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Relationship between Water Table Depth and EC and pH of Soil with Vegetation (Case Study: West Coastland of Maharloo Lake at Fars Province)

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ABSTRACT

Maharloo Lake covers an area of 257 km² that located on 18 km East of Shiraz city. This research aimed to investigate the vegetation of lake's western border land. At first location, geology, hydrogeology, pedology and climatology were studied. Aim of this research is relationship between water table depth and EC and pH of soil with vegetation. Because of it, in first step, vegetation types were made on the basis of geomorphology of region and then within each vegetation type, sampling the vegetation completely randomly by transect method using transect of 30 m and 3 transects per each type. In each type, sampling soil to a depth of one meter by foreseeing two depths (first depth 0-50 cm and second depth 50-100 cm) were done and soil samples tested by experiments involving saturated percentage, electrical conductivity, pH of soil and texture. Total depth of groundwater obtained using total station camera and the topographical maps and wells in the area and field studies. Finally, according to data obtained from vegetation studies, soil and underground water depth, the relationship between these factors was obtained by Pc-ordination software and by Canonical Correspondence Analysis (CCA) was analyzed.

Keywords: Maharloo lake, Vegetation, Soil, Groundwater depth, CCA

INTRODUCTION

Saline lands are large part of the country where over 10% are included [1]. At this point, there are plants that are unique and have their own characteristics. Plants of this land in many cases are used as forage plants and many of them have industrial, medicinal talents.

Non-normative perceptions and using these plants as forage plants or otherwise, would jeopardize the survival of them. To prevent the destruction of this cover and protect them first step is to fully understand the relevant ecosystems in terms of ecological, edaphical, botanical, etc.

As you know, in saline lands edaphic factors effect on vegetation is more than other factors, including climatic factors [2], thus, in this study, further research practice is focused on edaphic factors. Given the importance and the need for planning for sustainable use of these plants, answers the following questions in the research:

1. In view of the importance of plants in the area, how edaphic characteristics distribute plants and how are generally their effects on the plants?
2. How is the role of plants in the region in terms of habitat, soil conservation, production and Ethno botany (used by the people)?
3. What methods and mechanisms to improve the plants should be used?

MATERIALS AND METHODS

The basin of Maharloo Lake within geographical area 52°14' to 53°28'E and 29° to 29°57'N and from the northwest

to the southeast it stretches, its length is about 160 km and its width is maximum 43 km. The basin area is 4272 km^2. The amount of 2323 km^2 is highlands and 1949 km^2 is plain areas [3].

Maharloo Lake, in 18 km South-East of Shiraz in the range of longitude 52°56' to 52°40' and latitude 29°35' to 29°35', has a maximum length of 50 and maximum width of 12 km [4].

The highest point in the Gorr Mountain is 3720 m and the lowest point at the center of the northwestern part of the lake is at an altitude of 1460 m. The average height of the lake is 1,500 m above sea level [5]. Figure 1 shows the location of Maharloo Lake.

RESEARCH METHODOLOGY

Vegetation studies

The general trend of these studies is as follows:

First step

At this stage, all the research and information that has already been done in the area of vegetation in the region were collected. The topographic maps in scale of 1:50/000 range as well as aerial photos in scale of 1:55/000 obtained and mosaic were taken from them.

Second step

At this stage, initially due to topographic maps as base map, and also due to the ways and points are marked on the map, attempted to justify the map on the field and using altimeter and compass, range of different lands identified and finally were detected. Vegetation types based on geomorphic took place because the classification of types of vegetation will be based geomorphologic units.

Figure 1: The location of Maharloo lake

For this typing, geomorphologic maps and aerial photos were used. In each type completely randomly sampling was done that line transect method was used. The plant types were named according to the species or dominant species.

Third step

Includes operations headquarters, setting information and final analysis

Soil studies

The general trends of these studies are as follows:

First step: Field studies

According to land capability map of the region, three points were randomly selected of any type for sampling soil and the samples were from anywhere in two depths of 50-0 and 100-50 cm. Then, similar samples were pooled and maintained in separate plastic bags and labeled with vegetation type and the depth to send them to lab for different tests.

Second step: Laboratory studies

One of the factors affecting distribution of soil is physical and chemical properties of the soil [6].With testing the samples, the information was obtained from the soil of vegetation types and was used in the analysis of the relationship between vegetation and soil. Studies of tissue, electrical conductivity, and saturated percentage and soil acidity were conducted on the samples under study. Appropriate methods were used for each of these factors, so that to determine soil texture and the electrical conductivity (EC); hydrometric method and conductivity meter were used, respectively. The following formula was used to determine the saturation percentage [7]:

Weight of absorbed water/Weight of dry soil*100

Electrical conductivity meter and/or Electrometric method were used to determine the acidity of the soil [8].

Groundwater table depth studies

Given that the study area is mountainous and changes in groundwater depth is very variable, the depth of water in each type was obtained using topographic maps, wells in the area of field studies and the Total Station Camera.

Analyzing vegetation and soil parameters

The most common type of data in each ecological community is the data of the abundance component of species which obtained by sampling units such as plots or releve [9]. This data is in the form of a matrix in which species are in row and sampling units in its columns. This matrix has multiple dimensions and there are different ways to access the most important aspects of the data set, including sorting sample components or species according to environmental gradient or ordination. In this paper, however, Wards ordination method used to ordination vegetation type. On the other hand, the Canonical Correspondence Analysis (CCA) was used to analyze the vegetation and edaphic factors.

RESULTS

Here, the results show the five types of vegetation so that include each vegetation type, dominant species, some related species, length of the western edge of the lake that cover the type, condition and trend of the type which are summarized in Table 1.

The results of the tests on the samples represent the texture, saturated percentage, electrical conductivity and pH. Table 2 summarizes this information for each type.

The changes in groundwater table depth in each type are given in Table 3.

The results of the vegetation

According to studies conducted in the region, five vegetation types are identified and presented as follows Table 4:

***Plant type no. 1* (*Artemisia sieberi*)**

The dominant species of this type is *Artemisia sieberi* of Compositeae family which is a perennial plant with herbaceous habitat form and palatability degree of II. Some species of this type include:

- *Stipa barbata* of Gramineae family and palatability degree of III.

Table 1: General information about vegetation types

Type number	The dominant species	The length on the west coast for each type (Km)	Condition	Trend
1	*Artemisia sieberi*	1/9	Medium	Upward
2	*Astragalus arbusculinus – Eryngium bungei – Echinops robustus*	5/1	Medium	Upward
3	*Echinops robustus – Astragalus arbusculinus*	3/8	Medium	Upward
4	*Juncus species*	8/2	Good	Upward
5	*Astragalus arbusculinus*	3/3	Poor	Upward

Table 2: The lab results of soil samples in each type

	Type number	1			2			3			4			5		
First depth (0-50) cm	Transect number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	5
	Texture	Cl	Cl	Cl	Scl	Scl	Scl	Sc	Sc	Sc	Sc	Sc	Sc	Sl	Sl	Sl
	pH	7/86	7/82	7/85	7/91	7/88	7/88	7/99	7/96	7/95	8/16	8/18	8/19	8/41	8/44	8/41
	EC	0/37	0/34	0/35	0/52	0/52	0/50	0/35	0/34	0/36	0/62	0/62	0 61	0/65	0/67	0/66
	SP	61	62	61	62	61	63	62	63	62	64	62	63	58	57	58
Second depth (50-100) cm	Texture	Cl	Cl	Cl	Scl	Scl	Scl	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc
	pH	7/86	7/82	7/86	7/94	7/85	7/86	7/97	7/95	7/94	8/18	8/17	8/ 18	8/42	8/41	8/42
	EC	0/37	0/35	0/35	0/51	0/5	0/5 1	0/35	0/35	0/36	0/62	0/62	0/ 62	0/65	0/65	0/66
	SP	61	61	60	61	60	62	61	63	62	64	63	62	59	57	57

Table 3: Changes in groundwater depth for each vegetation type

Changes range in groundwater depth (H_w) (meter)	Type Number
H_w>14	1
H_w>14	2
H_w>14	3
7<H_w<15	4
0<Hw<14	5

- *Astragalus arbusculinus* of Leguminosae family and palatability degree of III.
- *Echinops robustus* of Gramineae family and palatability degree of III.
- *Amygdalus scoparia* of Rosaceae family and palatability degree of III.

The tree species of *Ficus johannis*, however, can be found only in the bases of rocks. Due to improper slope type, there is not any agriculture and tree planting in the region.

The condition of this type is moderate and its trend is upward. In hillsides, the average slope of this type is about 31%.

***Plant type no. 2* (*Astragalus arbusculinus–Eryngium bungei-Echinops robustus*)**

The dominant species of this type, respectively, are: *Astragalus arbusculinus* of Leguminosae family that is a perennial plant with herbaceous habitat form and palatability degree of III.

Then, *Eryngium bungei* of Umbelliferae family is also a perennial plant with herbaceous habitat form and palatability degree of III.

Echinops robustus of Compositeae family is a perennial plant with herbaceous habitat form and palatability degree of III.

The other related species includes *Artemisia sieberi* of Compositeae family and palatability degree of II.

As type No. 1, *Ficus johannis* can be found only in the bases of rocks. In high slopes, *Amygdalus scoparia* species can be found. Due to improper slope type, there is not any agriculture and tree planting in the region.

The condition of this type is moderate and its trend is upward. In hillsides, the average slope of this type is about 27%.

***Plant type no. 3* (*Echinops robustus-Astragalus arbusculinus*)**

The dominant species of this type, respectively, are: *Echinops robustus* of Compositeae is a perennial plant with herbaceous habitat form and palatability degree of III.

Then, *Astragalus arbusculinus* type of Leguminosae family is also a perennial plant with bushy habitat form and palatability degree of III.

The other related species includes *Eryngium bungei* of Umbelliferae family with palatability degree of III.

Ficus johannis and *Amygdalus scoparia* can be found only in the bases of rocks and in high slopes. There is not any agriculture and tree planting in the region.

The condition of this type is moderate and its trend is upward. In hillsides, the average slope of this type is about 15%.

Plant type no. 4 (Juncus species)

The dominant species of this type is Juncus species of Juncaceae family which is a perennial with herbaceous habitat form and palatability degree of II. Its native name is "Khonk". The other related species includes *Taraxacum seratinum* of Compositeae family with palatability degree of I. In terms of phenology, the time between flowering and seeding is not significant so that in the middle of winter, for a while, the plant can also be seen in the flowering and seeding stage simultaneously. Compared to other types, this type has the highest cover in the region.

Average slope is about 2% which has created a good condition for farming and tree planting. The main garden areas are located in this region. On the other hand, agriculture can be seen in the type. The condition of this type is good and its trend is upward.

Plant type no. 5 (Astragalus arbusculinus)

The dominant species of this type is *Astragalus arbusculinus* of Leguminosae family is a perennial with plant habitat form and palatability degree of III.

The other related species are included: *Echinops robustus* of Compositeae family with palatability degree of III; *Poa bulbosa* of Gramineae family with palatability degree of III; *Atriplex leucoclada* of Chenopodiaceae family with palatability degree of II and *Cressa cretica* of Convolvulaceae family with palatability degree of III.

In abundance, *Poa bulbosa* can be found in arable lands that have a greater distance from lake. *Cressa cretica* can be seen in smaller amount in arable lands that have a smaller distance from lake.

The regional average slope is around zero percent and water is visible on the ground. There is a permanent peat and certain plants can be seen that are resistant to high humidity conditions. The condition of this type is poor and its trend is upward.

The results of the soil test

The results of tests on different types of soil samples in the region are as follows:

In type 1, the results of soil testing show clay loam texture, pH=7/8, EC less than 0.5 dS/m and saturated percentage 61%.

In type 2, the results of soil testing show silty clay loam texture, pH=7/9, EC less than 0.5 dS/m and saturated percentage 62%.

In type 3, the results of soil testing show silty clay texture, pH=7/9, EC less than 0.5 dS/m and saturated percentage 62%.

In type 4, the results of soil tests indicate silty loam texture, pH=8/1, EC higher than 0.5 dS/m and saturated percentage 64%.

In type 5, the results of soil testing show silty loam texture, pH=8/4, EC more than 0.5 dS/m and saturated percentage 58% (Table 2).

The results of the water table depth

Table 3 shows the changes in groundwater depth for each type.

The results of vegetation and soil parameters analysis

Ordination results indicate that in the cut surface at 80% achieved four ecological groups. While in the initial geomorphological typology obtained 5 types. By comparing the two groups found that the comparison groups fit together and just geomorphological types two and three together formed an ecological group and other types of geomorphological and ecological groups are the same. The reason can be many similarities between these two types of geomorphological types two and three.

Results from the canonical corresponding analysis that was conducted at two depths indicate, in the first depth (0-50 cm), *Astragalus arbusculinus* has the highest correlation and *Juncus* sp. has the lowest correlation with the first axis and *Astragalus arbusculinus* has the highest correlation and *Artemisia sieberi* has the lowest correlation with the

second axis and *Poa bulbosa* has the highest correlation and *Echinops robustus* has the lowest correlation with the third axis. The electrical conductivity of the soil has the lowest correlation with the first axis and silt percentage has the highest correlation with the first axis, also in second axis, pH has the highest correlation and the percentage of sand has the lowest correlation with it and in the third axis pH has the highest correlation and clay percentage has the lowest correlation with it (Figures 3-8).

In the second depth (50-100 cm), *Astragalus arbusculinus* has the highest correlation and *Juncus* sp. has the lowest correlation with the first axis and in the second axis *Artemisia sieberi* has the highest correlation and *Astragalus arbusculinus* has the lowest correlation with it and in the third axis *Poa bulbosa* has the highest correlation and *Echinops robustus* has the lowest correlation with it.

Also, silt percentage has the highest correlation with the first axis and saturated percentage has the lowest correlation with it and in the second axis, sand percentage has the highest correlation and pH has the lowest correlation with it, and in the third axis, pH has the lowest correlation and clay percentage has the lowest correlation with it (Figures 2-8 and Tables 5-8).

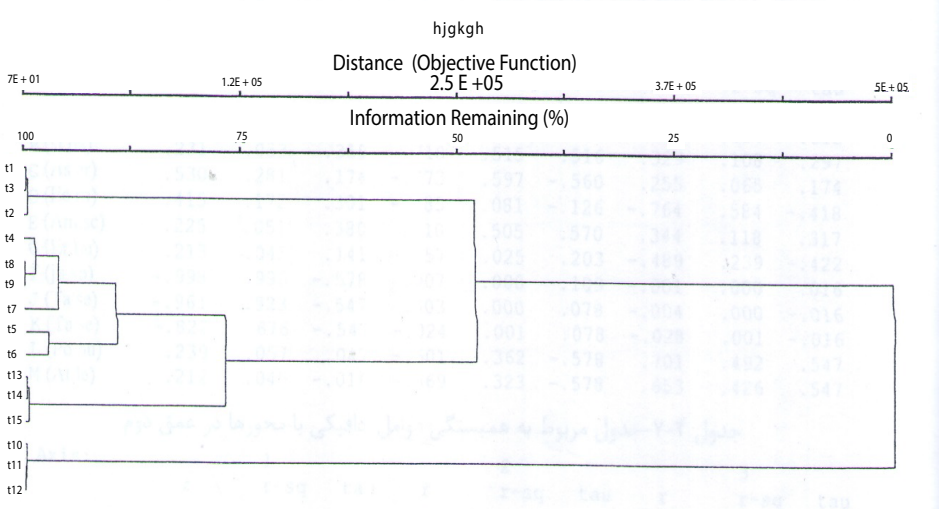

Figure 2: Wards dendrogram

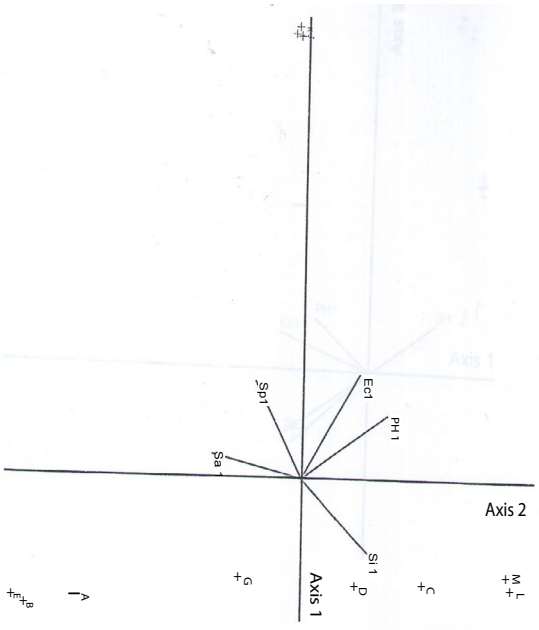

Figure 3: Distribution diagram of the species relative to axis 1 and 2 in the first depth

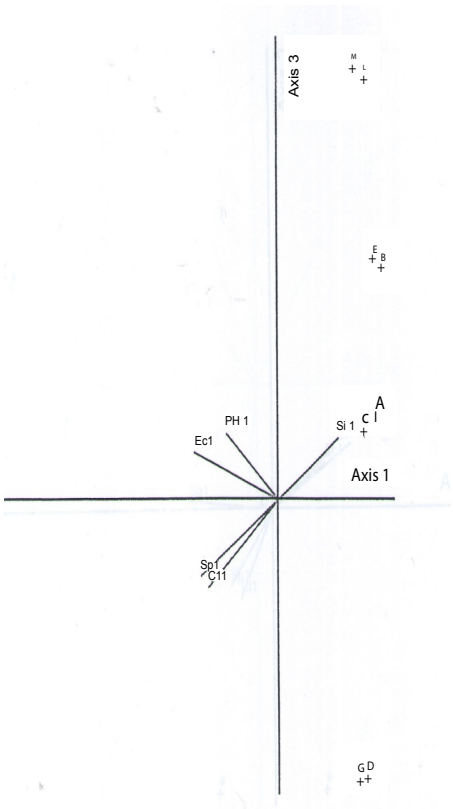

Figure 4: Distribution diagram of the species relative to axis 1 and 3 in the first depth

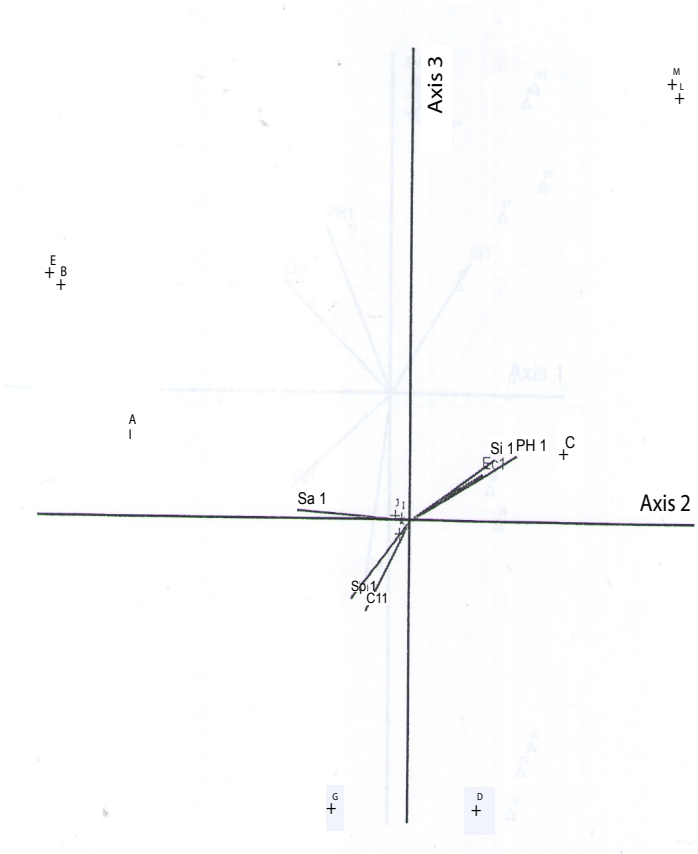

Figure 5: Distribution diagram of the species relative to axis 2 and 3 in the first depth

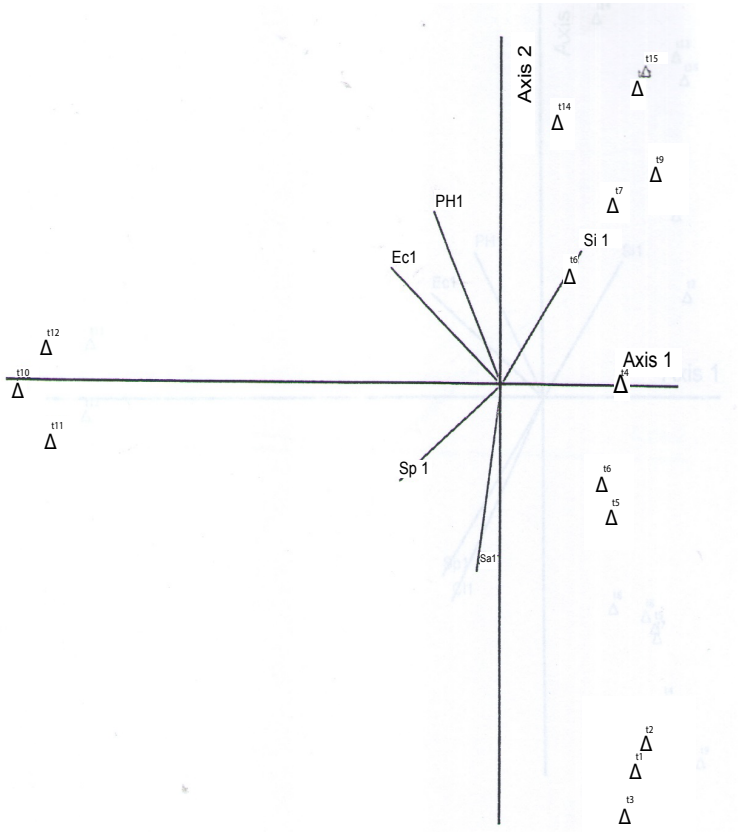

Figure 6: Distribution diagram of the transects relative to axis 1 and 2 in the first depth

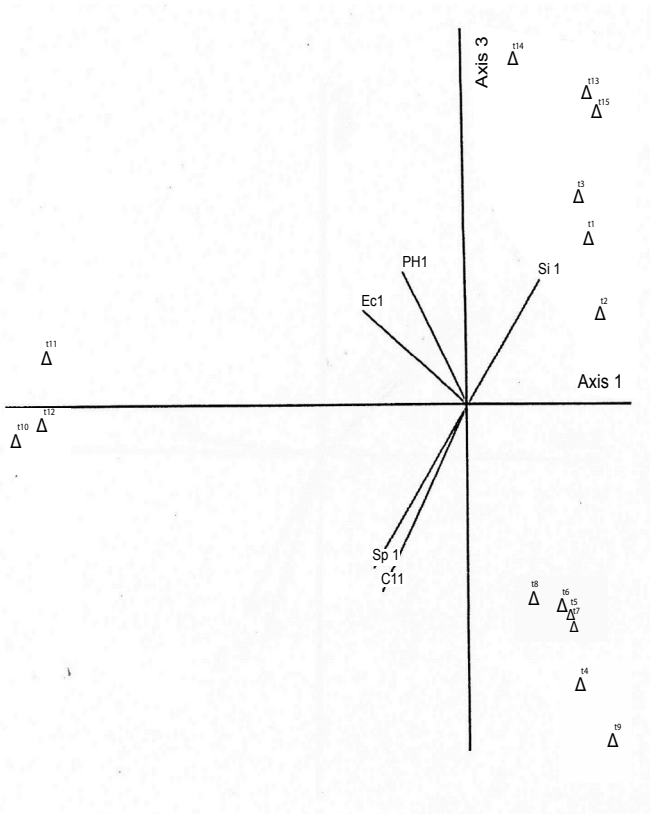

Figure 7: Distribution diagram of the transects relative to axis 1 and 3 in the first depth

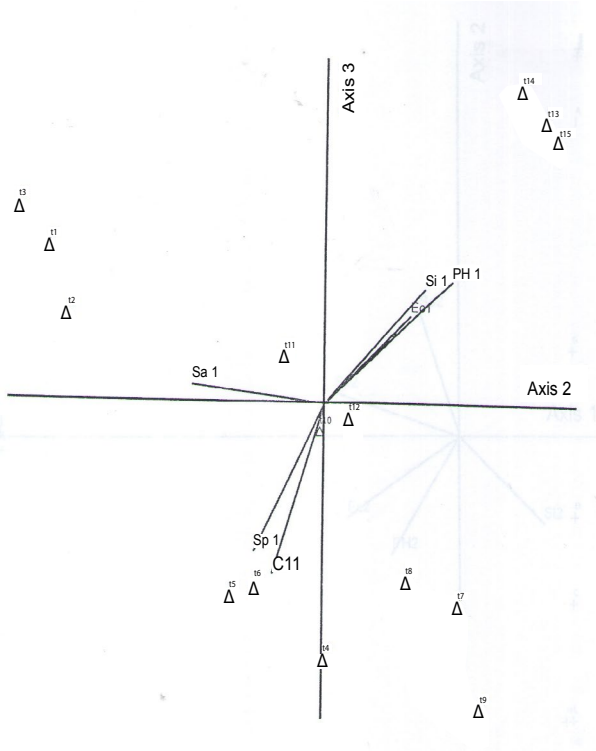

Figure 8: Distribution diagram of the transects relative to axis 2 and 3 in the first depth

Table 4: General information about plant species in region types

No.	Species name	Family name	Plant life	Growth habit	Nutritional values
1	*Artemisia sieberi*	Compositeae	Perennial	Grass	∏
2	*Stipa barbata*	Gramineae	Perennial	Grass	III
3	*Astragalus arbusculinus*	Leguminosae	Perennial	Shrub	III
4	*Echinops robustus*	Compositeae	Perennial	Grass	III
5	*Amygdalus scoparia*	Rosaceae	Perennial	Bushy tree	III
6	*Eryngium bungei*	Umbelliferae	Perennial	Grass	III
7	*Poa bulbosa*	Gramineae	perennial	Grass	III
8	*Atriplex leucoclada*	Chenopodiaceae	Perennial	Grass	∏
9	*Juncus species*	Juncaceae	Perennial	Grass	∏
10	*Cressa cretica*	Convolvulaceae	Perennial	Shrub	III
11	*Taraxacum seratinum*	Compositeae	Perennial	Grass	I
12	*Ficus johannis*	Moraceae	Perennial	Tree	III

Table 5: Correlation between species with axes in the first depth

Axis		1			2			3	
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
A (Ar.si)	0.37	0.137	0.317	-0.894	0.8	-0.717	0.183	0.033	0.012
B (st.ba)	0.249	0.062	0.328	-0.726	0.527	-0.578	0.335	0.112	0.297
C (As.ar)	0.515	0.265	0.29	0.781	0.611	0.541	0.241	0.058	0.116
D (Ec.ro)	0.399	0.16	0.398	0.271	0.073	0.185	-0.792	0.627	-0.476
E (Am.sc)	0.237	0.056	0.317	-0.726	0.572	-0.602	0.341	0.116	0.317
G (Er.bu)	0.196	0.038	-0.109	-0.153	0.024	-0.234	-0.419	0.176	-0.359
I (ju.sp)	-0.992	0.984	-0.547	-0.019	0	-0.047	0.004	0	0.016
J (Ta.se)	-0.96	0.922	-0.578	-0.034	0.001	-0.078	0.007	0	-0.016
K (Ta.se)	-0.839	0.704	-0.578	-0.02	0	-0.078	-0.018	0	-0.016
L (Po.bu)	0.24	0.058	0.172	0.618	0.383	0.578	0.702	0.492	0.547
M (At.le)	0.197	0.039	0.109	0.568	0.322	0.516	0.679	0.461	0.609

Table 6: Correlation between edaphic factors with axes in the first depth

Axis		1			2			3	
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
Ec1	-0.47	0.221	-0.204	0.497	0.247	0.379	0.428	0.183	0.34
PH1	-0.29	0.084	-0.279	0.733	0.537	0.644	0.602	0.362	0.279
Sp1	-0.434	0.188	-0.395	-0.403	0.163	-0.125	-0.723	0.523	-0.499
C11	-0.391	0.153	-0.319	-0.299	0.089	0.139	-0.825	0.68	-0.657
Si1	0.335	0.112	0.247	0.579	0.336	0.35	0.563	0.317	0.185
Sa1	-0.103	0.011	-0.078	-0.776	0.603	-0.566	0.088	0.008	0.156

Table 7: Correlation between species with axes in the second depth

Axis		1			2			3	
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
A (Ar.si)	0.348	0.121	0.458	0.911	0.83	0.74	0.183	0.034	0.012
B (st.ba)	0.231	0.053	0.359	0.718	0.515	0.516	0.329	0.108	0.297
C (As.ar)	0.53	0.281	0.174	-0.773	0.597	-0.56	0.255	0.065	0.174
D (Ec.ro)	0.415	0.172	0.301	-0.285	0.081	-0.126	-0.764	0.584	-0.418
E (Am.sc)	0.225	0.051	0.38	0.71	0.505	0.57	0.344	0.118	0.317
G (Er.bu)	0.213	0.045	0.141	0.157	0.025	0.203	-0.489	0.239	-0.422
I (ju.sp)	-0.998	0.996	-0.578	0.007	0	0.109	-0.001	0	0.016
J (Ta.se)	-0.961	0.923	-0.547	0.003	0	0.078	-0.004	0	-0.016
K (Ta.se)	-0.822	0.676	-0.547	-0.024	0.001	0.078	-0.028	0.001	-0.016
L (Po.bu)	0.239	0.057	0.047	-0.601	0.362	-0.578	0.701	0.492	0.547
M (At.le)	0.212	0.045	-0.016	-0.569	0.323	-0.578	0.653	0.426	0.547

Table 8: Correlation between edaphic factors with axes in the second depth

Axis		1			2			3	
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
Ec2	-0.488	0.238	-0.242	-0.496	0.246	-0.423	0.409	0.167	0.342
PH2	-0.289	0.084	-0.304	-0.717	0.514	-0.638	0.615	0.379	0.343
Sp2	-0.541	0.293	-0.332	0.271	0.073	0.131	-0.646	0.417	-0.493
C12	-0.423	0.179	-0.324	0.207	0.043	-0.108	-0.839	0.704	-0.618
Si12	0.361	0.13	0.226	-0.534	0.285	-0.226	0.579	0.336	0.284
Sa2	-0.165	0.27	-0.01	0.773	0.597	0.612	0.023	0.001	0.126

DISCUSSION AND CONCLUSION

In general, the area's soils were studied in five groups that soil texture is moderate to very heavy. The moderate soil texture is seen just in one type and the rest of the types have heavy through very heavy texture.

The pH is slightly alkaline throughout the region because it is between 7.8 to 8.4.

Electrical conductivity of soils is less than 1 dS/m.

Saturated percentages of soils are between 58 to 64.

All in all, according to soil parameters variation and slightly changes in types of vegetation can be concluded that the soil parameters have not a considerable impact on the distribution of vegetation.

The studies showed that only two types of area have slightly or zero slope. Therefore, the effect of groundwater depth on vegetation can be noted specially in the fifth type, where the underground water level in the coast of lake is zero.

Slope of the region in the first three types, are significant and in the final two types, slope is slightly. According to it, *Ficus johannis* in the region is seen just in the first three types. *Amygdalus scoparia* also seen in the steep slopes of second and third types.

Vegetation was studied in five types that the largest cover is seen in fourth type and Juncus species and the lowest cover is also seen in the fifth type. *Astragalus arbusculinus* has the most distribution in the area and is dominant species in three types and then *Echinops robustus* is dominant species in two types. On the other hand, *Cressa cretica* has the smallest distribution in the area which is in the fallow farmlands of the fifth type with close distance from lake. After that is *Taraxacum seratinum* which is in the fourth type and then is *Poa bulbosa* that is in the fallow farmlands of the fifth type with far distance from lake.

Of all species in the area, just *Taraxacum seratinum* has palatability degree of I, of course, this is only in the fourth type and other species have palatability degree of Π and III.

Most species have herbaceous habitat form, as well as all of the plants are permanent.

Just the fourth type has good condition and the fifth type has poor condition. Condition of other types is moderate.

As well as all types have progressive trend because the area is under protection by the Department of Environment of Fars province as well as the Department of Natural Resources of Fars province.

In conclusion it can be said, in previous studies done in the area, results are similar to this, except in a few cases. In Sedighian studies in 1975 [10] and Plan and Budget Organization in 1992 [3] and 1989 [5], Western edge of the lake is divided into five divisions exactly same this research. Studies of groundwater depth and soil parameters of this research and them are the same too. Only there are few differences related to vegetation factors because condition, trend and other vegetation factors will become changed along time.

SUGGESTIONS

1. Given that agriculture is the most important jobs for local residents and animals living in the area are a few, it cannot be seen uncontrolled grazing in the area, and only when nomads move from cold regions of Kohkiluyeh and Boyer Ahmad province to tropical regions of Fars province and vice versa , they pass from this area. Just at this time, uncontrolled grazing can be seen.
2. Cutting plants in the region are seen slightly. The reason is the lack of urban gas pipelines in the region and need to do this or delivery of gas cylinders there would be permanent.
3. Due to the proximity of the lake to the city as well as its own beauty, good tourist situation in this region can be seen that according to the principles of conservation, other concerned organizations must attract domestic and foreign tourists.
4. Given that this area is the most important center in the province for salt production and also the number of factories added every day, increasing of factories must be according to the principles of sustainable development.

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