland, irrigated farmland, rain fed farmland, and abandoned rain fed farmland. Statistical data indicated that, although there were significant differences in the Cation Exchange Capacities (CEC), the range of these changes was not very broad and that cation exchange capacity varied from 20 to 40 milliequivalents per 100 grams of soil (which confirmed the presence of minerals of the mica group). Moreover, results of Total Iron Content (TIC) indicated the presence of iron in the soils and confirmed the degradation process of mica minerals (Illite to Vermiculite) stated in the theory "The logical sequence of degradation of mica minerals."

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Introduction

The CEC and TIC can be attributed to its management and location (Duguma *et al.*, 2010). Clays influence many of the physical, chemical, and biological properties of soils. Soil cation and anion exchange capacities are among the chemical properties, and specific surface is among the physical properties, that are affected by the quantities and types of soil clay. Minerals constitute about 50 percent of the volume of most soils, are responsible for the physical support of plants, provide the required air for the optimal growth of plants, and release plant nutrients through their weathering process (Ayoubi *et al.*, 2008). Our notion of the origin of the negative charge results from the accepted idea that weathering changes mica to hydrated mica and then to vermiculite and weathering of smectite changes it to kaolinite and eventually to gibbsite (Raghimi, 2008). Clays control the fixation of some cations such as potassium and ammonium and the release of plant nutrients into soil solution to be absorbed by plants, and influence soil water holding capacity, soil infiltrability, hydraulic conductivity, soil plasticity, and stability of soil aggregates (Barzagar, 2001). Various studies have been conducted to assess the effect of land use changes on soil physical and chemical properties in Ethiopia (Yimer *et al.*, 2008). The soil chemical properties i.e. pH, organic C, total N, total P, basic cations concentrations, and Cation Exchange Capacity is variable in different land use types. In this research, the relationship between soil total iron content and cation exchange capacity and the types of clay minerals was studied in four types of land use (rangeland, irrigated farmland, rain fed farmland, and abandoned rain fed farmland) in western Isfahan in about 2000-hectare area, the results of which are presented in the section titled. The density of total iron was measured by an atomic absorption device which did it using specific waves (Nelson and Sommers, 1987). One of common characteristics of environmental factors is the continual spatial variability. Study of these variations, from a point to another point, is not as simple as possible by usual statistical analysis methods. Thus, to evaluate and

estimate the environmental variables, modern applicatory methods such as geostatistics is needed (Mohammadi, 1999).

Therefore, the main aid of this research is investigating the effect of Land use changes from range lands to croplands in order to measurements and evaluates Total Iron Content (TIC) and Cation Exchangeable Capacity (CEC) in this area. Because understanding about the range of some soil chemical properties such as TIC and CEC is very useful to identify clay mineral Species in soil and reach to theory of logical sequence of the mica group minerals degradation.

Materials and methods

Study Area

The studied area forms part of the Aghcheh watershed, has an area of 1970 hectares, is situated in the western part of Isfahan Province, constitutes a part of Faridan, and borders on Lorestan Province. The Daran-Aligodarz road and the Zarneh Hills bound it on the north, by Afus and the Kolahgas Mountain on the south, by Buin, Miandasht, and the Aghcheh Stream on the east, and by the continuation of the Agha Gul Heights and Ghaleh Ekhlās on the west.

Sampling

The distance sampling method was used to take samples from the depth of plowing in the four types of land use (rangeland, irrigated farmland, rain fed farmland, and abandoned rain fed farmland). The total iron contents of the soil samples in the four types of land use were determined by using a model PF 990 atomic absorption spectrophotometer manufactured by PG Instrument at the specified wavelength (Baker and Macher, 1998). Moreover, cation exchange capacities of the soil samples were measured in four stages at the laboratory by using the method of saturation with sodium acetate and by employing a flame photometer (Page, 1992).

Data Analysis

The data were analyzed by SPSS software and obtain

the ANOVA results of the effects of various types of land use on total iron content and CEC. The comparison of the means of iron and CEC in different types of land use was done and the results show in histograms using excel software.

Results and discussion

Statistical Results

Table 1 show the ANOVA results of the effects of various types of land use on total iron content and cation exchange capacity in soil and Table 2 demonstration the comparison of the means of iron and cation exchange capacity in different types of land use in the study area. Rameshni and Banaei (1999) studied soils of the region south of Ardakan

and Eghlid and found that changes in minerals were slight in this dry and warm region because no chemical weathering took place. They expected Chlorite, Mica, Illite, and Polygorskite to be the more prevalent minerals, horizons to be more varied, and organic matter to be more abundant with a rise in precipitation and a decline in soil temperature from that suitable for profile evolution. They stated that, with an increase in precipitation and in temperature, gypsum, lime, and salt horizons appeared near soil surface. Increased smectite and cation exchange capacity are also observed in high-rainfall areas (which is one of the reasons for the fertility of the soils).

Table 1. The ANOVA results of the effects of various types of land use on total iron content and CEC.

Mean of Squares	df	Variability
CEC (meq.100g soil ⁻¹)	Fe (mg.kg ⁻¹)	
115.502*	19709.667*	3
		Land Use

*: Significant in 5% of Duncan test.

Table 2. Comparison of the means of iron and CEC in different types of land use in the area.

Mean of Index		Land Use
CEC (meq.100g soil ⁻¹)	Fe (mg.kg ⁻¹)	
22.26 ^d	457.9 ^{a *}	Rangeland
25.65 ^c	357.2 ^d	Irrigation Farming
27.53 ^b	425.5 ^b	Rain Fed
30.36 ^a	384.6 ^c	Abandon Rain Fed

*: The similar data is non-significant in 5% of Duncan test.

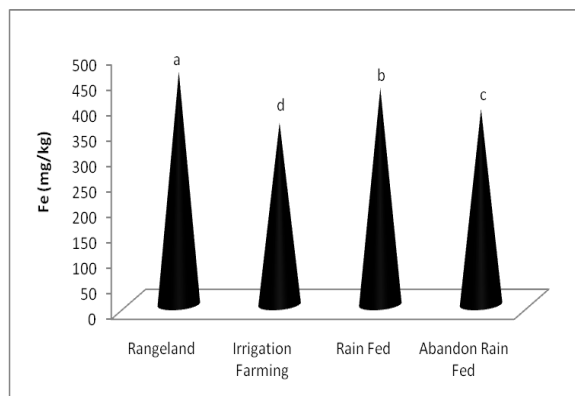


Fig. 1. Comparison of total iron (Fe) content in various types of land use (The different letters present the statistical significant in 5% of Duncan test).

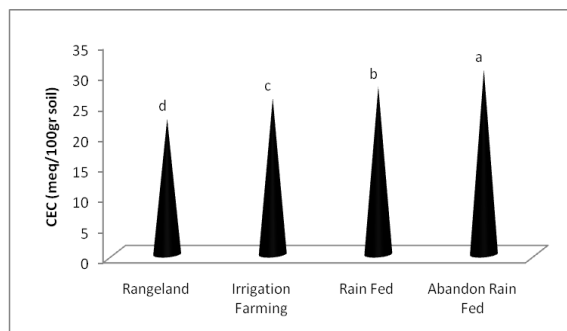


Fig. 2. Comparison of soil Cation Exchange Capacities in various types of land use (The different letters present the statistical significant in 5% of Duncan test).

CEC and TIC Results

Figures 1 and 2 shows the comparison of Total Iron Content and cation exchange capacities of soils in various types of land use, respectively. X-ray diffraction test was performed on the samples, and using the results of this test is the most accurate method for the identification of clay minerals in soils. Therefore, here our purpose was only to obtain the figures related to cation exchange capacity. According to Bohn *et al.* (2007) and Foot (1998), cation exchange capacity of between 20 and 40 milliequivalents per 100 grams of soil suggests the presence of mica and chlorite groups. According to the results of the statistical analysis performed in this study, although significant differences were observed in cation exchange capacity values, the range of these differences was not great (20-40 mill equivalents per 100 grams of soil), which confirms the presence of minerals of the mica group. Since the presence of minerals of the kaolinite group was proved in Atterberg limits test and by the diffractograms obtained from the X-ray diffraction test, the presence of chlorite in the soils of the area is rejected. The reason for this is that these two minerals rarely exist together in a clay sample because they are formed under different weather conditions: chlorite in dry environments (Khormali *et al.* 2006) and kaolin under wet conditions. Results of total soil iron content also indicated the presence of iron in the soils of the area. This confirms Dorothy Carroll's theory of "Logical Sequence in the degradation of mica minerals" (shown in Figure 3) concerning the process of degradation of minerals of the mica group (Illite to vermiculite) (Gholami, 2010).

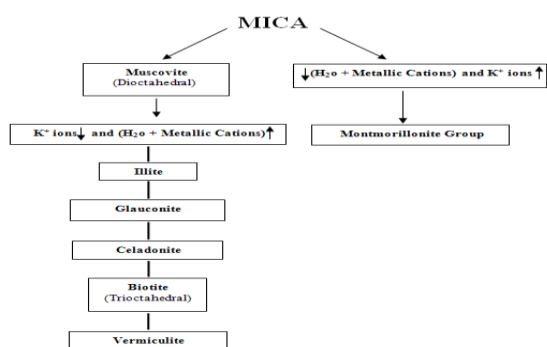


Fig. 3. Arrangement of the logical sequence of mica minerals.

Logical Sequence Results

Figure 3 show the Arrangement of the logical sequence of the degradation of mica minerals. In the section on soil mineralogical studies, the results obtained from analysis of total iron and cation exchange capacity confirmed the presence of the vermiculite, illite, kaolinite, attapulgite, and quartz minerals in the soils of the area. Moreover, the results obtained in this section indicated that the logical sequence of degradation of mica minerals is taking place. Therefore, the release of potassium, and the replacement of iron in the trend of the transformation of illite to vermiculite according to the theory of the logical sequence of the degradation of mica minerals introduced by Dorothy Carroll, can also cause increased soil potassium content in the end.

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