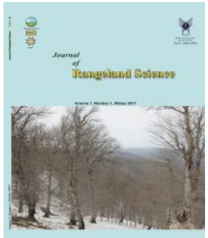
Contents available at ISC and SID

Journal homepage: www.rangeland.ir



Research and Full Length Article:

Effects of Exclosure on Soil Properties in Winter Rangelands in Golestan Province, Iran

Hamid Niknahad – Gharmakher[A], Esmaeil Sheidai-Karkaj[B], Isa Jafari[C]

[A]Assistant Professor, Department of Rangeland Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran, (Corresponding Author), Email: niknahad@gau.ac.ir
[B]Assistant Professor, Ahar Faculty of Agricultural Sciences and Natural Resources, Tabriz University, Iran
[C]PhD. Student in Rangeland Sciences, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

Received on: 28/02/2016
Accepted on: 20/07/2016

Abstract. Rangeland degradation is one of the global concerns affecting the pastoralists and those who suffer from its negative environmental consequences. Grazing exclosure has been extensively used among the techniques implemented by the government to protect the fertility of threatened rangelands. The impact of exclosure has been a controversial issue; therefore, it is important to understand its effectiveness in restoring the degraded rangeland ecosystems. The goal of the present study was to evaluate the changes in some physico-chemical properties of soils following the grazing exclusion as compared to the adjacent grazed areas in three winter rangelands in Golestan province, Iran in 2011-2012. In each rangeland, ten soil samples were taken at the depth of 0–20 cm. Then in the laboratory, some soil properties such as soil texture, bulk density, porosity, saturated humidity, pH, EC, OM, total N, lime content, the amount of exchangeable Na^+, K^+, Mg^{++} and Ca^{++} were measured. Data of exclusion and grazed areas were analyzed using the independent T test in SPSS18 software. The results demonstrated that the establishment of exclosure had positive significant effects on the soil physico-chemical properties in Gomishan and Inchehbroun rangelands. So, a significant increase in the mean value of porosity, saturated humidity, OM and total nitrogen ($p<0.05$) as well as the significant decrease in bulk density and lime content ($p<0.05$) was observed in these rangelands. According to the results, the application of exclosure is recommended in Gomishan and Inchehbroun rangelands.

Key words: Exclosure, winter rangelands, physico-chemical soil properties, Iran

Introduction

Iran has about 86 million ha of rangeland, and 850,000 ha of rangelands are located in Golestan province in the north of Iran. Land degradation is a recurrent event in this province. Overgrazing, the absence of clear land ownership, drought event, weak community participation because of lack of trust between the natural resources office and pastoralists and lack of the integrated range management approaches due to the technical approach of natural resources office are major range mismanagement issues in Golestan province. The major activities in Golestan province are animal husbandry and dry farming. Sheep, goats, and camels are the main livestock of the province (Mir-Deylami *et al.*, 2015).

Land degradation and vegetation deterioration as the negative environmental consequences are major issues affecting particularly those living in the rangelands. Rangelands can be degraded because of climate changes, human activities or livestock overgrazing. Overgrazing alters the floristic composition from perennial grasses to annual forbs and from species that are palatable to livestock to non-palatable species (Hoshino *et al.*, 2009). The elimination of preferred species, the reduction of plant coverage and its biodiversity, the decrease of forage production, and the increase of soil erosion and runoff are the common rangeland degradation indicators (Ahmad *et al.*, 2012); these factors might lead to the desertification eventually (Harris, 2010). Because of different interactions among various biological, environmental and social factors, the rangeland management is difficult (Ahmad *et al.*, 2012).

Pei *et al.* (2008) pointed out that numerous studies have indicated that the overgrazing of rangeland causes a decline in quality of bio-physicochemical properties resulting in dramatic changes in vegetation and modifications in nutrient cycling; indeed, it could lead in the permanent degradation of land productivity and the ecosystem destruction. Raiesi and Riahi (2014) stated that the effects of animal grazing on soil quality such as physicochemical and microbiological properties of soil have been reported in many rangeland ecosystems worldwide and in most cases, rangeland (over/continuous) grazing resulted in severe soil erosion and subsequently land degradation.

Overgrazing effects are evident particularly in the arid and semiarid rangelands where the limited resources exist (i.e., low residue inputs and available water) (Raiesi and Riahi, 2014). Jeddi and Chaieb (2010) declared that livestock grazing is one of the main causes of degradation in the arid and semiarid areas. Desertification which includes the degradation of vegetation cover, soil degradation, and nutrient depletion is a major ecological and economical problem in these areas. They observed that the effects of grazing on the plant community and soils are considered destructive because of the reduction of ground cover, productivity and litter accumulation, the destruction of topsoil structure, and compaction of soil as a result of trampling. These processes in turn increase the soil crusting, reduce the infiltration, enhance the soil erosion susceptibility and cause a decline in soil fertility.

The degradation of rangelands led the government to set up some measures to restore the fertility of threatened areas in Golestan province. Among the implemented techniques, the re-vegetation to stabilize the sediment, the planting of forage species and grazing exclosure have been extensively used. Establishment of exclosures, which closed off he denoting areas from grazing for a specific period, is a well-known management tool to restore the degraded rangeland ecosystems (Verdoodt *et al.*, 2010). It has been widely applied in arid

Australia, United States, dry tropical Africa and North Africa (Amghar *et al.*, 2012).

The impact of exclosure has been a controversial issue due to climatic conditions, soil type and vegetation structure (Schneider *et al.*, 2008). Some studies documented the improvements in vegetation, soil and water infiltration inside exclosures while the others reported site-specific and minor differences between the protected and adjacent grazed areas (Haftay *et al.*, 2013). Mureithi *et al.* (2014) have mentioned that withdrawal of livestock grazing is often not sufficient to initiate the autogenic recovery of vegetation.

In view of the increasing adoption of rangeland exclosure and the pressure exerted on the remaining communal grazing areas, it is important to understand rangeland exclosure effectiveness in restoring the functions of degraded rangeland ecosystems. Recently, some intensive studies concerning the relationship between exclosure and its effectiveness in improving the bio-physicochemical properties of soil have been reported (Mekuria and Aynekulu, 2011; Mekuria, 2013).

In Golestan province, Iran, some studies concerning the effects of exclosure on vegetation characteristics have been reported (Mirzaali *et al.*, 2006; Hematzadeh *et al.*, 2009; Rezashateri and Sepehry, 2011; Salarian *et al.*, 2013; Hosseini *et al.*, 2012) but a few have focused on its effect on soil properties. Information about soil properties is required for a better understanding of the restoration mechanisms, appropriate management, and conservation of degraded rangelands. The goal of this study was to evaluate the changes in some soil physicochemical properties following grazing exclusion as compared to the adjacent grazed areas in three winter rangelands in Golestan province, Iran.

Materials and Methods

Site Information

The research was conducted in 2011-2012 in the three winter rangelands in the northern part of Iran namely Gomishan in the west, Inchehbroun in the north and Maravehtappeh in the east of the Golestan province (Fig. 1). The exclosure of Maravehtappeh is the indicator of loess lands and the exclosure of Gomishan is the indicator of low and salty land of Golestan province. The exclosure of Inchehbroun is located in the buffer zone of above-mentioned areas.

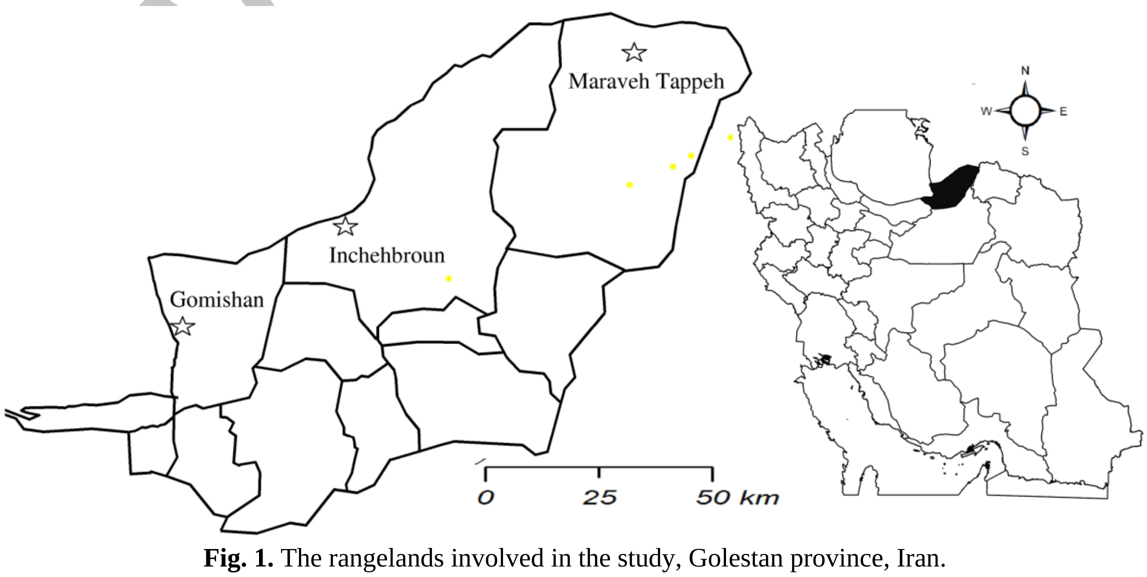


Fig. 1. The rangelands involved in the study, Golestan province, Iran.

In the study area, there are two distinct seasons; the rainy season starts generally from mid-November to May, and the dry season is from mid-May to October (Table 1).

The vegetation characteristics of the studied areas are presented in Table 2. The vegetation cover in all exclosures is higher than the adjacent grazing ranges. The dominant plant type in Gomishan is *Halostachys caspica - puccinellia distans* (Mirzaali *et al.,* 2006); in Inchehbroun, the dominant type is *Halocnemum strobilaceum - Halostachys caspica* (Rezashateri and Sepehry, 2011) and in Maravehtappeh, it is *Artemisia sieberi - Poa bulbosa* (Hematzadeh *et al.,* 2009).

Table 1. Normal environmental characteristics of exclosures in the study area

Environment factors	Exclosure		
	Gomishan	Inchehbroun	Maraveh tappeh
Location	54° 04´ E, 37° 10´ N	54° 29´ E, 37° 14´ N	55° 52´ E, 37° 46´ N
Altitude (m)	-18 m	-4 m	620 m
Annual Rainfall(mm)	343	250	482
Annual temperature(°C)	16.6	17.8	16.7
Livestock number(A.U)	45000	5000	3200
Climate	Arid-temperate	Semi desert	Semiarid

Table 2. Vegetation characteristics of the studied areas

Rangeland	Life forms	Plant composition (%)	
		Exclosure	Grazing range
Maraveh tappeh	Shrubs	19.30	6.10
(Hematzadeh *et al,* 2009)	Forbs	33.75	19.85
	Grasses	42.15	26.95
Gomishan	Shrubs	27.30	19.95
(Mirzaali *et al,* 2006)	Perennial forbs	3.00	1.10
	Perennial grasses	28.50	4.21
	Annual grasses	19.51	13.70
	Annual forbs	29.10	9.80
Inchebroun	Length of vegetation patches(cm)	89.46	40.23
(Rezashateri and Sepehry, 2011)	Bare area distances (cm)	119.15	328.48

Soil sampling and analysis

Five transects (length of 100 m and intervals of 50 m) were established randomly– systematically in key areas of each studied rangeland. Three soil samples at the depth of 0–20 cm were collected from the beginning, middle and end of each transect and mixed. So, one mixed soil sample (Patil, 2002) was obtained from each transect and ten soil mixed samples were collected from each rangeland. A total of 30 soil mixed samples were collected. Once in the laboratory, with plant materials and other removed debris, the soil samples were air-dried and sieved to pass a 2-mm screen. Particle size was determined using the hydrometer method (Bouyoucos, 1962). Soil bulk density was determined from the core samples (Patil, 2002). Soil porosity was determined using the equation 1 (Buckman and Brady, 1960).

Porosity = 1- (BD / Pd) ×100 (1)

Where BD is soil bulk density and PD is soil particle density.

The present of saturated humidity was calculated by the equation 2 (Dingman, 2002):

Humidity= (A / B) ×100 (2)

Where, A is the weight of lost water of oven dried saturated soil and B is the weight of dried soil.

Then, soil samples were air-dried and finely ground to pass a 0.5-mm sieve. Soil pH and electrical conductivity (EC) were determined by pH-meter and conductivity meter, respectively (saturated paw method) (AFNOR, 1987). Soil organic matter (OM) was determined by the Walkley–Black method (Nelson and Sommers, 1982). Kjeldahl's method (Krik, 1950) was used to analyze total nitrogen (N). Exchangeable Na and K were determined using flame photometer and exchangeable Ca and Mg were obtained by titration method (Page *et al.*, 1987).

Data analysis

Before subjecting the data to a statistical analysis, the uniformity of the physic-chemical characteristics of topsoil was checked (Verdoodt *et al.*, 2010) in order to find outlier or extreme values. Then in each rangeland, the effect of grazing exclosure on soil properties was evaluated by the independent T-test that was conducted with $SPSS_{18}$ software. The probability values lower than 0.05 were considered as significant.

Results

Maravehtappeh

Pair-wise comparison of the exclosure and adjacent grazing rangeand (Table 3) proved that the exclosure has not improved significantly ($p>0.05$) the majority of the studied soil physic-chemical properties. According to the results, the significant effect of exclosure was observed only on three soil physic-chemical properties. So, the mean values of soil pH and K^+ have decreased from 7.77 in the grazing rangeland to 7.36 in the exclosure and from 18.26 in the grazing rangeland to 7.73 (ppm) in the exclosure, respectively. The mean value of soil Na^+ has increased from 2.13 in the grazing rangeland to 2.40(ppm) in the exclosure.

Gomishan

Unlike Maravehtappeh, the exclosure has improved significantly ($p<0.05$) the majority of the studied soil physico-chemical properties in Gomishan (table 3). So, the mean value of soil bulk density has decreased from 1.41 in the grazing rangeand to 1.21 g/m^3 in the exclosure and the mean soil porosity and soil saturated humidity percent have increased from 46.76% in the grazing rangeland to 54.48% in the exclosure and from 61.49% in the grazing rangeland to 63.25% in the exclosure, respectively. The results revealed that the mean soil lime percent has decreased from 33.8% in the grazing rangeland to 30% in the exclosure and the mean soil organic matter and total nitrogen have increased from 4.05 in the grazing rangeland to 6.08% in the exclosure and from 0.06 in the grazing rangeland to 0.09% in the exclosure, respectively. There was a significant difference in soil pH between exclosure and adjacent grazing rangeland ($p<0.05$); so, its mean values had increased from 7.94% in the grazing rangeland to 8.64% in the exclosure. There were no significant differences between the mean value of exchangeable Na^+, K^+ and $Mg^{++}$for exclosure and adjacent open rangeland ($p>0.05$), but the mean value of exchangeable Ca^{++} has decreased significantly from 7.08 ($meqL^{-1}$) in the grazing rangeland to 5.78 ($meqL^{-1}$) in the exclosure.

Inchehbroun

The data analysis (table 3) identified significant effect ($p<0.05$) of exclosure on all the studied soil physico-chemical properties, except soil EC. The results demonstrated that the mean value of bulk density has decreased from 1.57 in the grazing rangeland to 1.41 g/m^3 in the exclosure while the mean soil porosity and saturated humidity percent have increased from 40.45% in the grazing rangeland to 46.44% in the exclosure and from 59.82% in the grazing rangeland to 69.07% in the exclosure, respectively. According to the results, the mean soil lime percent has decreased from 21.50% in the grazing rangeland to 16.70% in the exclosure. Moreover, the mean soil organic matter percent and total nitrogen have increased from 4.06% in the grazing rangeland to 5.41% in the exclosure, and from 0.06% in the grazing rangeland to 0.087% in the exclosure, respectively. There was a significant difference concerning soil pH between exclosures and grazing rangelands ($p<0.05$); so, its mean values has decreased 7.64 in the grazing rangeland to 7.45 in the exclosure. No significant differences were found between the exclosure and the grazing rangeland in terms of soil EC ($p>0.05$). There was a significant difference between the mean value of exchangeable Na^+ and K^+ for exclosure and open rangeland ($p<0.05$). The mean values of exchangeable Na^+ and K^+ have decreased from 19.30 (ppm) in the grazing rangeland to 16.30 (ppm) in the exclosure, and from 13.92 (ppm) in the grazing rangeland to 9.22 (ppm) in the exclosure, respectively. There was a significant difference between the mean value of exchangeable Mg^{++} and Ca^{++} for exclosure and open rangeland ($p<0.05$). The mean values of exchangeable Mg^{++} and Ca^{++} have increased from 4.26 ($meqL^{-1}$) in the grazing rangeland to 6.82 ($meqL^{-1}$) in the exclosure and from 3.29 ($meqL^{-1}$) in the grazing rangeland to 10.30 ($meqL^{-1}$) in the exclosure, respectively.

In general, the highest mean value of the soil pH, porosity and lime was observed in Gomishan. Moreover, the highest mean value of the soil saturated humidity and the lowest mean value of the soil EC were observed in Maravehtappeh whreas the highest mean value of the soil EC was observed in Inchehbroun. No significant difference was found between exclosures and adjacent grazing rangelands in terms of their effects on soil texture. The soil texture in Maraveh tappeh, Gomishan and Inchebroun was silt-clay loamy, silt-clay and silt loamy, respectively.

Table 3. Results of independent T test on average of surface soil (0–20 cm) physico-chemical properties between exclosure and grazing range in studied rangelands

Site	Variable	Bulk Density (g cm^3)	Porosity (%)	Saturated humidity (%)	organic matter (%)	Total Nitrogen (%)	pH	EC (dSm^{-1})	CaCO3 (%)	Na^+ (ppm)	K^+ (ppm)	Mg^{++} ($meql^{-1}$)	Ca^{++} ($meql^{-1}$)
Maraveh tappeh	Grazing range	1.46±0.06	44.65±2.17	70.86±4.71	5.09±1.04	0.09±0.01	7.77±0.13	0.53±0.24	20.00±1.00	2.13±0.05	18.26±2.17	3.9±0.62	2.13±1.04
	Exclosure	1.40±0.10	47.16±3.77	70.60±0.10	5.20±0.52	0.09±0.01	7.36±0.11	0.58±0.15	25.83±8.04	2.40±0.20	7.73±3.95	4.3±1.00	2.33±0.47
	T test	ns	ns	ns	ns	ns	*	ns	ns	*	**	ns	ns
Gomishan	Grazing range	1.41±0.04	46.76±1.59	61.49±0.45	4.05±0.19	0.06±0.011	7.94±0.096	5.13±3.28	33.80±0.84	22.30±0.04	16.02±1.35	10.66±0.58	7.08±0.18
	Exclosure	1.21±0.03	54.48±1.35	63.25±0.69	6.08±0.80	0.09±0.005	8.64±0.104	3.90±0.62	30.00±1.41	21.84±0.03	15.60±1.59	8.00±2.46	5.78±0.80
	T test	**	**	**	**	**	**	ns	*	ns	ns	ns	*
Inchebroun	Grazing range	1.57±0.04	40.45±1.40	59.82±6.73	4.06±0.76	0.06±0.014	7.64±0.065	10.31±3.93	21.50±3.35	19.30±0.04	13.92±1.39	4.26±0.17	3.29±0.76
	Exclosure	1.41±0.09	46.44±3.33	69.07±7.65	5.41±0.79	0.09±0.006	7.45±0.043	8.04±4.06	16.70±1.20	16.30±0.09	9.22±3.33	6.82±0.56	10.30±0.79
	T test	**	**	*	*	**	**	ns	*	*	**	**	**

*, **= T student is significant at 5% and 1%, probability levels, respectively.

Discussion

According to Braunack and Walker (1985), it is considered that the natural recovery of soil physical properties would depend on soil type, the severity of grazing impact and the climate and biological agents. This study demonstrated that soil physical properties had altered as a result of exclosure. Multiple factors probably drive these changes, but based on our results, a significant decrease in soil bulk density and a significant increase in soil porosity of the exclosure areas in Gomishan and Inchehbroun rangelands can be due to the significant increase in their soil organic matters (Lemenih *et al.*, 2005) because bulk density of the organic matter is less than soil particles (Vaillant *et al.*, 2009). The increase in soil OM causes to improve soil aggregation. With the increased porosity and aeration of soil, soil structure is changed, and the mean value of its bulk density is reduced. Since the saturated soil moisture is directly associated with the amount of soil OM (Pei *et al.*, 2008; Ajami, 2007), it can be argued that the significant increase in soil OM of Gomishan and Inchehbroun rangelands has led to significant improvement of their saturated humidity.

It has been known that the decreased soil compaction and the increased plant litter as a result of grazing exclusion can lead to the increase of soil OM (Xie and Wittig, 2004). Jeddi and Chaieb (2010) stated that favorable living conditions for humus incorporator organisms lead to soil OM increasing.

It is considered that forage production and litter are higher inside than adjacent of exclosures (Hosseini *et al.* 2012). The presence of plant cover and its litter decrease the bare soil surface, evaporation, soil compaction and erosion. Improvement of plant cover influenced soil humidity, aeration and surface soil temperature (Albaladejo, 1998) and as a result, soil microbial activities have changed (Javadi *et al.*, 2005); so, the ratio of soil carbon input (primary net production) to the loss of soil carbon (microbial respiration and decomposition of OM) has increased. Our results are in agreement with prior studies (Su *et al.*, 2004; Yong-Zhong *et al.*, 2005; Pei *et al.*, 2008; Steffens *et al.*, 2008; Teague *et al.*, 2011). In rangelands, soil OM is one of the most important sources of soil total nitrogen; thus, changes in soil total nitrogen are likely related to soil OM change (Teague *et al.*, 2011).

According to David *et al.* (2004), more root biomass and more active microorganism metabolism in the rhizosphere can lead to the reduction in pH mean value of soil. Hinsinger *et al.* (2003) noted that the secretion of organic acids from the roots and amounts of CO_2 released from roots and micro-organisms could lead to the decrease in pH. According to Mahdavi-ardakani *et al.* (2011), some alkaline bicarbonate is formed in soil because of the mineralization of organic residues of some plants such as *Haloxylon sp.*, *Seidlitzia sp.* and *Anabasis sp.* Thus, in the exclosure of Gomishan, litter quality and consequently, the difference in soil microorganisms and their related effects on the decomposition of organic residues may lead to an increase in soil pH.

Contrary to other studies (Shaltout *et al.*, 1996; Jeddi and Chaieb, 2010), there was no significant difference in soil salinity in the present study between exclosure and open grazing. This is somewhat surprising as this variable is often linked to the presence of foliage and litter cover that lead to a decrease in the exposure of soil surface to radiation, evaporation, soil compaction and erosion (Yates *et al.*, 2000; Jeddi and Chaieb, 2010)

In Gomishan and Inchehbroun rangelands, the significant increase in soil OM has led to the production of organic and inorganic acids that among them, carbonic acid is abundant. Its permanent production in the soil leads to the dissolution of lime although this kind of acid is a weak acid (Hossienzadeh *et al.*, 2008).

Improvement in soil humidity and the increase in soil carbon dioxide (because of more microbial activity) in Gomishan and Inchehbroun rangelands can lead to the de-liming process (Khormali and Shamsi, 2009).

$CaCO3+ H2O+ CO2 \rightarrow Ca (HCO3)_2$

In the case of soil cations, the reduction in the concentration of K ions in all the studied rangelands is partly astonishing as its concentration is often linked to the soil OM percent. The absorption of K ions by soil aggregates is reduced as a result of increased soil OM (Malakouti and Homaee, 2005; Evangelou and Blevins, 1988; Evangelou *et al*., 1986).

Conclusion

The soil inside the protected areas had a greater cover of herbaceous species, woody debris, litter, high levels of microtopography and little erosion. These conditions had a major impact on soil properties. This study indicates that grazing exclosure results in altering soil physical and chemical properties which can render serious consequences for plant growth in the studied sites. From a range management perspective, these changes illustrate the potential improvability of studied rangelands and highlight the need for more studies in order to assess the time scale of exclusion better and to achieve a better understanding of the ecology of arid and semiarid rangeland ecosystems.

Acknowledgements

This work was funded by the Research and Technology Vice Presidency of Gorgan University of Agricultural Sciences and Natural Resources.

Literature Cited

Ajami, M., 2007. Soil quality attributes micropedology and clay mineralogy as affected by land use change and geomorphic position on some loess-derived soils in eastern Golestan Province, Agh-Su watershed. M.Sc. Thesis. Gorgan University of Agricultural Sciences and Natural Resources, 191p. (In Persian).

AFNOR., 1987. Recueil de normes francaises, qualite des sols, methodes d'analyses. 1. ed. Association francaise de normalisation (Afnor), pp. 19–30. (In French).

Ahmad, S., Islam, M., Mirza, S. N., 2012. Rangeland degradation and management approaches in Balochistan, Pakistan. *Pakistan Jour. Botany*, 44: 127-136.

Albaladejo, J., 1998. Soil Degradation and Desertification Induced by Vegetation Removal in a Semi and Environment. *Soil use and Management*, 14: 1-5.

Amghar, F., Forey, E., Margerie, P., Langlois, E., Brouri, L., Kadi-Hanifi, H., 2012. Grazing exclosure and plantation: a synchronic study of two restoration techniques improving plant community and soil properties in arid degraded steppes (Algeria). *Ecologie -La Terre Et La Vie*, 67:257-269.

Bouyoucos, G. J., 1962. Hydrometer method improved for making particle size analysis of soils. *Agronomy*, 54: 464–465.

Braunackm, V. and Walker, J., 1985. Recovery of some surface soil properties of ecological interest after sheep grazing in a semi-arid woodland. *Australian Jour Ecology*, 10:451- 460.

Buckman, H.O.and Brady, N.C., 1960. The Nature and Properties of Soils (6th ed.). Macmillan, New York. p. 567.

David, L. J., Hodge, A. and Kuzyakov, Y., 2004. Plant and mycorrhizal regulation of rhizodeposition. *New Phytologist*, 163: 459–480.

Dingman, S.L., 2002. Physical Hydrology. Prentice Hall, Upper Saddle River, New Jersey, USA. 2 nd edition, 646 pp.

Evangelou, V. P., Karathanasis, A. D., Blevins, R. L., 1986. Effect of soil organic matter accumulation on potassium and ammonium quantity-intensity relationships. *Soil Science Society of America Journal*, 50(2):378-382.

Evangelou, V. P. and Blevins, R, L., 1988. Effect of long-term tillage systems and nitrogen addition on potassium Quantity-Intensity relationships. *Soil Science Society of America Journal*, 52(4):1047-1054.

Haftay, H., Yayneshet, T., Animut, G., Treydte, A. C., 2013. Rangeland vegetation responses to traditional enclosure management in eastern Ethiopia. *The Rangeland Journal*, 35: 29–36.

Harris, R. B., 2010. Rangeland degradation on the Qinghai-Tibetan plateau: A review of the evidence of its magnitude and causes. *Jour. Arid Environments*, 74: 1–12.

Hematzadeh,Y., Barani, H., Kabir, A., 2009. The role of vegetation management on surface runoff (Case study: Kechik catchment in northeast of Golestan Province). *Jour. Water and Soil Conservation,* 16(2):19-33. (In Persian).

Hinsinger, P., Plassard, C., Jaillard, B., Tang, C. X., 2003. Origins of root-mediated pH changes in the rhizosphere and their responses to environmental constraints: a review. *Plant Soil,* 248: 43–59.

Hoshino, A., Tamura, K., Fujimaki, H., Asano, M., Ose, K., Higashi, T., 2009. Effects of crop abandonment and grazing exclusion on available soil water and other soil properties in a semi-arid Mongolian grassland. *Soil and Tillage Research,* 105: 228–235.

Hosseini, S. A., Khatir Namany, J., Akbarzadeh, M., 2012. Studying the Vegetation Changes of Natural Rangelands in Inche Shorezar of Agh Ghala, North Golestan Province, Iran. *Jour. Rangeland Science,* 2(4):615-623.

Hossienzadeh, G., Jalilvand. H., Tamartash, R., 2008. Vegetation Cover Changes and Some Chemical Soil Properties in Pastures with Different Grazing Intensities. *Iranian journal of Range and Desert Research,* 14 (4): 500 – 512. (In Persian).

Javadi, S. A., Jafari, M., Azarnivand, H., Alavi, S. j., 2005. An Investigation of the Grazing Intensity Effects on Variations of Soil Organic Matter and Nitrogen in Lar. *Iranian Journal of Natural Resources,* 58 (9): 711- 718. (In Persian).

Jeddi, K. and Chaieb, M., 2010. Changes in soil properties and vegetation following livestock grazing exclusion in degraded arid environments of South Tunisia. *Flora,* 205: 184–189.

Khormali, F. and Shamsi, S., 2009. Investigation of the quality and micro morphology of soil evolution in different land uses of a loess hill slope of Golestan province, a case study in Ghapan region. *Jour. Agricultural Sciences and Natural Resources,* 16(3):14-27. (In Persian)

Krik, P.L., 1950., Kjeldahl method for total nitrogen. *Analytical Chemistry,* 22: 354-358.

Lemenih, M., Karltun, E., Olsson, M., 2005. Assessing soil chemical and physical property responses to deforestation and subsequent cultivation in smallholders farming system in Ethiopia. Agriculture, *Ecosystem and Environment,* 105: 373-386.

Mahdavi–Ardakani, S.R, Jafari, M., Zargham, N., Zare – Chahoki, M. A., Baghestani, N., Tavili A. 2011. Investigation on the effects of Haloxylon aphyllum, Seidlitzia rosmarinus and Tamarix aphylla on soil properties in ChahAfzal. *Iranian Journal of Forest,* 2(4):357-365. (In Persian).

Malakouti, M. J., Homaee, M., 2005. Soil fertility of arid and semi-arid regions "Difficulties and Solutions". 2nd, ed. Tarbiat Modarres University Press, 508p. (In Persian).

Mekuria, W. and Aynekulu, E., 2011. Exclosure land management for restoration of the soils in degraded communal grazing lands in northern Ethiopia. *Land Degradation and Development,* 24: 528–538.

Mekuria, W., 2013. Conversion of communal grazing lands into exclosures restored soil properties in the semi-arid lowlands of Northern Ethiopia. *Arid Land Research and Management,* 27: 153–166.

Mir-Deylami.S.Z., Sheidai-Karkaj,E., Akbarlou,M., 2015. Identify the most important changes in the quantitative and qualitative elements of vegetation because of exclosure in Dashtecalpoush rangelands using multivariate analysis. *Jour. Rangeland and Watershed management,* 68 (2): 371-383.

Mirzaali, E., Mesdaghi, M., Erfanzadeh, R. 2006. The study of effects of exclosure on vegetation and soil surface in saline ranges of Gomishan, Golestan province. *Jour. Agricultural Sciences and Natural Resources,* 13 (2): 194 – 201. (In Persian).

Mureithi, S. M., Verdoodt, A., Gachene, C. K., Njoka, J. T., Vivia, O. W., Neve, S . D., Meyerhoff, E., Ranst, E. V., 2014. Enclosure management on soil properties and microbial biomass in a restored semi-arid rangeland, Kenya. *Jour. Arid Land,* 6(5): 561–570.

Nelson, D. W. and Sommers, L. E., 1982. Total carbon, organic carbon, and organic matter. In: Page, A.L. (Ed.), Methods of Soil Analysis, vol. 2. American Society of Agronomy, Soil Science Society of America, Madison, WI, pp. 539–579.

Page, M. C., Sparks, D. L., Woll, M. R., Hendricks, G. J., 1987. Kinetics and mechanisms of potassium release from sandy Middle Atlantic coastal plain Soils. *Soil Science Society of America Journal,* 51:1460-1465.

Patil, G.P., 2002. Composite sampling. pp 387–391. In Encyclopedia of Environmetrics. Edited by El-Shaarawi, A. and Piegorsch, W. John. Wiley & Sons, Ltd, Chichester, 2502p.

Pei, S. h., Fu, H., Wan, C., 2008. Changes in soil properties and vegetation following exclosure and grazing in degraded Alxa desert steppe of Inner Mongolia, China. *Agriculture, Ecosystems and Environment,* 124: 33-39.

Raiesi, F. and Riahi, M., 2014. The influence of grazing exclosure on soil C stocks and dynamics, and ecological indicators in upland arid and semi-arid rangelands. *Ecological Indicators,* 41: 145–154.

Rezashateri, M. and Sepehry, A., 2011. The effect of grazing on vegetation dynamics patches. *Iranian Jour. Range Desert Research,* 17 (4): 604-614. (In Persian).

Salarian, F., Ghorbani, J., Safaeian, N. A., 2013.Vegetation changes under exclosure and livestock grazing in Chahar Bagh rangelands in Golestan province. *Iranian Journal of Range and Desert Research,* 20 (1): 115-129. (In Persian).

Schneider, K., Huisman, J. A., Breuer, L., Frede, H. G., 2008. Ambiguous effects of grazing intensity on surface soil moisture: A geostatistical case study from a steppe environment in Inner Mongolia, PR China. *Jour. Arid Environments,* 72: 1305-1319.

Shaltout, K. H., EL-Halawany, E.F., EL-Kady, H. F.,1996. Consequences of protection from grazing on diversity and abundance of the coastal lowland vegetation in Eastern Saudi Arabia. *Biodiversity and Conservation,* 5: 27–36.

Steffens, M., Kolbl, A., Totsche, K. U., Kogel-Knabner, I., 2008. Grazing effects on soil chemical and pHysical properties in a semiarid steppe of Inner Mongolia (P.R. China). *Geoderma,* 143: 63-72.

Su, Y. Z., Zhao, H. L., Zhang, T. H., Zhao, X. Y., 2004. Soil properties following cultivation and non-grazing of asemiarid sandy grassland in northern China. *Soil Tillage Research,* 75: 27–36.

Teague, W. R., Dowhowera, S. L., Bakera, S. A, Haileb, N., De Launea, P. B., Conovera, D. M., 2011. Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie. *Agriculture, Ecosystems and Environment,* 141: 310–322.

Vaillant, G. C., Pierzynski, G. M., Ham, J .M., De Roucheym J., 2009. Nutrient Accumulation below Cattle Feedlot Pens in Kansas. *Jour. Environmental Quality,* 38: 909-918.

Verdoodt, A., Mureithi, S. M., Van – Ranst, E., 2010. Impacts of management and enclosure age on recovery of the herbaceous rangeland vegetation in semi-arid Kenya. *Jour. Arid Environments,* 74:1066-1073.

Xie, Y. and Wittig, R., 2004. The impact of grazing intensity on soil characteristics of Stipa grandis and *Stipa bungeana* steppe in North China (autonomous region of Ningxia). *Acta Oecol,* 25:197–204.

Yates, C. J., Norton, D. A., Hobbs, R. J., 2000. Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: implications for restoration. *Australian Ecology,* 25: 36–47.

Yong-Zhong. S., Yu-Lin, L., Jian-Yuan, C., Wen-Zhi, Z., 2005. Influences of continuous grazing and livestock exclusion on soil properties in degraded sandy grassland, Inner Mongolia, northern China. *Catena,* 59: 267-278.

بررسی اثرات قرق بر برخی خصوصیات خاک در مراتع قشلاقی استان گلستان، ایران

حمید نیک‌نهاد قرماخر[الف]* ، اسماعیل شیدای کرکج[ب]، عیسی جعفری[ج]

[الف] استادیار گروه مرتعداری دانشگاه علوم کشاورزی و منابع طبیعی گرگان، ایران (نگارنده مسئول)، پست الکترونیک: niknahad@gau.ac.ir
[ب]استادیار دانشکده علوم کشاورزی و منابع طبیعی اهر، دانشگاه تبریز، ایران
[ج]دانشجو دکتری علوم مرتع دانشگاه علوم کشاورزی و منابع طبیعی گرگان

تاریخ دریافت: ۱۳۹۴/۱۲/۰۹
تاریخ پذیرش: ۱۳۹۵/۰۴/۳۰

چکیده. تخریب مراتع مسئله‌ای جهانی است که نه تنها بر بهره‌برداران مراتع اثرگذار می‌باشد بلکه پیامدهای زیست محیطی منفی آن بر سایر افراد جامعه نیز اثرگذار است. قرق از تکنیک‌هایی است که توسط دولت به منظور حفاظت از حاصلخیزی مراتع در معرض خطر اعمال می‌شود. اثرات قرق موضوع مناقشه برانگیزی بوده است لذا، فهم اثر بخشی آن در احیا زیست بوم‌های مرتعی تخریب یافته اهمیت دارد. هدف این مطالعه که در زمستان ۱۳۹۰ انجام گردید، ارزیابی تغییرات برخی ویژگی‌های فیزیکی و شیمیایی خاک در نتیجه اعمال قرق در مقایسه با اراضی مجاور خارج از قرق در سه مرتع قشلاقی در استان گلستان است. بدین منظور، ده نمونه مرکب خاک از عمق ۲۰–۰ سانتیمتری زمین در هر مرتع برداشت شد. سپس در آزمایشگاه، برخی خصوصیات فیزیکی و شیمیایی خاک از قبیل بافت، جرم مخصوص، تخلخل، رطوبت اشباع، اسیدیته، شوری، ماده آلی، نیتروژن کل، آهک، مقادیر سدیم، پتاسیم، کلسیم و منیزیم قابل تبادل اندازه‌گیری شدند. تجزیه و تحلیل داده‌ها با استفاده از آزمون t مستقل و با استفاده از نرم افزار $SPSS_{18}$ انجام شد. نتایج دو قرق گمیشان و اینچه‌برون نشانگر آن است که اعمال قرق اثرات مثبت معنی‌داری بر خصوصیات فیزیکی و شیمیایی خاک داشته است. بطوریکه افزایشی معنی‌دار ($p<0.05$) در میانگین تخلخل، رطوبت اشباع، ماده آلی و نیتروژن کل به همراه کاهش معنی‌دار ($p<0.05$) میانگین جرم مخصوص و آهک این مراتع مشاهده شد. با توجه به نتایج به‌دست آمده، اعمال قرق در مراتع گمیشان و اینچه‌برون توصیه می‌گردد.

کلمات کلیدی: قرق، مراتع قشلاقی، خصوصیات فیزیکی شیمیایی خاک، ایران