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STUDYING THE EFFECT OF DIFFERENT LAND-USES ON CHANGING SOME SOIL PROPERTIES (CASE STUDY OF EAST OF AHVAZ CITY)

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ABSTRACT

Studying the effect of different land-uses on changing soil properties allows identifying sustainable managements and subsequently preventing increased soil degradation. This research considered four different land-uses including agricultural, industrial, rangeland, and desert uses. Twenty-five soil samples of each use (totally 100 soil samples) were prepared from 0-30 cm depths and electrical conductivity of saturated extraction, pH, cation exchange rate, and percentages of calcium carbonate equivalent, organic materials, sand, silt, and clay of the samples were measured. Research results determined the most amounts of silt, clay, organic material and cation exchange in pasture use as 39.6, 36.3, 1.07 percent and 19.48 meq/100 g of soil, respectively. Maximum and minimum values of electrical conductivity were 54 dS/m and 8.55 dS/m for desert use and agriculture use, respectively. There were no significant difference among agricultural, industrial, and rangeland uses as far as pH was concerned ($p<0.05$), but it showed a significant relationship as far as desert use was concerned ($p<0.05$). Finally, there were no significant relationships among the four uses in terms of calcium carbonate equivalent at the level of 5 percent. The results showed that condition of pasture use was more favorable than the one of other uses as far as the properties under study.

Keywords: Land-use change, soil properties, Khuzestan province

INTRODUCTION

With the world population growing, especially in the developing countries, non-normative utilization of valuable natural resources made it necessary to study them continuously (Mohammadi *et al.* 2005). Soil quality can be defined as a continuous ability of soil in fulfilling its duty as a living vital system in ecosystem and under different utilizations (Vahdatkhah *et al.*, 2013). The living system should maintain biologic production, improve quality of water and air, and provide humans, animals, and plants with health. Soil quality evaluation is performed by measuring soil properties (Mohammadi, *et al.*, 2005). Soil quality should be examined as far as temporal and spatial aspects are concerned (Guilin *et al.*, 2007).

Liebig *et al.* (2004) examined the effect of tillage and cultivation on soil properties in two tests (one in 1984 and the other in 1993) at 0-7.5, 7.5-15, and 15-30 cm depths and realized that the effect of management is limited to 0-7.5 cm depth. They stated that farmers might improve soil quality by acquiring appropriate production systems and tillage management. Celik (2005) discussed that changing use of natural ecosystems into managed ecosystems had harmful impacts on soil properties. Deforestation and change of

pastures into agricultural lands destroy or disturb natural ecosystems and reduce current or future production capacity of soil. This might be due to erosion, reduced fertility, change in soil moisture, soil salinization, and/or change in vegetation and soil microorganisms.

Kiani et al. (2007) discussed the role of deforestation, graze, and degradation of pastures in soil properties of loess lands of Golestan province. The results showed that changing natural forests into agriculture lands reduced maximum 66 percent of soil organic matter and changed aggregates stability into one third of the original quantity. Quality of the grazed rangelands in this research was more favorable than other uses as far as physical, chemical, and biological indices were concerned.

Emadi et al. (2008) mentioned that land-use change in northern regions of Iran have usually followed by reduction of organic matter and nutrients of soil and led to soil structure degradation, distribution change, and aggregates stability. Haghighi et al. (2010) studied the effect of land-use change on physical properties and soil organic carbon. They realized that land-use change from pasture to agriculture lands increase bulk density and reduce organic matter,

porosity, mean-weight diameter of aggregates and hydraulic conductivity. Niknahad Gharmakher (2011) studied land-use change on soil properties of Kechik Watershed (in Golestan province), took samples from three uses including forest, rangelands, and agriculture lands, and proved that land-use change altered soil texture from sandy-clay-loam to sandy-loam and reduced average diameter of aggregates. As a result, agriculture soil had lower porosity as compared with forest and pasture soils and it had higher density. Moreover, organic matter and cation exchange capacity of soil in agriculture use had a significant decrease at the level of 5 percent as compared with forest and pasture uses.

Vahdatkhah et al. (2013) prepared 50 soil samples randomly from 0-30 cm depths to study changes of soil quality indices in orchard, tree cover (non-productive), pistachio orchards, agricultural, arid, abandoned, ploughed, and Haloxylon-planted uses. They measured organic matter contents, potential microbial respiration, bulk density, pH, EC, and soil texture in them and proved that soil quality of vegetation, orchard, agriculture, and pistachio orchard uses was superior to other uses.

This research aims at studying the effect of different land-uses on some physical and chemical properties of soil in the region under study.

MATERIALS AND METHODS

A) The region under study

Total area of the region under study is 457,281 hectares between longitude of 48°21'48" and 49°18'11" of east and latitude of 30°59'06" and 31°42'46''of north. Moisture and thermal regime of the region are respectively aridic and hyperthermic (Banaei, 1998). The region is east of Ahvaz. It gained attentions as it had four agricultural, industrial, rangeland, and desert uses.

B) Sampling

Region map was gridded as 1x1 km and coordinates of the center of each grid was determined. Samples were taken from the points using a GPS in a spatial manner. Based on this, 100 samples of soil from 0-30 cm depths were prepared from four uses of agricultural, industrial, desert and rangeland.

C) Laboratory Analyses

The soil samples were air-dried after transferring to a laboratory. They were then crushed and passed through a 2-mm sieve. Some chemical and physical properties of the soil were measured as follows:

pH was measured by a METROHM 827 pH-meter.

EC of soil saturated extract was measured using a METROHM 712 EC-meter (Page et al., 1982)

Soil organic matter was measured by wet-oxidation method (Page et al., 1982)

Cation exchange rate of the soil was measured using the ammonium acetate method (Sumner and Miller, 1996)

Calcium carbonate equivalent (TNV) was measured using the back-titration method (Adrano, 1998)

Percentages of sand, silt and clay were measured using Hydrometery method (Bouyoucos,, 1962)

D) Data Analysis Method

After collecting laboratory data, statistical process of all the data was carried out using SPSS 18. First, the data were studied in terms of having normal conditions. Next, ANOVA was carried out. Duncan's test at the significance level of 5% was used for comparing the means. The Pearson correlation coefficient of the parameters under study was calculated in order to examine the statistical relationship between them.

RESULTS AND DISCUSSION

Statistical Description of Data

Table 1 shows a summary of the results of statistical description concerning the measured physical and chemical properties of soil. The results showed that the pH with skewness of -0.3, kurtosis of -0.41 and mean of 7.5, calcium carbonate with skewness of -0.25, kurtosis of 0.43 and mean of 42.8 percent, cation exchange rate with skewness of -0.04, kurtosis of -0.13, and mean of 16 meq/100 g, silt with skewness of -0.24, kurtosis of -0.29 and mean of 34.7 percent and clay with skewness of 1.1, kurtosis of 31.8 percent had almost normal distribution. Means of EC, organic matter and sand in soil were 29.8 dS/m, 0.78 percent and 32.8 percent, respectively. Figure 2 shows frequency distribution of the physical and chemical properties measured in soil. As Figure 2 shows, distribution of pH, calcium carbonate, cation exchange rate, silt, normal but saline, clay, organic matter and sand have positive skewness. The above results are consistent with the ones obtained by Vahdatkhah et al. (2013), Nasrifard et al., (2013), Haghighi et al., (2010), and Khormali and Shamsi (2009).

Table 2 shows mean of physical and chemical properties measured in soil in the uses under study. As Table 2 shows, maximum and minimum rates of EC were respectively related to desert and agricultural uses. Maximum and minimum rates of acidity and calcium carbonate were respectively in agricultural and desert uses.

Maximum and minimum rates of cation exchange capacity were respectively in rangeland and desert uses. Maximum and minimum rates of organic matter and clay were respectively in rangeland and industrial uses. Maximum and minimum rates of sand were respectively in desert and rangeland uses. Maximum and minimum rates of silt were respectively in desert and agricultural uses.

Table 1: Statistical description of EC, pH, organic matter, calcium carbonate, cation exchange capacity, sand, silt, and clay

Statistic	EC dS/m	pH	Organic Matter %	Calcium Carbonate %	Cation Exchange Capacity meq/1OOgr	Sand %	Silt %	Clay %
Mean	29.8	7.5	0.78	42.8	16	32.8	34.7	31.8
Standard Deviation	23.5	0.27	0.47	4	3.6	16.6	11.7	10.4
Skewness	0.54	-0.3	0.32	-0.25	-0.04	0.55	-0.24	1.1
kurtosis	-1.05	-0.41	-0.71	0.43	-0.13	-0.2	-0.29	0.89

Table 2: Comparing mean of physical and chemical parameters measured in soil in the uses under study

Variable	Unit	Agricultural	Industrial	Rangeland	Desert
Electrical Conductivity	dS/m	8.55^c	31.3^b	25.2^b	54^a
Acidity	-	7.64^a	7.62^a	7.61^a	7.3^b
Calcium Carbonate	%	43.25^a	42.73^a	42.83^a	42.37
Cation Exchange Capacity	meq/100gr	16.22^b	14.48^{bc}	19.48^a	13.78^c
Organic Matter	%	0.78^{ab}	0.61^b	1.07^a	0.65^b
Sand	%	32.2^{ab}	36^{ab}	24.1^b	38^a
Silt	%	28^b	37.2^{ab}	39.6^a	33.8^{ab}
Clay	%	36.2^a	26.7^b	36.3^a	28.2^b

$^{a, b, c}$ **show significant changes of the means at the level of 5 percent.**
(Figures with different symbols have significant differences.)

B   A

pH   Soil EC in dS/m

D   c

F   **E**
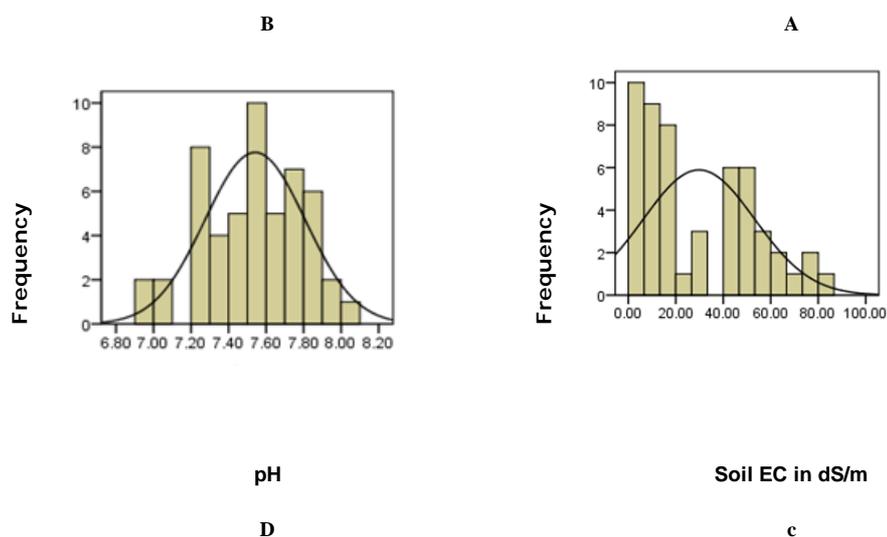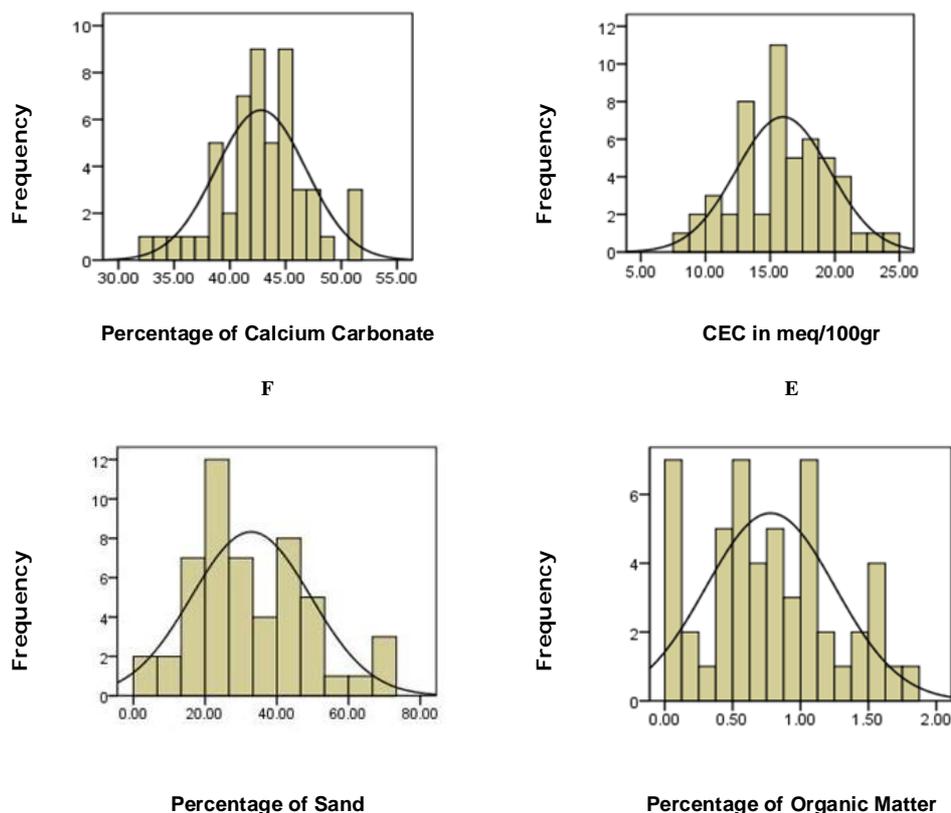

Figure 1: Frequency distribution of soil EC (A), pH (B), CEC (C), percentage of calcium carbonate (D), percentage of organic matter (E), percentage of sand (F), percentage of silt (G), percentage of clay (H)

Electrical Conductivity (EC) and Acidity (pH) of Soil: Mean of EC of desert soil was 54 dS/m and it was significantly higher than other uses at the probability level of 5 percent. The lowest EC was 8.55 dS/m that was related to the agricultural lands. EC of industrial and rangeland uses were respectively 31.3 and 25.2, which did not show a significant different at the level of 5 percent (Table 2). Soil's EC represents amounts of conductive salts in soil solution. Low amount of EC in agriculture use might

be due to water consumption for growing crops. High amount of salinity in the low-precipitation region is generally due to high temperature and high level of ground water (Ghobadian, 1995).

Soil acidity is effective in factors such as usability of nutrients required for plants, motion of heavy elements, and activity of soil microorganisms. Although soil acidity may change due to different managements of lands (Vahdatkhah et al., 2013), as shown by Table 2, mean of soil acidity of agricultural,

industrial, rangeland uses were 7.64, 7.62, and 7.61, respectively and it did not show any significant difference at the significance level of 5 percent. There was a significant difference at the level of 5 percent between mean of acidity of above uses and mean of acidity of desert (7.3). Higher value of pH in agricultural use as compared with other uses

probably depends on management activities such as fertilization (Geissen et al., 2009). Balesdent et al. (2000) stated that cultivation would increase pH as it affects organisms' activity. Results of EC and pH changes in different uses mentioned here are consistent with the ones of the research of Vahdatkhah et al., (2013).
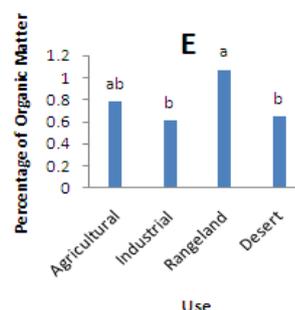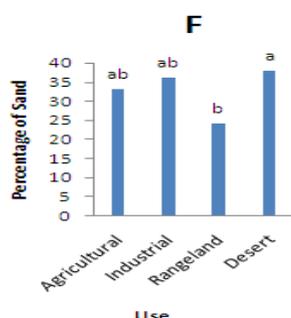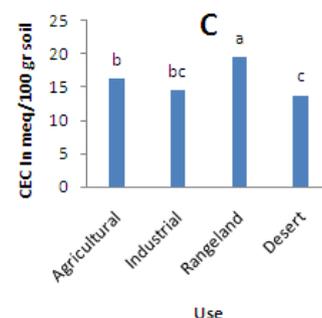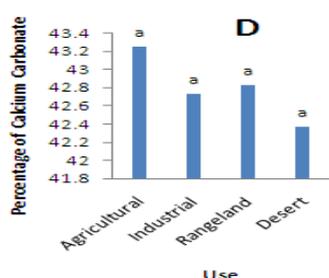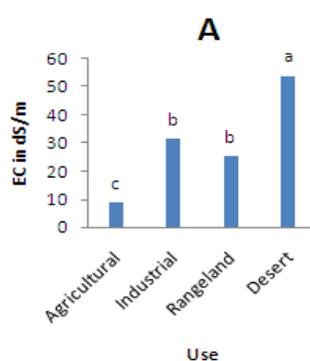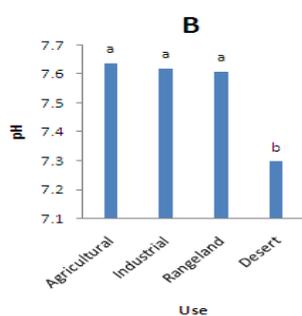
Figure 2- Diagrams comparing means of EC (A), pH (B), cation exchange capacity (C), percentage of calcium carbonate (D), percentage of organic matter, (E) percentage of sand (F), percentage of silt (G), percentage of clay (H) in the uses under study

Percentage of Calcium carbonate equivalent (TNV): Table 2 shows that TNV percentage did not show a significant difference at the level of 5 percent among the four uses under study. Agricultural use and desert use had the highest and lowest TNV percentages of 43.25 and 42.37, respectively. Generally, the studied uses had the highest rate of 40 percentage of calcium carbonate, which is consistent with the study of Nasrifard et al., (2013). The possible reason might be that the above uses are in the arid and semi-arid regions. Notably, Haajabbasi, et al. (2007) did not observe a significant difference for calcium carbonate in the regions they studied (rangeland and agriculture land) in south and southwest of Esfahan.

Cation Exchange Capacity (CEC) of Soil: The highest and the lowest CEC were related to the rangelands (19.48 meq/100gr of soil) and the desert lands (13.78 meq/100gr of

soil), respectively. It did not show a significant difference at the probability level of 5 percent. CEC of agricultural and industrial use were respectively 16.22 and 14.48 meq/100gr soil, which did not show a significant difference at the level of 5 percent (Table 2). CEC rates follow the rates of organic matter of soil (Jaiyeoba, 2003). Ajami (2007) attributed soil organic matter reduction and clay particles reduction in soil to significant reduction of CEC in lands. The results obtained here also confirm it because the desert lands, with low amount of organic matter and clay, have the lowest CEC and the rangelands, with the highest amount of organic matter and clay among the uses under study, have the highest CEC. CEC of soil in this research have a significant correlation with organic matter ($p<0.01$, $n=100$ and $r=0.34$).

Percentage of Organic Matter of Soil: Table 2 shows that maximum organic matter

is 1.07 percent, which is related to rangeland use and minimum amounts of organic matter are 0.61 and 0.65 percent respectively for industrial use and desert use. Percentage of organic matter in agricultural use is 0.78, which is lower than the one of rangeland. The results are consistent with the ones obtained by Haghighi *et al.* (2010) and Niknahad Gharmakher (2011). Organic matter of agricultural lands is less than the one of rangeland; this might be due to cultivation and topsoil disturbance and consequently accelerated biologic biodegradation of organic matter, accelerated soil erosion, and following that loss of organic matter by runoff in the agricultural lands (Aguilar *et al.*, 1998). Nardi *et al.* (1996) believe that organic matter physical protection due to crushing coarse aggregates during cultivation is effective in biodegradation of organic matter in soil of agricultural lands, and Carter *et al.* (1998) believed that increased soil temperature due to reduction of vegetation canopy was effective in biodegradation of organic matter in soil of agricultural lands. Low level of organic matter in desert and industrial lands may be due to high salinity of soil and vegetation sparseness in the regions.

Percentage of Sand, Silt, and Clay: Table 2 shows that mean of sand, silt, and clay have

significant difference with one another in various uses, which is consistent with the results obtained by Khormali and Shamsi (2009) on change of soil texture due to land-use change. Maximum and minimum amounts of sand were related to the desert lands (38 percent), and rangelands (24.1 percent), respectively. They had a significant difference at the probability level of 5 percent. Maximum and minimum amounts of silt were related to the rangeland (39.6 percent) and agricultural lands (28 percent), respectively. Maximum amounts of clay for the agricultural lands and rangeland were 36.2 and 36.3 percent, respectively. Minimum amounts of clay for industrial lands and desert lands were 26.7 and 28.2 percent, respectively. Difference of mean of soil texture components in various uses may be due to further erosion in desert lands as compared with rangeland and agricultural lands. In fact, erosion leads to degradation of surface layers and exposure of deep layers (Ajami, 2007).

Assessment of Features Correlation in the Study

Pearson correlation coefficient was calculated (Table 3) to determine the correlation between the features under study. Based on the results of Table 3, CEC (r=0.38**) and silt amount (r=0.4**) had a

highly significant correlation (p<0.01) with the organic material. CEC follows the amount of organic material of soil (Jaiyeoba, 2003). Moreover, silt amount (r=0.41 **) and clay amount (r=0.33**) respectively had a highly significant correlation (p<0.0l) and

significant correlation (p<0.05) with CEC. Reduction of clay particles in soil causes CEC reduction in soil (Ajami, 2007). The above results are consistent with the ones obtained from studies of Jaiyeoba (2003) and Ajami (2007).

Table 3- Pearson correlation coefficient for the features under study

Variables	EC	pH	OM	CaCO3	CEC	Sand	Silt	Clay
EC								
pH	-063**							
OM	0.01	0.27						
CaCO$_3$	-0.29*	-0.08	-0.15					
CEC	0.01	0.21	0.38**	-0.5**				
Sand	0.04	0.2	-0.43	0.19	-0.5			
Silt	0.35*	-0.25	0.4**	-0.29*	0.41**	-0.79**		
Clay	-0.28*	-0.06	0.19	0.08	0.33*	-0.69**	0.15	

EC: soil saturation extract salinity, pH: pH of saturation mud, OM: percentage of organic matter, CaCO3: soil lime percentage, CEC: cation exchange capacity, Sand: percentage of sand, Silt: percentage of silt, Clay; percent of clay

CONCLUSION

Research results showed that soil properties is different in the uses under study; this is related the type of use and the management employed in these lands. Maximum percentage of clay, silt, organic matter and maximum CEC were obtained from rangeland use. Maximum percentage of sand and maximum EC was observed in desert use, which may be due to vegetation density reduction and soil surface aridity. There was no significant difference among agricultural, industrial, rangeland uses as far as acidity is concerned; however, acidity in desert use was less than above uses and it showed a significant difference at the probability level of 5percent. Finally, there was no significant difference among the uses under study as far as TNV percentage was concerned. TNV

percentage was above 40, which indicates soil calcification of the region.

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