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Assessing rangeland capability in Iran using landscape function indices based on soil surface attributes

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Abstract

To identify the functioning of the soil-landscape system and its effects on plant growth for native rangeland the relationships between soil properties and landscape function analysis (LFA) indices and between plant growth characteristics and LFA indices were investigated. The results interpreted based on statistical analysis and expert knowledge. This research was carried out for a semi-arid rangeland in the Lar aquifer in Iran. Land stratification allowed the study area to be subdivided into Land Units, according to specified criteria including landform attributes (slope, aspect, and altitude), and vegetation type. A factorial model on the basis of a completely randomized design was used to analyse the data collected from 236 land units. The landscape function indices including nutrient cycling index, infiltration index, stability index, and landscape organization index were derived by various integrations of soil surface attributes. Landscape attributes differed from one another in their effects on the different landscape function indices. Increasing slope gradient significantly reduced all landscape function indices as well as soil organic carbon and total nitrogen percentages. Slope class exhibited highly significant interaction effects with vegetation type factors for stability, nutrient cycling, and landscape organization indices. Aspect did not significantly affect stability, infiltration, and landscape organization indices, but significantly affected the nutrient cycling index. The Duncan test indicated that north aspect (shady side) had the highest mean

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value (28.42) and south aspect the lowest mean value (25.57) for nutrient cycling index. These results are consistent with the effects of aspect on total soil nitrogen and soil organic carbon percentage for which the north aspect had the highest values. The values declined in the sequence east, west, and south aspects, respectively. This research indicates that the nature of native rangeland plant communities and their measures of production are closely related to nutrient cycling index.

Keywords: Landscape function analysis; Landscape attributes; Soil properties; Rangelands

1. Introduction

The most important and basic bio-physical resource of rangeland is the soil. The history of soil science shows that some soil surface functions and soil properties are strongly related to soil productivity and stability. Investigation of relationships between plant cover, runoff, and sediment transport by Greene et al. (1994) found a significant negative relationship between runoff rate and plant cover. They showed that soil productive potential may be changed without the occurrence of significant actual soil loss. In this situation the vegetation attributes should be evaluated in relation to the criteria for site conservation. Those soil cover situations that meet the criteria for protection of the land would be assigned as site conservation ratings.

In the 1990s some researchers started to identify and use soil properties in range condition assessment and range monitoring (Tongway and Smith, 1989; Ludwig and Tongway, 1993). In 1995 Tongway and Hindley published a manual for assessing soil surface condition of rangelands in Australia. He identified some diagnostic factors of the soil surface based on indicators of surface hydrology. Developing Tongway and Hindley's method of soil condition assessment at the hillslope scale, Ludwig and Tongway (1997) adopted a new framework entitled "Trigger-Transfer-Reserve-Pulse". This framework enabled the simply observed soil surface indicators to assess the landscape function at the hillslope scale. The framework enables the determination of threshold amounts of available resources. The most important of which are water and nutrient supply. Through analysis of landscape function, some ecologists can judge the landscape's capability based on how it works as a biogeochemical system, ranging from being fully functional to entirely dysfunctional. This respectively characterizes systems as highly conserving to leaky of vital resources, or from completely robust to totally vulnerable (Ludwig and Tongway, 1997; Herrick and Wander, 1998).

The indices derived in the methodology of landscape function analysis (LFA) using soil surface attributes that can generally be used in range capability assessment and especially in rangeland monitoring and management programs are:

1. Stability (resistance to erosion)
2. Infiltration (capacity for rain and run-on water to infiltrate)
3. Nutrient cycling (organic matter decomposition and cycling)