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COMPARATIVE ANALYSIS OF SOIL VARIABLES IN DIFFERENT LAND USES OF THE SHAZAND WATERSHED, IRAN

SUMMARY

Different land uses affect physical, chemical and biological properties of the soil and hence change the quality of soil. However, limited researches have been conducted in due course on the basis of high resolution field surveying. Therefore, the current study aimed to evaluate the effects of land use types on different variables of the Shazand Watershed (Iran) with a calcareous soil in central semi-arid region of Iran with an area about 1740 km^2. Towards this, five different main land uses viz. irrigated farms, rain fed farms, rangelands, orchards and outcrops dominant areas were primarily selected. Some 140 soil samples were then taken from the top 30-cm of the soil from homogeneous units representing an area about ≥ one km^2 and various soil properties such as sand, silt, clay, gravel, bulk density (BD), soil organic carbon (SOC), pH, electrical connectivity (EC), calcium carbonate ($CaCO_3$), nitrogen (N) were analyzed. The findings indicated that land use types had no significant effect ($P > 0.05$) on different soil variables. Nevertheless, the SOC and $CaCO_3$ in irrigated farm with respective values of 0.69 and 29.88 % were found to be more than those of other land uses. It is suggested from the results that other factors of slope, elevation and micro-climate might affect inter-variation of the study soil variables. These findings can be used for designating proper soil management strategies in the study watershed.

Keywords: Land use/Land cover change, Land degradation, Soil organic carbon, Watershed management.

INTRODUCTION

In a watershed, there are potent relationships between land use types and hydrological processes such as runoff and water quality, flooding, soil erosion, and sediment yield (Gao et al., 2014; Zhao et al., 2015; Davudirad et al., 2016). Over the past 50 years, humans have altered ecosystems more rapidly and extensively, largely to meet rapidly growing demands for resources along with economic development. The change and degradation of forests, agricultural lands, grasslands, and other land uses have a great impact on the intensity,

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duration, and continuity of all of aforementioned phenomena. Changes in land use have a severe effect on chemical, physical and biological properties of soil and hence change the soil health and quality (Irshad et al., 2015; Jaiarree et al., 2011). The relationships among various land uses could be considered as water–soil–plant relationships. Therefore, to clarify these relationships, it is necessary to achieve adequate information about soil. Many studies (e.g., Franzluebbers and Stuedemann, 2010; Mohawesh et al., 2015; Deng et al., 2016) indicated that strong and statistically significant relationships between soil quality, land degradation and land use type. Improper agricultural practices and overgrazing reduce the soil resistance to the forces of erosion (Conant et al., 2016). Forestry activities changed the top soil surface structure (Enez et al., 2015; Watson et al., 2000).

Effects of land use changes on soil properties is inherently regional and highly dependent on the soil type (Abu –Hashim et al., 2016), climate (Berhongaray et al., 2013; Yang et al., 2016), and topography (Ayoubi et al., 2012; Dessalegn et al., 2014; Falahatkar et al., 2016; de Blécourt et al., 2017). So, there is a need to assess the effects of different land uses on soil properties in different ecological regions.

The Shazand watershed with a calcareous soil in central semi-arid region of Iran is a fertile region, so that over the past decades, most of the inhabitants were supported by farming. There are various land uses and excessive destructive human activities in the Shazand watershed whose effects on changing soil characteristics have not been minutely studied.

MATERIAL AND METHODS

Study area

The study was carried out for the Shazand watershed in Markazi Province. The study watershed is 1,740 km2 in area located between 49° 04′ 15″ to 49° 52′ 12″ E and 33° 44′42″ to 34° 12′ 13″ N (Fig. 1). From its total area, 50.15% includes highlands and hard formations, and 49.85% contains alluvial sediments and/or sub-mountain screes. A complex topography, with elevation ranges from 1,800 m to more than 3,300 m (above mean sea level), results in steep gradients of rainfall on both spatial and temporal scale. More than 90% of geologic formations belong to second and third geological era (i.e., Quaternary, Neogene and Cretaceous).

The climate is semi-arid with an average annual precipitation of 420 mm, mostly falling in winter, autumn and spring and a mean annual temperature of 12ºC. Agricultural lands located mostly in 5–15% slopes and mainly are utilized for wheat dry farming. The exchanges of land use for period of 1973 to 2014 showed that rangeland area reduced about 380 km^2. In the study period, rain fed and irrigation farm lands first increased and then reduced as well as area of orchards increased with the highest annual rate (0.265%) (Davudirad et al., 2016; Hazbavi and Sadeghi, 2017). The soils have low organic matter (about 1%) and are mainly calcareous and clay loam texture.

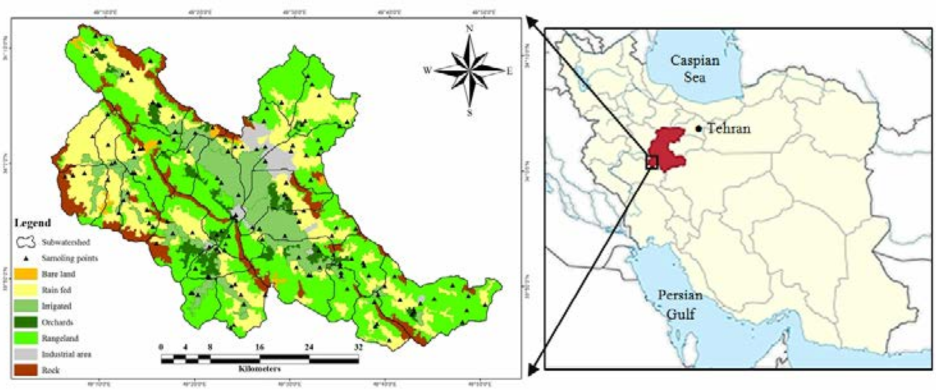

Figure 1. General view and location of the Shazand Watershed in Markazi Province, Iran

Field sampling and laboratory analyses

The investigations were carried out within the Shazand watershed in five different land uses. Some 140 soil samples were collected from different land uses. The soil samples were taken from the center of each quadrate by driving a core sampler up to 30 cm in depth. The soils were collected by an augur and kept in polythene bags so that they remained in field moist condition. After completion of collecting soil samples, the unwanted materials like stones, granules, leaves, roots etc. were discarded from the samples. The samples were then dried at room temperature, crushed, mixed thoroughly and sieved with a 2-mm sieve (Islam et al., 2016). Particle size distribution was determined by the hydrometery method (Bouyoucos, 1951). Bulk density (BD) was calculated using the cold method (Blake and Hartge, 1986). Soil pH and electrical conductivity (EC) were also measured on a 1:5 soil to water ratio suspensions with the help of by a pH/conductivity meter (Rhoades, 1996). Nitrogen (N) and Carbonate ($CaCO_3$) were determined using the Kjeldahl method (Bremner, 1996) and pressure calcimeter method, respectively (Richard and Donald, 1996). The Walkley and Black method was ultimately used to determine SOC (Nelson and Sommers, 1996).

All data were analyzed using SPSS 22.0 statistical software. One-Way ANOVA (analysis of variance) was used to detect the differences in the measured variables among land use types at significant level 5%. In addition, comparing the means among groups was investigated by different methods of Post Hoc Test (Kiani-Hrachegani et al., 2016).

RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics of the properties of the soils studied. $CaCo_3$ varied from 22.29 to 29.88 % in outcrops dominant areas and irrigated land use, respectively. High amounts of calcium carbonate in different land uses indicate the soils of the Shazand watershed are calcareous. The results of Table 1 also show that SOC varied from 0.57 to 0.69 % in different land uses, indicating low to moderate storage of organic carbon in the soil of the area. In addition, the results of particle size distribution show that orchards have the highest silt + clay contents (32.64 + 33.00%) compared to other land uses. The highest percentage of sand and gravel (39.10 and 31.64 %) were also observed at irrigated farms and outcrops dominant areas, respectively. Therefore, these findings can help to local manages designate proper soil management strategies in the study watershed (Mohawesh et al., 2015; Deng et al., 2016).

Table 1. Mean and standard divination of soil properties in different land use within the Shazand watershed, Iran

Land use	Area (%)	Sample size (n)	Fine earth			Rock fragment (%)	Bulk density (gr cm^{-3})	Organic carbon (%)	pH	Electrical connectivity (ds m^{-1})	Calcium carbonate (%)	Nitrogen (%)
			Sand (%)	Silt (%)	Clay (%)							
Irrigated	11.81	26	39.10 ±16.49	32.08 ±13.06	28.82 ±9.30	21.42 ±13.55	1.47 ±0.35	0.69 ±0.27	7.89 ±0.14	0.21 ±0.05	29.88 ±11.08	0.12 ±0.06
Rain fed	25.38	37	38.20 ±13.43	33.12 ±10.73	28.68 ±9.14	19.18 ±10.25	1.46 ±0.31	0.59 ±0.27	7.86 ±0.11	0.20 ±0.05	28.98 ±9.92	0.10 ±0.06
Rangeland	38.31	59	39.07 ±12.80	33.04 ±9.89	27.89 ±9.54	24.41 ±14.91	1.39 ±0.31	0.59 ±0.28	7.84 ±0.14	0.20 ±0.06	27.37 ±11.77	0.12 ±0.07
Orchards	7.79	10	34.36 ±11.37	32.64 ±5.48	33.00 ±7.88	23.18 ±15.72	1.49 ±0.12	0.57 ±0.34	7.87 ±0.09	0.21 ±0.05	29.80 ±9.16	0.13 ±0.09
Outcrops dominant areas	16.71	8	35.85 ±9.25	33.13 ±7.68	31.02 ±5.57	31.64 ±13.53	1.50 ±0.21	0.63 ±0.32	7.84 ±0.18	0.23 ±0.15	22.29 ±12.28	0.11 ±0.07

The results of the One-Way ANOVA to assess the effect of different land uses on soil characteristics have been presented in Table 2. The One-Way ANOVA clearly showed that land uses had no significant effect ($P > 0.05$) on different soil variables. Also, comparing the mean between groups was investigated by different methods of Post Hoc Test and various variables of soil were observed only in a group. It is probably attributed to inherent similarity in main affecting factors on soil formation and development (i.e., dominant geologic formation, topography and climate) in the study area, which different researchers have considered them (i.e., Dessalegn et al., 2014; Abu –Hashim et al., 2016; Ayoubi et al., 2018).

There was no significant difference ($P > 0.05$) among SOCs in different land uses, which agrees with Blécourt et al. (2017) who stated there was no statistically significant difference among land uses in viewpoint of SOC in Xishuangbanna Region, China. However, it disagree with the findings of Falahatkar et al. (2016) who expressed the mean values of the SOCs in the selected land uses in the Deylaman Region were significantly different (p <

0.05). Nevertheless, the SOC and $CaCo_3$ in irrigated farm with respective values of 0.69 and 29.88 % were found to be more than those of other land uses.

Table 2. Results of One-Way ANOVA for comparison of soil characteristics in different land uses within the Shazand watershed, Iran

variable	p-Value	Mean Squared		F-Value
		Between Groups	Within Groups	
Sand (%)	0.79	0.46	1.13	0.41
Silt (%)	0.97	12.79	110.76	0.12
Clay (%)	0.56	63.72	84.58	0.75
Gravel (%)	0.28	0.11	0.09	1.26
Bulk density (gr cm^{-3})	0.58	0.01	0.01	0.71
Organic carbon (%)	0.46	0.05	0.06	0.91
pH	0.51	0.01	0.02	0.83
Electrical connectivity (ds m^{-1})	0.89	0.004	0.01	0.27
Calcium carbonate (%)	0.56	91.89	122.55	0.75
Nitrogen (%)	0.35	0.01	0.01	1.11

CONCLUSIONS

In recent decades, land degradation processes are driven or exacerbated by human activity as change in land use. Changes in land uses are expected having a severe effect on chemical, physical and biological properties of soil and hence change the soil health and quality. In this regards, the effects of different land uses on soil properties of the Shazand Watershed (Iran) with a calcareous soil in central semi-arid region of Iran was investigated. We found non-significant difference among study variables in different land uses of the Shazand watershed, Iran. It is therefore suggested from the results that in the study of spatial and temporal scales, other factors of slope, elevation and micro-climate might affect inter-variation of the study soil variables, which need to be accurately studied in future endeavors.

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