An Investigation of Management Effects on Range Functionality
(Case Study: Karkaboud and Kouin, Taleghan)

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Abstract: Ecosystem function is affected by management activities in rangeland ecosystems. Hence, it is necessary to consider management effects on rangeland ecosystem to reduce its degradation. In order to determine the effects of management activities on rangeland ecosystem, four management treatments were chosen in Taleghan, Iran. Functionality characteristics including: stability, infiltration and nutrient cycling were calculated using Landscape Function Analysis (LFA). LFA calculates these parameters using 11 soil surface indicators. Results showed that stability, infiltration and nutrient cycle were higher in Karkaboud than the other locations because of low grazing pressure and non-accessibility conditions. As grazing pressure increased we witnessed less stability, infiltration and nutrient cycling in Karkaboud cascade, Kouin and Kouin-Marjan. Main causes of decline in stability, infiltration and nutrient cycling are perennial vegetation removal, soil trampling and decrease in soil organic matter and subsequent increase in erosion and soil instability.

Key words: Soil surface indicators, functionality characteristics, management, Taleghan

INTRODUCTION

Assessment of functionality and health of rangeland ecosystems in operational management of these ecosystems over time is very important (Pyke et al., 2002). Rangeland ecosystems can be found from fully-functional to dysfunctional (Ludwig and Tongway, 1997). A functional landscape tends to retain, utilize and cycle resources, characterized as ‘resource retentive’, whereas a dysfunctional landscape tends to lose resources beyond the local watershed boundary (Ludwig and Tongway, 1997). To apply scientific and proper management on pasture ecosystems, information on ecosystem as health indicators and ecosystem function is needed. Different management activities have various effects on rangeland function (Heshmati, 1997). Management activities can cause increased degradation and desertification process in pasture (Ludwig and Tongway, 2000; Irshad et al., 2007; Maiangwa et al., 2007). For example, intense livestock grazing increases the trampling and the bulk density of soil (Liacos, 1962), soil infiltration losses (Rauzi, 1963) and change the composition of vegetation (Ahmadi et al., 2008; Hosseinzadeh et al., 2010). Recognizing soil surface indicators and features has great importance in range function analysis and can show the impact of management activities on ranges (Ludwig and Tongway, 1997).

Various methodologies have been used for assessing ecosystem health and function. Some of these methods focus on successional changes in vegetation by measuring composition (species) and structure (morphology). The problem of these methods is the lack of attention to hydrological and soil properties of rangeland ecosystems that are the main concepts of rangeland ecosystems. Soil and habitat stability, hydrological functioning, infiltration and nutrient cycling of the rangeland are the most important functional features (Pyke et al., 2002). Tongway and Ludwig (2002) and Tongway and Hindley (2004) that should be considered in the assessment. Landscape Function Analysis (LFA) is a method by which these features can be evaluated in a wide range of climates. LFA would assist in understanding how rangeland ecosystems are responding to changes over time (Lane, 2008). LFA measures the landscape’s ability to retain and restore
natural resources such as nutrients, water and organic material (litter and seeds) (Tongway and Hindley, 2004), provides guidance to land managers as to where and how they should concentrate their efforts to improve ecosystem function (Lane, 2008). This study aimed at identification of changes in soil surface indicators and functional futures in reaction to various management activities.

MATERIALS AND METHODS

The study area, namely Taleghan Basin is located in the north west of Tehran Province, Iran. It is situated in Alborz Mountains, 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). 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 which were different in activities and included: Karkaboud, Karkaboud cascade, Kouin and Kouin-Marjan. Below a brief description of these areas is given.

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

Karakbood 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 transects each 50 m (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. Five replications of patches and inter-patches were selected randomly to assess soil surface. Then, 11 soil surface indicators were measured in replications based on LFA manual. Soil indicators in each patch and inter-patch were conducted in “query zones”. This zone includes the length of transect that was allocated to patches and inter-patches. Stability was measured via rain splash protection, the amount of litter, cryptogam cover, crust brokenness, soil erosion type and severity, deposited materials, surface nature (resistance to disturbance) and slake test indicators. Infiltration was measured by perennial grass basal area and tree and shrub foliage cover, litter cover, origin and degree of decomposition, surface roughness, surface resistance to disturbance, slake test and soil texture indicators. Nutrient cycling was measured by perennial grass basal area and tree and shrub foliage cover, litter cover, origin and degree of decomposition, cryptogam cover and surface roughness indicators. The data were analyzed using LFA software.

Statistical analysis: Analysis of variance and mean comparison at the 95% confidence used to compare the effect of management effects on range functionality. The SPSS statistical software mainly used.

RESULTS

Soil surface indicator: Perennial grass basal area and tree and shrub foliage cover indicators were high in Karkaboud and decreased as grazing pressure increased in other treatments. This indicator assesses the contribution of the below-ground biomass of perennial vegetation in contributing to nutrient cycling and infiltration processes. The amount of this indicator was 2.54 in Karkaboud (highest amount between treatments) and 1.08 in Kouin-marjan (lowest amount between
different with other treatments (Table 2). The objective of this indicator is to assess the nature and amount of alluvium transported to and deposited on the query zone. Soil surface roughness was higher in Karkaboud than other treatments. This indicator was 2.8 in Karkaboud vs 1.86 in Koun-Marjan (Table 1). High surface roughness slows outflow rates, permitting a longer time for infiltration and may comprise a safe site for the lodgment of propagules and litter. Karkaboud was significantly different with Koun-Marjan in surface resistance to disturbance indicator, but had no significant difference with other treatments (Table 2). The objective of this indicator is to assess the ease with which the soil can be mechanically disturbed to yield material suitable for erosion by wind or water. There was no significant difference between Karkaboud and other treatments in slake test indicator. The P-value of comparison between Karkaboud and other treatments was 0.926, 0.118 and 0.613 (Table 2). Karkaboud had no significant difference with Koun and Karkaboud cascade but was significantly different with Koun-Marjan in soil texture indicator (Table 2).

**Functional features**

**Stability index**: Karkaboud had the highest level of stability index (48.6) and Koun-Marjan had the lowest level (35.45). Stability index in Karkaboud cascade and Koun was 40.8 and 39.1, respectively. There are significant differences between treatments in stability index (Fig. 2).

**Infiltration index**: Infiltration index was different in different treatments. Infiltration index in Karkaboud was
Fig. 2: Stability index comparison in management treatments (letters a, b, c and d shows statistical significance). Karkaboud, a highest value of stability (48.6) between treatments. b, c and d shows 40.8, 39.1 and 35.45 in Karkaboud cascade, Kourin and Kourin-Marjan, respectively.

Fig. 3: Infiltration index comparison in management treatments (letters shows statistical significance). a: The value of infiltration in Krakaboud was 38.1. b: There was no significant difference between Karkaboud cascade and Kourin. c: Koun-Marjan was significantly different with other treatments with the value of 19.35.

38.1. Karkaboud was significantly different with other treatments in infiltration index. Between Karkaboud cascade and Kourin, there was no significant difference in infiltration and this index was 27.6 and 27.5 in the two treatments, respectively. Koun-Marjan had the lowest level of infiltration index and was significantly different with other treatments. This index was 19.35 in Koun-Marjan (Fig. 3).

Nutrient cycling: There were significant differences between treatments in nutrient cycling index (Fig. 4). This index in Karkaboud, Karkaboud cascade, Koun and Koun-Marjan was 29.85, 19.9, 15.75 and 12.1, respectively.

Fig. 4: Nutrient cycle index comparison in management treatments (letters shows statistical significance). Karkaboud had highest value of nutrient cycle index and was significantly different with other treatments (a). Karkaboud cascade had significant difference with Karkaboud and Koun-Marjan regions (b). Koun had significant different with Karkaboud in Nutrient cycle but had not significant difference with other treatments (bc). (c) Koun-Marjan had the lowest value of nutrient cycle between treatments and was significantly different with karkaboud cascade and Karkaboud.

DISCUSSION

Ludwig and Tongway (1997) affirm that perennial plant patches are good indicator of conserving landscape function. Karkaboud had good functionality because the number of perennial patches (shrub) was high in this location but Koun-Marjan was poor because of the intense grazing and human disturbances resulting in low perennial plant patches.

The results showed that as grazing pressure and degradation increased, soil surface indicators and functional characteristics decreased (Ludwig and Tongway, 2000). Rain splash protection indicator in Karkaboud was in the highest level due to dense perennial plant cover and high rock coverage. Persistent cover provided by perennials is important in minimizing loss of soil and water (Bastin, 2005). As a grazing pressure and human presence increased in Karkaboud, rain splash protection decreased. This indicator has declined significantly in Koun due to high grazing pressure. In Koun-Marjan, vegetation cover was very poor due to the proximity to residential areas, the continuous presence of livestock (Hassani et al., 2008) and the plowing of the soil. These activities (intensive grazing, plowing and human disturbances) have declined soil protection (Breman and Cisse, 1977). The amount of litter in Karkaboud was higher than other treatments due to high perennial plant cover.
As grazing pressure increased and perennial plant decreased, the amount of litter was decreased (Amiri et al., 2008) in Karkaboud cascade, Kouin and Kouin-Marjan. Kouin-Marjan had the lowest level of litter among the treatments; the reason can be continuous grazing of livestock and plowing. Crust brokenness indicator, soil erosion type and severity, deposited materials and surface nature indicators increased as grazing pressure, human presence and human activities increased. The reasons for this are removal of vegetation cover and livestock trampling (Smith and Wischmeier, 1962). Soil surface roughness was declined in Kouin-Marjan due to livestock trampling. Surface resistance to disturbance indicator was high in Karkaboud where the surface coverage was very good and grazing intensity was low. Soil texture was uniform in Karkaboud, Karkaboud cascade and Kouin, but it was different in Kouin-Marjan due to different soil formation.

LFA stability index was generally well related to vegetation type (Marchiori, 2008) and patchiness (Ludwig and Tongway, 1997), where dense perennial plant cover in Karkaboud had the highest level of stability index, Karkaboud cascade with sparse perennial plant coverage, Kouin with herbaceous plants and Kouin-Marjan with annual grass were lower than Karkaboud.

Karkaboud had a high level of infiltration index, due to minimum disturbance (grazing and human presence) and high number of perennial plant patches. Costanini and Loch (2002) found that sites with minimum disturbance had high infiltration rates; sites with vegetation patches also had higher level of infiltration rate than bare soil (Lotfi Anari et al., 2010).

Nutrient cycling index is well related to litter and perennial plant cover (Tongway and Hindley, 2004), so Karkaboud had a high nutrient cycling because of high perennial plant coverage. The lowest level of nutrient cycling was seen in Kouin-Marjan because of perennial patches absence.

CONCLUSION

This study demonstrated effects of management actions on range functionality. Management's actions such as high grazing pressure, high human presence and unmanaged plantation could change a fully functional rangeland to a dysfunction rangeland. LFA method was implemented relatively easily and consistently and the results were found also consistent with the expert knowledge and experience. Hence, we could affirm the method's applicability in the study area.

REFERENCES


