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A STUDY ON RELATIONS BETWEEN SOIL AND PLANT SPECIES IN ALPINE ZONE AT KAZDAĞI NATIONAL PARK, TURKEY

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Abstract

This study examines the plant species' distribution and cover abundance scales relations with soil and other environmental factors such as elevation, exposure, slope in the alpine region. 10 sample areas were determined for experimental field study in the alpine region. Plant species and their cover abundance scales and 0-5 and 5-15cm soil depth analysis were conducted in the field study. C, N, pH, soil salinity, soil texture, C/N and $CaCO_3$ (%) were determined in soil laboratory analysis. To examine the effect of land use by the local people; sample areas were determined both on used area and non-used area in the alpine region.

Introductıon

Soil and plant species relation may vary by conditions of the environment. Especially in the alpine region the environmental conditions are more restricted and inadequate. Windy, snowy and cold climatic conditions as well as stony and shallow soil conditions for plant grow are very common in the alpine regions. On the other hand, peculiar to the study area, specific traditional land use conditions by the local people were observed. They use the summit area with sacred beliefs.

Alpine regions are generally located above timber line and alpine plants are the native plants that grove above timberline (Foster, 1968). Rich diversity of plant species can be seen on alpine regions (Sarı, 2010) because altitude is one of the important determinants of the species richness (Saqib *et al*., 2011). In mountainous regions altitude has a much greater effect on plant species and unique habitat types (Khan *et al*., 2013). Even in a single mountain as Caucasus or Andes of Venezuela includes plant diversity nearly in the same amount as arctic tundra. Geographic isolations, tectonic movements, climatic changes, glaciation, varied micro habitats and evolution increase taxonomic diversity in alpines (Körner, 2003). 8000-10.000 plant species determined in alpine regions all over the world (Körner, 1995). Similarly, 42% of the key botanical sites of Turkey- that is called important plant areas- located on mountains (Özhatay *et al*., 2003).

As mentioned before; alpine and subalpine regions start by the timberline. The elevation of timberline varies in different geographic regions. In South Norway, timberline starts at 1250 meters, for the Alps of Austria at 1500 meters and for Caucasus at 2500 meters. Elevation of alpine and subalpine regions increases bythe higher continentality (Kılınç & Kutbay, 2004). Though, it is changing according to the geographic region, generally in Turkey sub alpine regions start at 1800 meters and goes above 2000 meters as it does in alpine regions (Atay *et al*., 2009). From the aspect of ecologic conditions of alpine regions; hard, windy, snowy cold climatic conditions and short time vegetation period for plant grove can be observed clearly. Because of these hard ecologic conditions, alpine plants generally have a dwarf, spiny and compact morphological characteristics. Alpine plant species are mostly belonged to *Orchidaceae*, *Primulaceae* and *Gentianaceae* families that have shiny, bright, colorful and small flowers. This is needed for pollination by insects. Common plant species for alpine regions are; *Juniperus communis* subsp. nana, *Daphne oleoides*, *Thymus* sp., *Acantholimo*n sp., *Alchemilla* sp., *Allium* sp., *Alyssu*m sp., *Astragalus* sp., *Bellis* sp., *Campanula* sp., *Carex* sp., *Centaurea* sp., *Crocus* sp., *Dianthus* sp., *Draba* sp., *Gentiana* sp., *Gypsophilla* sp., *Onosma* sp., *Papaver* sp., *Potentilla* sp., *Primula* sp., *Ranunculus* sp., *Salvia* sp., *Saxifraga* sp., *Sedum* sp., *Silene* sp and *Veronica* sp. (Karahan, 1998).

Inspite of the fact that soils develop as a result of complex inter- relationship between climates, the rocks or substrates on which, and from which, they are formed, vegetation and soil fauna and flora (Polunin & Walters, 1985); acid soil characteristics of the alpine regions are determined. Alpine region humus soils are seen between 1000-4000 meters elevation as peculiar to these areas, and include humid and humus. In alpine regions, organic materials totally decomposed and mixed with mineral matter (Blanquet, 1932). The measurement of soil acidity is in terms of the concentration of hydrogen ions (H+) in the soil, and is indicated by pH. The greater the concentration of ions of hydrogen -express by a low pH number- the higher the acidity. Acid soils have hydrogen ion concentration, or pH's ranging from 4 to less than 7, while alkaline soils have pH's of above 7 up to 9 (Polunin & Walters, 1985).

On the other hand, study area subjected to traditional uses of local people due to their sacred beliefs to a woman saint who had once lived in the summit region of Kazdağı. They go up to the mountain in every occasion for praying and to picking *Sideritis trojana* species which they use as traditional tea. They like spending time at the summit area which their ancestor cemetery located and they sacrifice for the saint and their ancestors. Harvesting of *Sideritis trojana* by the local people helps decreasing the number of species by harvesting, on the other hand, by their harvesting style they help plant species' distribution. They pick this plant species after plant goes to seed.

Material and Methods

Study area: The study area is located in the Kazdaği National Park in Edremit district of Balikesir Province on the north-west part of Turkey. The Edremit Gulf is situated at the southern end of the area. The coordinates of the area are between 39° 41' and 39° 42'latitudes and 26° 49' and 26° 53'longitudes. The alpin study area has a size of 691, 5 ha. The elevation of the study area is between 1600-1774 meters and includes the summit area. The study area is used by Turkmens which are locals from surrounding national park villages with traditional worship purposes according to their sacred beliefs to a saint who had lived at the summit of Kazdağı (Fig. 1).

The climatic characteristics for the region are warm to hot dry summers and mild cool wet winters. The study area is located in the distinct semi-arid region of the Mediterranean. The annual average temperature in the Edremit Province is 16.4°C and the annual rain fall is 665.6mm. Rain fall increases in November and December. According to Walter (1979) Climatic diagram of the Edremit Province, the dry period lasts approximately 5.5 months from May to October (Fig. 2).

General soil and plant characteristics of the study area: Most of the alpine soil in Kazdağı National Park develops from limestone rock. Mountain meadow soils are locally found and brown forest soils are formed over marble and crystalline limestone in patches (Güngör, 2009). Soils over marble have a mean pH of 6.1, ranging from 5.3 to 6.6. These soils have a relatively high moisture, particle density, pore space, clay, stones and litter, total N and extractable K, Ca, Mn, B, Cu and Z (Graves & Monk, 1985). Trends in vegetation and species distributions are correlated with soil variability. The number of species isfound greater on marble. Herb species make up the largest part of the difference. Herbs crowd the forest floor over marble (Graves & Monk, 1985).

Alpine regions of Kazdağı National Park are located above 1600 meters. Subalpine and alpine zones do not have a prominent line. Some species separate these zones. Near timberline as subalpine zone; generally *Juniperus communis* subsp. nana, *Cerasus prostrata*, *Genista lydia* and *Daphne oleoides* species are common while upper elevations *Acantholimon ulucinum* and *Astragalus angustifolius* species are common (Mayer & Aksoy, 1998).

Vegetation analysis: For vegetation analysis; 10 sample areas with the size of 10m^2 on the alpine meadows which have homogenous structure of alpine region were determined. The size of the sample areas was determined according to Ellenberg (1956) and the numbers of the sample areas were determined according to Scamoni (1963). The quadrats were located in a typical representative section of each community. The plant species composition on the sample areas was characterized by classical phytosociological plots according to Braun-Blanquet cover-abundance values (Blanquet, 1964) which means that total coverage for each species (vertical projection onto the ground) was estimated visually and recorded within 7 cover classes: r: 1 or 5 individuals; +: few individuals (< 20) with cover < 5%; 1: many individuals (20–100) with cover < 5 %; 2: 5 % –25 % cover; 3: 25 %–50 % cover; 4: 50 %–75 % cover; 5: 75 %–100 % cover (Blanquet, 1964; Godefroid & Koedam, 2004). In addition to the floristic composition of plant community of alpine region, we recorded the following environmental variables in each sample; elevation, exposure, slope and location and all of them were measured on site. The botanical nomenclature follows the "Flora of Turkey and East Aegean Islands" of Davis (Davis, 1965-1985). Sample areas determined both on used and non-used area by the worshippers to examine their effects.

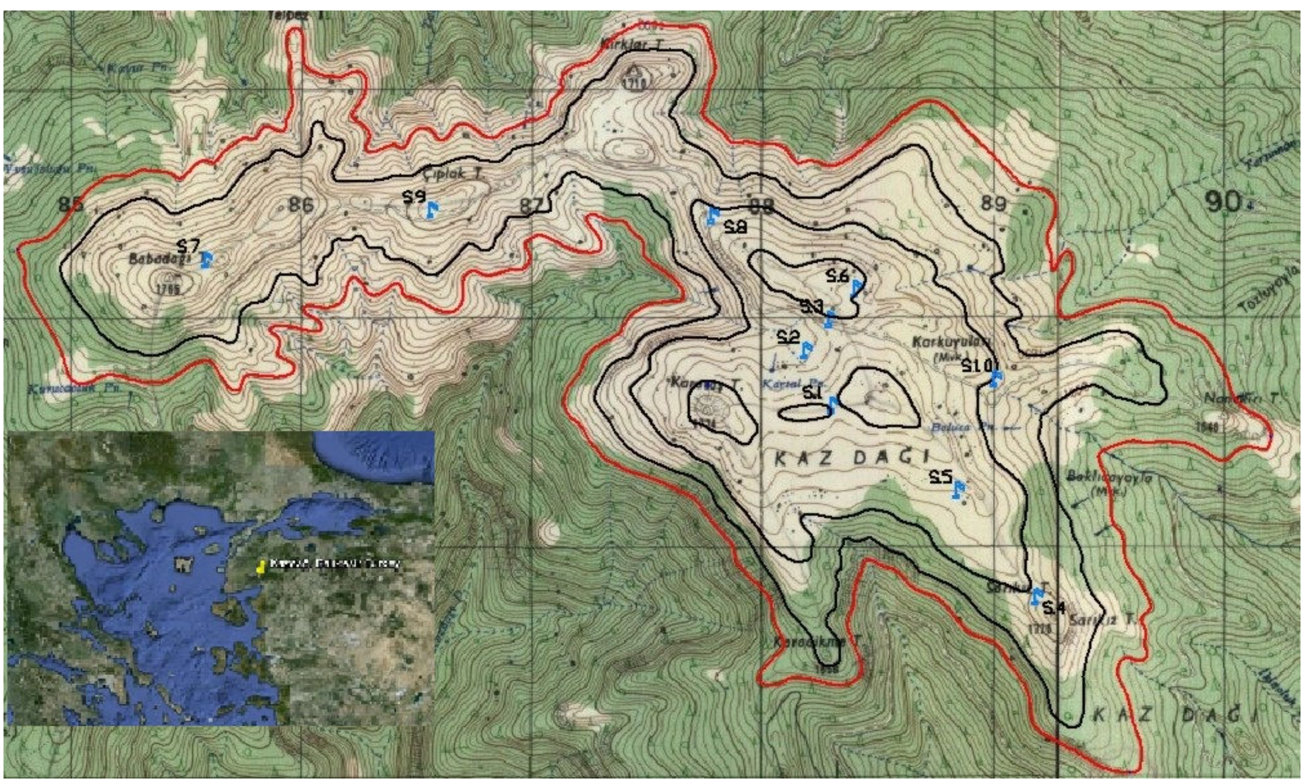

Fig. 1.Bordersof the study area, and the location of the Kazdağı national park in Turkey and the 10 sample areas' locations in the study area.

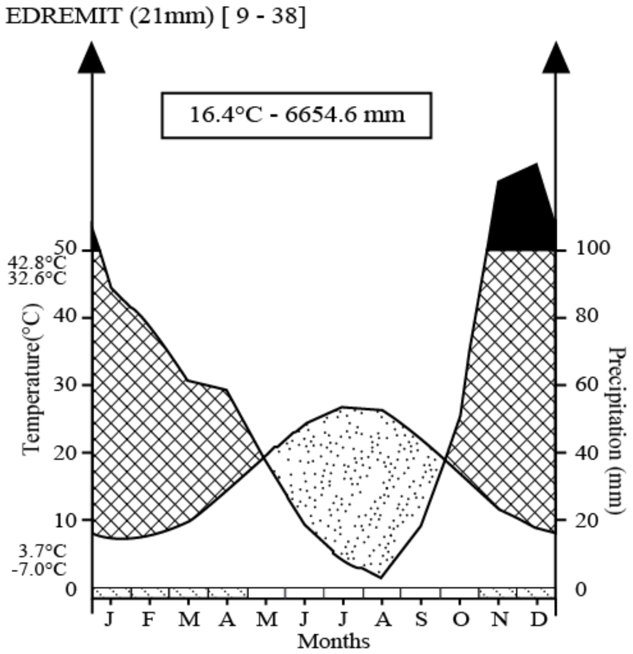

Fig. 2. Climatic diagram of the Edremit Province where the study area was located (Walter, 1979).

Soil analysis: Soil samples were taken from 10 vegetation sampling areas from 0-5 and 5-15cm soil depths with the aid of 250 cm^3 steel soil cores in the alpine region. Sampling was carried out in June, 2012. Soil samples were taken from three different points in each sample area. Soil samples dried under 105°C in an oven for 24 hours. Soils were sieved through a standard 2 mm sieves and thus, fine soil (<2 mm), and rock (>2mm) weights were found. Sand, silt and clay ratio of soil samples in the laboratory were found by Bouyoucos hydrometer method. Total carbon and nitrogen contents were determined by CN Analyzer (LECO-Truspec 2000). Calcium carbonate (CaCO3), pH and electrical conductivity values were measured in the laboratory as described in Karaöz (1989a, 1989b). Furthermore, soil compaction was measured at 60 different soil points in 10 sample areas by using hand penetrometer and the average of each sample areas' measurement tabled for both soil depths.

Results and Discussion

60 plant species belong to 27 families determined in total vegetation sample areas. 2.28% of the total species are belonged to tree and shrub layers. Rests of them belongto herb layer. On the second sample area, even it is located on the area used by the worshippers, high species diversity is observed. Respectively 2nd, 10th, 4th and 5th sample areas have relatively high diversity. Sample areas 2, 4, and 5 are located near and inside the used area.

Ten endemic species of Kazdağı are determined on the sample areas. These are *Achillea fraasii* var. *trojana, Asperula sintenisii, Armeria trojana, Astragalus idae, Centaurea odyssei, Gallium trojanum, Hypericum kazdaghensis, Silene balanthoides, Sideritis trojana* and *Thymus cherlerioides* var. *cherlerioides* species. Sample areas 8 and 10 are relatively include more endemic species.

Even it is located beside the used area, cover abundance scales are found high in the first sample area. Local people were observed to be harvesting *Sideritis trojana* plant species for the purpose of preparing a traditional drink. This endemic plant species has a local distribution on the mountain; however, the way it is being harvested by the local people positively helps the distribution of this endemic plant species. Since they use this plant species for hundred years, they know how and when to harvest. The appropriate time for harvesting is postemergence. According to these results there is no adverse effect of local people's activities on plant species cover abundance scales (Table 1).

Regarding to the soil features; in other parts of the world; generally alpine and sub-alpine soils have acid, wet and high content organic matter, humus soil character. Besides, contain appreciable content of clay (25-30%) and relatively low C/N ratio (12-17) (Wood, 1970). According to our study area; content of clay is lower and varies 2,7-12,7 and average is 11,6. C/N ratio found higher in 1st, 2nd, 3th, 4th,6th, 9th and 10th sample areas. This means decomposition rates are low in these areas. Decomposition rates are influenced by temperature, moisture, substrate quality and decomposer organisms (Hill *et al*., 1988; Seastedt *et al*., 2001; Gonzalez & Seastedt, 2001).

Soil pH was one of the main soil parameters which were affected by the vegetation disturbance (Güleryüz *et al*., 2010). Visitor pressures most affect the soil and vegetation properties and visitor activities can alter the soil pH and soil pH increases with the increasing visitor activities (Cakır *et al*., 2010). On the contrary; pH values of the sample areas were found to be acceptable for plant growth in alpine regions (>4,5 pH). Slightly acid soil character were observed in the study area.

Generally soil samples were found to be stony, whereas common soil type was loamy and free draining. No salinity problem observed. 17th and 18th soil samples have remarkable carbon values. Generally organic material is found to be adequate except for 9th and 10th soil samples. Similar N (%) values measured for all soil samples; there is no nitrogen deficiency aspect of plant nutrition. Total C (%) and C/N ratio has a significant difference in 9th sample area. Total organic carbon decreases by the removal of the plant cover.In the study examining the recreational use effect on soil properties; total organic carbon content found high in the undisturbed soil which implemented on heavily recreational used area Uludağ Mountain (Güleryüz *et al*., 2010). Organic carbon was highest in sample area 9 for both soil depths (9%-10%) and was low in sample area 5 (0,7%-0,5%) which is located on the way of two heavily used area. Soil samples do not include $CaCO_3$ except for 9th sample area. This can be related to highest total organic carbon value of this sample area. (Tables 2-3).

General rule for measuring the compaction of the soil on the sample areas by using penetrometer is that; the higher the value is the higher compaction it gives. Highest compaction measured on the 2nd sample area. 6th and 7th sample areas' compaction was also measured relatively higher. Sample areas 1, 2, 3, 4 and 5 are located on the used area by worshippers.

Table 1. Plant species and cover-abundance scales of 10 sample areas at the alpine region in Kazdağı summit area.

No.	Plant specıes	Cover-abundance scales and sample areas									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.	*Acantholimon ulicinum*	+			+						+
2.	*Achillea fraasii var. trojana*				1						
3.	*Acinos alpinus*	3						r			r
4.	*Alyssum saxatile*		1								
5.	*Anthemis pseudocotula*		3								
6.	*Armeria trojana*		r			r					
7.	*Asperula sintenisii*			1	r	r	r	r	1	1	+
8.	*Astragalus angustifolius*				1					2	
9.	*Astragalus heldreichii*			+					+		
10.	*Astragalus idae*			2	2		2	+	2		+
11.	*Asyneuma limonifoilum*	+	+	r	+					r	+
12.	*Asyneuma virgatum*				+						
13.	*Bellis perennis*					1					
14.	*Carduus nutans*		1	r			2	3	2		1
15.	*Centaurea odyssei*								1	+	
16.	*Cerasus prostrata*				1						
17.	*Chamaecytisus eriocarpus*	4				+					r
18.	*Cynoglosum montanum*								r		
19.	*Daphne oleoides*						+				+
20.	*Dianthus arpadianus*	+	r	1		+		2			+
21.	*Echium russicum*		r			r	r				
22.	*Epilobium angustifolium*								1		
23.	*Festuca ustulata*		1				1				
24.	*Gallium trojanum*						r	+	1		1
25.	*Genista anatolica*	2		2	r						1
26.	*Hypericum kazdaghensis*	+		r	+	+					r
27.	*Hypericum olympicum*								+		
28.	*Juniperus communis* subsp. *Nana*	r					+	+			2
29.	*Koeleria cristata*		1								
30.	*Linum boissieri*									+	
31.	*Lotus corniculatus*	+	1	1		r			1	r	
32.	*Minuartia garckeana*		r	+	+	+			1	1	
33.	*Muscari bourgaei*									r	
34.	*Parnassia palustris*	+		+			r				+
35.	*Paronychia sintenisii*	+		r							
36.	*Pinus nigra* subsp. *Pallasiana*	r		r		1	r				2
37.	*Piptatherum coerulescens*							1			
38.	*Poa bulbosum*				2	1					
39.	*Potentilla recta*	r	1				+				
40.	*Ranunculus illyricus*		+		+					r	r
41.	*Rosa sicula*					+	+				
42.	*Rumex acetosella*		r								
43.	*Saxifraga sibirica*	+	r			+					
44.	*Scabiosa columbaria*	r		3		1	1				+
45.	*Scrophularia scopolii*							r	1		
46.	*Sedum lydium*	+	r		+			1			
47.	*Sesleria alba*	1	r								
48.	*Sideritis trojana*		r	+	+				+	+	
49.	*Silene balanthoides*										r
50.	*Sinapis alba*				+						
51.	*Stachys cretica*							2	+		
52.	*Thymus cherlerioides* var. *cherlerioides*	+	r			2			+	+	1
53.	*Thymus sipyleus*		+								
54.	*Thymus vulgaris*		+		+						
55.	*Trfiolium angustifolium*									+	
56.	*Trifolium fragiferum*		1								
57.	*Tulipa sylvestris*								r		
58.	*Verbascum scamandri*			r							r
59.	*Verbascum vacillans*							+	1		
60.	Viola tricolor		1	+	+	1					+

Table 2. The results of soil analyses of the soil samples taken from the 10 sample areas.

Sample area No.	Soil depth (cm)	Soil sample	Rock weight (kg/l)	Fine soil weight (kg/l)	Sand (%)	Silt (%)	Clay (%)	pH	Salinity (µS/cm)	C (%)	N (%)	C/N (%)	$CaCO_3$ (%)
1	0-5	1	1.96436	0.80524	83,3	12,0	4,7	6,21	174,4	3,6268	0,12830	28,268	0,00
	5-15	2	1.07136	1.77612	79,3	14,0	6,7	5,52	98,9	3,1227	0,12330	25,326	0,00
2	0-5	3	0.885	1.20956	81,3	10,0	8,7	5,51	109,0	2,7329	0,11400	23,972	0,00
	5-15	4	0.32364	2.62084	77,3	10,0	12,7	5,65	107,6	1,5498	0,11028	14,053	0,00
3	0-5	5	0.58464	0.84564	85,3	8,0	6,7	5,81	151,8	2,2070	0,10053	21,953	0,00
	5-15	6	1.87124	2.04656	85,3	10,0	4,7	6,03	122,7	1,7153	0,11180	15,342	0,00
4	0-5	7	1.16824	1.18716	89,3	8,0	2,7	6,09	54,1	3,6314	0,12304	29,513	0,00
	5-15	8	1.24548	1.59844	85,3	8,0	6,7	5,76	63,8	2,1613	0,10891	19,844	0,00
5	0-5	9	0.88124	1.85192	85,3	8,0	6,7	6,03	52,8	0,7356	0,11201	6,567	0,00
	5-15	10	1.61748	1.987	85,3	8,0	6,7	6,01	30,1	0,5307	0,10528	5,040	0,00
6	0-5	11	0.42676	0.90404	73,3	16,0	10,7	5,79	79,2	2,2682	0,10933	20,746	0,00
	5-15	12	1.11992	0.91084	69,3	18,0	12,7	5,82	119,8	2,0739	0,10624	19,520	0,00
7	0-5	13	0.9082	1.10096	83,3	12,0	4,7	6,07	126,9	1,4371	0,11605	12,383	0,00
	5-15	14	1.31612	2.0342	91,3	6,0	2,7	6,21	128,1	1,3830	0,09959	13,886	0,00
8	0-5	15	0.75852	1.02592	85,3	10,0	4,7	6,39	131,5	1,4365	0,09974	14,402	0,00
	5-15	16	1.14784	1.59344	83,3	12,0	4,7	6,51	207,1	1,6015	0,10249	15,625	0,00
9	0-5	17	0.41368	0.98476	93,3	4,0	2,7	6,62	188,2	10,1270	0,14220	71,216	0,2563
	5-15	18	0.52868	2.08124	87,3	8,0	4,7	6,69	209,0	9,7483	0,15569	62,613	0,2456
10	0-5	19	0.58636	1.21216	77,3	12,0	10,7	6,91	86,7	2,1319	0,10431	20,438	0,00
	5-15	20	0.95092	1.60364	79,3	10,0	10,7	6,66	87,4	2,0979	0,12042	17,421	0,00

Table 3. Average measurement results of penetrometer.

Sample areas no	Top soil (kg/ cm^2)	0-5 cm (kg/ cm^2)	0-15 cm (kg/ cm^2)
1	26.375	12.75	09.16
2	34.93	34.62	13.12
3	27.37	17.12	18.12
4	18.75	09.53	05.83
5	27.5	12.12	11.25
6	32.25	27.75	13.33
7	32.62	31.25	22.5
8	22.5	16.37	15
9	24.12	29	18.75
10	18.12	9.25	08.75

Conclusion

For this study we can specify 5 main factors as pointed out comes. Those can briefly explained as ordered below;

Species diversity found not related with the used area by the local people. Even the sample areas 2, 4 and 5 are located in or near the used area, their species diversity measurement was high.

Contrary to general; pH values found acceptable for plant growth for all that activities of the local people. In general, pH values increase by increasing visitor activities.

Local people's behaves are observed environmentally firendly at the field studies. Either conscious or non-conscious local people's behave has positive effect for the plant species distribution. Only cover abundance scales are effected in sample areas 2, 4 and , 5 which are located in or near the heavily used areas by local people.

There is no significant relation determined between used areas and soil compaction. Soil compaction does not go in parallel with fine soil weight values as far from usual; this can be related with stony soil character of the study area. Only in sample are 2 which was located at the used area, compaction was high.

No significant relation determined plant species distribution or cover abundance scales and soil properties in the alpine region.

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