ECOPERSIA

2015, 3 (1), 917-932

# Role of Soil and Topographic Features in Distribution of Plant Species (Case study: Sanib Taftan Watershed)

Mahdieh Ebrahimi[1*], Alireza Masoodipour[2] and Masood Rigi[2]

[1]*Assistant Professor, Department of Range and Watershed Management, University of Zabol, Zabol, Iran*
[2] *Former M.Sc. Student of Range Management, Department of Range and Watershed Management, University of Zabol, Zabol, Iran*

Received: 18 February 2015 / Accepted: 4 April 2015 / Published Online: 15 July 2015

**ABSTRACT** The study was carried out to investigate the effective soil and topographic features on distribution of plant types in Sanib Taftan Watershed in Sistan-and-Balouchestan Province, Iran. Initially, land units map was specified by combining three maps of slope, aspect and altitude. Five types including *Artemisia santolina- Hammada salicornica*, *Artemisia sieberi- Amygdalus lycioides*, *Artemisia lehmaniana- Amygdalu slycioides*, *Amygdalus lycioides-Amygdalus scoparia*, *Pistacia atlantica- Amygdalus scoparia* were identified. Sampling of vegetation in the land units was conducted using linear transect method, so that presence and absence of the plant species, canopy cover, stone and pebbles, litter and bare soil percent were catculated in 50 or 100 m transects (2-4 $m^2$ plots) in a randomized systematic method. Soil sampling was done with respect to the width of each land unit (from 0-30 cm depth). Principal component analysis (PCA) was conducted on vegetation and plant type-environmental variables matrix. The most important and effective factors in vegetation distribution of the studied area were slope, altitude, soil texture (silt and sand) and total nitrogen and the factors related to topography (slope and altitude) were more effective than those related to the soil.

**Key words:** *Altitude, Plant community, Soil characteristics*

## 1 INTRODUCTION

Investigating the relationship between different plants with biotic and abiotic component, which are in an ecosystem, is usually a part of the ecological studies. The results of the studies help to improve our knowledge of each plant community (Jafari *et al.,* 2013).

The distribution, pattern and abundance of plant species in arid and semiarid environments has most often been related to three groups of factors; physical environmental variables, soil chemistry and anthropogenic disturbance (Enright *et al.,* 2005). In fact, these factors cause the establishing of the different kind of plant species in different habitats (Jafari *et al.,* 2003) and they may be able to distinguish plant communities from the other groups (Metaji and Zahedi-Amiri, 2006). It is interesting to note that all these things mix together (Mesdaghi, 2003), so the differences in the plant communities found for the same geographical origins are due to differences in their natural habitats (Makhdoom, 2002).

Although relationships between plant and both soil properties and environmental factors have been well developed for some plants, comparable understanding of how a variety of plant species in native rangelands respond to soil properties and environmental factors is poorly developed (Rezaei, 2003; Masoodipour

**Corresponding author: Assistant Professor, Department of Range and Watershed Management, University of Zabol, Iran, Tel: +98 913 146 4893, E-mail: maebrahimi2007@uoz.ac.ir*

*et al.,* 2014, Moradi *et al.,* 2014). Xian-Li and Ke-Ming (2008) studied the relationships between vegetation, soil and topography in the dry valley of China. Their results affirmed that plant diversity was mainly correlated with soil water content, and soil water content was mainly determined by soil texture specially clay content. Yibing (2008) in a research conducted by principal component analysis (PCA) and canonical correlation analysis in China indicated that physical and chemical features of the soil, including humidity, salinity and acidity were effective in homogeneity of the plant communities in the region.

Zhang and Dong (2010) in study of the relationships between environmental factors and vegetation diversity in Lesi plateau of China observed that altitude, soil type, slope and aspect were important factors in Lesi zones' recovery and had determinant roles in vegetation distribution. Also, Ebrahimi-Kebria (2002) showed that topographic factors had a considerable effect on the plant cover and diversity in Sefid-Ab of Haraz basin rangeland. Moradi and Ahmadipour (2006) in investigation the role of morphology and soil on the plant vegetation in Vas sub watershed basin reported that slope, aspect and altitude provides different conditions for the plant growth and expansion. Moradi *et al*. (2014) indicated in a study in Kakan watershed, located in Kohgelouye and Bouyerahmad Province that such edaphic factors as the soil texture, organic carbon, total nitrogen and magnesium and such topographic features as slope, aspect and altitude, respectively, play a major role in the plants establishment and distribution.

To better management of arid and semiarid environments and to offer a base line for restoration attempts, an understanding of the factors that determine the rangelands vegetation distribution and composition is needed. For this purpose, the present research was conducted to study 1: the roles of soil features and topography in the plant species distribution of Sanib Taftan watershed in Sistan-and-Balouchestan Province (Iran), and 2: to find the most effective factors contributing to distribution of the plant types of the study watershed.

## 2 MATERIALS AND METHODS

### 2.1 The study area

The present study was carried out in Sanib Taftan Watershed. The area of the basin is 4310 ha. The basin located at 50 km northwest of Khash city in Sistan and Balouchestan Province (Iran), between 60° 51´ and 60° 57´ of eastern longitude and 28° 34´ and 28° 40´ of northern latitude (Figure 1). The minimum and maximum altitudes are 1805 m in the south and 2940 m in the north. Mean annual precipitation is 174.5 mm and mean annual temperature is 15.7 °C. The warmest month is August with a mean maximum temperature of 36.2 °C and the coldest month is January with the mean minimum temperature of 1.1 °C. General lithology of the region often includes external igneous rocks which are influenced by their position at Taftan volcanic area. In spite of this issue, presence of sedimentary rocks, internal igneous rocks and expansion of quaternary system new deposits have caused lithology diversity in the region. The soils of study area based on U.S.D. A Soil Taxonomy method are classified into Aridisols (Masoodipour *et al.,* 2014).

### 2.2 Sampling method

In order to investigation of the plant vegetation, a field survey was done. Then, the slope (Figure 2), aspect (Figure 3) and altitude (Figure 4) maps were prepared using ArcGIS 9.2 package. By combining these three maps, land units map was specified (Figure 5).





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

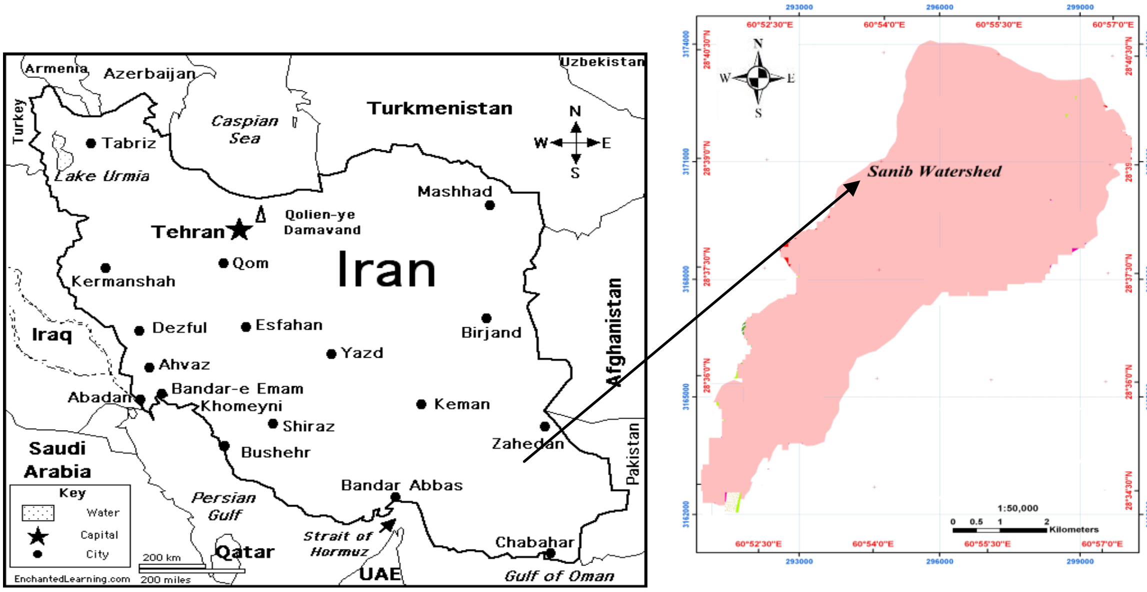


**Figure 1** Location of the study area in Sistan and Balouchestan Province

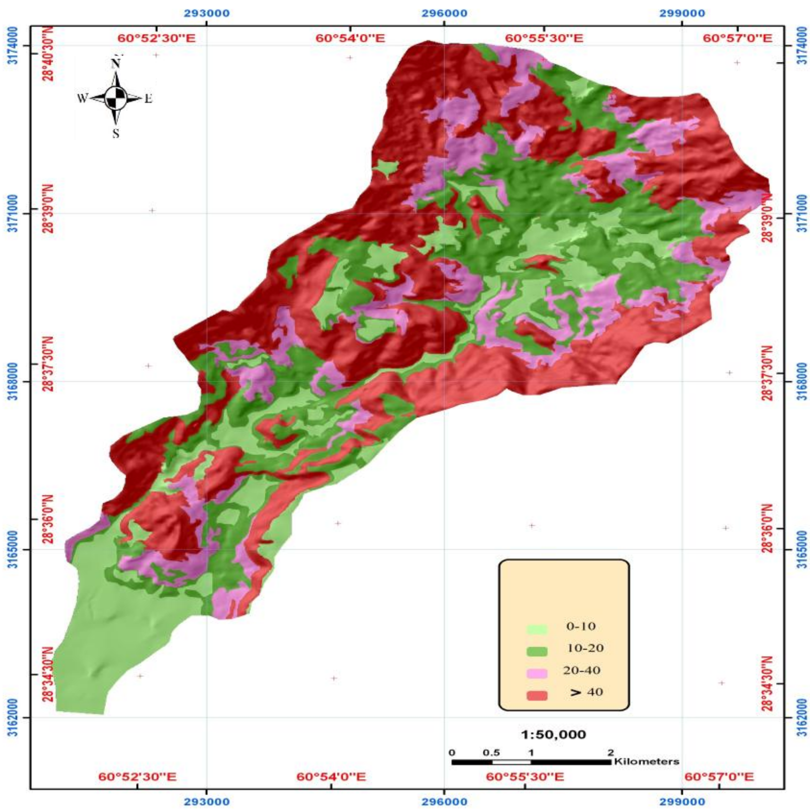


**Figure 2** Slope map of the study area





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

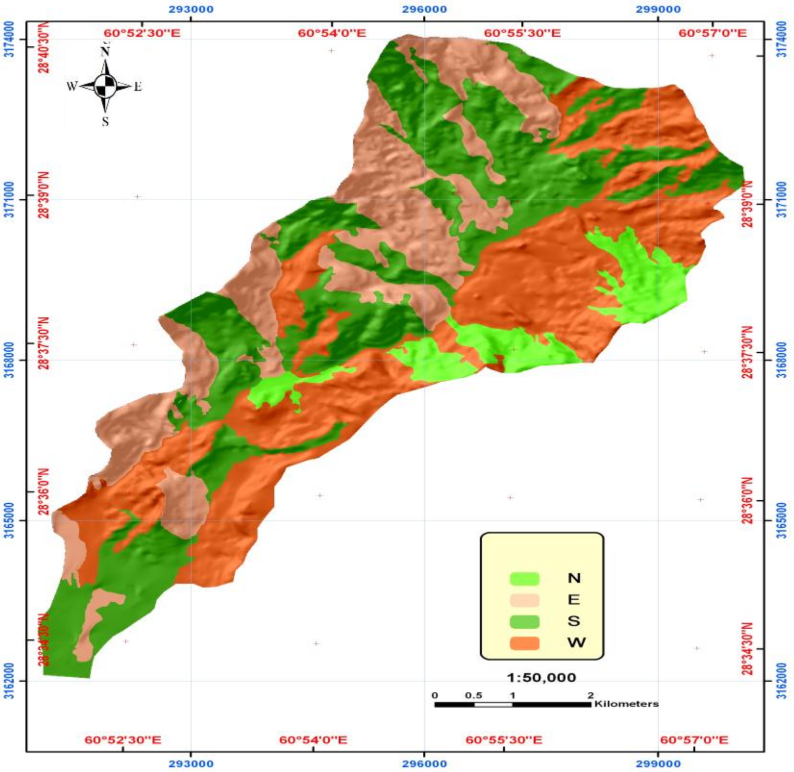


**Figure 3** Aspect map of the study area

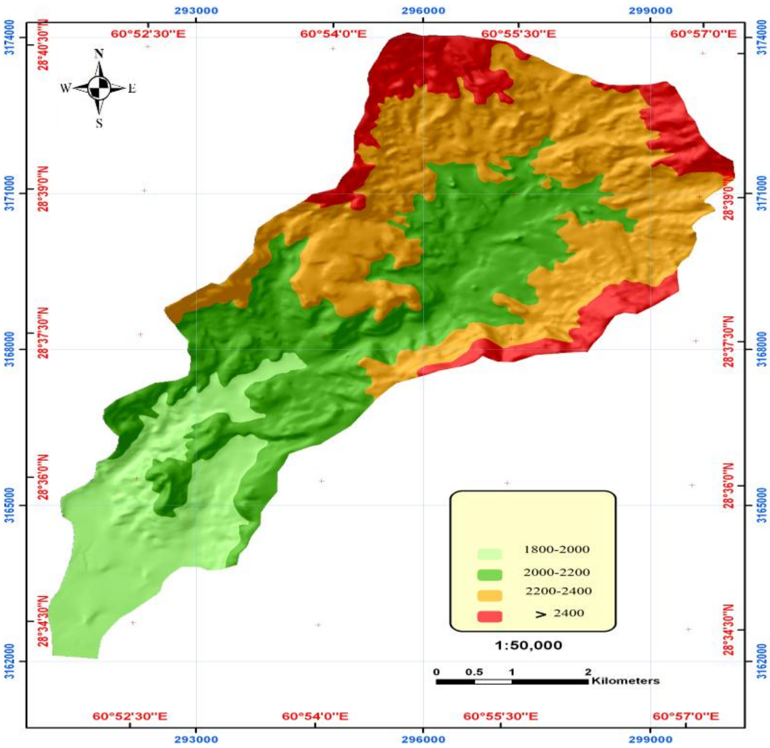


**Figure 4** Hypsometry map of the study area




[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

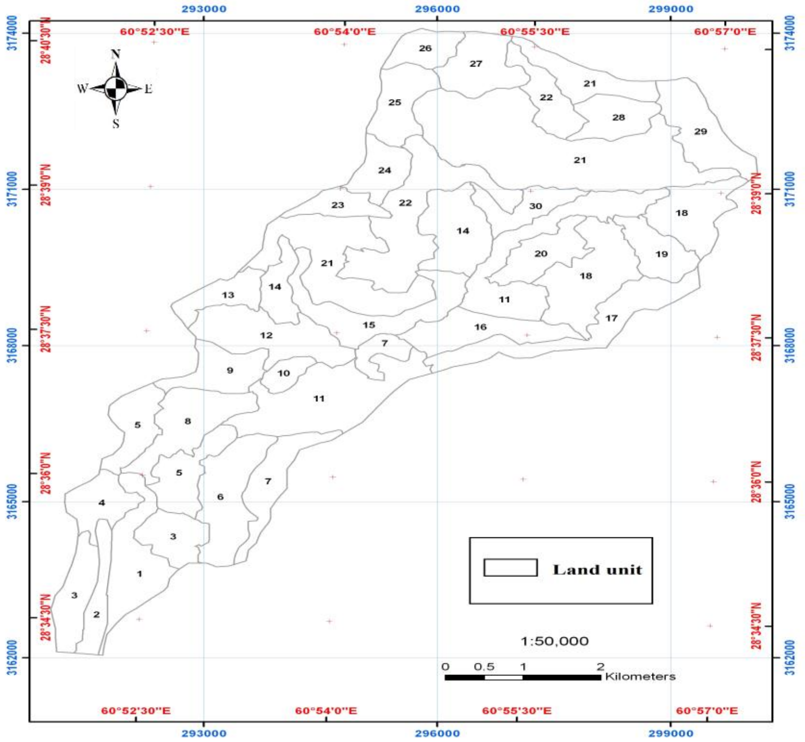


**Figure 5** Land units map of the study area

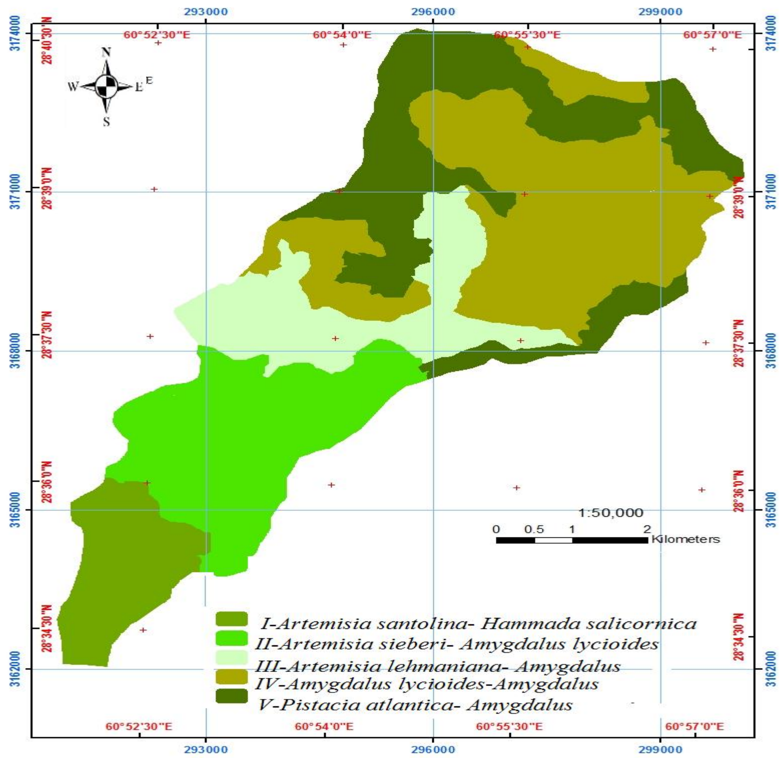


**Figure 6** Map of the vegetation types

Primary vegetation type study was done using topography maps and identified five types Including: *Artemisia santolina- Hammada salicornica*, *Artemisia sieberi- Amygdalus lycioides*, *Artemisia lehmaniana- Amygdalus lycioides*, *Amygdalus lycioides-Amygdalus scoparia*, *Pistacia atlantica- Amygdalus scoparia* (Figure 6).

Sampling was done within the land units with systematically-randomized method. In each land unit (30 land units), 2-3 transects with the length of 50-100 m each including 10 quadrats of 2-4 $m^2$ were established in two directions of the general slope and perpendicular to the slope. Regarding the kind, distribution pattern and density of the plant vegetation, the quadrat size determined with minimal area method. Totally, 70 transects and 350 plots were measured (Azarnivand *et al.,* 2007; Shokrollahi *et al.*, 2012). Presence and absence of the plant species (the plat species were identified in herbarium of University of Zabol using Flora of Iranica) (Ghahraman, 2000), canopy cover (using the line-intercept method) (Coulloudon, 1999), stone and pebbles, litter and bare soil percent within quadrats were recorded.

Regarding areas of the land units 2-3 soil samples (65 samples) were collected using a soil auger (7.5 cm diameter) from depth of 0-30 cm. The soils were put in plastic bags with label; they were thereafter air dried and ground to pass through a 2 mm sieve. The soil samples were taken to the laboratory at the Department of Range and Watershed management, University of Zabol, for laboratory analysis of soil physicochemical properties. The soil's texture was determined by the hydrometer method (Day, 1982); pH was determined in a 1:5 soil to distilled water slurry after one hour of agitation using a digital pH-meter (Model 691, Metrohm AG Herisau Switzerland) (Thomas, 1996); electrical conductivity (ECe) using an EC-meter (DDS-307, Shanghai, China) (Rhoades, 1996); total soil N was analyzed calorimetrically with a continuous flow ion analyzer following wet digestion in sulfuric acid using of Kjeldahl (Bremner, 1996); organic carbon was measured by the Walkley-Black method (Nelson and Sommers 1996). Available phosphorus was determined by the method of Bray and Kurtz (1954). Available potassium was measured by flame photometry method (Knudsen *et al.*, 1982); the $CaCO_3$ equivalent was determined by neutralizing with HCl and back titration with NaOH (Black *et al.*,1965).

### 2.3 Data analysis

In the first step, PCA was conducted on vegetation and plant type-environmental variable matrix using the program PC-ORD (McCune and Mefford, 1997). PCA is ordination technique that constructs the theoretical variable that minimizes the total residual sum of squares after fitting straight lines to species data. PCA does so by choosing the best values for the sites (Jafari *et al.*, 2003). To apply PCA, data standardization is necessary if we are analyzing variables that are measured in different units. Also, species with high variance, often the abundant ones, therefore dominate the PCA method, whereas species with low variance, often the rare ones, have only minor influence on the method. These may be the reasons to apply standardized PCA, in which all species receive equal weight (Jafari *et al.*, 2003). Therefore, data were standardized by centered and standard deviation (Jongman *et al.,* 1987; Zare Chahouki *et al.,* 2007). Eigenvalues for each principal component was compared to a broken- stick eigenvalue to determine if the captured variance summarized more information than expected by chance. Broken-Stick eigenvalues have been shown to be a robust method for selection of nontrivial components in PCA (Jackson, 1993; Zhou *et al.,* 2008). For the conversion of data related to the aspect which is in terms of degrees, the equation: $1-(\cos(\theta-45)/2)$ was used where is the amount of direction at 360° basis (McCune and Mefford, 1997). In this regard, north, west, south and east aspects were considered as 0°, 90°, 180° and 270°, respectively.

The distance between indicator points of the vegetation types with axis indicate the relationship power in explanation of variations. Whatever the length of vector loading that indicate the vegetation types, is bigger and angle between vector with the axis is smaller, there is more correlation between vegetation types, with axis and relation power (Jafari *et al.*, 2003).

## 3 RESULTS

### 3.1 Properties of plant types

In the present study, 30 land units were obtained in the watershed. Some properties of the land units were listed in Table 1. Table 2 presents some vegetation factors in each plant type. A brief description of each plant type is shown in Table 3.

**Table 1** Some properties of land units

| Land unit | Aspect | Slope (%) | Altitude class (m) | Area (ha) | Area (%) |
|---|---|---|---|---|---|
| 1 | S | 0-10 | 1800-2000 | 133.14 | 3.10 |
| 2 | S | 0-10 | 1800-2000 | 55.56 | 1.30 |
| 3 | S | 0-10 | 1800-2000 | 151.32 | 3.50 |
| 4 | W | 0-10 | 1800-2000 | 151.32 | 3.50 |
| 5 | E | <40 | 2000-2200 | 163.29 | 3.80 |
| 6 | W | 10-20 | 1800-2000 | 145.86 | 3.40 |
| 7 | W | <40 | 2000-2200 | 124.92 | 2.90 |
| 8 | W | 10-20 | 1800-2000 | 125.45 | 2.90 |
| 9 | E | 10-20 | 2000-2200 | 82.01 | 1.90 |
| 10 | N | 10-20 | 2000-2200 | 29.14 | 0.70 |
| 11 | W | 20-40 | 2000-2200 | 389.41 | 9.00 |
| 12 | S | 10-20 | 2000-2200 | 148.13 | 3.40 |
| 13 | S | <40 | 2200-2400 | 61.03 | 1.40 |
| 14 | E | 20-40 | 2000-2200 | 173.48 | 4.00 |
| 15 | S | <40 | 2000-2200 | 131.33 | 3.00 |
| 16 | N | <40 | 2200-2400 | 107.04 | 2.50 |
| 17 | N | <40 | <2400 | 147.68 | 3.40 |
| 18 | W | 20-40 | 2200-2400 | 270.18 | 6.30 |
| 19 | N | 10-20 | 2200-2400 | 73.49 | 1.70 |
| 20 | W | 10-20 | 2000-2200 | 80.99 | 1.90 |
| 21 | S | 10-20 | 2200-2400 | 743.10 | 17.20 |
| 22 | E | <40 | 2200-2400 | 290.79 | 6.70 |
| 23 | S | <40 | 2200-2400 | 47.51 | 1.10 |
| 24 | E | <40 | 2200-2400 | 65.34 | 1.50 |
| 25 | S | <40 | <2400 | 89.35 | 2.10 |
| 26 | E | <40 | <2400 | 54.46 | 1.20 |
| 27 | E | 20-40 | <2400 | 97.23 | 2.20 |
| 28 | W | 20-40 | 2200-2400 | 73.28 | 1.70 |
| 29 | W | <40 | <2400 | 118.83 | 2.70 |
| 30 | S | 0-10 | 2000-2200 | 64.49 | 1.50 |





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

**Table 2** Mean vegetation factors in each plant type

| Plant type code | Canopy cover (%) | Litter (%) | Stone and pebbles (%) | Bare soil (%) | Area (ha) |
|---|---|---|---|---|---|
| *Ar. sa- Ha. sa* | 12.70 | 1.40 | 47.50 | 38.40 | 412.30 |
| *Ar. si- Am. ly* | 13.90 | 1.60 | 55.40 | 29.10 | 1060.07 |
| *Ar. le- Am. ly* | 15.70 | 2.10 | 63.00 | 19.20 | 621.01 |
| *Am. ly- Am. sc* | 18.90 | 2.60 | 46.60 | 31.90 | 1231.95 |
| *Pi. at- Am. sc* | 16.20 | 1.90 | 66.50 | 15.40 | 984.46 |

**Table 3** Vegetation types and environmental factors of the region

| Plant type code | pH | EC (ds/m) | $CaCo_3$ (%) | OC (%) | Clay (%) | Silt (%) | Sand (%) | N (%) | P (ppm) | K (ppm) | Altitude (m) | Slope (%) | Dominant aspect | Texture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ar. sa- Ha. sa* | 8.00 | 0.70 | 9.70 | 0.26 | 9.00 | 32.00 | 59.00 | 0.03 | 2.18 | 272.50 | 1900 | 5 | S | Sandy loam |
| *Ar. si- Am. ly* | 7.96 | 0.62 | 12.81 | 0.36 | 10.10 | 33.76 | 56.14 | 0.04 | 2.60 | 234.20 | 2050 | 30 | W | Sandy loam |
| *Ar. le- Am. ly* | 8.04 | 0.56 | 12.12 | 0.20 | 9.20 | 30.60 | 60.20 | 0.03 | 2.24 | 217.00 | 2150 | 40 | S | Sandy loam |
| *Am. ly- Am. sc* | 7.99 | 0.59 | 11.52 | 0.39 | 9.80 | 35.80 | 54.40 | 0.04 | 3.54 | 219.00 | 2275 | 20 | S-W | Sandy loam |
| *Pi. at- Am. Sc* | 7.86 | 0.58 | 11.74 | 0.28 | 11.56 | 22.22 | 66.22 | 0.03 | 3.19 | 254.40 | 2450 | 50 | E-W | Sandy loam |

### 3.2 The most important variables affecting the plant types

In order to find the most effective factors on the separation of vegetation types, PCA was used. As it is shown in Table 4, PC1 and PC2 have accounted for 73.98 % of the variance. PC1 and PC2 include 43.62 % and 30.36%, respectively. According to correlation coefficients between factors and components (Table 5), PC1 includes silt, altitude and slope. Therefore, PC1 mostly can be considered as an indicator of topographic factors. Factors of sand and nitrogen are mostly correlated with PC2. Since PC1 explains the majority percentage of vegetation variation, silt, altitude and slop are the most effective factors on the separation of plant types, while sand and nitrogen in the second position.

Figure7 represents the diagram of vegetation types distribution in relation to the soil and environmental factors in PC1 and PC2. According to the diagram, the distance between the indicator points of vegetation types shows the degree of similarity and dissimilarity of the soil and environmental factors.

**Table 4** Eigenvalues and variance of each component

| Component | Eigenvalue | Variance (%) | Cumulative Variance (%) | Broken – Stick Eigenvalue |
|---|---|---|---|---|
| 1 | 6.979 | 43.62 | 43.621 | 3.381 |
| 2 | 4.858 | 30.36 | 73.983 | 2.381 |
| 3 | 2.706 | 16.91 | 90.897 | 1.881 |
| 4 | 1.457 | 9.10 | 100.00 | 1.547 |

**Table 5** The correlation between plant types, edaphic and environmental factors

| Environmental factors | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 |
|---|---|---|---|---|---|---|
| Acidity (pH) | 0.260 | 0.025 | <u>-0.440</u> | -0.018 | -0.237 | 0.135 |
| Electrical conductivity | 0.289 | -0.175 | 0.310 | -0.053 | -0.203 | <u>-0.630</u> |
| Lime | -0.212 | 0.254 | -0.153 | <u>-0.460</u> | -0.375 | -0.208 |
| Organic Carbon | 0.054 | 0.382 | 0.315 | 0.026 | <u>0.392</u> | 0.129 |
| Clay | -0.317 | 0.051 | 0.324 | -0.003 | <u>-0.552</u> | 0.329 |
| Silt | <u>0.296</u> | 0.261 | -0.135 | -0.061 | -0.194 | -0.056 |
| Sand | -0.268 | <u>-0.310</u> | 0.083 | 0.071 | -0.107 | 0.129 |
| Nitrogen | 0.082 | <u>0.424</u> | 0.117 | -0.163 | -0.118 | 0.027 |
| Phosphorous | -0.159 | 0.298 | 0.213 | <u>0.427</u> | -0.143 | -0.021 |
| Potassium | 0.074 | -0.318 | <u>0.415</u> | 0.032 | -0.170 | -0.209 |
| Altitude | <u>-0.331</u> | 0.118 | 0.044 | 0.330 | 0.103 | -0.121 |
| Slope | <u>-0.364</u> | 0.001 | -0.117 | -0.157 | 0.043 | -0.289 |
| Aspect | 0.094 | -0.303 | -0.302 | <u>0.408</u> | -0.188 | 0.084 |

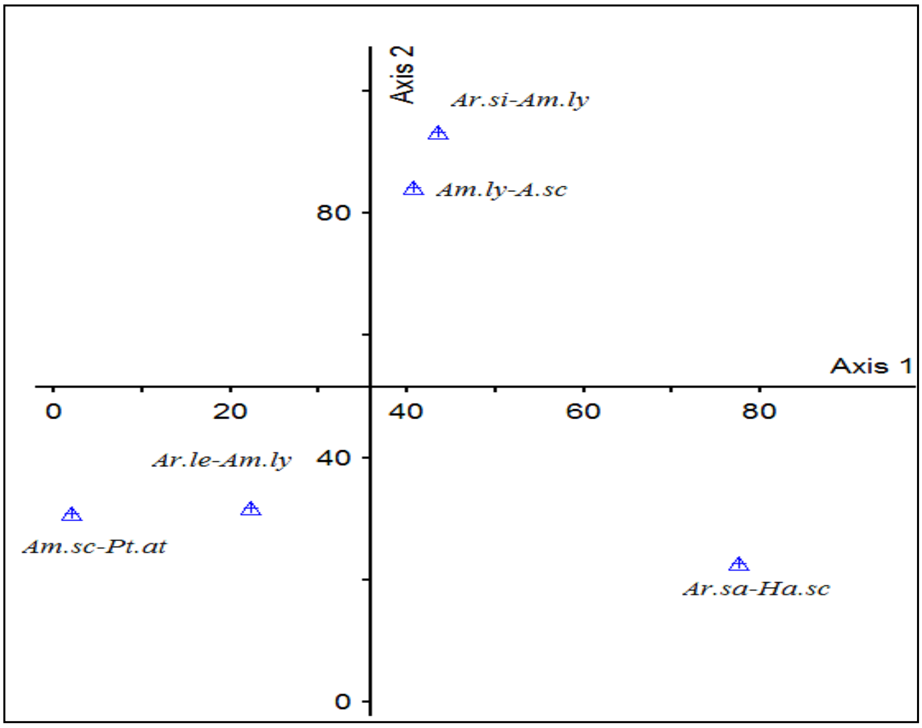


**Figure 7** PCA ordination diagram of vegetative types regarding environmental factors and soil characteristics in the study area





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

Considering PC1, the coefficients of the topographic factors that were significant, are negative. Therefore, plant sites situated in positive direction of one axis have indirect relationship with topographic factors, while silt factor is positive, and plant sites situated in positive direction of one axis have direct relationship with silt. In PC2, coefficient factor of sand is negative, although nitrogen is positive.

The types that are on the left side of first axis 1 have a positive relationship with slope and altitude. These types are *Pi. at- Am. sc* and *Ar. le- Am. ly* that located at the highest altitude (2450 and 2275 m respectively) and the highest slope (50 and 40% respectively) (Table 3).

*Ar. sa- Ha. sa* equally affected by axis 1 and axis 2, so this type has a negative relationship with slope, altitude and nitrogen and it has a positive relationship with silt and sand (Figure 7). The type was found at the lowest altitude and slope of the study area (1900 m, 5%) (Table 3) and the presence probability of this type decrease with increase altitude and slope.

Considering the situation of point indicator of the vegetation types in relation to second axis, *Ar. si- Am. ly*, *Am. ly- Am. sc*, that are located in the upper part of the first axis have direct relation with nitrogen and silt, they both have a strong negative relationship with altitude, slope and sand (Figure 7).

## 4 DISCUSSION

Similar habitat needs cause a group of plant species with a somehow same ecological nature to be placed close to each other and provide a relatively similar environment for themselves. Therefore, there are some ecological factors in each plant group with a specific floristic composition which may be able to distinguish them from the other groups (Metaji and Zahedi-Amiri, 2006).

The present study examined the relationship between environmental variables and plant distribution in a part of arid ecosystem of Sanib Taftan watershed, Iran. In our study area, the PCA results showed that the plant distribution have been potentially affected by altitude, slope, soil texture and total nitrogen. Analysis with PCA confirms that there is a relatively high correspondence between vegetation and these factors that explain 90.89% of the total variance in data set.

Each land unit provides different conditions for the plant growth and expansion due to unique slope, aspect and altitude (Moradi and Ahmadipour, 2006). Study of the effective factors in distribution of vegetation types can specify the relationships between vegetation and morphological factors; thereby, the optimized management of natural resources can be applied systematically to the corresponding planning (Makhdoom, 2002).

PCA assumes linear relationships between vegetation and environmental factors (Mesdaghi, 2003). The use of PCA specifies both the most effective and important environmental factors to separate plant types and somewhat ecological similarities and differences of the plant types in such a way that the plant types can be categorized in terms of ecological similarities. This also shows that each the plant type has either strong or poor relationships (directly or inversely) with environmental factors. Generally, the results of the present study indicated that the most important effective factors in vegetation distribution are divided into two groups: topographic factors, including altitude and slope as well as edaphic factors including soil texture (silt and sand) and nitrogen.

The altitude is one of the indirect environmental gradients which has direct effects on environmental gradients such as climate and soil and directly affect the other factors, including temperature through which plant species distribution will be also changed and the rangeland ecosystem structure will be




[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

revolutionized. By changing the altitude, precipitation amount and type as well as evaporation and distillation will be varied and thereby, vegetation type will be changed. In the present study, the altitude has a negative correlation with the adjacent plant types having a positive direction on the axis 1 and a positive correlation with the adjacent plant types having a negative direction of the axis 1. *Am. sc-Pi. at* and *Ar. le-Am. ly* types have direct and strong relationships with altitude while the *Ar. sa-Ha. sa* type has an inverse relationship with altitude. It should be argued that the altitude is related to plant distribution since it affects precipitation amount, relative humidity, and temperature and is one of the effective factors in vegetation distribution (Ebrahimi-Kebria, 2002). Moradi *et al*. (2014) indicated that altitude plays a significant role in regulating vegetation pattern, including vegetation density, distribution and composition. Zhang and Dong (2010) also documented the altitude is one of the effective factors in the distribution of vegetation types in Lesi plateau of China.

In addition, slope was another important effective topographic factor in vegetation distribution. The slope is a limiting factor in the plant growth. With the increased ground slope particularly in mountainous regions, the gravity and erosion will be more intense and the soil depth will be decreased and in this case, other properties which can be effective in the plant communities' establishment will be appeared (Heydari *et al*., 2009). Increased ground slope has a significant impact on runoff and penetration amount, ground form indicators and the ground functioning and in this way, it applies its impacts on plants available humidity (Rezaei and Arzani, 2007).

In the present study, the types *Ar. le-Am. ly* and *Am. sc-Pi. at* have direct relationships with the increased slope while other types showed an inverse relationship. Saberian (2002) reported that canopy percent has an inverse relationship with slope and is directly related to altitude in white rangelands of Semnan plain.

In addition to topographic specifications, edaphic factors were also effective in vegetation distribution of the studied region. In the present study, soil texture was effective in distribution of plant species, so that the types *Ar. si- Am. ly* and *Ar. sa- Ha. sa* showed direct relationships with the silt. Also in terms of the sand factor, the types *Ar. sa- Ha. sa* and *Ar. le-Am. ly* showed direct relationships while the type *Am. ly- Am. sc* showed an inverse relation. The soil texture is one of the stable physical properties of the soil and affects the other soil properties including soil bulk density, moisture storage, soil construction, soil penetrability, Cation Exchange Capacity (CEC), saturation percentage and amount of organic matter (Jafari-Haghighi, 2003). *Ar. si- Am. ly*, *Am. ly-Am. sc* (located in the upper part of the first axis) have strong relationship with medium textured. These both plant types had also the most amount of nitrogen among all the plant types and had a strong relationship with nitrogen. While *Ar. sa- Ha. sa* had a positive relation with sand and a negative relationship with nitrogen. Therefore, we can conclude with decreasing amount of sand in the texture of the soil, amount of nitrogen will be decreased. Soil texture affects the nitrogen amount of the soil. Fine texture soils have more nitrogen than the medium texture soils, and the course texture soils have the lowest nitrogen (Shokrollahi *et al.,* 2012). Therefore, the plant vegetation changes have affected strongly by the soil texture (Noy-Meir, 1973; Jafari *et al.,* 2006).

Fatahi *et al.* (2009) was addressed the soil texture as an effective factor in *Astragalus gossypinus* communities in Hamedan rangelands. Heydari *et al*. (2009) were considered silt percent and bulk density as effective factors in rangeland separation of Melehgavan Ilam protected zone. Gurgin-Karaji *et al*. (2006) showed the type *Achillea* requires





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

more sand and less silt in Saral Kurdestan rangelands.

Soil texture is reported as an effective factor in water penetration and storage as well as plant's accessibility to water and foodstuff. In addition to the impacts on plant group determinations, soil texture is also effective in plant species distribution (Sperry and Hacke 2002). For example Davies *et al*. (2007) who documented positive association of soil texture content with plant species composition in a semiarid environment.

The soil nitrogen amount was another effective factor in the canopy and density of plant species. In the present study, the types *Ar.si-Am.ly* and *Am.ly-Am.sc* showed a direct and strong relationship with the soil nitrogen amount. Zare *et al.* (2011) showed that in addition to soil texture, available nitrogen was one of the major soil factors responsible for variations in the pattern of vegetation. Nitrogen was regarded as one of the effective factors in vegetation distribution (Fahimipour *et al*., 2010). Fu *et al*. (2003) during investigation of the relationships between soil properties, topography and plant diversity in China, found that among all soil factors, organic materials and total amount of nitrogen have the highest impacts on the plant communities distribution.

## 5 CONCLUSION

Totally, among all of the investigated environmental properties, slope, altitude, silt, sand and total nitrogen had a more important role in the separation of the vegetation types. Consequently, according to the vegetative properties, ecological needs and tolerant rate of each species had related to some environmental features, and these relationships are different for each species. Hence, the results obtained of the area can be used to amend and recover the vegetation of regions with similar conditions. Focusing next studies to find indicator factors of each species help us to determine the optimum range of these factors for each plant species. Recognition of environmental features in the vegetation establishment can lead us to the compatibility of the native species and the corresponding ecological management should be carried out based on the nature of these native species.

## 6 ACKNOWLEDGMENTS

The Authors express their thanks to Department of Range and Watershed Management, University of Zabol for providing necessary facilities to undertake this study.

## 7 REFERENCES

Azarnivand, H. Niko, Sh. Ahmadi, H. Jafari, M. and Mashhadi, N. Investigation of environmental factors effecting in distribution of plant communities in Damghan (case study: Damghan. Semnan province). Nat. Resour. J., 2007; 60: 323-341. (In Persian)

Black, C.A, Evans, D.D, White, J.L, Ensminger, L.E. and Clark, F.E. Methods of Soil Analysis, American Society of. Agronomy, Madison, Wisconsin. 1965; 770 P.

Bray, R.H. and Kurtz, L.T. Determination of total, organic and available forms of phosphorus in soils. Soil Sci., 1954; 39-45.

Bremner, J.M. Nitrogen total, Methods of Soil Analysis, Bartels, J.M. (Ed.), Soil Science Society of America, Madison, Wisconsin. 1996; 1085-1122.

Coulloudon, B., Eshelman, K., Gianola, J., Habich, N., Hughes, L., Johnson, C., Pellant, M., Podborny, P., Rasmussen, A., Robles, B., Shaver, P., Spehar, J. and Willoughby, J. Sampling vegetation attributes. Technical Reference, Department of Agriculture, Natural

Resource Conservation Service, Grazing Land Technology Institute, Denver, Colorado. 1999; 171 P.

Davies, K.W, Bates, J.D. and Miller, R.F. Environmental and vegetation relationships of the *Artemisia tridentate* spp. Wyomingensis alliance. J. Arid Environ., 2007; 70: 478-494.

Day, P.R. Particle fractionation and particle-size analysis, Methods of Soil Analysis, Agronomy, Page, A.L, Miller, R.H. and Keeney, D.R (Eds.). American Society of Agronomy, Madison, Wisconsin. 1982; 545-567.

Ebrahimi-Kebria, K. Investigation of topographic factors effects and grazing on plant cover percentage and diversity in Sefid-Ab of Haraz basin rangeland. MSc thesis of Mazandaran University. 2002; 90 P. (In Perasian)

Enright, N.J. Miller, B.P. and Akhter, R. Desert vegetation and vegetation-environment relationships in Kirthar National Park, Sindh, Pakistan. J. Arid Environ., 2005; 61: 397-418.

Fahimipour, A. Zare Chahouki, M.A. and Tavili, A. Investigation of plant diversity changes with environmental factors in middle rangelands of Taleghan, Iranian Journal of Watershed Management Research (Pajouhesh and Sazandegi), 2010; 87: 32-41. (In Persian)

Fatahi, B. Aghabeygi-Amin, S. Ildermi, A.R. Maleki, M. Hasani, J. and Sabetpour, T. Investigation of some environmental factors effective on *Astragalus gossypinus*in Zagros mountainous rangelands (case study: Hamadan province), 2009; 3(2): 203-216. (In Persian)

Fu, B.J. Liu, S.L. Ma, K.M. and Zhu, Y.G. Relationships between soil characteristic, topography and plant diversity in a heterogeneous broad-leaved forest near Beijing China. Plant Soil, 2003; 261: 47-54.

Ghahraman, A. Flora of Iranica, Forest and Rangeland Organization press. Tehran, Iran, 2000; 215-260. (In Persian)

Gurgin-Karaji, M. Karami, P. Shokri, M. and Safaian, N. Investigation relationship between some important species and physical and chemical soil factors (case study: Farhadabad sub catchment in Kurdistan; Saral rangelands), Iran. J. Watershed Manage. Res., (Pajouhesh and Sazandegi), 2006; 73: 126-132. (In Persian)

Heydari, M. Mahdavi, A. and Atar-Roushan, S. Identification of relationship between some physiographic attributes and physico chemical soil properties and ecological groups in Melehgavan protected area, Ilam, Iran. J. Forest and Poplar Res., 2009; 17 (1): 149-160. (In Persian)

Jackson, D.A. Stopping rules in principal component analysis–A comparison of huristic and statistical approaches. J. Ecol., 1993; 74: 2204-2214.

Jafari, M. Biniaz, M. Janfaza, E. Nematolahi, M.J. and Karimpour Reyhan, M. Relationship between soil characteristics and vegetation types in Damghan, Desert. 2013; 17: 129-135. (In Persian)

Jafari, M. Zare Chahouki, M.A. Tavili, A. and Kohandel, A. Soil vegetation relationship in rangelands of Qom province. Journal of Watershed Management Research (Pajouhesh and Sazandegi). 2006; 73: 110-116. (In Persian)

Jafari, M. Zare Chahouki, M.A. Tavili, A. and Azarnivand, H. Soil- Vegetation relationship in hoz-esoltan region of





[ DOR: 20.1001.1.23222700.2015.3.1.7.1 ]

Qom province, Iran, J. Nutr., 2003; 2(6): 329-334.

Jafari-Haghighi, M. The methods of soil decomposition-sampling and important physical and chemical decompositions by focus on theoretical and practical principles. Neday-e-Zoha, Iran. 2003; 236 P. (In Persian)

Jongman, R.H.G. TerBreak, C.J.F. and Van Tongeren, O.F.R. Data Analysis in community and landscape ecology. Center Fire Agricultural Publishing and Documentation, Wageningen. 1987; 342 P.

Knudsen, D, Peterson, G.A. and Pratt, P. Lithium, sodium and potassium, Methods of Soil Analysis, Page, A.L. (Ed.). American Society of Agronomy, Soil Science Society of America, Madison, Wisconsin, 1982; 225-246.

Makhdoom, V. The land logistics model. University of Tehran press, Iran. 2002; 289. (In Persian)

Masoodipour, A. Ebrahimi, M. and Rigi, M. Effect of Edaphic, Geologic and Topographic Characteristics in the Distribution of Plant Species in the Sanib Taftan Watershed. Range Management M.Sc. Thesis. University of Zabol, 2014; 93P. (In Persian)

McCune, B. and Mefford, M.J. PC-ORD. Multivariate Analysis of Ecological Data Version 3.0. MjM Software Design. Gleneden Beach, OR, 1997; 125 P.

Mesdaghi, M. Range management in Iran. Astan Ghods Razavi press, Mashhad, Iran, 2003; 252 P. (In Persian)

Metaji, A. and Zahedi-Amiri, G.H. The relationship between plant ecologic groups and edaphic conditions of the habitat (Case study: Khiroudkenar Jungle of Noshahr). Nat. Resour. J. Iran, 2006; 59(4): 453-863. (In Persian)

Moradi, H. and Ahmadipour, S. Investigation the role of morphology and soil on plant vegetation using GIS in Vas sub watershed basin. Geogr. Res. J., 2006; 58: 17-32.

Moradi, M. Ebrahimi, M. and Armin, M. The role of edaphic and topographic factors in plant species distribution of geological formations in Kakan watersheds of Kohgelouye-and-Boyerahmad province. Range Management M.Sc. Thesis. University of Zabol, 2014; 116 P. (In Persian)

Nelson, D.W. and Sommers, L.E. Total carbon, organic carbon, and organic matter, Methods of soil analysis. 961-1010 (Bartels, J.M. (Ed.), Soil Science Society of America, Madison, Wisconsin, 1996; 961-1010.

Noy-Meir I. Multivariate analysis of the semi-arid vegetation of southern Australia. II. Vegetation catenae and environmental gradients. Aust. J. Bot., 1973; 22: 40-115.

Rezaei, S.A. and Arzani, H. The use of soil surface attributes in rangelands capability assessment. Iran. J. Range and Desert Res., 2007; 14 (2): 232-248. (In Persian)

Rezaei, S.A. The use of a soil quality index in site capability assessment for extensive grazing. Ph.D Dissertation, University of Western Australia, Perth, Australia, 2003; 93 P.

Rhoades, J.D. Salinity: Electrical conductivity and total dissolved solids, Methods of Soil Analysis, Page, A. L. (Ed.), American Society of Agronomy, Madison, Wisconsin, 1996; 417-435.

Saberian, G. The investigation of correlation degree between plant cover with topographic in Sephid Dasht- Margsar. M.Sc. Thesis in Range Management of Mazandaran University. 2002; 113 P. (In Persian)

Shokrollahi, S.H. Moradi, H.R. and Dianati Tilaki, Gh.A. Effects of soil properties and physiographic factors on vegetation cover (Case study: Polur Summer Rangelands). Iran. J. Range and Desert Res., 2012; 19 (4): 655-668. (In Persian)

Sperry, J.S. and Hacke, U.G. Desert shrub water relations with respect to soil characteristics and plant functional type. Funct. Ecol., 2002; 16: 367-378.

Thomas, G.W. Soil pH and soil acidity, Methods of soil analysis, Bartels, J.M. (Ed.), Soil Science Society of America, Madison, Wisconsin, 1996; 475-490.

Xian-Li, X. and Ke-Ming, M. Relationships between vegetation and topography in a dry warm river valley SW Chin. Jour. Catena, 2008; 75: 138-145.

Yibing, Q. Impact of habitat heterogeneity on plant community pattern in Gurbantunggut Desert. J. Geogr. Sci., 2008; 14 (4): 447-455.

Zare, S. Jafari, M. Tavili, A. Abbasi, H.R. and Rostampour, M. Relationship Between Environmental Factors and Plant Distribution in Arid and Semiarid Area (Case Study: Shahriyar Rangelands, Iran). American-Eurasian J. Agric. and Environ. Sci., 2011; 10 (1): 97-105.

Zare Chahouki, M.A, Jafari, M. and Azarnivand, H. Relationships between species diversity and environmental factors of Poshtkouh rangelands in Yazd. Iran. J. Watershed Manage. Res., (Pajouhesh and Sazandegi). 2007; 21(1): 192-199. (In Persian)

Zhang, J.T. and Dong, Y. Factors affecting species diversity of plant communities and the restoration process in the loess area of China. Ecol. Eng., 2010; 36: 345-350.

Zhou, P.L., Uukkanen, O. Tokola, T. and Nieminen,J. Vegtation dynamics and forest landscape restoration in the Upper min River Watershed, Sichuan China, Restor. Ecol., 2008; 16:345-355.

# نقش ویژگی‌های خاک وتوپوگرافی در پراکنش پوشش گونه‌های گیاهی
# (مطالعه موردی: حوزه آبخیز سنیب تفتان)

مهدیه ابراهیمی[1*]، علیرضا مسعودی‌پور[2] و مسعود ریگی[2]

۱- استادیار گروه مرتع و آبخیزداری، دانشگاه زابل، زابل، ایران

۲- دانش‌آموخته کارشناسی ارشد مرتع‌داری، گروه مرتع و آبخیزداری، دانشگاه زابل، زابل، ایران

تاریخ دریافت: ۲۹ بهمن ۱۳۹۳ / تاریخ پذیرش: ۱۵ فروردین ۱۳۹۴ / تاریخ چاپ: ۲۴ تیر ۱۳۹۴

**چکیده** این مطالعه به‌منظور ارزیابی تأثیر فاکتورهای خاک و توپوگرافی در پراکنش پوشش گیاهی حوزه آبخیز سنیب تفتان، در استان سیستان و بلوچستان انجام شد. ابتدا نقشه واحدکاری با تلفیق سه نقشه شیب، جهت و طبقات ارتفاعی تهیه شد. پنج تیپ گیاهی شامل *Artemisia santolina- Hammada salicornica, Artemisia sieberi- Amygdalus lycioides, Artemisia lehmaniana- Amygdalu slycioides, Amygdalus lycioides- Amygdalus scoparia, Pistacia atlantica- Amygdalus scoparia* تشخیص داده شد. نمونه‌برداری پوشش گیاهی در واحدهای کاری با استفاده از روش ترانسکت خطی انجام شد. در ترانسکت‌های ۵۰ یا ۱۰۰ متری (پلات‌های ۴-۲ مترمربعی)، حضور و عدم حضور گونه‌های گیاهی، درصد تاج پوشش، درصد سنگ و سنگ‌ریزه، درصد لاشبرگ، درصد خاک لخت برآورد گردید. نمونه‌برداری خاک باتوجه به وسعت هر واحد کاری (از عمق ۰ تا ۳۰ سانتی‌متری) صورت گرفت. بررسی رابطه بین عوامل محیطی و پراکنش تیپ‌های گیاهی با استفاده از تجزیه‌ی مؤلفه‌های اصلی (PCA) انجام شد. مهم‌ترین عوامل مؤثر در پراکنش پوشش گیاهی حوزه مورد مطالعه شیب، ارتفاع، بافت خاک (سیلت و شن) و ازت بودند و تأثیر توپوگرافی (شیب و ارتفاع) بیش‌تر از عوامل مربوط به خاک بود.

**کلمات کلیدی:** ارتفاع از سطح دریا، جامعه گیاهی، خصوصیات خاک