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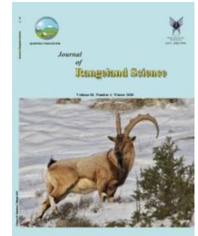

Research and Short Length Article:

Effect of Rangeland Conversion to Dryland Farming on Soil Chemical Properties (Case study: Kian rangelands, Lorestan, Iran)

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Abstract. Land use change as the most important destructive factor in natural ecosystems is a globally problem that changes soil properties. Therefore, correct management and recognition of change aspects on each component of the ecosystem is necessary. This process causes land destruction, ecosystem instability, soil erosion, and more biological threats. Due to increasing land use conversion from rangelands to dryland farming, the effect of this phenomenon was studied on soil chemical properties in three land uses as protected rangeland, dryland farming and abandoned dryland in Kian rangelands in Lorestan province, Iran in 2016. Soil properties including Soil Organic Carbon (SOC), pH, Electrical Conductivity (EC), and lime were compared between three land uses in two depths of 0-20 cm and 20-50 cm. Results showed that land use changes significantly affect these soil properties. In dryland farming, organic carbon was reduced in comparison to rangeland by 42% and 52% in the first and second depths, respectively. In contrast, the pH, EC and lime values increased in dryland farming than natural rangelands as 0.9%, 25.8%, 63.1% in the first depth, and 0.4%, 50%, 15.1% in the second depth, respectively. By stopping farming in abandoned dryland, the soil properties positively changed toward rangeland. These findings revealed that soil chemical properties were changed by conversion of rangeland to dryland farming via agricultural activities and human manipulation. Regarding these effects on soil properties and to keep ecosystems stability, attention has to be paid on land capability and prevention from wrong land uses.

Keywords: Abandoned dryland, Kian, Land destruction, Land use change

Introduction

Globally, rangelands are used to raise livestock for food and fiber, harvest renewable and non-renewable energy and mineral resources, provide habitat for wildlife, and open space for human enjoyment and recreation. But the rangelands are threatened continuously especially by land use changing and converting to dryland farming which will be abandoned finally. Land degradation is widespread and a serious threat affecting the livelihoods of 1.5 billion people worldwide of which one-sixth or 250 million people reside in drylands. Globally, it is estimated that 10–20% of drylands are already degraded and about 12 million ha are degraded each year (Yirdaw *et al*., 2017). Severe rangeland degradation can create significant social, economic, and environmental problems. Reduced rangelands area by land use changes, cause undesirable effects on soil production capability (Engeman and Leroy, 1995). Such land use changes are very common in the Zagros rangelands of Iran (Vahabzadeh, 2008) and they are increased progressively.

During recent decades, soil properties concept has emerged and is used to assess land or soil quality under various systems. It is assumed that soil quality can be used to judge impact on erosion, ground and surface water status and quality, and food and air quality (Wang *et al.*, 2003). More information is now available that clearly shows that severe decline in soil occurs along with increased soil erosion as a result of agricultural activities following land use changes.

Soil keeps nutrients and moisture for plant growth and this function is affected by soil features. Land use changes cause significant effects on the geochemical cycle of organisms, and changes in soil properties over time (Wu *et al*., 2007). Such changes in rangeland conditions usually lead to the increased soil compaction, reduced soil aggregate stability, and soil fertility. Since a key component of overall ecosystem sustainability occurs belowground, recovery is tied to the soil physical, chemical and biological functions and processes (Snyman and du Preez, 2005). Soil degradation is a critical biophysical process affecting ecosystem functions and the sustainability of all land uses (Yirdaw *et al*., 2017).

Understanding changes in soil characteristics under different rangeland conditions is essential when making rangeland management decisions. The fact that the quality of natural resources must be maintained to ensure sustainable land use brought about that soil quality is contemplated intensively these days (Miller and Wali, 1995). The purpose of this study was to understand the impact of rangeland degradation conditions on the soil chemical properties along a gradient in three land uses in Western Iran.

Materials and Methods

Site Description

The study area is located in Kian rangelands in western Iran, a part of Zagros rangelands in Lorestan province, Khorramabad, Iran. The area is mountainous and its geographical coordinates are 48°40′ 59″ E and 33° 24′ 47″ N. Mean annual rainfall is 493 mm, altitude is 1975 m.a.s.l. (Meter above sea level), and aspect of this site is northern and the soil texture was clay.

Three types of land use with similar altitude, aspect and slope were selected as rangeland, dryland, and abandoned dryland with dominant plant types of *Astragalus microcephalus-Bromus tectorum, Triticum aestivum-Heteranthelium piliferum*, and *Bromus tectorum-Heteranthelium piliferum*, respectively. Selected dryland previously was a rangeland but now, it is under wheat cultivation.

The range condition trend was upward. Its situation was assessed as “good” (by four-factor method). Vegetation cover percent was 81.3%, 93.2%, and 59.4%in rangeland, dryland and abandoned dryland, respectively.

Data collection

To conduct an appropriate comparison between treatments, three land uses (Rangeland, Dryland farming, and Abandoned dryland) were selected adjacent each other without any differences in topographic conditions (slope, altitude, aspect). It was in accordance to the research purpose.

Three 50m transects were established between each three land uses of rangeland, dryland farming and, abandoned dryland. On each transect, 10 plots were established by the same distance that half of them (5 plots) were placed in rangeland and the other 5 plots were placed in dryland farming. Similarly, in three other 50m transects, half of plots (5plots) were placed in rangeland and half of them were in abandoned dryland. The conditions of the experiment were equal in soil analyses of rangeland, dryland farming, and abandoned dryland, and soil samples were obtained according to grid sampling (Wollenhaupt and Wolkowski, 1994) by 5.5×5.5 m grid sizes using a randomized systematic method from two depths of 0-20 cm and 20-50 cm (the depth of tillage and root zone in drylands) (Boroumand *et al*., 2014) with 15 replications in each land use. According to our method, in each land use, 15 points were selected and soil samples in each point were collected from two depths. Totally, 90 soil samples were collected (three land uses, 2 depths of the soil, in 15 replications). These samples were labeled and were transformed to the laboratory in plastic bags.

Samples were air-dried at room temperature and stored to be analyzed for soil organic carbon (SOC) according to Walkley and Black (1934) method. The soil acidity was measured by pH meter. The soil electrical conductivity *(*EC*)* was measure using Nelson and Sommer (1982) method. Finally, the soil lime ($CaCO_3$) content was measured using Dreleimanis (1962) method.

Obtained data from soil chemical properties in each land use were normalized and data were analyzed using one-way analysis of variance and means comparisons were made by Duncan's multiple range tests using SPSS (Ver. 20).

Results

Observed plant species number in this research in each land use of rangeland, dryland, and abandoned dryland was 56, 33, and 41 species, respectively. Vegetation cover percent of dominant species in each land use was *Astragalus microcephalus* 20.2%, *Bromus tectorum* 12.8% in rangeland, *Triticum aestivum* 83.1%, and *Heteranthelium piliferum* 1% in dryland farming, *Heteranthelium piliferum* 18.9% and *Bromus tectorum* 16.8% in abandoned dryland.

Analysis of variance between soil chemical properties of two depths (0-20 cm and 20-50 cm) in three land uses (rangeland, dryland, and abandoned dryland) showed that there were significant differences between soil properties in three treatments ($p<0.05$) (Table 2).

Table 2. Analysis of variances of soil properties for three land use systems in two soil depths in Kian, Lorestan, Iran

Source of variation	DF	MS							
		SOC (%)		pH		EC(dSm^{-1})		$CaCO_3$ (%)	
		0-20 cm	20-50 cm	0-20 cm	20-50 cm	0-20 cm	20-50 cm	0-20 cm	20-50 cm
Between Groups	2	2.423*	0.729*	0.027*	0.005*	0.107*	0.285*	225.848*	67.65*
Within Groups	42	0.003	0.002	0.001	0.001	0.001	0.001	0.224	0.134

*= significant at 95% probability levels

Chemical soil properties were significantly different between three land use treatments so that higher values of SOC were obtained in the first depth (0-20 cm). Land use change from rangeland to dryland farming led to decreases of SOC in dryland farming than natural rangeland given as 42% and 52% in the first and second depths, respectively (Fig. 3). In contrast, pH, EC and $CaCO_3$ values of dryland farming were increased than natural rangelands as 0.9%, 25.8% and 63.1% in the first depth, and 0.4%, 50% and 15.1% in the second depth (Fig. 3). In abandoned dryland by stopping the farming, soil properties were ranked in mid-rangeland and dryland classes. By stopping the farming in that area, the abandoned dryland suspended soil destruction process and soil properties in abandoned dryland improved gradually by appearance and establishment of plant species.

The highest concentration of total SOC (1.77% and 0.79% in the first and second depths, respectively) was observed in rangeland. After the conversion of rangeland to dryland farming, this factor decreased considerably in both depths, but by stopping the farming in these lands, the recovery process was started slowly in both depths. In contrast, pH values were low in natural rangeland soil in upper depths of 0-20 cm and its values were increased in depth of 20-50 cm in both dryland farming and abandoned dryland treatments. Two factors of EC and lime values were increased in dryland but decreased in abandoned dryland in upper depths except for lime in the second depth of abandoned dryland increased in comparison with dryland (Fig. 3).

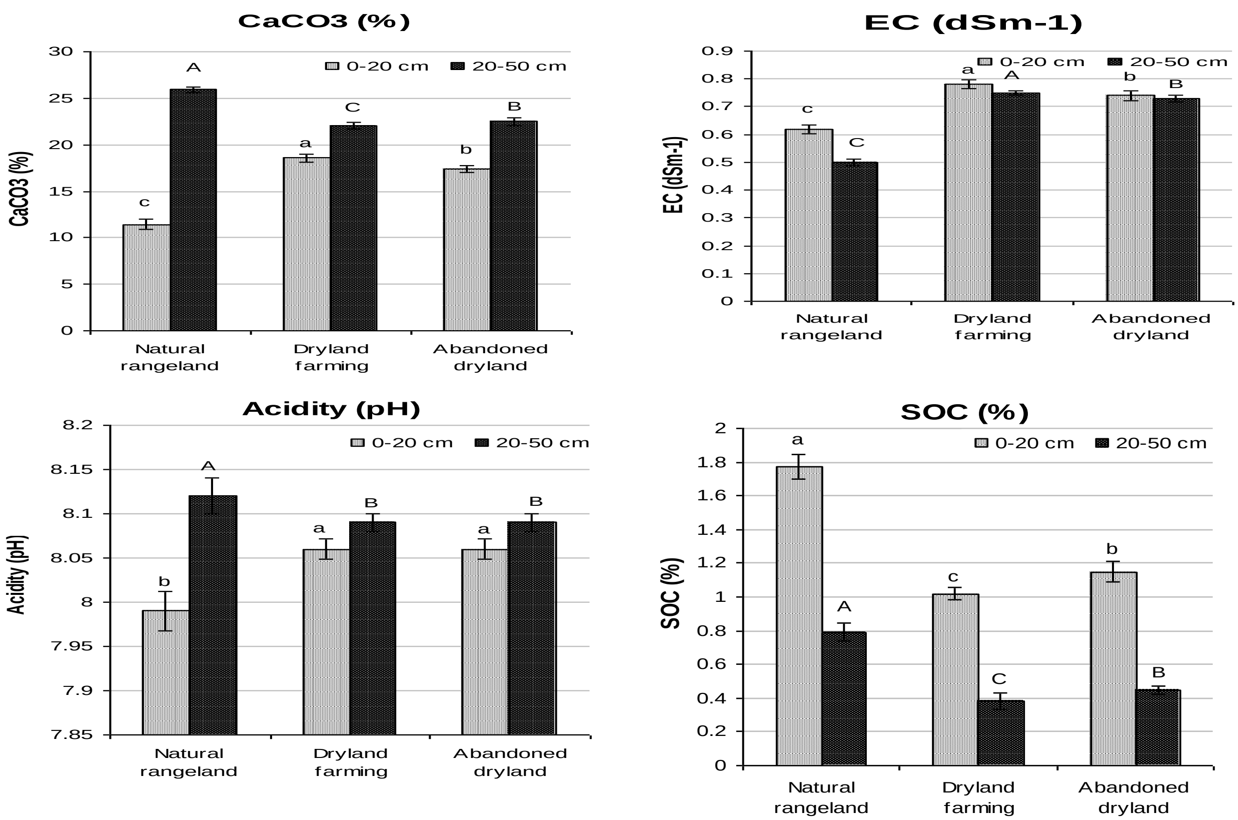

Fig.3. Mean ±SE of soil properties in two soil depths of three land use systems in Kian, Lorestan, Iran
Means of columns for 0-20 cm soil depth with similar lowercase letters and Means of column for 20-25cm depth with similar uppercase letters are not significantly different.

Discussion and Conclusion

According to our findings, rangeland changed to dryland by cultivating *Triticum aestivum* since 1981. So, rangeland dominant species such as *Astragalus microcephalus* and *Bromus tectorum* were replaced by *T. aestivum* and associated species. During this event, by tillage and rummage of soil, some soil nutrients moved between soil layers. Soil tillage influences water erosion and consequently, loss of soil organic carbon (SOC) in surface runoff. Nutrients and SOC were transported by surface runoff in particulate form, adsorbed to soil colloids or soluble in water depending on the soil tillage type. Guo and Gifford (2002) reviewed 74 literatures from various countries and reported that changes in soil carbon are associated with land use changes. In our research, SOC was decreased after farming in rangeland; this is in accordance with Chen *et al*. (2017) results. This is due to SOC discharge in soil by crop harvesting and the low entrance of carbon into agricultural soils (Bagherifam *et al*., 2013). Rasouli Sadaghiani *et al*. (2016) referred to this point that input carbon decreased by land use changes to croplands. Also, this element comes up to soil by tillage and will be exposed more to biodegradation.

Root secretion and leakage (exudates) generally have low molecular weight and degrade easily. Some of the total photosynthesis products in plants release in soil. Some nutrients mobility changed by secretion of compounds from plant and microorganisms in rhizosphere. Competition between these microorganisms and roots for uptake nutrients induced more changes in soil chemical properties (Demoling *et al*., 2007).

The decrease in soil organic carbon in cropping systems is well known globally and the subject of an extensive literature. Sainepo Bernice *et al*. (2018) suggest that land use types have an influence on soil properties and their management can contribute to sustainable land management to mitigate negative effects on the environment. Hashemi Rad *et al*. (2018) revealed a difference in soil samples of land uses including rangeland and dryland farming in Iran. Leifeld and Kogel-Knabner (2005) results showed a reduction in SOC in depth of 0-30 cm from permanent grassland of southeastern Germany to arable systems. Rezapour and Samadi (2012) showed that long-term farming decreased SOC significantly.

The pH of the first depth of soil was increased in dryland and abandoned dryland and this is in agreement with the results of Kiani *et al*. (2007). This is related to tillage in dryland, rising up lime and increases in pH (Khormali and Shamsi, 2009). In the second depth by tillage and leaching of salts to lower horizons, pH was decreased. Tillage and cropping systems cause variations in pH values of soil (Kahlon and Gurpreet, 2014).

Plant roots can create a different chemical condition in the soil. Various crops have several compatibility mechanisms to uptake nutrients from soil sources (Hinsinger, 1998). Farming and crop plant roots by an influence on microorganisms can increase soil pH (Boroumand *et al*., 2014). In our research, long-term wheat cultivation affected soil microorganisms followed by pH enhancement. Generally, crop residues can change the pH of soil depending on soil and weather conditions (Safahani Langeroodi *et al*., 2016).

EC showed an increasing trend with the change of rangeland to dryland. This may be due to nutrient leaching and accumulation of the nutrients as degradation of rangeland has occurred (Kassahun *et al*., 2012). Because of tillage in dryland, permeability will increase so that rainwater can transform nutrients to the down layer of soil easier than rangeland with no tillage. Bolan *et al.* (1991) referred to this point too. Decomposition of crop residues caused to release component of these residues, so they can increase the iron amount in soil solution. This element is effective in EC (Kabirnejad *et al.*, 2014). Iron content has a significant relationship with EC values in soil (Emsens *et al.*, 2016).

Lime in the first layer was lower than the second one in all land uses because of leaching from topsoil and accumulation in lower layers (Rahimi Ashjerdi and Ayoubi, 2013). However, in dryland farming by tillage and rummage of soil, lime material goes up to surface and pH increases (Khormali and Shamsi, 2009). In depth of 20-50 cm in dryland farming and abandoned land, the soil is more permeable than rangeland, so leaching is high and the lime amount decreases (Malekpour *et al*., 2011).

Environmental degradation caused by inappropriate land use is a worldwide problem that has attracted attention to sustainable agricultural production systems. Indicators for identifying the deterioration of natural resources are an aspect justifying future attention. These indicators must include the continual monitoring of rangelands where its implementation must definitely take place with the determination of threshold values to be successful within a production system. Soil disturbance as a result of land use change should be minimized by proper management (Parras-Alcabtara *et al.*, 2017). Results from this study showed that land degradation contributed significantly to the soil properties due to cultivation, agricultural activities and human manipulation. This process transforms soil properties. Agriculture development and intensive farming in Zagros rangelands are major threats to the sustainability of this important ecosystem.

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اثر تبدیل مراتع به دیمزار بر برخی از خصوصیات شیمیایی خاک (مطالعه موردی: مراتع کیان، لرستان)

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چکیده. تغییر کاربری اراضی به عنوان مهم‌ترین عامل مخرب اکوسیستم‌های طبیعی، یک مشکل جهانی بوده و عامل مؤثری بر تغییر ویژگی‌های خاک می‌باشد و برای مدیریت صحیح آن، شناخت تأثیرات آن بر هر یک از اجزای اکوسیستم ضروری است. این فرآیند موجب تخریب زمین، ناپایداری اکوسیستم، فرسایش خاک و خطرات و تهدیدهای زیستی می‌شود. با توجه به افزایش تبدیل مراتع به اراضی زراعی و با هدف تعیین اثرات آن بر خاک، در این تحقیق برخی از خصوصیات شیمیایی خاک (کربن آلی، اسیدیته، هدایت الکتریکی و آهک) در سه کاربری مرتع قرق، دیمزار و دیمزار رها شده در مراتع کیان استان لرستان در غرب ایران در سال ۱۳۹۵در دو عمق ۲۰-۰ و ۵۰-۲۰ سانتی‌متری مقایسه شدند. نتایج نشان داد تغییر کاربری مرتع بر این خصوصیات تأثیر دارد به طوری که در دیمزار میزان کربن آلی در مقایسه با مرتع شاهد در عمق اول و دوم به ترتیب ۴۲٪ و ۵۲٪ کاهش یافت و اسیدیته، هدایت الکتریکی و درصد آهک در اثر این تغییر کاربری به ترتیب ۰/۹٪، ۲۵/۸٪، ۶۳/۱٪ در عمق اول، و ۰/۴٪، ۵۰٪، ۱۵/۱٪ در عمق دوم افزایش داشتند. رها کردن دیمزار و عدم کشت در آن، موجب شد خصوصیات خاک در دیمزار رها شده خود را بازیافت نماید و شباهت بیشتری به خاک مرتع داشته باشد. این یافته‌ها مشخص نمود که خصوصیات شیمیایی خاک با تغییر کاربری زمین، تغییر قابل توجهی می‌کند که به دلیل کشت و کار، فعالیت‌های کشاورزی و دخالت‌های انسانی می‌باشد. چنین فعالیت‌هایی موجب تغییر در خصوصیات خاک می‌گردد. لذا با توجه به این تأثیرات بر خاک و اهمیت خاک در اکوسیستم‌ها، برای حفظ پایداری اکوسیستم، توجه به قابلیت اراضی و پرهیز از تغییر کاربری زمین و تصمیم‌گیری‌های نامناسب امری حیاتی است.

کلمات کلیدی: تخریب زمین، تغییر کاربری، دیمزار رها شده، کیان