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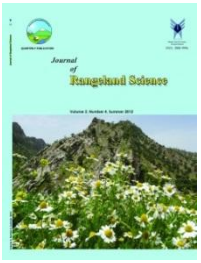

Full Length Article:

The Effects of Range Management Plans of Soil Properties and Rangelands Vegetation (Case Study: Eshtehard Rangelands)

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Manuscript Received: 30/09/2012
Manuscript Accepted: 08/12/2012

Abstract. The effects of Range Management Plans (RMP) on soil and vegetation characteristics were studied in Eshtehard rangelands at Alborz province. The parameters of yield, canopy cover, range condition and trend, bulk density, Organic Matter (OM%), Nitrogen (N), Phosphorous (P) and Potassium (K) were estimated on soil samples in sites of Ghenzel Cheshmeh as RMP and sanctum of Rahmanyeh village. The data were analyzed using T- test. The results showed that due to the reduction of plant species in the arid and semi-arid areas and the need for vegetation change for long time, the difference of canopy percentage between two sites were not significant but implementation of rangeland management plan increased the yield and improved range condition and trend. RMP had increased the N and OM% of the soils and decreased P, K and bulk density.

Key words: Range management, Vegetation canopy, Range condition, Soil characteristics.

Introduction

About 86 million ha of Iran's area (55%), covered with rangelands. About 85% of these rangelands composed of fair to very poor rangelands. These figures call for the necessity of a scientific and appropriate rangeland management. Poor condition of rangelands request for management planning that is on the basis of environmental capability. To amend the rangelands with poor condition, improvement plans are prepared and implemented (Domehri *et al*., 2002). Ignorance of the role of natural events, appropriate management is the only way which can prevent land degradation and erosion. In this respect, three present management methods are used for rangelands management in Iran as 1) Disauditing of rangelands (management that in fact apply by the exploiter and pastor), 2) Auditing and regulating of rangelands (management that is applied under the supervision of the government), 3) Range management plan. (Under supervision of both government and exploiter) (Mousavi Nejad, 1997).

Range management plan is a codified plan that considers rangeland grazing capacity, grazing season and exploitation period issued in the name of qualified rangers. Eftekhari *et al*. (2012) stated that a RMP is a complied program through which soil and water resources are preserved and sustainability of the production with maximum production possible based on potential of the region is guaranteed. For grazing of livestock in the grazing seasons on the rangeland (The law of conservation and exploitation of forests and ranges). On the other hand, range management plan apply to the ranges that after auditing, conservation, amending, sustainable developing and exploitation, management plans are prepared and executed. In each range management plan, natural condition of the area consist of; location, survey, climate condition, soils condition, topography condition, vegetation (range condition, percentage of canopy, grazing capacity, by products & etc.), water condition, range provender condition and etc. For conservation, restoring, amending, sustainable development and exploitation of these rangelands, programming will be done. Current amendment operation in the range management plans consist of: seed sowing (direct planting), shrub planting, hoeing and sowing, collection of precipitation water, enclosure, fencing, grasses planting, provision of drinking water for livestock (Construction of water point, mending the springs) required construction and buildings consist of, digging, engine room and barn (Mesdaghi, 1998). History of these management methods in USA commenced since 1900, and in Iran the first RMP conducted in Obato in Kordestan province with 86000 ha of area (Moinoddin, 1993).

Three method of RMP were investigated on 18 range units of Semnan province (with range management plan, audited, non- audited), (Mousavi Nejad, 1997). In spite of all existing problems deal with designing and performance of range management plans, most of them were successful.

Givi *et al*. (2001) reported that there was a significant difference between yield, trend and range condition in rangelands with management plan and without management. Comparison of the yield and range condition in audited and non-audited ranges did not show any significant difference. Improvement and development operations along with proper management were important and range auditing and grazing license were not effective.

Azarnivand *et al*. (2004) explained that after comparing 15 year fenced treatment to a land under grazing in the Sabzkooh area in Chahar mahal o Bakhtiari province, organic matter, CEC and usable water of the soils was greater and bulk density was lower. The best physical

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characteristics and productivity was due to more condensed vegetation in the fenced treatment. They concluded that range management and improvement operations play an important role in the balance settlement between exploitation and conservation of the exiting potential in the rangelands. Execution of range management plan in the rangelands of Zarandieh in south of Tehran province increased canopy cover percentage, presence of class I & II plants, harvestable grasses, range capacity and herder income (Mahdavi, 2007). Pei *et al.* (2008) reported that exclosure enhanced Soil Organic Carbon (SOC) and total N accumulation, and decreased pH and bulk density. Soil organic carbon and total N in the 0–20 cm soil were increased significantly with exclosure period and plant biomass, similarly vegetation was diversity increased by increasing exclosure period. In semi-steppe ranges in Turkey, content of biomass in protected area was 4 times greater than that for grazed area (Ozgol & Oztas, 2002). Zarei *et al.* (2011) in assess the effects of plantation-exclusion project on vegetation properties reported that used plan caused a significant increase in cover percentage and production. Extreme use of range species and intensive grazing in the semi-arid area of Kenya weakened the rangeland, decreased the canopy and changed the composition and diversity of plants (Macharia & Ekaya, 2005).

Due to the increase of grazing intensity in semi-arid steppes of Mongolia, organic matter and N were decreased, pH remained unchanged and bulk density was increased (Steffens *et al.*, 2008). Azarnivand *et al.* (2011) studied the effects of overgrazing on the soil physical characteristics and vegetation cover changes. The results showed that as the density of grazing increased, soil bulk density increased and soil moisture, soil porosity, aggregate stability index and vegetation cover percent decreased.

These studys played an important role in the livestock feeding and also ambiguity of the effect of performed management in the form of range management plan on the characteristics of rangelands' vegetation and soils, call for this investigation.

This study was performed to explore:

- Comparison of the vegetation characteristics including: yield, cover, plant composition, range condition and range trend between management plan and traditional management which are located in the same climatic and physiographic condition.
- Comparison and investigation of soil characteristics including: bulk density, organic matter, N, P and K in both management systems.

Materials and Methods

Study Site

Two sites of Gezal Cheshmeh and sanctum range of Rahmaniyeh village (Plang abad) located in adjacent to each other. Owing to disregarding the principles of proper exploitation and also shortage of precipitation, range management plan was prepared for Gezal cheshmeh in 1994. This plan was commenced in 1995 and ended by 1999 (5 years). Now these rangelands are managed by the same criteria.

The following operations were performed for range management plan (1995-1999):

1- Hoeing and seed sowing (650 ha)

2- Construction of three system of watering point

3- Accomplishment of alternative resting-grazing system.

The area of this range is 2233 ha of which 2205.5 ha is exploitable. The highest altitude in the south of the area is 2019 m above sea level. This winter range is located in Karaj region with arid climate and average precipitation of 224 mm (De Martin method).

Plant communities of the study area are belonged to Asteraceae, Papilionaceae, Polygonaceae, Caryophyllaceae, Lamiaceae, Salsolaceae, Brassicaceae and other families.
Vegetation types of the RMP area in Ghezel Cheshmeh were follows:

1. *Pteropyrum olivieri- Artemisia sieberi*: covered 970.5 ha equal to 44% of the range area.
2. *Artemisia sieberi- Astragalus tribuloides*: covered 481 ha equal to 21.8% of the range area. Living place of stockmen and also livestock keeping place is located in this type.
3. *Artemisia siberia- Centaurea gadorensis*: covered 754 ha equal to 34.2% of range area.

Vegetation types of control area Rahmaniyeh village were composed of two types:

1. *Pteropyrum olivieri-Artemisia sieberi:* covered 4550 ha equal to 39/98% 0f the range area.
2. *Artemisia sieberi-Centaurea gadorensis:* covered 6680 ha equal to 60/02% 0f the range area.

General Methods

In each plant type reference area was selected and then sampling plots (40 plots with 2 m^2 area) along four 100 m transects with 100 m distance from each other were located along North-South direction. To remove the slope effect in hills and mountainous area, sampling transects were located parallel to slope direction and vertical to slope direction. In these types direction of two transect was North-South and two transect was East-West. Sampling points were systematically selected with10m distances along each transect. Regarding the type of existing vegetation and dimensions of shrub, 2x2 m plot, which are twice as much as the size of average canopy of the *Pteropyrum* shrub in this area, was selected. Totally, 10 plots for each transect, 40 plots for each type and 3 soils sample for the direction of each transects and totally 12 soils samples were collected. After locating transects, canopy cover was recorded separately for each species. Cover of stone and gravel, bare soils and litter was recorded. To determine the yield, the method of double sampling was used. The Amended Four Factors Method and trend scale were used to determine the range condition and range trend respectively.
To determine the effect of management on forage production, four species were selected and their production was compared. In the *Pt.ol-Ar.si* vegetation type, two key species were selected, one grass species with high palatability class of I and one species with low palatability class of III and they were compared to each other.
The method of Walkly-black was used for soil organic matter analysis. Furthermore, Kjeldahl method and Olsen method were used for analysis Nitrogen and phosphorus respectively. For potassium and bulk density of the soils normal ammonium acetate method and Paraffin method were used respectively.

Data analysis

All raw data were arranged in excel environment by species and plots, and then assumptions of normality and homogeneity of data were tested using KS test and Levene's test respectively. T-test performed using Minitab13 environment to compare the vegetation and soils characteristics in the area with range RMP and without RMP.

Results

The general result of the range types with RMP and control area is shown in (Table 1). The results indicated of higher values of vegetation cover, forage production, organic matter in RMP area than that control. The RMP ranges had also good

Condition couple with positive trend. In contrast, the higher values were obtained for bulk density, P and K values in non RMP area (Table 1).

Table 1. Vegetation characteristics and physiochemical characteristics of soils in the areas with and without RMP

Area	Type	Cover %	Yield Kg/ha	Condition	Trend	OM%	Bulk density	N%	P (ppm)	K (ppm)
RMP Area	*Pt.ol-Ar.si*	39.48	119.73	Fair	Stable	0.48	2.32	0.04	18.57	349.2
	Ar.si-As.tr	41.40	292.90	Good	Positive	0.88	1.85	0.07	18.23	377.5
	Ar.si-Ce.ga	44.15	242.13	Good	Positive	0.92	1.63	0.08	18.02	330.8
Control	*Pt.ol-Ar.si*	29.55	99.85	Poor	Negative	0.27	2.89	0.02	19.25	418.3
	Ar.si-Ce.ga	28.6	122.93	Fair	Negative	0.44	2.65	0.05	19.08	404.2

OM: Organic Matter; N: Nitrogen; P: Phosphorous; K: Potassium

Effects of RMP on forage yield

In the *Pt.ol-Ar.si* vegetation type, the forage yield of *Pteropyrum olivieri Artemisia sieberi, Stipa hohenackeriana* and *Poa bulbosa* were significantly difference in both areas (P<0.01). All of these species except *Poa bulbosa* had higher forage production in RMP than that for non RMP area (Table 2).

In the *Ar.si-Ce.ga* vegetation type, four other species were considered and their forge yield was compared. Forage production of *Artemisia sieberi* and *Stipa hohenackeriana* were higher for RMP area. In contrast, the higher yields were obtained for *Centaurea gadorensis* and *Bromus danthoniae* in control area (Table 2).

Table 2. Comparison of forage yield in eight index species belong to *Pt.ol-Ar.si* and *Ar.si-Ce.ga* vegetation type in RMP and non RMP areas

Vegetation Type	Species	RMP Area	Control	DF	T
Pt.ol-Ar.si	*Pteropyrum olivieri*	38.9±3.1	22.7±2.7	78	3.92**
	Artemisia sieberi	65.3±9.00	38.5±6.7	78	-2.39*
	Stipa hohenackeriana	5.23±0.79	1.04±0.42	78	-4.67**
	Poa bulbosa	0.64±0.23	2.69±0.60	78	3.22**
Ar.si-Ce.ga	*Centaurea gadorensis*	19.9±3.5	28.1±2.1	78	2.00*
	Artemisia sieberi	71.60±7.5	53.8±5.1	78	-1.97*
	Stipa hohenackeriana	13.3±3.5	0.85±0.41	78	-3.51**
	Bromus danthoniae	0.88±0.30	3.01±0.66	78	2.95**

*and** = No Significant difference and Significant difference at 5% and 1%, respectively

Effects of RMP on canopy and soil properties

For canopy rates, the difference between canopy rates in the *Pt.ol-Ar.si* type was not significant but for the *Ar.si-Ce.ga* type it was significant (P<0.01) and the average values of 44.15 and 28.6 were obtained for RMP and non RMP area, respectively (Table 3).

Results of Organic Matter (OM%) indicate that in both vegetation types the higher values were obtained for RMP

area (P<0.01). For *Pt.ol-Ar.si* type the OM% values of 0.48% and 0.27% were obtained for RMP and non RMP area, respectively. Similarly for *Ar.si-Ce.ga type*, the average values were obtained 0.92 and 0.44% for RMP and non RMP sites, respectively (Table 3).

The trend of N content change in both types was the same so that in both vegetation types, N content had significant difference between two areas (P<0.01). The higher N% with average values of 0.04 and 0.08% were obtained for *Pt.ol-Ar.si* and *Ar.si-Ce.ga* vegetation type in RMP area, respectively (Table 3).

There was no significant difference of P content in *Pt.ol-Ar.si* type between areas with RMP and without RMP. But for *Ar.si-Ce.ga* vegetation type, there was a significant difference for P content between these two areas (P<0.01). For *Ar.si-Ce.ga* the higher values of 19.08 were obtained for non RMP area (Table3).

Potassium content and bulk density in both types of Pt.ol-*Ar.si* and *Ar.si-Ce.ga*, showed significant difference between areas (P<0.01). For both traits the higher values was obtained for non RMP area (Table 3).

Table 3. Comparison of means of two vegetation types for canopy and soil properties in RMP and non RMP areas

Parameters Name	Vegetation Type	RMP Area	Control	DF	T Test
Cover%	*Pt.ol-Ar.si*	30.48 ± 1.30	29.55±0.93	78	0.57 ns
	Ar.si-Ce.ga	44.15±1.50	28.6±1.0	78	-8.37**
OM%	*Pt.ol-Ar.si*	0.48±0.068	0.27±0.054	22	2.39**
	Ar.si-Ce.ga	0.92±0.047	0.44±0.058	22	6.49**
Nitrogen (%)	*Pt.ol-Ar.si*	0.04±0.004	0.02±0.005	22	3.08**
	Ar.si-Ce.ga	0.08±0.005	0.05±0.005	22	4.20**
Phosphorous(ppm)	*Pt.ol-Ar.si*	18.57±0.35	1925±0.36	22	-1.35 ns
	Ar.si-Ce.ga	18.02±0.32	19.08±0.40	22	-2.07*
Potassium(ppm)	*Pt.ol-Ar.si*	349 ± 19	418±12	22	-3.13*
	Ar.si-Ce.ga	330 ± 20	404±12	22	-3.10*
Bulk density	*Pt.ol-Ar.si*	2.32±0.046	2.89±0.028	10	-3.13*
	Ar.si-Ce.ga	1.63±0.04	2.65±0.038	10	-3.10*

ns, *and** = No Significant difference and Significant difference at 5% and 1%, respectively

Discussion

Difference between canopy percentages of two areas for *Ar.si-Ce.ga* type was significant and for *Pt.ol-Ar.si* type it was not significant that is due to the gradual changes of range management in arid and semi-arid areas. If the present condition continue, its following changes would be noticeable. Arzani *et al.* (1999) reported that vegetation change of Yazdkooh during 12 years wasn't significant. They concluded that the changes trend in dry areas is very slow and longer period is required to separate the annual variability from real changes. Canopy percentage of *Centaurea gadorensis*, between areas with RPM and without RPM in *Ar.si-Ce.ga* type, had significant difference. Frequency of *Centaurea gadorensis* in non RPM area was more than RPM area. This species is not considered as palatable species and livestock don't consume it, this species form a considerable part of the type species,

while in area with RPM due to management, grazing of palatable species is not heavy and the rate of this species is not comparatively high.

Since *Artemisia sieberi* is a palatable species, livestock consume it in non RMP and consequently, this reduces the percentage of canopy. But in the area with RMP area because of grazing system, this species is less grazed. Canopy percentage of *Stipa hohenackerina* in both vegetation types in the area with RMP was greater than that for non RMP area. This species is also palatable and was under intensive grazing in the non RMP area. Species of *Poa bulbosa* in *Pt.ol-Ar.si* type and *Bromus danthoniae* in *Ar.si-Ce.ga* type, are not palatable, therefore, their canopy percentage in area without RMP was comparatively greater than for RMP area. Tilman *et al.* (1997) concluded that intensive grazing makes change in structural and functional group of range ecosystem by decreasing the perennial high quality plants and Nitrogen fixation that subsequently increases annual invasive plants. Comparison of yield volume in the types in the area with RMP and the types in the area without RMP indicated significant difference so that yield volume in both types in the area with RMP was greater than the area without RMP. This difference is because due to the correct and proper management operations specially: timing entrance of livestock, range capacity and also timing livestock removal.

Ozgul and Oztas (2002) reported that in semi-steppe ranges of Turkey biomass was four time as much as grazed fields. Todd *et al.* (1998), using the natural indices explained that yield volume in ungrazed ranges was significantly greater than grazed ranges. Yield volume of *Artemisia sieberi* and *Stipa hohenackerina* that are palatable plants, in both types of area with RMP was greater than non RMP area for the same types. This is because of proper management that provides good condition for plant growth and increases the viability of plants and finally increases the amount of vegetation and yield volume. But *Stipa hohenackerina, Poa bulbosa* and *Bromus danthoniae* that are less palatable and also are considered as invasive plants in non RMP area due to the lack of proper management, had greater percentage of canopy and subsequently yield volume in comparison with the other palatable plants and the area with RMP. Jeddi and Chaieb (2010) showed that exclosures enhance the total plant cover, the dry matter yield and some palatable species were frequently found inside the protected site. Holechek *et al.* (2001) explain that intensive grazing condition, decrease the potential of yield of perennial plants. Implementation of RMP in studied area has improved the condition of both range types. In the area without RMP, trend of types' condition is negative and backward. This recession is because of the improper management especially in terms of livestock removal, overgrazing and continuous grazing. But in the area with RMP owing to proper management and observation of grazing capacity, entrance timing and removal of livestock, types had positive or stable trend. These results correspond to results of Zarei *et al.* (2011) and Efterkhari *et al.* (2012). Macharia & Ekaya (2005), declare that overgrazing of the range species, weaken the range condition, reduce the canopy percentage and make change in plant composition and diversity. On the other hand, intensive grazing weakens the range and makes retrogradation of range trend.

In the area with RMP, the amount of organic matter was greater than the area without RMP that is due to using alternative grazing system in the area with RMP that reduces the intensity of plant's aerial parts over consuming. This finding agrees with Steffens *et al.* (2008), Heitchmidt (1990), Naeth *et al.* (1991),

Sharif *et al.* (1994), Javadi (2003) and Sanadgol (2002). They found that grazing intensity increases, the amount of aerial part of plant and subsequently the amount of soils organic matter would be decreased. In the area without RMP, because of intensive grazing, amount of Nitrogen was less than the area with RMP. This result corresponds to finding of Dormer *et al.* (1989), Frank *et al.* (1995), Javadi (2003), Sanadgol (2002), Maffumo (2002), Steffens *et al.* (2008) and Mofidi *et al.* (2012) who found that as intensity of grazing increases, immobility of mineral nitrogen increases and subsequently this reduces the release of exchangeable or mobile nitrogen. In the area without RMP, too much traffic of livestock cause much burying of feces and litter and also this traffic cause the greater amount of feces in the area without RMP in comparison with the area with RMP, subsequently the amount of phosphorous in area without RMP was greater than the area with RMP. These findings correspond to the study of Javadi (2003) and Sanadgol (2003). Because of livestock traffic and their feces in area without RMP, difference between Potassium content in two areas was the same as phosphorous. Moreover, due to sparse vegetation in the area without RMP, plants consume less potassium of the soils than the area with RMP. This finding corresponds to study result of Javadi (2003) and Sanadgol (2002). Presence of surplus livestock that exceed grazing capacity, continuous grazing, cause soil compaction. Consequently, bulk density in the area without RMP was statistically greater than the area with RMP. This finding corresponds to Abdel-majid *et al.* (1987), Welts and Wood (1986), Blackburn (1984), Sanadgol (2002) and Steffens *et al.* (2008).

This study shows that proper management of ranges via executing range management plan improves and increases the canopy percentage, presence of plants class I and II, yield, range condition and trend. Moreover, executing the RMP increases the organic matter and Nitrogen content as well as decreases the phosphorous, potassium and bulk density of soils. These findings in agreement with results obtained by Mousavi Nejad (1997), Azarnivand *et al.* (2004), Dehdari (2012) and Eftekhari *et al.* (2012) and do not correspond to results of Sardari (1999) and Ramezani (1998) that stated in their study social and economical agents and lack of adequate supervision by government were reasons of unsuccessful this plans.

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