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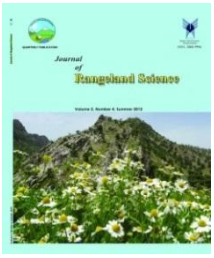

Full Length Article:

Studying the Vegetation Changes of Natural Rangelands in Inche Shorezar of Agh Ghala, North Golestan Province, Iran

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Abstract. Studies on vegetation changes of rangelands under grazed and non-grazed conditions are of great importance in the range management planning programs. To determine the change process of vegetation, this study was performed in Inche Shorezar site of Golestan province for nine years (1997-2005). The vegetation parameters were measured every year in several fixed plots inside and adjacent of exclosures. The canopy cover of each species was estimated in each plot. Forage production was randomly measured on one meter square plots in each year using the clipping and weighing method. Correlations between canopy cover of species and growth forms with the rainfall of different months and periods were calculated using SPSS software. Results showed that total canopy cover in 2005 was significantly higher than 1997 both inside and adjacent of exclosures which has been mainly related to increased annual plant cover but the perennial canopy cover was decreased in these years. Perennial species of (class I) did not grow inside the fixed plots. Cover of increasers (class II) species was reduced from the first year to the final one for both inside and adjacent of exclosures. However, the cover of (class III) species in the final year was not significantly increased than that for the first year. Forage production generally was higher inside than adjacent of exclosures. Litter increased during the study period for both inside and adjacent. Litter was significantly higher inside of exclosures than adjacent in 2005. Although the plant canopy cover was affected by rainfall but correlation coefficient was statistically significant only for total, annual and some perennial canopy cover species. Although total and annual cover was high inside and adjacent of exclosures in 2005, the cover of perennials was decreased. By the reduction of palatable species, unpalatable species were increased inside and adjacent. Although by increasing the plant cover, the range condition was relatively improved, this improvement was achieved by the increase in the annuals instead of perennials. It was concluded that the exclosure cannot be used as a range improvement method to improve these rangelands' conditions. For the rehabilitation of these areas, human interference is necessary.

Key words: Exclosure, Canopy cover, Forage production, Golestan Province.

Introduction

Rangelands are among the blessings of god which play the important role in the environment and also national economic growth and development of each country's (Jahanshahi & Nikzad, 1985). Soil conservation, forage production, modulation of climate and water flows, medicinal and industrial plant production, recreational areas and wild life are considered as the benefits of rangelands (Mesdaghi, 2003). Golestan province with 862825 hectare Rangelands was the best center of rangelands in Iran, especially as winter rangelands which had all year long exploitation (Hosseini *et al.*, 2012). Growing population and the severe economic dependence on natural resources such as rangelands lead in the retro-gradation of vegetation. Therefore, principles and logic to deal with these vast and valuable resources are essential and undeniable. Many attempts in the recent years have been done by experts in the province to prevent the rangelands' degradation and destruction that unfortunately due to complex social and economic issues, the trends are still negative. So in addition to canopy cover and forage production reduction in terms of quality replacement of invading species and species with low value, valuable and palatable species have been observed. Regarding the physical factors, exclosure and study of vegetation changes inside exclosure are practical strategies for rangeland improvement through proper management. Obviously, the adoption of appropriate strategies for its utilization in rangeland improvement is needed to identify the relationships between the elements constituting them. These relationships offer the improved appropriate management utilization. In order to identity these relationships, some investigations should be done on non-vegetation changing under grazing and grazing conditions. Vegetative improvement or regression and destruction of vegetation can be cleared through these investigations. The results can provide necessary recommendations for the vegetation improvement and successful utilization of the optimized procedures in these resources. In addition due to several revenues of rangelands, productivities are irregular in our country so that the vegetation inside the exclosure is regarded as a shelter for desirable forage species which remain safe from the intensive grazing by livestock and have a chance to be protected and propagated. Therefore, natural plant resources could be protected through this method. Noor *et al*. (1991) stated that the differences between covers of grasses, shrubs, forbs in plant composition inside and adjacent of exclosure were not significant. Through studying the effects of precipitation and livestock grazing on the vegetation of shrub lands in South Africa, Connor and Raux (1995) showed that changing in the plant community was mainly under the effects of precipitation and long period grazing in this area. Alzerreca *et al*. (1998) investigated the effects of livestock grazing and non-grazing on the dynamics of vegetation of southwestern Utah desert rangeland plant communities and concluded that the variability and dynamism of plant community are significantly affected by the livestock grazing rather than the climate. Vahhabi (1989) assessed the effects of exclosure and livestock grazing for five years on 19 vegetation types of Freidan area in Esfahan, Iran. Results show that differences between 17 vegetation types inside and adjacent of exclosure were significant. Mohammadi Golrang *et al.* (1994) studied the vegetation changes of Karaj Dam watershed during 1973-1993 and the main reason of changes observed in

the area was the excessive grazing of livestock. Karimi dost (2003) investigated the main reason to the density decrease of vegetation in the region of Kerman during the past 40 years and reported the increase in the number of uncontrolled exclosure of livestock. Mousavi (2001) studied semi-steppe rangelands of Semnan after 13 years and stated that total canopy cover of inside was relatively increased and this increase in the first stage has been related to the increasers (class II) and then reducers of species (Class I). Hoveizeh *et al*. (2001) reported that total canopy cover which mainly involves the perennial forbs of increasers was increased inside the exclosure in semi- steppe rangelands of Khuzestan. In Hosseinabad rangelands of Shiraz after a 22 year exclosure, canopy cover of decreasers' species was significantly higher than the adjacent (Qhanbaryan, 2001). Akbarzadeh (2005) investigated the total canopy cover of perennial species which increased about 20% inside the exclosure during first six years of the study period. Much of this increase has been related to the shrubs and forbs but the grasses' canopy cover was very low. The increasers in composition were high but the reducers were seldom. Hosseinzadeh *et al.* (2008) reported that palatable species in the reference region, average palatable ones in the key region and low palatable or non palatable plants in the critical region have the most vegetation cover percentage. So, perennial and palatable grasses had the highest vegetation cover percentage in the reference region but by the increase of grazing, palatable species were gradually decreased and average or non palatable plants increased. Aghajanlo *et al*. (2010) studied the effects of exclosure and grazing on vegetation changes in Arquin site of Zanjan and reported that total canopy cover of Arquin exclosure was increased inside compared to the outside and it was statistically significant. The responses of life forms to exclosure and the grazing were different. The vegetation composition was changed in the study area. The relative increase of increasers in the last year was by 160 percent as compared to that of the first year inside the exclosure; whereas the changes were not apparent. The rate of plant production was specially depended on precipitation fluctuation. Asadian *et al*. (2009) concluded that total canopy cover of perennial species during the study period (1996-99) inside exclosure was significantly different. The cover of all life forms such as shrub, grasses and forbs increased significantly inside the exclosure in this period. The cover of perennial was increased about 16 percent outside of exclosure, but there were significant differences for shrubs and grasses and no difference was observed for the forbs. Reducers and increasers of species were increased and invaders were decreased inside, but outside of exclosure, there was an opposite trend. Ghaemi *et al.* (2012) indicated the increase in total canopy cover inside the exclosure where the highest increase rates were observed with perennial grasses (>3.5 times) and with perennial forbs (>2.5times). Outside the exclosure, the total canopy cover approximately remained unchanged and life forms showed less changes. Inside the exclosure, favorable species appeared to vegetation composition of about 19%. The proportion of increasers in the vegetation composition increase more than double; however, non-favorable species were decreased to half. Outside the exclosure, desirable species were rare and the proportion of increasers' species increased to 28%.

The purpose of this study was to compare the change processes of vegetation inside and adjacent of exclosure during nine-year period in Inche shorezar site of North Golestan province.

Materials and Methods

The study on the vegetation changes of natural rangelands in Inche Shorezar site, one of the winter rangelands of Golestan province was carried from 1997 year until 2005 for 9 years. The exclosure area is 25 hectares that is located in the northern Agh Ghala city. Altitude of area is approximately 10 m. The average annual rainfall is 300 mm that mostly occurs during November to May. The average of daily temperature is 17.8°C. The soil is deep, saline and alkaline with a compact structure and slow drainage. This soil is ranged in the physiographic units of low lands which seem to be formed mainly from the alluvial matter of Gorgan River. General slope of lands is almost flat and without relief.

After the construction of exclosure, all present species inside and adjacent of exclosure including annual and perennial plants in several stages were collected and then identified. Present plants based on life forms (annual grasses, perennial grasses, annual forbs, perennial forbs and shrub) were classified. Vegetation measures were in the form of paired transects that each pair was combined of 20 plots. The number of transects were equal inside and adjacent of enclosures. Transects were established parallel to each pair in a unit with the length of 20 m on land. The plot size was 60 × 25 cm with the distance of 1.5 m to 10 on each transect. Inside of each plot, canopy cover of species was estimated and the number of perennial species was recorded in special forms. Forage productions were estimated from 1×1^2 plots and clipping and weighing method was carried out. Then, the perennial plants of each plot were class as I, II, III and annual grasses and forbs were weighed together.

Correlations between canopy cover of species and life forms with the rainfall of different months and periods were calculated using SPSS software.

Results

Changes of canopy cover in the first year (1997) and the final year (2005) are shown in (Table 1). Rainfall changes with the changes of total canopy cover, canopy cover of palatability classes, life forms and production are shown in (Figs. 1 to 4).

Results showed that the total canopy cover was significantly increased in the final year as compared to the first year, also inside and exclosure adjacent. Total canopy cover of the final year was significantly greater inside than adjacent of exclosure (Table 1). Increases in the total canopy cover were affected by the changes in life forms of annual plants, especially annual grasses which have significant covers in these years.

Changes of the total canopy cover were significantly correlated ($r>0.80$) year to year with the rainfall of periods and months. The large values of correlation coefficient indicated that the cover variation in different years has been affected by the rainfall in the region.

Cover of annual grasses was significantly increased in the final year than the first one, inside and the adjacent. While the cover of annual forbs in inside of exclosure significantly decreased for the first year but increased greatly in the first year for the adjacent. In the final year, cover of annual grasses inside was significantly greater than the adjacent and cover of annual forbs was less than the adjacent. Changes of annual cover had significant correlations with the rainfall. However, the highest correlation values were related to total rainfall in March and April (for grasses, $r= 0.90$ and for forbs, $r=0.84$).

In the final year of study, cover of shrubs inside and adjacent of exclosure showed no significant differences but total cover of

shrubs was higher for the inside than the adjacent. Among the shrubs, *Halocnemum strobilaceum* was only recorded in the fixed plots of inside and adjacent. Changes of canopy cover of this species showed no significant correlations with the rainfall variations in different years and the correlation coefficient for the months or rainfall periods was low (r=0.27) or negative.

In the final year, total cover of perennials in the inside and adjacent of exclosure was reduced. This reduction was not significant for the adjacent. The total cover of perennials in the end year in the inside and adjacent of exclosure was significantly different. Changes of total canopy cover of perennial showed no significant correlations with the rainfall volatility in different years and correlation coefficient calculated for the months or rainfall periods was low or nonsignificant.

Cover of perennial grasses was significantly reduced in the final year inside and the adjacent (Table 1). Among grasses, only *Aeluropus lagopoides* was recorded in the fixed plots of inside and adjacent. Changes of canopy cover of these species showed no significant correlations with the rainfall volatility in different years and correlation coefficient calculated for the months or rainfall periods was very low (r=0.18) or negative.

Perennial forbs were of small cover in the studied rangeland. Among perennial forbs, two species were placed inside the fixed plots. Cover of *Frankenia hirsuta* was recorded inside and adjacent of exclosure. Canopy cover changes of these species during the study period showed a significant correlation with the changes of winter rainfall (r=0.78). Perennial species of class I was not observed inside the fixed plots. Cover of class II species was gradually reduced during the study years and the final year but in the first year it was significantly decreased inside and adjacent. The cover of class III species however in the final year was relatively increased but it was not significantly different with the first year. Canopy cover changes of class II species in different years of study had no correlations with the rainfall variations and correlation coefficients calculated for the months or rainfall periods were low (r=0.30 for winter rainfall) or negative. In (class III) species, changes of canopy cover correlation with the changes of rainfall during the months or rainfall periods were significant (r=76) especially for total winter and spring rainfall. Forage production was mainly observed inside the exclosure more than the adjacent. Total changes of forage production inside the exclosure in the study years were affected by rainfall variations (Fig. 4) and its correlation with March to May rainfall was significant (r=0.74). Also, annual production during the periods of study was significantly affected by the rainfall, especially March and April rainfall (r=0.96).

Table 1. Changes of canopy cover % of plant species in Inche shorezar site during the years of 1997-2005

Species	Inside Exclosure		Adjacent Exclosure		2005 Year	
	1997	2005	1997	2005	Inside	Adjacent
Shrub						
Halocnemum strobilaceum	17.3[a]	18.4[a]	12.2[a]	12.4[a]	18.4[a]	12.4[a]
Total	17.3[a]	18.4[a]	12.2[a]	12.4[a]	18.4[a]	12.4[a]
Perennial grasses						
Aeluropus lagopoides	6.8[a]	0.38[b]	11.5[a]	6.5[b]	0.38[b]	6.5[a]
Total	6.8[a]	0.38[b]	11.5[a]	6.5[b]	0.38[b]	6.5[a]
Perennial forbs						
Frankenia hirsuta	0.2	0.0	0.13[a]	0.6[a]	0.0	0.6
Total	0.2	0.0	0.13[a]	0.6[a]	0.0	0.6
Annual grasses	7.3[b]	29.4[a]	0.03[b]	14.4[a]	29.4[a]	14.4[b]
Annual forbs	4.1[a]	1.6[b]	1.14[b]	3.6[a]	1.6[b]	3.6[a]
Total	35.7[b]	49.7[a]	25 [b]	37.5[a]	49.7[a]	37.5[b]
Perennial Total	24.3[a]	17.8[b]	23.8[a]	19.5[a]	17.8[a]	19.5[a]
Class I	0.0	0.0	0.0	0.0	0.0	0.0
Class II	6.8[a]	0.38[b]	11.5[a]	6.5[b]	0.38[b]	6.5[a]
Class III	17.5[a]	18.4[a]	12.3[a]	13[a]	18.4[a]	13[b]

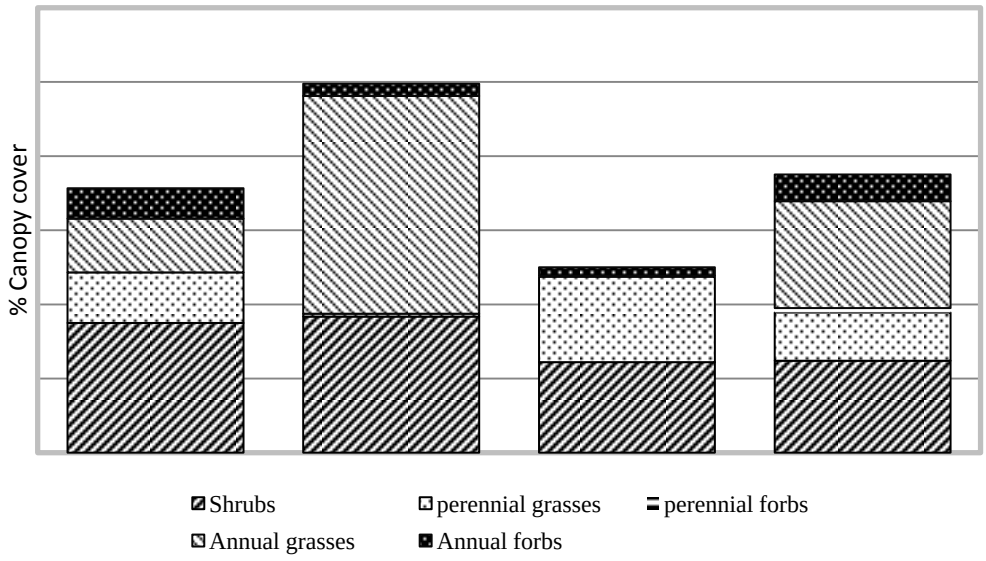

Fig. 1. Canopy cover's changes inside and adjacent of exclosure in first year as compared to the final year

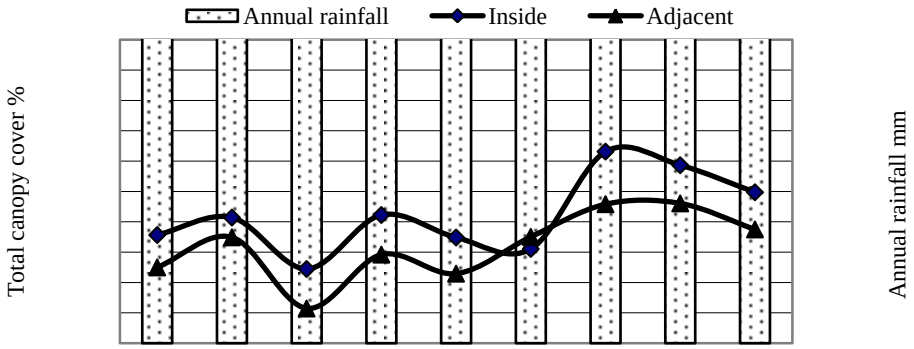

Fig. 2. Diagram of changes of total canopy cover with rainfall variations inside and adjacent of exclosure

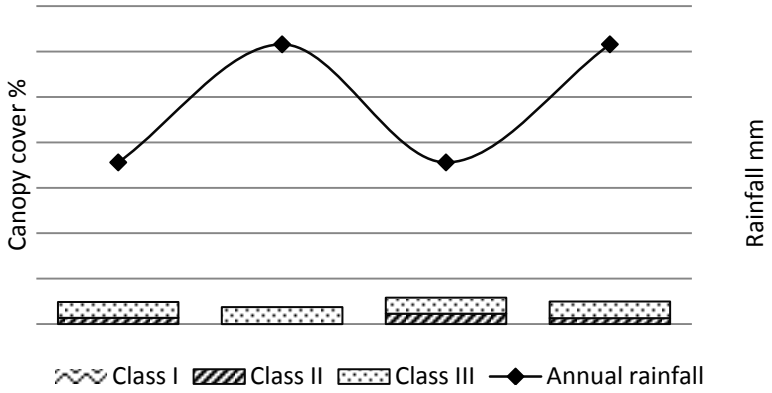

Fig. 3. Diagram of changes of canopy cover for different classes of palatability with rainfall variations inside and adjacent of exclosure

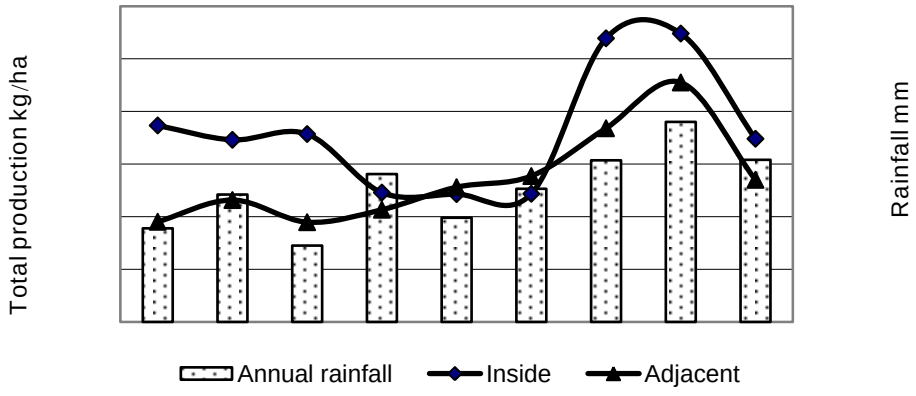

Fig. 4. Diagram of changes of total production with rainfall variations in the inside and adjacent of exclosure

Discussion and Conclusion

Results showed that in Inche Shorezar site after 9 years, total canopy cover was significantly increased in both inside and adjacent of exclosure related to the increases of annual grass cover which were observed in both areas and were different from the canopy cover of inside as compared to the adjacent of exclosure in the first year.

The canopy cover of *Halocnemum strobilaceum* (class III) was not significant in the first year as compared to the last year inside and adjacent of the exclosure, but in the last year cover was significant inside as compared to the adjacent of exclosure because of high cover in the first year. However for the annual grasses, there were significant differences between canopy cover of inside and adjacent of the exclosure. In this area, exclosure decreased the canopy cover of annual forbs so that exclosure is considered as a factor to restrict the growth of these plants. The canopy cover of perennial grass, *Aeluropus lagopoides* (class II) was decreased in the first year of study in the inside and adjacent of exclosure. It seems that the drought of 1999 to 2002 has been ineffective in the decrease of canopy cover of plants. The perennial forb cover of *Frankenia hirsuta* had no significant changes inside and adjacent of exclosure. Results showed that for forage production, there was a significant difference between the inside and adjacent of exclosure, but this difference was not only related to the impact of exclosure, but at the beginning of exclosure, the production rate of inside and adjacent had a significant difference which is retained or a little added until the end of the study.

According to the results of this study and Inche Shorezar site which is located in the region with arid and semiarid climate and saline and alkaline soil, the exclosure has no effects on the state of vegetation in this region. The results of this research are in agreement with those reported by Noor *et al*. (1991) and Connor and Raux (1995), but are not consistent with the results obtained by Vahhabi (1989), Asadian *et al*. (2009), Aghajanlo *et al*. (2010) and Ghaemi *et al*. (2012). Non-consistency with the results of some researchers may be related to the differences of soils, vegetation and climate. According to the results obtained in terms of physical conditions, the region of Inche shorezar cannot be used as a modified method for vegetation like the rangelands because of lands' salt, amount of EC, soil surface evaporation, seed direct planting which harden the germination conditions.

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