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An Assessment of Structural Characteristics of Patches in Different Natural and Managerial Conditions in Taleghan (Case Study: Karkaboud and Kouin)

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Abstract: Preservation of ecosystems requires an understanding of the ecosystem processes that regulate ecosystem resources. Patches and inter-patch features are parts of the ecosystem that are partially responsible for effects on transporting and storing materials in the ecosystem. The structural features of ecological patches including size, number and the average inter-patch length are important because they are key factors in determining the fate and movement of sediments and organic matter. The purpose of this study is to assess the effects of management actions on the structural characteristics of patches. To this end, landscape function analysis (LFA) method was used in four management treatments in Taleghan, North West of Tehran. Patches were defined in terms of vegetative form, then size and number of patches and the average inter-patch lengths were measured. The results showed that with increase in grazing pressure size and the number of patches decreased and the average inter-patch length increased. Structural characteristics showed significant difference between management treatments.

Key words: Landscape function analysis · Ecological patches · Ecological inter-patch · Taleghan

INTRODUCTION

Preservation of ecosystems requires an understanding of the ecosystem processes that regulate the resources. Patches and inter-patches are parts of the ecosystem that are partially responsible for transporting and storing materials in the ecosystem. Patches can be a single plant, a group of plants, rock or any object that could keep the resources [1]. Patches play an important role in determining the amount of runoff and sediment in a pasture ecosystem, especially in arid and semiarid regions [2, 3 and 4]. The structural features of ecological patches including size, number and average inter-patch length are important because they are key factors in determining the fate and movement of sediments and organic matter [5]. Functioning of an ecosystem is to its ability to trap and hold rain water and food by patches [6]. The structural features of patches change due to disturbances [7]. For example, Bastin [8] concluded in a review that the number, length and average width of patches is reduced due to fire; Tongway and Hindley [9] concluded that the reaction of patches against fluctuations in precipitation is variable and patch dimensions are smaller in the dry season. Abedi *et al*. [10] examined the structure and function of ecological patches in the Zarand Saveh region and Taleghan and stated that with increase in grazing intensity, structure of the patches destroys, distance between the patches increases and soil permeability decreases. Ludwig *et al*. [6] investigated the grazing gradient from watering points and stated that size of patches near the watering points was reduced. Landscape function analysis model [9] provides an easy method for measuring the structural characteristics including the number of patches, total area of the patches, patch area index, landscape organization index and the average distance between patches (inter-patch length).

This study aims at using landscape function analysis model for assessment of changes in the structural characteristics of the patches with management activities.

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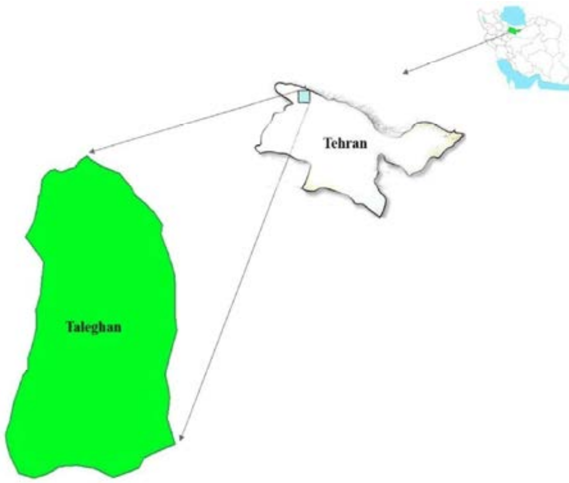

Fig. 1: Location of study area

MATERIALS AND METHOD

The study area, namely Taleghan Basin is located in the north west of Tehran Province, Iran. It is situated in Alborz Mountains and between 50° 47′ 59½ to 50° 53′ 4½ E and 36° 10′ 28½ to 36° 17′ 44½ N (Fig. 1) and is approximately 7780 ha. The average annual precipitation is 455 mm, the maximum temperature in the hottest month of the year is 35°C and the minimum temperature in the coldest month is-24°C (IRIMO[1]). The main aspect of Taleghan basin is west to east. Soil in Taleghan basin is very divers. The minimum elevation of the study area is 1833 m while the maximum is 3926 m.

Four management treatments were chosen in four regions including: Karkaboud, Karkaboud cascade, Kouin and Kouin-Marjan. Below a brief description of these areas is given.

Kakabood: This location is far from residential areas so human and livestock presence is very low. This location was selected as control.

Kakabood Cascade: Distance to residential areas is low and human presence is very high, usually used for recreational purposes.

Kouin: Distance to residential areas is low and usually used for livestock grazing.

Kouin-Marjan: The nearest among the selected treatments to residential areas which is used for livestock grazing and sometimes is plowed.

Sampling: Systematic random sampling design was implemented. The sampling units were line transects in which vegetation and surface phenomena were measured. Two transect each 50 meter (fifty meter away from each other) in each management area toward the regions downstream were placed. Patches and inter-patches were identified in each transect. Inter-patches were boundaries based on basal cover, then the length and width of the patches and inter-patches length were measured. The data were analyzed using LFA software.

RESULTS

Four kinds of patches including shrub, forb, grass and rock were identified based on initial survey of the four treatments. The number of shrub patches was higher than other patches in Karkaboud and Karkaboud cascade, while forb patches were more abundant than other patches in Kouin and Kouin-Marjan (Table 1).

Number of grass patches in the Krakaboud was almost two times the number of grass patches in the Kouin and Karkaboud cascade. In Marjan no grass patch were seen (Table 1).

The average length of shrub, rock and bare soil patches was higher than average length of grass and forb patches in Karkaboud (Table 2).

Table 1: Number of different patches types in management treatments

	Patch			
Location	Rock	Forb	Grass	Shrub
Karkaboud	10	10	9	22.5
Kouin	6	10	4	7
Karkaboud cascade	9.5	4	4.5	11.5
Kouin-Marjan	-	11	-	6

[1]Islamic Republic of Iran meteorological Organization

Table 2: patch mean width, percentage of transect length and mean length in management treatments

Treatment	Patches	(m) mean width	percentage of transect lenght	(m) mean lenght
Karkaboud	Shrub	55.51	32.03	0.43
	grass	23.78	8.47	0.29
	forb	30.61	10	0.30
	rock	79.52	15.33	0.47
	bare soil	-	34.11	0.41
Kouin	Shrub	41.39	11.16	0.48
	grass	15.25	3.83	0.28
	forb	27.7	10.66	0.32
	rock	42.08	8.83	0.44
	bare soil	-	65.5	0.881
Karkaboud cascade	Shrub	52.84	19.08	0.49
	grass	13.45	3.52	0.23
	forb	26.41	6.2	0.41
	rock	53.13	15.49	0.48
	bare soil	-	59.2	0.67
Kouin-Marjan	Shrub	24.83	4.56	0.22
	forb	15.29	6.41	0.17
	bare soil	-	89.01	1.48

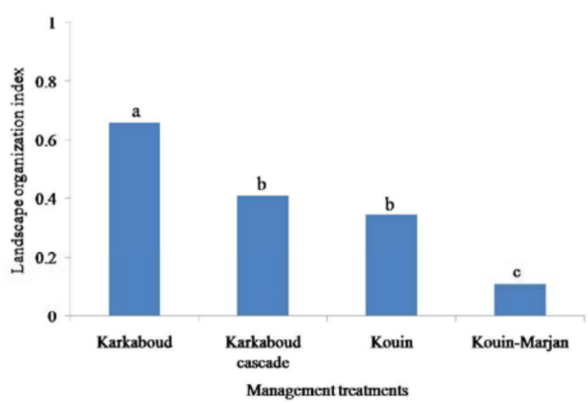

Fig. 2: Landscape organization index in management treatments

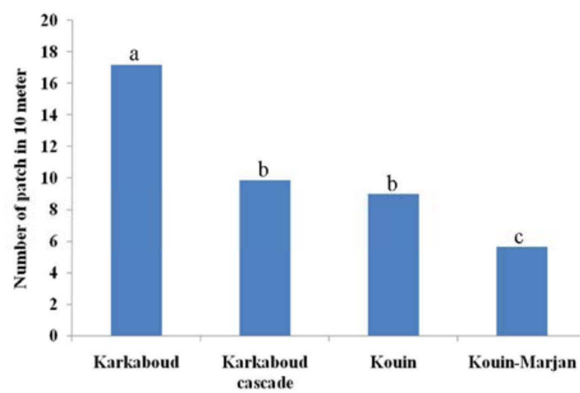

Fig. 3: Number of patches in 10 meter in management treatments

Shrub and bare soil percentage along the transect length was higher than other patches in Karkaboud. The highest percentage of transect length belonged to the bare soil and shrub patches in Kouin. The highest percentage of transect length was allocated to bare soil and shrub patches in Karkaboud cascade. In Kouin-Marjan bare soil and forb patches had the highest percentage of transect length (Table 2). Shrub and rocks had maximum width between patches in all treatments (Table 2).

Karkaboud had the maximum amount of landscape organization index between treatments and was significantly different ($P < 0.05$) with other treatments (Fig. 2). There was no significant difference between Karkaboud cascade and Kouin in this index (Fig. 2). The least amount of landscape organization index belonged to the Kouin-Marjan (Fig. 2).

The number of patches in 10 m was 17.2 in Karkaboud and was significantly different with other treatments. The number of patches in 10 m in Karkaboud cascade and Kouin was 9.85 and 9 respectively and there was no significant difference between these two treatments. Kouin-Marjan with 5.65 patches in 10 m had the lowest index between the management treatments (Fig. 3).

Patch area index was 0.04 in Karkaboud and was significantly different ($P < 0.05$) with other treatments. This index was 0.02 for the Karkaboud cascade, 0.01 for

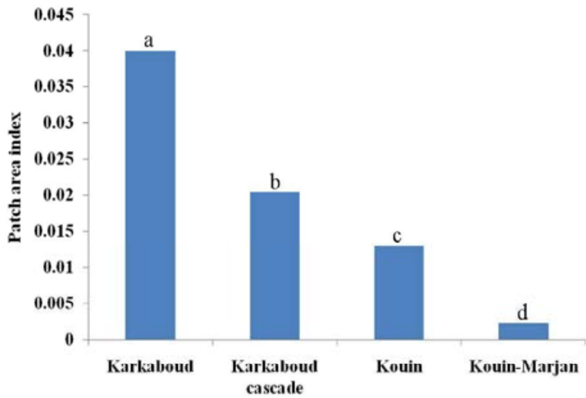

Fig. 4: Patch area index comparison in management treatments

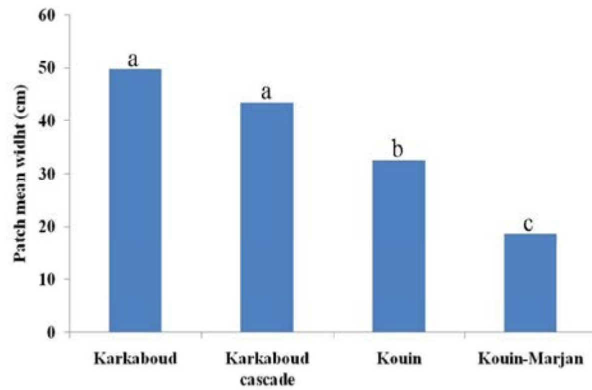

Fig. 6: Average patch width comparison in management treatments

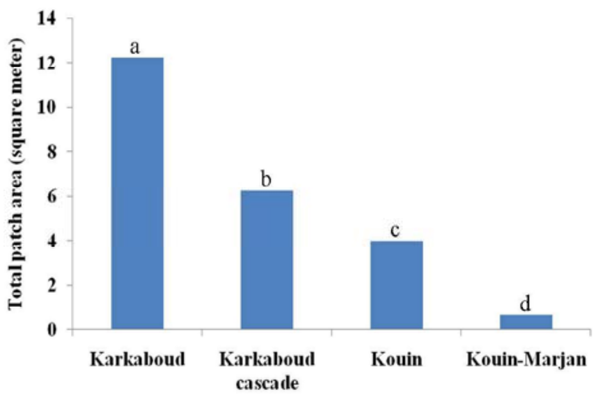

Fig. 5: Total patch area comparison in management treatments

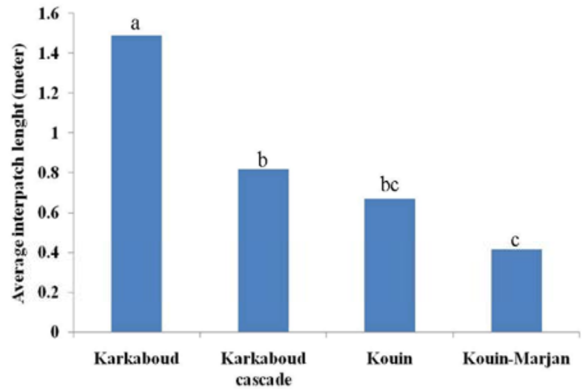

Fig. 7: Average inter-patch length comparison in management treatments

the Kouin and 0.002 for the Kouin-Marjan. There was a significant difference between all treatments in this index (Fig. 4) Total patch area was 12.25 square meters in Karkaboud and significant differences were observed with other treatments (Fig. 5). The total patch area for Karkaboud cascade was 6.25 square meters and was significantly different with other treatments. The total patch area for the Kouin and Kouin-Marjan was 4 and 0.65 square meters, respectively (Fig. 5).

There was no significant difference between Karkaboud and Karkaboud cascade in average patch width but significant difference was observed with other treatments (Fig. 6). Average width of patches was 49.85 in Karkaboud, 43.55 in Karkaboud cascade, 32.55 in Kouin and 18.65 in the Kouin-Marjan (Fig. 6).

The average distance between patches (inter-patch length) in Kouin-Marjan was higher than other treatments and was significantly different with other treatments. This value was 49.1 meter in Kouin-Marjan. Karkaboud with 0.415 m had the lowest average distance between the patches (Fig.7). There was no significant difference between the Kouin, Karkaboud and Karkaboud cascade in this indicator (Fig. 7).

DISCUSSION AND CONCLUSION

Landscape organization index (which reflects the ability of an ecosystem) in Karkaboud was more than other treatments. The reasons can be more patches, more patch dimension and more litter in Karkaboud than other treatments [6], [11]. Larger patch size in Karkaboud can be due to low grazing intensity. As livestock grazing intensity increased, patch size was decreased [12]. As livestock grazing intensity increased, the number of fertile patches was also decreased. Low number of patches is an indicator of landscape degradation as a consequence of improper management activities [9, 10]. Saco [13] and Turnbull *et al*. [14] also confirmed that the reduction in fertile patches can result in land degradation through increment in runoff and erosion rates in heavy rains.

As livestock grazing intensity and human presence increased, the distance between patches was increased. This is due to removal of palatable patches through grazing [10]. A notable point about number of patches is that as grazing intensity increased, also the number of invasive forbs such as *Echinops sp*, *Verbascum sp* and *Glycyrrhiza glabra* increased. Ghodsi *et al*. [15] argue that the number of invasive forb patches increase in intensive grazed regions. Ahmadi *et al.* [16] also emphasized that invasive patches have high percentage of vegetation composition near the residential areas. Given the increasing trend in species such as invasive forbs, the number of suitable patches like those composed with palatable grasses was decreased. The survey results confirm this, so that the number of grass patches in Karkaboud, where grazing intensity was low, was higher than Karkaboud cascade and Kouin. There is no grass patch in Kouin-Marjan due to high grazing intensity and land degradation. Also as degradation increased, the palatable patch width was strongly reduced. Total patch area very well reflect differences in conditions in Karkaboud and other treatments. This indicator also showed the effects of incorrect management activities. The high human presence is the main cause of the reduction in patch size in Karkaboud cascade. Human presence can increase the soil compaction by trampling, so this reduces the amount of available moisture to patches.

This study concluded that the analysis of the structural features of patches using landscape function analysis can reflect the impact of management activities. Results of researches on patch structure can be used in range management programs.

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