Assessment of the Effects of Overgrazing on the Soil Physical Characteristic and Vegetation Cover Changes in Rangelands of Hosainabad in Kurdistan Province, Iran

H. Azarnivand[A], A. Farajollahi[B], E. Bandak[C] and H. Pouzesh[D]

[A]**Professor, Faculty of Natural Resources, University of Tehran, Karaj, Iran, E-mail: hazar@ut.ac.ir**
[B]**M.Sc. Student, Combating Desertification Engineering, University of Tehran.**
[C]**M.Sc. Student, Combating Desertification Engineering, University of Tehran.**
[D]**(Corresponding Author) Member of Young Researchers Club, Islamic Azad University, Yasuj Branch, Iran.**

Manuscript Received: 11/8/2010
Manuscript Accepted: 31/10/2010

Abstract. Soil physical properties have an important role on vegetation growth through affecting the development of root system. The aim of this study was to investigate the trampling effect of livestock grazing on soil physical properties and vegetation cover changes. The experiment was conducted on three range condition sites (Reference, Key and Critical area) with ten frequencies in Hosseinabade Kudistan in 2009. Soil physical characteristics consist of humidity, bulk density, porosity and aggregate stability index. In this study remarked soil cover changes in three mentioned regions. The results showed that soil moisture reduced from reference to critical area. Soil bulk density was the lowest in reference area and the highest in critical area. Reference site had the highest soil porosity while the soil porosity reduced in critical area. However, as the density of grazing increased, soil bulk density increased and soil moisture, soil porosity, aggregate stability index and vegetation cover percent decreased. Bare soil percentage was the highest in critical region. According to the results of this research, the grazing seems caused to major changes in the physical properties of the topsoil. Since the region has high ecological potential, if the intensity of grazing would be in a moderate level, the region soil will be able to compensate the negative aspects of livestock trampling.

Key words: Soil Physical Properties, Overgrazing, Livestock Trampling, Rangelands of Hosseinabad.

Introduction

One of the effective factors in growth of rangeland plants is soil physical properties. These soils characterize implement important role in root growth and extension rangeland plants. When the animal is moving, pressures are higher as its weight is on only 2 or 3 hooves and kinetic energy is involved. Since the depth of influence below the soil surface of a given contact pressure increases with the width of the applied stress, the comp active effect of grazing livestock is shallower than for vehicles (Greenwood and McKenzie 2001). Livestock grazing has restricted water movement into and through the soil profile, especially during rainstorms Linnartz *et al*. (1966). This effect can be attributed to both compacted soil and reduced vegetation cover. Studies in New Zealand have shown that cattle grazing pastures on sloping land contribute to run-off, soil erosion and loss of nutrients McDowell *et al*. (2005). Grazing can cause disorder to the natural chemical processes of the soil, while at the same time, causing erosion to soil. However, overgrazing, when not properly managed is often a problem. Grazing, in general, affects the ecosystem, disrupting both physical characteristics and the surrounding species population. Overgrazing can lead to a decreased forage yield, which correlates to lower quality forage. In addition, the lack of ground cover causes the top soil to be more susceptible to erosion and increased weed production. The vegetation is bound to the soil to help prevent erosion and run-off during rainfall, however when livestock grazing takes place on or near these areas it causes “shifts in the plant community structure and removal of plant growth or biomass”. This leads to more dilemmas with sediment loss and temperature change. Overgrazing decreased bank stability and increased peak flows from compaction Proffitt *et al*. (1995) studied a sheep trampling on physical soil characterize in west Australia rangeland. They applied three treatments including: continuous grazing controlled grazing, enclosure. In continuous grazing region, soil bulk density was significant in comparison to other region John and Wiliam (2000) compared soil of grazed areas and ungrazed areas and showed that livestock grazing can cause the compact of the topsoil and destruction of soil structure Mc Dowell *et al*. (2004) studied the effect of deer grazing on soil quality in south New Zealand. The results showed that bulk density and coarse soil porosity were 1.06Mg m^{-3} and 8.8 percent respectively at one day after grazing and were 1.10 Mg m^{-3} and 6.4 percent respectively at six weeks after grazing in plying location of deer. Steffens (2008) studied grazing effects on soil chemical and physical properties in a semiarid steppe of Inner Mongolia and explained that after 25 years of exclusion; significantly different values were found for all parameters. Thus, physical and chemical parameters of steppe topsoil deteriorated significantly following heavy grazing, remained stable if grazing was reduced or excluded for five years, and recovered significantly after 25 years of grazing exclusion. Considering the rangeland degradation and the most determinant role of grazing livestock intensity on vegetation, soil destruction and erosion in Iran, is necessary in order to show that the destructive role of livestock intensity perfectly. This study tries to explain the destructive effects of livestock grazing intensity on soil physical characteristics, topsoil cover and detrimental effect of grazing intensity.

Materials and Methods

This research performed in Hosseinabad watershed that is located in north Sanandaj city in Kurdistan province. Study area is located in 47°2´15˝to 47°8´45˝ E and 35°32´50˝to 35°41´10˝N. Maximum and minimum heights in region are 2350m and 1660m respectively. Mean precipitation is 400mm and mean annual temperature is 13.9°C. Region soil texture is loam and sandy loam.

For implementation of this study, three regions with different grazing intensity classificated on basis of Moghadam method Moghadam (2002). The experiment was conducted on three range condition sites with ten frequencies including:

(A): reference region (light grazing)

(B): key region (medium grazing)

(C): critical region (intense grazing)

All study regions are similar in morphology (altitude, slope and aspect), bed rock properties and soil texture but these regions are different in condition livestock grazing intensity. The samples were collected based on the main ecological and vegetation cover characteristics of study area. To assessment soil physical properties in any region, soil at needful deal had tacked in systematic random method at (layer 30cm soil surface) the region of root seepage and extension and thus transmission on soil laboratory have dried in free weather. Soil texture was determined using Hydrometric method. The rate of soil humidity was determined by the weight method and aggregate stability index using of Dettman and Emerson method (1981). Bulk density= mass of oven dry soil. Core volume

Therefore it can be defined as:

$$\rho = \frac{M_s}{V_t}$$

Porosity calculated based on Bulk density and use of this formula (1)

$$\text{Porosity percentage} = (1 - \frac{P_B}{P_a}) \times 100$$

(2) Bd: bulk density(gr.cm^3)

Pd: particle density (gr.cm^3)

Point transect method was used to investigate vegetation cover. In this method, transect contact with all rangeland surfaces (alive vegetation cover, litter, bare soil, rock and gravell). Finally total contact points calculated for each parameter. For comparison of soil difference factors in mentioned regions and survey of existence significant difference between means Variance analysis and Duncan test methods used respectively.

Results

Based on the obtained results of data analysis ($p<0.01$), light grazing region had highest soil bulk density and intensity grazing region had the lowest deal (Fig. 1).

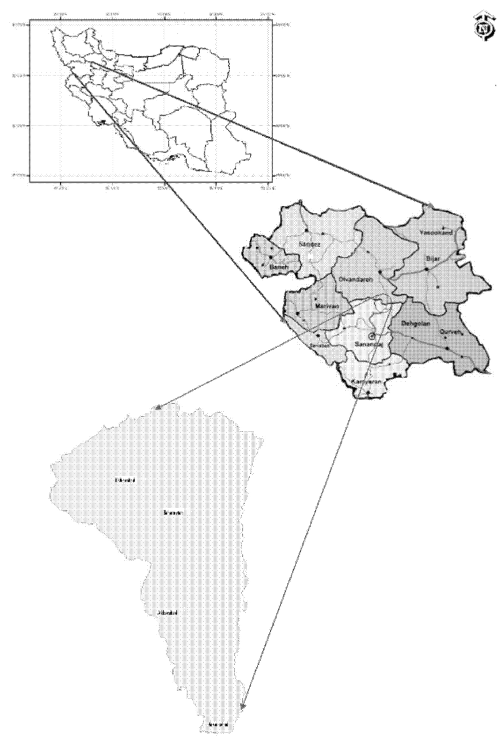

Fig. 1. Location of the Selected Station in Kurdistan Provinces, Iran

In addition, results showed that light grazing region had the highest aggregate stability index and intensity grazing region had the lowest deal of the aggregate stability index. Light and medium grazing region had a similar content in aggregate stability index but this factor decreased significantly in intensity grazing region (Fig. 2).

Soil porosity decreased from light grazing region to intensity grazing region (Fig. 3). Soil humidity in light grazing region was the highest and it was the lowest in intensity grazing region, but changes between light grazing and medium grazing regions in this properties was not significant (Fig. 4).

Based on obtained results from table 1, alive vegetation cover changes in the three studied regions. Reference region has much vegetation cover and little bare soil. In key region there was vegetation cover less than reference region and its bare soil more than reference region but this difference is not considerable, but in critical region with under intensity grazing results showed that these parameters have significant difference with both reference and key region and this critical region has the least vegetation cover and the highest bare soil in comparison. All of calculations have been done in the same time (2009).

Table 1. The Change of Soil Surface Cover in Study Region

Region	Vegetation Cover Percentage	Litter	Gravell	Bare soil
Reference	59.8	22.1	11.4	8.7
Key	51.3	18.5	17.2	13
Critical	21.2	4	37.5	33.5

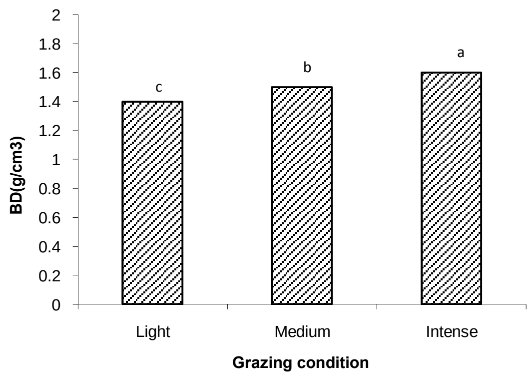

Fig. 2. Soil Bulk Density Mean in Three Study Region

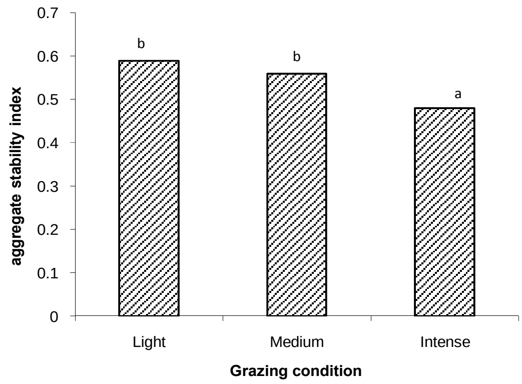

Fig. 3. The Change of Aggregate Stability Index in Three Study Region

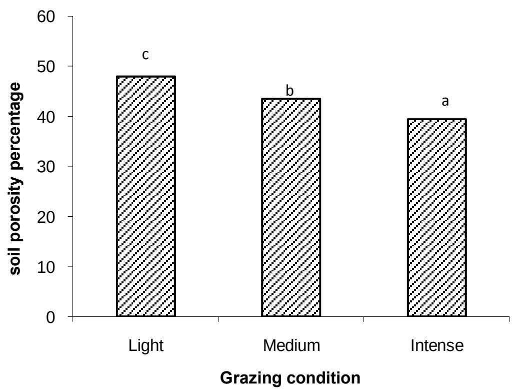

Fig. 4. The Change of Soil Porosity in Three Study Region

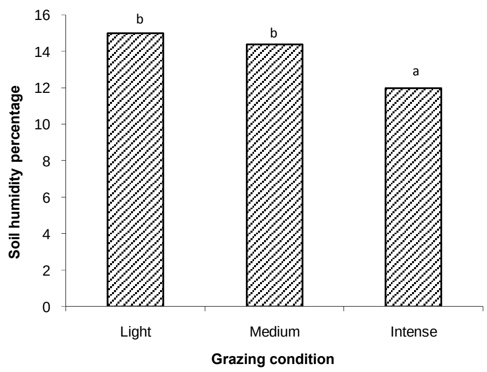

Fig. 5. The Change of Soil Humidity Percentage in Three Study Region

Discussion and Conclusion

Soil bulk density in critical region was higher than reference region. The reason for increasing of soil bulk density could result in livestock grazing pressure and lack of organic material. Chiefly soil compactness in critical region is due to increase of soil bulk density. This result is comparable to some other researchers, Dahlgren *et al*. (1997) and Drewry *et al*. (1999). The high aggregate stability index can be due to high organic material existence and higher vegetation cover surface in light grazing region. Mudahir and Taskin (2003) had found similar result. Decreasing soil porosity percentage from reference region to key and critical region is due to increase of soil bulk density that fully corresponds to territorial observation and other soil properties. Livestock grazing intensity and lack of vegetation cover are important factors in decreasing of porosity percentage. In this case Drewry *et al.* (1999), Mc Dowell *et al*. (2004) and Teague *et al*. (2010) also achieved similar results. The difference between reference and critical region in humidity content can be caused by increase of livestock number. Livestock trampling makes decrease in porosity, so it causes lack of water infiltration into soil which finally causes decreasing soil humidity. Generally mentioned region has a high rate of ecologic potential and if grazing pressure be mediocre, the soil will able to improve and compensate the livestock trampling.

Roundy *et al*. (1992) showed that humidity condition in comparison to dry condition had higher soil compact due to livestock trampling. Demolished vegetation cover not only exposes soil to erosion, but also decreases soil stability and resistance against livestock trampling Mapfumo *et al*. (2000). Livestock grazing intensity and lack of organic material are important factors that decrease porosity. These factors have more effect on critical region soil than key and reference regions Blackburn *et al*. (1982). With increasing Livestock grazing intensity, soil infiltration content will be decreased. This event is emphasized by most researchers: Warren *et al*. (1986), Naeth *et al*. (1990), Naeth *et al*. (1991), Shifang *et al*. (2008). High vegetation cover, percentage, and litter in specially reference region and slightly key region protect soil against water and wind erosion. This makes soil fertilize and improve its structure. Vegetation cover in critical region was limited by species, such as *Poa bulbosa*, *Echinops haussknechtii*, *Cousinia concinna*, *Astragalus aucheri* and other several plant species that have a low value. Total of these plant species that exist in critical region, will explain the rangeland destruction and expose rangelands to wind and waer erosion. Ruthven (2007) explained that a high-intensity, low-frequency grazing system utilizing moderate stocking rates employed during the dormant season is recommended for enhancing forb diversity and abundance.

Acknowledgements

This research was supported by University of Kurdistan. We would like to thank Khaled Avsati PhD student of watershed Management in University of Tehran for his help for the creation of this work.

References

Abril, A., P. Barttfeld., and E.H. Bucher. 2005. The effect of fire and overgrazing disturbes on soil carbon balance in the Dry Chaco forest. Forest Ecology and Management **206:** 399–405.

Alizadeh, A. 2001. Relation of water, soil and plant. 2^{th} Ed, Emam Reza University. Pp: 210-260, (In Persian).

Baibordi, M. 1993. Physic of soil, fives edition, University of Tehran, Pp: 420-450.

Blackburn, W.H., R.W. Knight., and M. K. Wood. 1982. Impacts of grazing on watersheds. Texas Agr. Exp. Sta. Mp. USA. Pp. 1496.

Broersma, K., M. Krzic., R.F. Newman., and A. Bomke. 1995. Effects of grazing on soil compaction and water infiltration in forest plantation in the interior of British Colombia Southern Interior Forest Extension, Kmloops, B. C., pp 89-92.

Chaichi, M. 2003. The effect of trampling and grazing on soil physical properties, *natural recourses journal of Iran*, Vole **56:** 491-508, (In Persian).

Dahlgren, R.A., M.J. Singer., and X. Huang. 1997. Oak tree and grazing impacts on soil properties. Biogeochemistry **39:** 45-64.

Dettman, M.G., and W.W. Emerson. 1959. A modified permeability test for measuring the cohesion of soil crumbs. *J.of soil Science*, **10:** 215-226.

Drewry, J.J., J.A. Lowe., and R.J. Paton. 1999. Effect of sheep stocking intensity on soil physical properties and dry matter production on a pallid soil in Southland, New Zealand *J. of Agricultural Research*. **42:** 493-499.

Eldridge, D.J., and W.G. Whitford. 2009. Soil disturbance by native animals along grazing gradients in arid grassland. *J. of Arid Environments* **73:** 1144–1148.

Faizul, B., D. M. Karlw., and L. Murray. 1995. Livestock grazing impacts on infiltration rates in a temperate range of Pakistan. *J. of Range Manage* **46:** 367-372.

Fatahi, B. 2003. Assessments the effect of grazing on vegetation cover and soil properties in winter rangeland of Plour. Dissertation of M.Sc. Tarbiat Modares University, 62p (In Persian).

Ferrero, A.F. 1991. Effect of compaction simulating cattle trampling on soil physical Characteristics in woodland. Soil and Tillage Research. **19(2):** 319-329.

Gallacher D.J., and J.P. Hill. 2006. Effects of camel grazing on the ecology of small perennial plants in the Dubai (UAE) inland desert, *J. of Arid Environments* **66:** 738–750.

Greenwood, K.L., and B.M. McKenzie. 2001. Grazing effects on soil physical properties and the consequences for pastures: a review. Aust. J. Exp. Agric **41:** 1231-1250.

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

John, D., and Ph. Wiliam. 2000. Impact of grazing strategies on soil compaction. Tektran. United States Department USA.

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

Khajadin, S.j., and M. Basiri. 1994. Initial seminar of range and range management in Iran, University of Sanati Esfahan, 489p. (In Persian).

Linnartz, N.E., C. Hse., and V.L. Duvall. 1966. Grazing impairs physical properties of a forest soil In Central Louisiana. J. Fore **64:** 239-243.

Lyons, J., B.M. Weigel., L.K. Paine., and D.J. Undersander. 2000. Influence of intensive rotational grazing on bank erosion, fish habitat quality, and fish communities in southwestern Wisconsin trout streams. *J. of Soil and Water Conservation*56, **3:** 271-276.

Mapfumo, E., D. S. Chanasyk., V. S. Baron., and M. A. Naeth. 2000. Grazing impacts on selected soil parameters under short-term forage sequences. *J. of Range Manage* **53:** 466-470.

Mc Dowell, R.W., J.J. Drewry., and R.J. Paton. 2004. Effects of deer grazing and fence- line pacing on water and soil quality. *J. of Soil Use and Management* **20:** 302-307.

Mc Dowell, R.W., J.J. Drewry., and R.J. Paton. 2005. Restricting the grazing time of cattle to decrease phosphorus, sediment and *E. coli* losses in overland flow from cropland. Aust. J. Soil Res **43:** 61-66.

McEvoy. P.M., M. Flexen., and J.H. McAdam. 2006. The effects of livestock grazing on ground flora in broadleaf woodlands in Northern Ireland, Forest Ecology and Management **225:** 39–50.

Milchunas, D. G. and W. K. Lauenroth. 1989. Plant communities in relation to grazing, topography, and precipitation in semiarid grassland. Vegetatio **80:** 11-23.

Moghadam, M. 2005. Range and range management, University of Tehran, 150-180, (In Persian).

Mudahir, O., and O. Taskin. 2003. Overgrazing effect on rangeland soil properties. International Conference on Sustainable Land Use and Management. Canakkle, Turkey

Naeth, M. A., A.W. Bailey, D. S. Chanasyk., and D. J. Pluth. 1991. Water holding capacity of litter and soil organic matter in mixed prairie and fescue grassland ecosystems of Alberta. *J. of Range Management* **44:** 13-17.

Naeth, M. A., A. W. Bailey., D. J. Pluth., D. S. Chanasyk., and R. T. Hardin. 1991. Grazing impact on litter and soil organic matter in mixed prairie and fescue grassland ecosystems of Alberta. *J. of Range Management* **44:** 113-117.

Naeth, M. A., D. S. Chanasyk., R. L. Rothwell., and A. W. Bailey. 1990. Grazing impacts on infiltration in mixed prairie and fescue grassland ecosystems of Alberta. Can. *J. of Soil Science* **70:** 593- 605.

Northup, B.K., J.R. Brown., and J.A. Holt. 1999. Grazing impact on the spatial distribution of soil microbial biomass around tussouck grasses in a tropical grassland. *J. of Applied Soil Ecology* **13:** 359-270.

Proffitt, A. P. B., S. Bendotti and D. Mc Garry. 1995. A comparison between continuous and controlled grazing on a red duplex soil. I: Effects on soil physical characteristics. Soil and Tillage Research **35:** 199-210.

Rauzi, F. 1963. Water intake and plant Composition as affected by differential grazing on Rangeland. *J.of Soil and Water Conservation* **18:** 114-116.

Roundy, B., A. Winkel., V. K. Khalifa., and H. Matthias. 1992. Soil water availability and temperature dynamics after one-time heavy cattle trampling and land imprinting. Arid Soil Research and Rehabilitation **6:** 53-69.

Ruthven, D.C. 2007. Grazing effects on forbs diversity and abundance in a honey mesquite parkland, *J. of Arid Environments* **68:** 668–677.

Sanadgol, A. 2002. Effect of short term grazing on physical and chemical properties of soil in pasture of *Bromus tomentellus*. *Natural resources journal of Iran*. **55:** 581-597. (In Persian).

Schmutz, E. M., C. C. Michaels and B. I. Judd. 1967. Boysag Point: A relict area on the North Rim of Grand Canyon in Arizona. *J.of Range Management* **20:** 363-369.

Schultz, T. T., and W. C. Leininger. 1990. Differences in riparian vegetation structure between grazed areas and exclosures. *J. of Range Management* **43:** 295-299.

Shifang, P., F. Hua., and W. Changgui. 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.

Singer, M. j., and M. N. Donald. 1991. Soil identification, translation by Gholamhosain Haghnia, Firdausi Mashhad University, Pp: 230- 270. (In Persian).

Steffens, M., A. Kölbl., K. U. Totsche., and I. Kögel-Knabner. 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., Y.L. Li., H.Y. Cui., and W.Z. Zhao. 2005. Influences of continuous grazing and livestock exclusion on soil properties in a degraded sandy grassland, Inner Mongolia, northern China. Catena **59(3):** 267–278.

Teague, W.R., S.L. Dowhower., S.A. Baker., R.J Ansley., and U.P. Kreuter. 2010. Soil and herbaceous plant responses to summer patch burns under continuous and rotational grazing, *J. of Agriculture, Ecosystems and Environment* **137:** 113–123.

Warren, S. D., W. H. Blackburn., and C. A. Taylor. 1986. Effects of season and stage of rotation cycle of hydrologic condition of rangeland under intensive rotation grazing. *J. of Range Manage* **39:** 500-504.

Weitz, M., and M. K. Wood. 1986. Short duration grazing in Central New Mexico: Effects on infiltration rates. *J. of Range Manage* **39:** 365-368.

Winkel, V. K., and B. A. Roundy. 1989. Effect of cattle trampling and mechanical seedbed preparation on grass seedling emergence. *J. of Range Manage* **44:** 8-25.