Determination of Ecological Species Groups and Effective Environmental Factors on Them

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Introduction

Plant communities have inherent dynamics. Environmental factors such as climate, topography and soil, can affect plants dynamics. Climate which depends on spatial and temporal scales has different effects on vegetation. In regional scale, ecosystem development and its variations in the world, are functions of climate, while smaller scale changes in each season and during the seasons of plant growth and development, were controlled by climate. Physical and chemical properties of soil cause extensive diversity and geographical distribution of vegetation. Topographic factors such as altitude; slope and size affect on the evapotranspiration of plants and soil drought. This can influence the availability of water for plants. Determination of the relationships between vegetation and environmental factors is necessary for careful management and planning programs of rangeland ecosystems, especially in arid regions. Knowledge and understanding of the realistic relationship is essential for sustainable utilization and proper management of these ecosystems. Therefore, the present study aims at identifying the plant communities and the most important environmental factors (soil, climate and topography) that influence the distribution of these communities.

Materials & Methods

The study area with 8404.833 hectares area is Sorkhdeh upland rangeland in the northern Semnan province. It is located 40 km on the East of Damghan city and 25 km southeast of Kiasar city. Vegetation and soil were sampled according to the method of equal random classification. Thus, the study area was divided to homogeneous units by overlaying maps of elevation, slope, aspect and geology. In general, 230 plots in 23 homogeneous units were established. The number and percentage of species were recorded in each plot. Three soil samples from 0 to 15 cm depth were taken in each homogeneous unit. Soil factors (electrical conductivity, acidity, lime, organic carbon, phosphorus, potassium, and nitrogen, percentage of sand, silt and clay) were measured in laboratory. For the extraction of topographic data, sampling points map was provided in Arc GIS (version 9.2) software. Afterwards, the topographic data was extracted by overlaying this map with the maps of slope, aspect and altitude. Studying the climatic data in a 15-year statistical period, three climate variables (mean annual precipitation, mean annual relative humidity and mean annual temperature) were selected. Thereafter, regression relationships between the stations elevation and desired variables were calculated and extended on an elevation map. Thus, maps of climatic factors were prepared for the region. Overlaying these maps with climatic factors, the environmental factors were extracted for each sampling point.

In general, 17 environmental factors were measured. For effective analysis of species, an environmental classification method was used before the analysis of quantitative of data on factors.

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For vegetation classification cluster analysis using PC-ORD software was applied. Effects of environmental factors on vegetation classes were determined using unbalanced ANOVA. Comparison was conducted by Duncan method using SPSS version 16.

Result & Discussion

Cluster analysis led to 15 sub-communities (Table 1) in the study area. This classification was on the basis of the presence and similarity of species composition in the plots of each sub-community, rather than that of other sub-communities. Since various plant species have special environmental and ecological requirements, to investigate and prove such relationship, comparison was conducted between the environmental factors mean values among plant communities. This showed the significant differences between environmental factors except for saturated soil moisture content among plant sub-communities.

Table 1: names and abbreviations of plant sub- communities

Names of plant sub-communities	Abbreviation	Number
Salicornia herbaceae-Eryngium billardieri	Sa.he – Er.bi	1
Hultemia persica-Rhamnus pallasii	Hu.pe – Rh.pa	2
Salsola arbusculiformis-Salsola dendroides	Sa.ar – Sa.de	3
Berberis integerrima-Acantholimon erinaceoum	Be.in – Ac.er	4
Halocnemum strobilaceum-Hypocylix kerneri	Ha.st – Hy.ke	5
Juniperus excelsa-Artemisia aucheri	Ju.ex – Ar.au	6
Acantholimon erinaceoum-Artemisia aucheri	Ac.er – Ar.au	7
Salsola dendroides-Coronpus didymus	Sa.de – Co.di	8
Hypocylix kerneri-Halocnemum strobilaceum	Hy.ke – Ha.st	9
Salicornia herbaceae-Salsola arbusculiformis	Sa.he – Sa.ar	10
Artemisia aucheri-Salicornia herbaceae	Ar.au – Sa.he	11
Salsola arbusculiformis-Artemisia aucheri	Sa.ar – Ar.au	12
Artemisia aucheri-Acantholimon erinaceoum	Ar.au – Ac.er	13
Artemisia aucheri	Ar.au	14
Salsola arbusculiformis-Alyssum inflatum	Sa.ar – Al.in	15

The highest EC values have been obtained in sub-community 5 and sub community 9 which formed halophyte types. EC values had no significant differences in other sub-communities. Soil pH values in all 15 sub-communities were more than 7.8. Therefore, the whole area's soil is neutral to alkaline. High soil pH in this region could be due to low precipitation which leads to the accumulation of exchangeable bases in soil. Sub-communities 9 and 5 had the highest pH values (> 8.5). However, they were not statistically different with each other and with sub-communities 10, 11, 14 and 15. Sub community 6 had the lowest pH value because of having more rainfall due to high elevation from sea level. The highest percentage of CaCO3 was obtained from sub-community 10. Other sub-communities (1, 2, 3, 4, 8, 11, 12, 13 and 15) had no significant difference with sub-community 10. Sub-community 6 significantly had the highest organic carbon amount. This can be attributed to plant residuals that cause the improvement of physical and biological properties of soil. Lowest organic carbon value was observed in sub-community 2 which did not show significant differences with other plant sub-communities, except for sub-communities 4, 5, 6, 7 and 12. Sub-community 8 had the highest rate of soil phosphorus and had significant difference with all other sub-communities. Liquidation amount of phosphorus in soil is a function of pH and interaction with some minerals, particularly the Ca-P. The high rate of pH (8.3) and CaCO3 in this sub-community and increasing the competing ions, i.e. Ca, is the reason for having the maximum amount of phosphorus in the soil of this sub-community. The lowest P amount has been seen in sub-community 6 that also had the lowest amount of pH and CaCO3. Potassium in sub-community 8 had maximum amount. The only sub-community which had no significant difference with it was sub-community 10. The presence of Na^+ in plants causes a decrease in absorption K. Thus, this will increase the amount of K in the soil. The lowest amount of K has been observed in sub-community 14 that had significant difference with sub-communities 1, 3, 8, 10, 11 and 13. Sub-community 6 had the highest amount of nitrogen. It had significant difference with other sub-communities, excluding sub-communities 4, 7 and 8. Vegetation compositions of sub-communities 4, 6 and 7 were very similar to common species such as *Acantholimon erinaceoum* ،*Astragalus sp.* and *Artemisia aucheri*. Species belong to leguminozeae have cyanobacteria in their roots. These bacteria are able to fix nitrogen in soil. The increase in nitrogen-rich plant residues such as legumes will increase reserves of soil organic nitrogen. High rate of soil nitrogen in sub-community 8 is natural according to the presence of dominant species of halophyte *Salsola dendroides*. The reason is the reduced salinity uptake of nitrogen in plants which increase it in soil. Sub-community 11 had the lowest nitrogen percentage, and has showed no significant difference with other sub communities, except for sub-communities 4, 6, 7 and 8. Sub-community 14 had the highest percentage of sand. *Artemisia aucheri* is the indicator of sand and gravel soils. It had no significant difference with sub-communities 1, 4, 6, 7, 10, 11, 12, except for *Artemisia aucheri*. The lowest percentage of sand was observed respectively in sub-communities 5, 8 and 9. The reason is that sub-communities 5 and 9 are located on the sidelines of a seasonal river. About sub-community 8, soil salinity was caused soil compaction and drainage problems. Therefore, the amount of sand is low and the soil texture is heavy and dense. Sub-community 8 had the highest silt and its soil texture is almost heavy. Sub-community 14 had the lowest silt amount. Sub-community 5 had the highest clay contents and sub-communities 7 and 14 had the lowest clay contents. ANOVA showed that the most effective agent respectively in sub-communities 2, 6, 7, 12 and 14 was average annual precipitation. This had no significant difference with sub-communities 4, 7 and 13. Plant composition in these sub-communities was similar to each other, and they were upland sub-communities in the area. The lowest elevation and precipitation belong to halophyte sub-communities (i.e. 5, 8 and 9), that had showed no significant differences with sub communities 3, 11 and 15. Plants in these sub communities such as *Hypocylix kerneri, Halocnemum strobilaceum, Salsola dendroides*, *Salsola arbusculiformis* have deep roots to provide their required moisture from underground water level. Other reason is that soil texture in the region is heavy to moderate; therefore, the water holding capacity of soil is high. Considering the direct correlation between heights, the effect of altitude on the vegetation of sub-communities of the area was similar to the effect of precipitation. Sub-communities 8 and 9 were the most affected ones by temperature, and the least affected one was sub-community 2. Sub communities 1, 3, 5, 8, 9, 11, 13 and 15 had no significant differences and had similar plant compositions. The influence of temperature on the 15 sub-communities had reverse trend in comparison with rainfall factor. This was due to negative correlations between altitude and temperature. Considering that the relative humidity is dependant directly to rainfall and indirectly to height, maximum and minimum relative humidity have been observed in sub-communities 2, 8 and 9, respectively. There were no significant differences between sub-community 2 and sub-communities 4, 6, 7, 12, 13. However, it had significant differences with other sub-communities. Also there were no significant differences between sub-communities 8 and 9 and sub-communities 3, 5, 10, 11 and 15. The effect of slope on sub-communities 6 and 2 were the most. These two had no significant difference with each other and with sub-communities 4, 7, 12 and 14. *Artemisia aucheri*, *Rhamnus pallasii*, *Acantholimon erinaceoum*, *Astragalus sp.* and *Stachys inflata* were common species within these sub-communities. The lowest slope was observed in sub-communities 5, 8 and 9. It should be noted that these three sub-communities had significant differences with others and had the lowest elevations. Sub-community 2 was influenced by slop factor more than the other sub-communities. There exist significant differences between number 2 and sub-communities 1, 3, 6, 7, 8 and 9. It had no significant differences with other sub-communities. The least effect of slop was observed in sub-community 3. The likely reason is that there were equal numbers of different geographical slops in the sampling points of this sub-community. Finally, the results showed that the studied environmental factors were able to interpret the ecological groups in this region very well.

Key words
Ecological Species Groups, Environmental Factors, Cluster Analysis, Analysis Of Variance, Sorkhdeh Rangelands.