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The effects of landscape attributes and plant community on soil chemical properties in rangelands☆

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Abstract

This study addressed the effect of landscape attributes and plant community type on the spatial distribution of soil chemical properties in an alpine rangeland in a semiarid area of Iran. To identify the effects of landscape attributes on soil chemical properties, the present study collected and analyzed information from air photos, satellite images, field survey, and the laboratory using statistical analyses. Land stratification allowed the study area to be subdivided into Land Unit Tracts (LUT), 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 analyze the data collected from 234 LUT. The interrelationships between soil chemical properties and landscape attributes were investigated and interpreted based on statistical analysis and expert knowledge. Most chemical properties of the 0- to 10-cm topsoil including EC, OC%, total N%, P, and K significantly related to slope gradient. Soil chemical properties including the grouping described as nutrient elements (CEC, N, P, K, and OC), and pH significantly related to aspect of slope. In addition lower soil temperature and less moisture evaporation on a north-facing slope (shady aspect) resulted in less organic matter decomposition and consequently more organic carbon and total nitrogen accumulation in the soil. Consequently, the soil nutrient pool and general fertility on north-facing slopes was greater than on south-facing slopes. The interdependency of landscape attributes, plant community, and soil chemical properties led to a variety of species, vegetation types, and plant communities existing in the study area. In this research, vegetation type was highly significantly related to all the determined soil chemical properties except for cation exchange capacity.

Keywords: Aspect; Slope; Altitude; Vegetation type; Soil properties

1. Introduction

The interdependency of vegetation type and soil chemical properties leads to a variety of species, vegetation types, and plant communities existing on a

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rangeland with the same parent material and single climate regime. This variety of natural vegetation types is one of the basic elements of native rangelands and is the final result of multiple interactions of several natural environmental factors. In addition, soil chemical properties and in turn plant growth are significantly controlled by variation in landscape attributes including slope, aspect, and elevation which influence the distribution of energy, plant nutrients, and vegetation by affecting organic activity, runoff and runon processes, condition of natural drainage, and exposure of soil to wind and precipitation (Buol et al., 1989).

Almost all soil properties exhibit variability as a result of dynamic interactions between natural environmental factors [i.e., climate, parent material, vegetation, and topography (Jenny, 1941)]. Many soil chemical properties are of a dynamic nature. In this research, the dynamic nature of soil chemical properties (cycling and concentrations of some nutrients) were hypothesized to be directly affected by landscape attributes in addition to the indirect influences of landscape attributes via providing different microclimates that support the growth of plant species with different characteristics (e.g., growth form and density). Management factors may exacerbate or deteriorate the effects of environmental factors. In other words, we examined how soil chemical properties are controlled by environmental factors in an alpine semiarid rangeland in Iran.

2. Study system and data generation

2.1. Site description

Experimental data was collected from three vegetation types within the Lar aquifer, between 35°4′36″ and 35°48′40″N and 51°32′ and 52°4′E, 78 km north of Tehran, Iran. The climate is semiarid with mean monthly temperatures ranging from −6.5 °C in January to 18.4 °C in July (Iranian Meteorological Organization, 2001). The annual mean precipitation is 496 mm, most of which falls during winter and spring seasons (November–May). The Lar area was selected for its relatively well managed rangelands, compared with other similar alpine rangelands of Iran. Many of the soils in the study area are quite shallow and steeply sloping. Based on the US soil taxonomy classification (USDA-NRCS, 1998), the study area is classified into different great groups of Lithic and Typic Xerorthents, Typic Haploxerepts, Haploxeralfs, and Fluvaquents. Elevation ranges between 2500 m in the lower part (Lar Dam) and 3950 m in the upper part. This range in altitude shows that the general landscape of the study area is mostly steeply mountainous terrain dissected by valleys (Fig. 1).

Fig. 1. A view of the study area shows the general landscape and vegetation type in the area.