Soil Quality Modeling in Roshtkhar Desert Region Affected by Holoxylon Aphyllum Planting using Multivariate Statistical Analysis

Kazem Nosrati*
ITVHE Academic Member, Ph.D. Student in Combat Desertification, Semnan University, Iran.
Mohammad Mehdi Hoseinzadeh
Assistant Professor of Faculty of Desert Studies, Semnan University, Iran.
Salman Zare
Assistant Professor of Faculty of Desert Studies, Semnan University, Iran.
Roya Zolfaghari
Assistant Professor of soil conservation and Watershed Management Research Institute, Iran.

Extended Abstract

Introduction

Desertification that accelerated by agriculture land development is an important issue in the world especially in arid and semi-arid regions. There are several management methods to combat desertification or to reduce the rate of desertification. One of the methods that use to control erosion and stabilize soil movement and sand duneis planting with compatible plants. More than 40 years ago the Holoxylonaphyllum planting was started in Iran in order to stabilize sand dune movement and it continued to restoration of rangeland in arid and semi-arid lands.
Although the effects of Holoxylonaphyllum planting on soil physic-chemical properties were studied, but there is insufficient information in affecting on soil quality. Different multivariate statistical techniques, such as factor analysis (FA) and discriminant analysis (DA) as well as modeling approaches are widely applied to evaluate soil quality through data reduction and classification for different soils and management scenarios. The objectives of this study therefore were to evaluate the effect of Haloxylon planting on soil physical and chemical properties and to determine soil indices in the Ahangaran village, southwestern Roshtkhar city..

Materials and Methods

The study was conducted in the Ahangaran region (34°24' to 34°52'N and 59°00' to 9°37' E) which is part of the Kalshoor Drainage Basin, Jannatabad, in65 km Southern of Roshtkhar city, Iran. The drainage area of the region is 58.4 km2. The catchment has a flat topography as a plain surrounded by two mountains in the south and north of the area. The minimum and maximum heights of the region are 827 m and 1220 m above sea level respectively. Long-term (1975-2003) mean annual precipitation in the study area is ca. 139.5 mm.The average annual of temperature is 17.5 °c.
Study area was classified based on Haloxylon planting canopy in three main groups; control area, between the canopy and under the canopy of Haloxylon Aphyllum. The samples were collected by taking a representative sample from the top 20 cm of the soil using a trowel.In each area 15 samples and overall 45 representative soil samples were collected from different locations within the study area and soil physical and chemical properties were measured.
Statistical analyses were followed by univariate analysis of variance (ANOVA; F-test) for the different soil properties individually as physical and chemical to examine for significant influences of control area, between the canopy and under the canopy of Haloxylon Aphyllum on soil properties. Only those variables for which the F statistics for control area, between the canopy and under the canopy of Haloxylonaphyllum categories was significant ($P < 0.05$) were retained for further analysis.

* Email: k_nosrati@sbu.ac.ir

Discussion and Results

The results of one-way ANOVA showed that the electrical conductivity, pH, lime, saturation percent, clay, sand, carbonate, and total nitrogen show significant contrasts between control area, between the canopy and under the canopy of Haloxylon Aphyllum categories at 5% level, while, there are not no significant level for bicarbonate, silt and organic carbon. Soil properties that were not significantly affected by control area, between the canopy and under the canopy categories within the study area (bicarbonate, silt and organic carbon) were therefore excluded from further consideration as possible candidates to identify SQI.

The results of FA showed that the first three principal components (PCs) with eigenvalues>1, accounted for >72% of variability in measured soil properties. Factor scores were calculated using the resulting component score coefficient matrix and tested for significant differences in response to control area, between the canopy and under the canopy categories. Factor scores for the first two factors (PCs 1 and 3) varied significantly with canopy categories. Thus, the soil properties related to these factors were considered for the selection of optimum composite of SQI. The results of canonical DA and redundancy analysis (RA) showed that canonical coefficients account more than 80% of variance and the primary soil quality model was determined as Eq.1.

$$Y1=1.3(PC1)-0.6(PC2)-1.1(PC3) \quad (1)$$

DA and redundancy analysis (RA) were done with the canopy categories as grouping variable and the retained soil properties as independent variables to remove redundant variables (Eq. 2).

$$Y2 = -(lime*0.12) + (pH*2.5) - (clay*0.3) - (sand*0.19) + (carbonate*3.7) \quad (2)$$

Conclusions

The results of investigating the effect of Haloxylonaphyllum planting on soil properties in three area including control area, between the canopy and under the canopy showed that the Haloxylonaphyllum planting can stabilize the sand dune movement and increase the soil quality index. Further research should investigate the sensitivity of selected SQI for assessment of soil quality in other regions with different plant.

Keywords: Wind erosion, desertification, soil properties, soil quality model.

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