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Impacts of Overgrazing in a Long Term Traditional Grazing Ecosystem on Vegetation Around Watering Points in a Semi-Arid Rangeland of North-Eastern Iran

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Abstract: In this study, the effects of livestock overgrazing on vegetation of the critical area around livestock watering points in a traditional grazing ecosystem was investigated on a semi-arid rangeland in North-East of Iran. Transects were placed in 8 geographical directions around watering points and samples were taken systematically. In each experimental plot, 4 m^2, percentage of canopy cover, abundance, density and species richness of vegetation were calculated. The results of this study showed that the percentage of canopy cover, density and species richness were changed with distance from watering points. Critical area immediately adjacent to watering points was dominated by unpalatable *Peganum harmala* and contained of ruderal species such as *Sophora* sp. Adjacent to this was a zone dominated by species of low palatability such as *Acantholimon* sp. and *Hulthemia persica*. In areas most distant from watering points relative importance of moderately palatable species such as *Artemisia herba-alba* increased. These results show the negative impacts of overgrazing on vegetation and palatability in a traditional grazing ecosystem, which may indicate the necessity of a monitoring programme, to manage livestock grazing and watering points in North-East of Iran.

Key words: Watering point, canopy cover, density, species richness, palatability, semi-arid rangeland

INTRODUCTION

Approximately 35% of the earth's land surface is characterized as arid to semi-arid region. Climatic conditions and grazing history are two important factors affecting species composition and biodiversity in rangeland in semi-arid ecosystems. Overgrazing by livestock has been considered as a major plant cover, soil and microclimate degrading factor in woodlands in south-western Australia (Yates *et al*., 2000). Overgrazing changes vegetation structure and composition as a result of which some species increase in abundance and others decrease. It is accepted that heavy grazing can change the composition of plant communities (Landsberg *et al*., 2002; Riginos and Hoffman, 2003). Previous studies have revealed that, in traditional grazing ecosystems, grazing can reduce ecosystem diversity of plants in poor soils (Anderson and Hoffman, 2007).

Overgrazing, especially around the watering points, causes destruction of decreaser species (palatable species and mostly grasses), which these species were replaced with low palatable grasses to unpalatable ruderal and shrubs. Based on the studies of vegetation in semi-arid rangeland of Damghan and Khorasan province (north-east of Iran), increase of ruderal plant species and decrease of decreasers plant species were entirely obvious toward the center of the critical areas, especially, in the permanent residences of livestock and in the watering points (Hassani, 2001). Abundance of watering points and shepherd activities are among the effective factors for proper distribution of livestock in rangelands and consequently, decrease of overgrazing and increase of grazing efficiency.

Environmental destruction decreases with distance from the watering points in biosphere, a gradients of animal impact (Fernandez-Gimenez and Allen-Diaz, 2001). The results of studies in Los Croks, New Mexico, showed that watering points had an important effect on livestock distribution in rangelands with dry and salty plant species, but its effects is less important in rangeland with fresh and succulent plant species (Valentine, 1947). Generally, there are some concentric circles around the watering points, where by increasing the distance from center forage utilization decrease (Klintenberg and Verlinden, 2008; Sasaki *et al*., 2008). Therefore, awareness of the distance from watering points and consumption value of forage is necessary for rangeland management (Fusco *et al*., 1995).

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The results of studies in South Australia showed that the numbers of palatable species increased with an increase in distance from the watering points (Heshmati, 2002).

Iran's climate is mostly arid and semi-arid, which the climatic conditions lead to a wide variety of plant species. Despite climate conditions, overgrazing is a main source of changes in soil and vegetation in Iran. Previous studies were qualitative and no/little quantitative data exists on the impact of livestock on vegetation and rangeland condition around watering points in north east of Iran. Therefore, the objective of this study was to determine the impacts of livestock on vegetation around watering points in this region.

MATERIALS AND METHODS

Study site characterization: The study was conducted in semi-arid rangeland of Northern Khorasan province in Iran in 2004. The area includes 4880 hectares of overgrazed rangeland. The area was south facing and general slope varied between 2 to 20%. The elevation ranged between 1102 and 1345 m and annual rainfall was 235 mm. The study area had warm summer and cold winter, which the maximum and minimum temperatures during the warmest and coldest months were 36.67 and 4.5°C, respectively. The soil was composed of evaporated sediments, plaster and lime salts with sandy to sandy clay texture. Soil salinity in the northern part of the district was higher than southern part, where, halophytes were found in the northern part. The area experience gully and rill erosion, where these kinds of erosion were more dominant toward the southern slops. The area included grasslands ecosystems that were traditionally grazed by sheep and goats for 6-7 months during summer. Percent of forage utilization for all species was about 78%. Forage utilization was higher than allowable forage use, where many of palatable species were not seen and some ruderal species were dominant.

Sampling technique: In the critical area around watering points, 8 directions were defined: north, south, east, west, northeast, northwest, southeast and southwest then transects (1000 m) were placed in each direction. Sampling plots were established along each transect every 50 m systematically. Data were collected from a total of 160 plots of 4 m^2 along the flowering period of dominant plants. Percentage of canopy cover, abundance, density and species richness of the vegetation were evaluated in each plot.

Statistical analysis: Percentage of canopy cover, abundance, density and species richness were analyzed by using MINITAB and SPSS software. The effects of distance from the center of the critical area on quantitative parameters of vegetation were analyzed using one-way ANOVA. Mean values were compared by Duncan's multiple range test. Probability of normal distribution of data was determined by using the Darling-Anderson Method in MINITAB software.

Importance value of each species was calculated in various distances from the center of the critical area by sum of relative dominance, relative density and relative abundance of the species. Species associations were analyzed using 2×2 contingency table and χ^2 analysis.

RESULTS

Data analyses showed that percentage of canopy cover, density and species richness, had normal distribution (Results were not shown). Average of canopy cover was about 76.5%, where *Artemisia herba-alba* had the highest with 22.31% and *Peganum harmala* had the lowest with 7.98%. Canopy cover of other species such as *Acantholimon* sp., *Sophora* sp., *Hulthemia persica* and *Salsola* sp., were 9.92, 8.15, 8.09 and 8.07% , respectively.

The results of the effects of distance from watering points on percentage of canopy cover, density and species richness has been shown in Table 1. These results showed that distance from watering point had significant effects on changes of percentage of canopy cover. Duncan's multiple range test showed that the average percentage of canopy cover in distances 50, 100, 150, 200, 250, 300 and 350 m from watering points are in the same group and there is no significant difference between them. In other words, 350 m distance is considered as the critical area around the watering points, where the most livestock intensity and overgrazing occurred in this area. No other grouping was found after 350 m. These results showed that distance from watering point had significant effects on changes of plant density. Duncan's multiple range test showed plant density was

Table 1: p-values generated from ANOVA for percent canopy cover, density and species richness

	Source				
Parameters	DF	SS	MS	F	p-value
Percentage of canopy cover					
Distance	19	38622	2033	13.58	0.000
Error	140	20950	150		
Total	159	59572			
Density					
Distance	19	171.367	9.019	19.00	0.000
Error	140	066.469	0.475		
Total	159	237.836			
Species richness					
Distance	19	03.1740	0.1671	02.64	0.001
Error	140	08.8591	0.0633		
Total	159	12.0332			

Table 2: Associations among the 6 species in a 2×2 contingency table

Name of co-species							
1st species	2nd species	Abundance of co-species	Abundance of 1st species	Abundance of 2nd species	χ^2	Mathematical expectation	Degree of association
Hu	Ar	8	117	32	0.016^{ns}	7.81	+
Sa	Ar	2	139	18	1.091^{ns}	4.40	-
So	Ar	5	181	12	0.056^{ns}	4.94	+
Pe	Ar	35	219	41	1.173^{ns}	30.16	+
Ac	Ar	4	325	15	6.024**	9.767	-
Sa	Hu	1	28	32	1.622^{ns}	1.49	-
So	Hu	8	141	8	5.114**	3.72	+
Pe	Hu	5	22	93	0.039^{ns}	4.13	+
Ac	Hu	4	46	18	2.07^{ns}	1.72	+
So	Sa	3	68	12	0.48^{ns}	1.66	+
Pe	Sa	3	43	102	2.62^{ns}	7.55	-
Ac	Sa	5	20	38	5.282**	1.679	+
Pe	So	4	48	65	0.266^{ns}	5.60	-
Ac	So	6	30	53	1.67^{ns}	3.31	+
Ac	Pe	7	83	12	6.57**	2.67	+
Hu	Ar	8	117	32	0.016^{ns}	7.81	+
Sa	Ar	2	139	18	1.091^{ns}	4.40	-

**Significant at the 0.01 probability level, ns: Not significant at p = 0.01, +: Positive association between different species, -: Negative association between different species

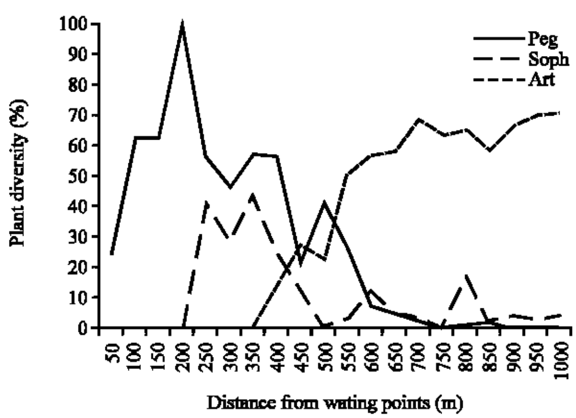

Fig. 1: The effects of distance from watering points on plant diversity of *Peganum harmala* (peg), *Sophora* sp. (Soph) and *Artemisia herba-alba* (Art)

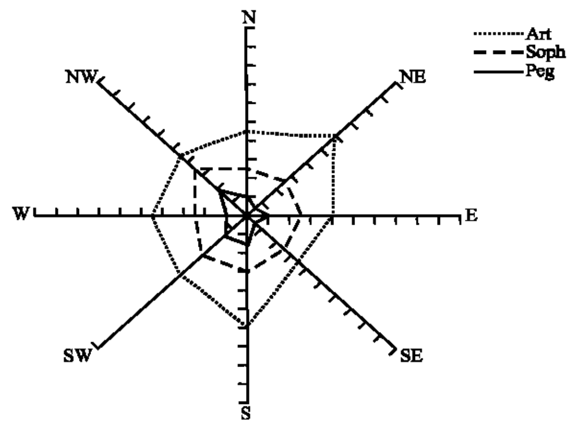

Fig. 2: Presence of *Peganum harmala* (peg), *Sophora* sp. (Soph) and *Artemisia herba-alba* (Art) in different geographical direction with distance from watering points

the same in 200 m distance from watering points. Also, distance from watering point had significant effects on species richness, but average of species richness in various distances was not in a group.

In all directions close to the center of the critical area, abundance of ruderal species such as *Peganum harmala* was more than other species up to 500 m. *Sophora* sp. was accompanied with *Peganum harmala* in the same distance, even after 500 m (Fig. 1). The average of importance value of *Peganum harmala* and *Sophora* sp. in all plots was 28.53 and 9.96%, respectively. The most relative importance of species was related to *Artemisia herba-alba* with average of 34.56%, which was found at 500-1000 m distance from the center of the critical area. The most species accompanied with *Artemisia* sp. were *Hulthemia persica* and *Acantholimon* sp., which are almost not observed among 1-500 m distance. The relative importance of *Hulthemia persica* and *Acantholimon* sp. was 6.05 and 4.54%, respectively.

Plant species were appeared in different distance from watering points in different directions (Fig. 2). *Peganum harmala* was appeared at 50 m distance from watering point in northeast and southeast directions, while it was appeared in northwest direction at 200 m distance from watering point.

Positive or negative association between different species is shown in Table 2. The values of χ calculated for pair species as *Artemisia herba-alba-Acantholimon*, *Hulthemia-Sophora*, *Salsola-Acantholimon* and *Peganum harmala-Acantholimon* were 6.024, 5.114, 5.282

and 6.57 , respectively. These values are larger than the value of χ (p = 0.01). It means that occurrence of these pair species is not accidentally.

DISCUSSION

The results of this study showed that the interactions between animals and watering points lead to changes in vegetation composition, where overgrazing around watering points changed percentage of canopy cover, density and species richness. High stocking rates or overgrazing in fragile ecosystems (arid or very saline) can decrease plant diversity (Milchunas *et al*., 1988; Hobbs and Huenneke, 1992; Olff and Ritchie, 1998). Brits *et al*. (2002) showed a great impact of utilization near the watering points and decreasing pressure as distance away from the watering points in Kruger National Park, where, almost complete lack of woody individuals were found in the immediate vicinity of the watering points, then woody plants density increased with distance from the watering point. In another study in woodlands of south-western Australia the same results were found where higher grazing pressure of livestock around watering points was associated with a decline in perennial and increase of annual cover (Yates *et al*., 2000).

Results of this study showed that the importance value of unpalatable species such as *Peganum harmala* and *Sophora* was increased in critical areas around watering points, but more palatable species such as, *Artemisia herba-alba* had higher importance value in distance from watering points (Fig. 1). Presence of unpalatable and absence of palatable species in critical areas were reported in other studies (Heshmati, 2002). Overgrazing, lead to absence of *Artemisia herba-alba* which the most likely mechanism leading to the decline of such species should be of the failure of reproductive organs. Todd (2006) indicated that areas most distant from watering points contained a greater proportion of species known to be highly palatable to livestock in Karoo shrublands, South Africa.

Different layers of overgrazing were found in different geographical directions (Fig. 2). *Peganum harmala* as the most tolerant species to overgrazing were appeared in northeast direction more closer to watering point than northwest direction. It may show higher pressure of livestock on vegetation and soil in northwest, where distribution of watering points was more abundant than other directions. These results are in agreement with some other studies (Hassani, 2001; Jafari *et al*., 2008).

Species association analyses (Table 2) show that there were 9 positive or negative associations among 15 associations. Overall the plant species association indicates that nearly all associations were occur due to the intense alterations in the ecosystem. It is concluded that some factors such as overgrazing or high stocking rate are responsible for these patterns. Heshmati (2002) were reported the same results in shrublands of south Australia.

The results of the Duncan's multiple range test for percentage of canopy cover, density and species richness show that in distance from watering points to 350 m there were no significant differences in canopy cover, also the average of plant density had no significant difference to the 200 m distance from watering points and was located in a same group. But the average of species richness was different in various distances from the watering points and wasn't located in a same group. It is speculated that percentage of canopy cover and plant density were shown a circle of critical area around watering points with radius of 200-350 m, but species richness wasn't a suitable parameter to show the extent of critical area around watering points.

Based upon the results of this study, it is conclude that the destructive impact of overgrazing on vegetation around watering points in the semi-arid rangeland of northeast of Iran was significant. Because of contribution of watering points to deterioration of semi-arid rangeland and changes in vegetation composition, more consider is suggested on distribution and management of watering points in this fragile regions.

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