http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 16 (5): 239-244, 2013
ISSN 1028-8880 / DOI: 10.3923/pjbs.2013.239.244

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

[1]H. Siroosi, [1]G.A. Heshmati, [2]A.S. Mahini and [3]H.R. Naseri
[1]Department of Range Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran
[2]Department of Environmental Sciences,
Gorgan University of Agricultural Sciences and Natural Resources, Iran
[3]Department of Rangeland Ecology and Management, International Research Center of Desert,
University of Tehran, Iran

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

Corresponding Author: H. Siroosi, Department of Range Management,
Gorgan University of Agricultural Sciences and Natural Resources, Golestan Province, Gorgan,
Shahid Beheshti Street, Iran

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.

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.

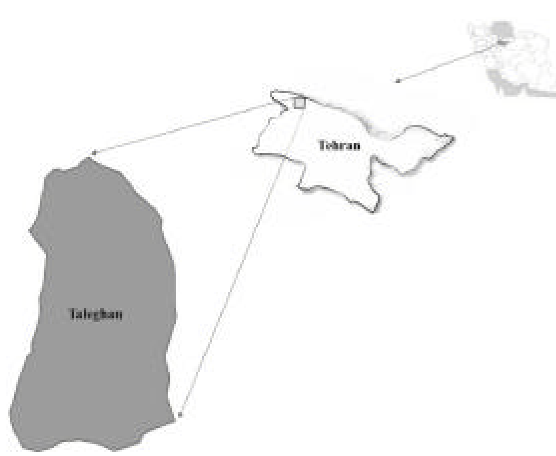

Fig. 1: Location of study area

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

Table 1: Soil surface indicators mean score in management treatments

Indicator location	Soil texture	Slake test	Soil surface resistance to disturb	Surface roughness	Deposited material	Erosion type and severity	Crust brokenness	Cryptogam	Litter	Perennial grass basal and tree and shrub foliage cover	Rain splash protection
Karkaboud	3.00	2.08	2.56	2.80	3.24	3.22	1.48	0.22	2.64	2.54	3.06
Kouin	2.84	1.98	2.54	2.36	2.80	2.22	2.44	0.16	1.62	1.72	2.70
Kakrkaboud cascade	2.80	2.28	2.80	2.20	3.10	2.38	2.14	0.20	1.76	1.94	2.48
Kouin-Marjan	1.00	2.03	2.96	1.86	2.10	1.76	2.86	0.03	1.40	1.08	1.14

Table 2: Statistical comparison of Karkaboud and other management treatments with regard to soil surface indicators

Index	p-value Comparison between Kakrkaboud and Kouin-Marjan	p-value Comparison between Kakrkaboud and Karkaboud cascade	p-value Comparison between Kakrkaboud and Kouin
Rain splash protection	0.000	0.001	0.005
Perennial grass basal and tree and shrub foliage cover	0.000	0.002	0.001
Litter	0.000	0.000	0.000
Cryptogam	0.252	0.982	0.725
Crust brokenness	0.000	0.002	0.000
Erosion type and severity	0.000	0.005	0.003
Deposited material	0.001	0.585	0.044
Surface roughnes	0.000	0.001	0.003
Soil surface resistance to disturb	0.055	0.258	0.997
Slake test	0.926	0.118	0.613
Soil texture	0.000	0.337	0.485

p-value less than 0.05 = significant

treatments) (Table 1). Rain splash protection indicator was high in Karkaboud and the lowest amount was seen in Kouin-Marjan. The objective of this indicator is to assess the degree to which physical surface cover and projected plant cover ameliorate the effect of raindrops impacting on the soil surface. This indicator was 3.06 of 5 (the highest value for this indicator in LFA method) in Karkaboud and 1.14 in Kouin-Marjan. The amount of litter was higher in Karkaboud than other treatments. There is a significant difference between Karkaboud and other treatments in litter indicator. The objective of this indicator is to assess the amount, origin and degree of decomposition of plant litter. The value of litter was 2.64 of 10 (10 is the best condition in LFA method) in Krakaboud region (highest value) and 1.4 in Kouin-Marjan (lowest value between treatments). There is no significant difference between Karkaboud and other treatments in Cryptogam cover ("Cryptogam" is a generic term that includes algae, fungi, lichens, mosses and liverworts) (Table 2). The P-value of comparison between Kouin-Marjan (worst condition) and Karkaboud was 0.252. Kouin-Marjan was significantly different with other treatments in crust brokenness. The objective of this indicator is to assess to what extent the surface crust is broken, leaving loosely attached soil material available for erosion. The value of crust brokenness was 1.48 (best condition between treatments) and 2.86 in Kouin-Marjan (worst condition). Karkaboud had the best score (3.22 of 4) of the type and severity of erosion indicators between treatments (Table 1). The objective of this indicator is to assess the type and severity of recent/current soil erosion i.e. soil loss from the query zone. Kouin had the highest value of deposited material indicators (3.24 of 4) and was significantly 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 Kouin-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 Kouin-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 Kouin and Karkaboud cascade but was significantly different with Kouin-Marjan in soil texture indicator (Table 2).

Functional features

Stability index: Karkaboud had the highest level of stability index (48.6) and Kouin-Marjan had the lowest level (35.45). Stability index in Karkaboud cascade and Kouin 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

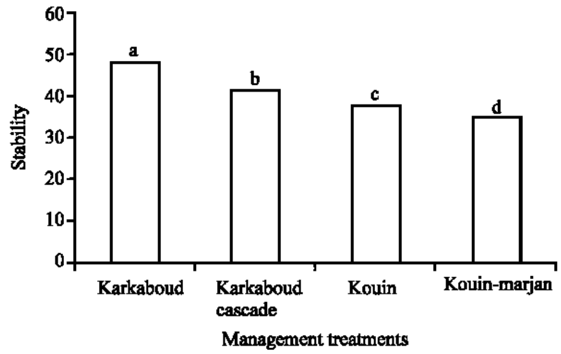

Fig. 2: Stability index comparison in management treatments (letters a,b,c and d shows statistical significance). Karkaboud, a highest value of stability (48.6) between treatments. b,c and d shows 40.8, 39.1 and 35.45 in Karkaboud cascade, Kouin and Kouin-marjan, respectively

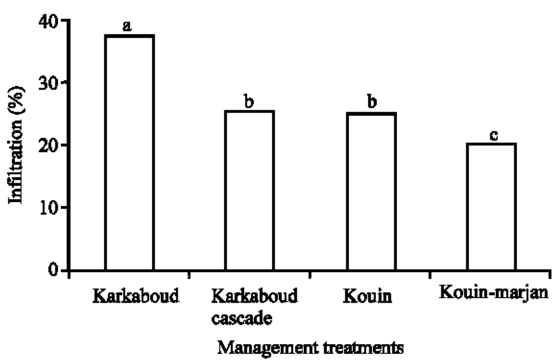

Fig. 3: Infiltration index comparison in management treatments (letters shows statistical significance). a: The value of infiltration in Krakaboud was 38.1. b: There was no significant difference between Karkaboud cascade and Kouin. c: Kouin-Marjan was significantly different with other treatments with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

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

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

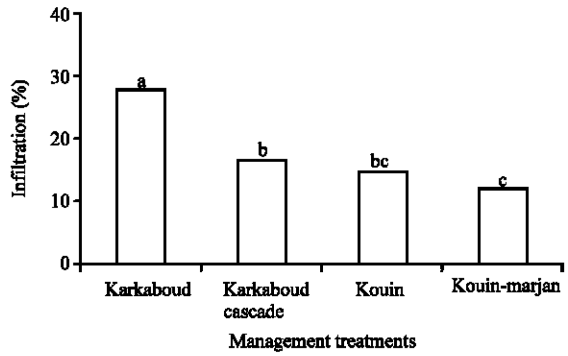

Fig. 4: Nutrient cycle index comparison in management treatments (letters shows statistical significance). Karkaboud had highest value of nutrient cycle index and was significantly different with other treatments (a). Karkaboud cascade had significant difference with Karkaboud and Kouin-Marjan regions (b). Kouin had significant different with Karkaboud in Nutrient cycle but had not significant difference with other treatments (bc). (c) Kouin-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 Kouin-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 Kouin due to high grazing pressure. In Kouin-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

Ahmadi, Z., GH.A. Heshmati., M.M. Saravi and H. Arzani, 2008. Determining critical threshold in rangeland ecosystems of loess lands. J. Agric. Sci. Natur. Resour, 15: 102-109.

Amiri, F., A. Ariapour and S. Fadai, 2008. Effects of livestock grazing on vegetation composition and soil moisture properties in grazed and non-grazed range site. J. Boil. Sci., 8: 1289-1297.

Bastin, G., 2005. Change in the rangelands of the desert uplands region, Queensland. Report to the Australian collaborative rangeland information system (ACRIS) management committee, CSIRO Sustainable Ecosystems, Alice Springs. CSIRO Alice Springs, pp: 156.

Breman, H. and A.M. Cisse, 1977. Dynamics of *Sahelian* pastures in relation to drought and grazing. Oecologia, 28: 301-315.

Costanini, A. and R.J. Loch, 2002. Effects of site preparation on runoff, erosion and nutrient losses from Pinus plantations established on the coastal lowlands of south-east Queensland, Australia. Aust. J. Soil Res., 40: 1287-1302.

Hassani, N., H.R. Asghari, A.S. Frid and M. Nurberdief, 2008. Impacts of overgrazing in a long term traditional grazing ecosystem on vegetation around watering points in a semi-arid rangeland of North-Eastern Iran. Pak. J. Biol. Sci., 11: 1733-1737.

Heshmati, G.A., 1997. Plant and soil indicators for detecting zones around water point in arid perennial chenopod shrublands of South Australia. Ph.D. Thesis, University of Adelaide, Adelaide

Hosseinzadeh, G., H. Jalilvand and R. Tamartash, 2010. Short time impact of enclosure on vegetation cover, productivity and some physical and chemical soil properties. J. Applied Sci., 10: 2001-2009.

Irshad, M., M. Inoue, M. Ashraf, Faridullah, H.K.M. Delower and A. Tsunekawa, 2007. Land desertification-an emerging threat to environment and food security of Pakistan. J. Applied Sci., 7: 1199-1205.

Lane, S., 2008. Stream health and sediment sources of pierces creek catchment, Australian capital Territory. M.Sc. Thesis, Australian National University.

Liacos, L.G., 1962. Water yield as influenced by degree of grazing in the California winter grasslands. J. Range Manage, 15: 67-72.

Lotfi Anari, P., G.A. Heshmati and A. Bahremand, 2010. The effects of different patches and interpatches on infiltration rate in an arid shrubland ecosystem. Res. J. Environ. Sci., 4: 57-63.

Ludwig, J.A. and D. Tongway, 1997. A Landscape Approach to Rangeland Ecology. In: Function and Management: Principles from Australia's Rangelands, Ludwig, J.A., D, Tongway, D. Freudenberger, D. Noble and K. Hodginson, (Eds.), Landscape Ecology, CSIRO Publishing, Melbourne, Australia, pp: 121-131.

Ludwig, J.A. and D.J. Tongway, 2000. Viewing Rangelands as Landscape Systems. In: Rangeland Desertification, Arnalds, O. and S. Archer, (Eds.), Kluwer Academic Publishers, Dordrecht, pp: 39-52.

Maiangwa, M.G., A.O. Ogungbile, J.O. Olukosi and T.K. Atala, 2007. Land degradation: Theory and evidence from the North-West zone of Nigeria. J. Applied Sci., 7: 785-795.

Marchiori, K., 2008. An assessment of spring creek and its catchment, Lake Cowal, New South Wales: Implications for natural sequence farming techniques. Master Thesis, School of Resources, Environment and Society, Australian National University, Canberra, Australia.

Pyke, D.A., J.E. Herrick, P.A. Shaver and M. Pellant, 2002. Rangeland health attributes and indicators for qualitative assessment. J. Range Manage., 55: 854-857.

Rauzi, F., 1963. Water intake and plant composition as affected by differential grazing on rangelands. J. Soil Water Conserv, 18: 114-116.

Smith, D.D and W.H. Wischmeier, 1962. Rainfall erosion. Adv. Agron., 14: 109-148.

Tongway, D. and J. Ludwig, 2002. Reversing Deserti?cation in Rattan. Encyclopa of Soil Science, New York.

Tongway, D. and NL. Hindley, 2004. Landscape function analysis: A system for monitoring rangeland. Afr. J. Range Forage Sci., 21: 41-45.