DESERT

DESERT
Online at http://jdesert.ut.ac.ir

DESERT 14 (2009) 1-14

Investigation of soil physico-chemical properties in playa wetlands (Case study: Daryacheh-Namak)

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Received: 5 December 2005; Received in revised form: 20 April 2007; Accepted: 23 July 2007

Abstract

Soil, is a reclamable and sustainable source. it is the basis of survival and it's implication, should be performed on the basis of productivity identification according to scientific and technical rules, we can protect this valuable source, and increase it's productivity and usage. Nowdays, saline soils cover nearly 14.6% of the country area. Study areas (Kashan' playa) have saline and alkali soils. Identification of these soils and their's reclamation and implementation for different usage, is very important, especially, they have abundant water resources. They have important influence on establishment and development of plants. Therefore, we started qualitative and quantitative pedological research. First, we prepared cover map as georeference with Ilwis 3.3 software. We overlaied cover map and georeference geological map. We determined 12 working units, and then we took samples from units. Physico-chemical factores such as EC, Gypsum%, soluble cations and anions, organic matter, $CaCO_3$ % and etc, determined from the depths of 0-10, 20-40, 40-80 of plant types(working units, QM, QC) in February and july. Result shows, Na, Mg, SO_4, K, pH, Cl, CO_3, HCO_3, $CaCO_3$, SAR, CEC rates decreased and Gypsum and Ca% rates increased, from the Lake to uplans. Also, the soil's texture was changed from clay sandy loam to sandy loam. At last, was drew Soil's salinity map according to the soil taxonomy, it is in entisol order, aquent suborder, endo aquent greatgroup and typic endoaquent subgroup. According to the results, the soil isn't suitable for dry farming and aquaculture (very bad class (class V)). Study area, covered by halophyte plants and it will be appropriate to develop and improve with other halophytes. It should be protected from animals. Especially camels that conserve soil structure and poor plant cover.

Keywords: Soil physico-chemical properties; Playa wetland; Daryacheh-Namak; Kashan; Soil Taxonomy; Profile explanation

1. Introduction

In spite of, the vast expansion of the arid and semiarid area in iran, a few studies have been made about the bioms and their components, and lack of the information, causes increasing desertification and loss of soil's potentials. Therefore, environment because of the vulnerable components, the biom's management and it's planning for sustainable development, is very important. It's needed to perform precise identification of their's ecological properties (8). Nowadays, Soil's protection due to mentioned reasons, is one of the human's main responsibilities, because, both the present generation and the future generation will be exposed to dangers. Then, It should be necessary to conserve the soil with compatible halophytes and use of soil and plant relationship with soil is

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very important, because, some of halophyte plants are indicators of specific soils and also plants influence on soil's structure and chemical properties. Statistical methods have us to understand ecological relation in natural biom. About ¾ Iranian's soils are saline and alkaline soils, due to dry climate. Desertification increased so much in two decades in Iran. The main reasons are soil' degradation and climatic factor. Therefore, it's useful and vital to find a solution to manage and conserve the soils and their sparse plants.

Hilgard (1906), was the one of the first scientists who introduced the method of alkalin soils recognition with respect to the plant growth. Robert (1997), studied the influence of halophytes plants on soil's properties, has shown the effect of halophytes on soil's chemical properties. Nivikev(1961), expressed that expansion of some halophyte spacies in Tunisia, have been influenced soil's texture. Kereni et al (1996), acheived the quantity relationships between halophytes's plants structure and soil's properties in Utah. Khani (1977), investigated the relationship of plants cover expansion regards to the salinity rates and soil's humidity in Eshtehard's region and he infered that the rates of the soluble exchangeable sodium, Electrical Conductivity, the rates of Cl, SO_4 and HCO_3 anions, are very important. Moghimi(1990), investigated the relationships between plant cover, soil's salinity and water table in Ghom's Hose Soltan and concluded that to move from uplands to low lands, water table depth, declined and the soil's salinity increased. Jafari (1990), investigated the relationships among plant cover, soil's salinity and the salinity influences on desert' plants compositions. He has shown that to move from the uplands to low lands, the salinity rates increased. Sameni (1993), investigated the water conductivity changes of some desert soils- that sodium ion and the saline circumstances, disturbed soil's structures- in the form of soils's sensitivity index against sodium and salin circumstances. He has shown that to increase the soil's sodium and SAR rates, the soil's sensitivity index or in fact, water conductivity, reduced, and he found the linear relationship between the SAR increases and the soil's ensitivity index decreases.

2. Materials and methods

2.1. The study area

The study area is situated in the southern margin of Salt Lake, at 45 kilometers of the north-eastern of Kashan city, Isfahan province. This area from the south, end to sanddunes, Maranjab Caravansary, Koshko field and Yakhab mountain; from the north to Salt Lake; from the east to the Abrizan mountain, Talbour and Sephidab and finally, from the west end to the villages and agricultural fields and Siahkouh, Sar, Takht Bozorg and Anabeneh uplands (Figure1). The region pounded by 51º 45′ 51″ to 51º 58′ 46″ E and 34º 17′ 34″ to 34º 20′ 29″ N. It's area is about 5422.448 ha and the average elevation is 975m. The study area is situated as narrow and wet bond in the southern edge of the Lake. It's annual mean rainfall is around 110 mm, and the region temperature with respect to the country annual isoterm map, is between 17.5 ºC to 23ºC. Also, Kashan's annual mean evaporation is nearly 2205.5mm.

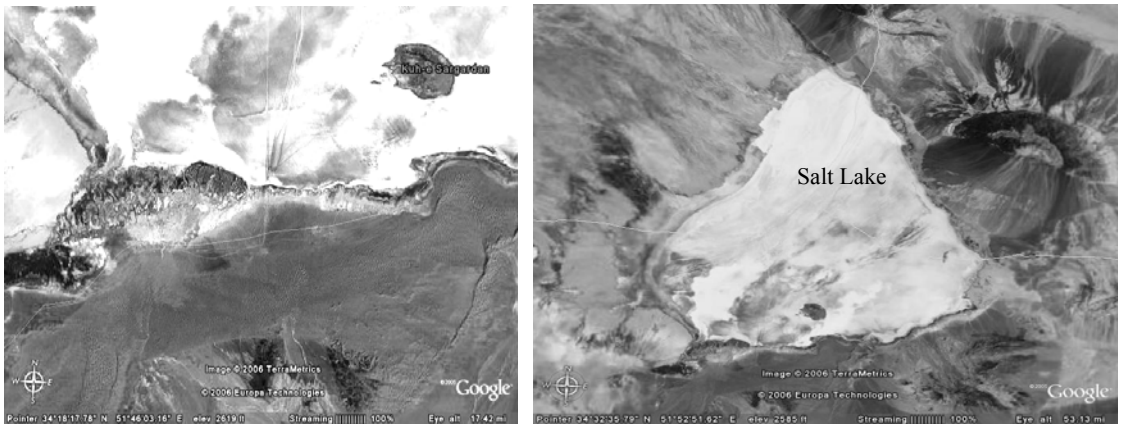

Fig. 1. The geoghraphical situation of the study area (south of Daryacheh-Namak)

At First, study area was specified by topography map 1:50000 and informations about the location, the common fitures and the field works determined. The necessary researches were performed. After the recognizing plant types (preparing the plant cover digital map) and the preparation of the work units digital map after overlaying the two maps, namely the plant cover and the working units digital map, the soils samples was picked up from the each working unit along notation of sampling points by GPS. The soil samples were taken from the each unit (with uniform plants cover) at the 0-20, 20-40, 40-80 cm depths at two periods (january and june). Then for the profile description of the each work unit, a profile was digged and necessary experiments were made in labratory.

2.2. Physico-chemical experiments

a) Determination of soil texture by Hydrometery method;
b) Soil's salinity measurements by Conductometer method;
c) Determination of soil pH by digital pH meter;
d) Determination of soil's organic mater by Walky-Blak method;
e) Determination of equivalent $CaCO_3$: First, one gram of the soil weighted, and then it
was poured into the 250cc orlen and then added the 50 mm volume of HCl 0.5 normal to on, then, after the finishing of the boiling, heated the orlen and then cleaned its. The extra acid was titrated by the soda 0.25 normal solution and by phenolphethalein reagent;
f) The Sodium and potassium amounts, was measured by Flame Photometer;
g) The Calcium and magnesium amounts, was measured by Compelexometery method;
h) Determination of soil's sulfate by Acetone method;
i) Determination of soil's carbonates: with use of phenolphethalein reagent- if the carbonate exist in the solution- the solution's colour would be made purple, then, it titre by HCl 0.5 normal and later, the carbonate rate would be Determined;
j) Determination of soil's HCO_3: the previous solution should be titrated by Methyl Oranzh reagent and HCl 0.5 normal and it will be Determined HCO_3 rate;
k) Determination of soil's Cl by silver nitrate or Mohr method.

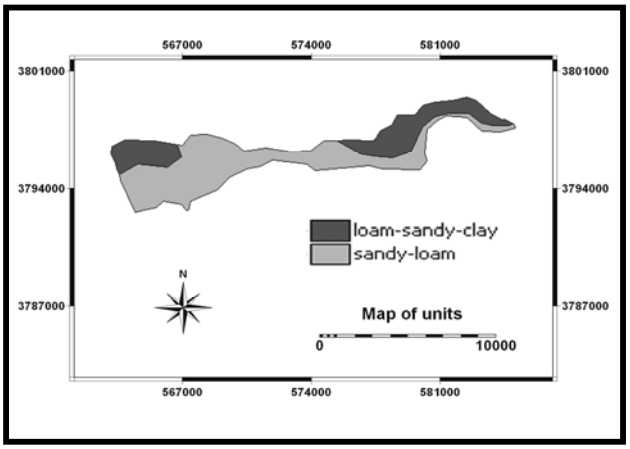

Fig. 2. Soil texture map of study area, Obtained from geology map

3. Results

According to the soil's mechanical experiments, the particles had the weak uniform and the matching coefficient was low. Also, the sand and silt percents were rather high. The region's soils humidity regimes, was aridic and torric, on the basis of the country's soils humidity regimes map (water and soil institute, 1995). Also, the Thermal regime was thermic, on the basis of country's soils thermal regimes map (water and soil institute, 1995).

3.1. Soil taxonomy

The region's soils, with respect to the high water table and the lack of soil's development in many reasons (the lack of the enough aeration, because of the high water table and etc, it would be induced to slow down soil's forming processes), accumulating the sediments overlaping together, the lack of the subsurface diagnostic horizons (salic, gypsic and etc.) was classified as entisol order, aquent suborder, endoaquent great group and typic endoaquent subgroup. Finally, their's profie was describle. At below, some of relations has been brought as different forms:

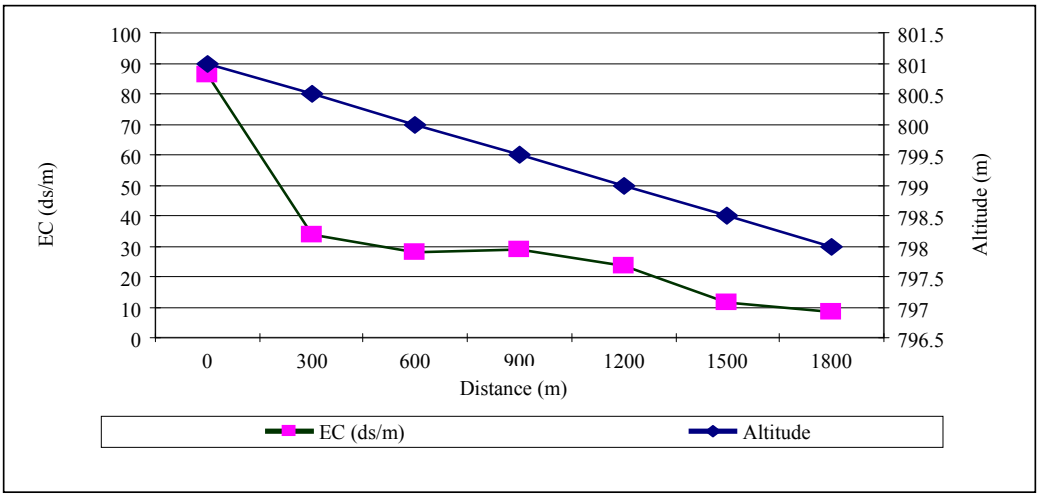

Fig. 3. EC's variations according to distance and the altitude from the Lake to the uplands

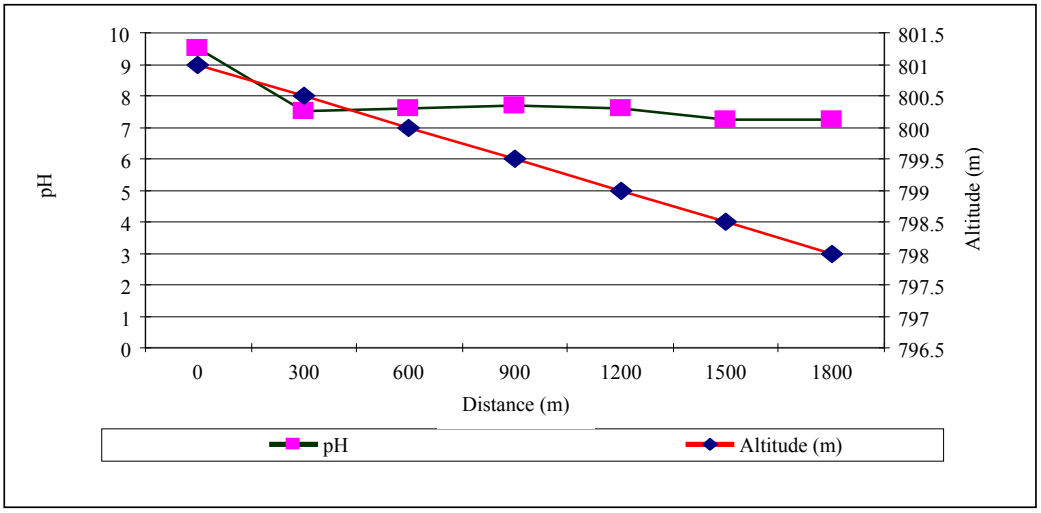

Fig. 4. pH's variations according to distance and the altitude from the Lake to the uplands

Table 1. Results of soil's physico-chemical experiments in *Tamarix SP*. Type (QM, QC)

Texture	%sand	%Silt	%Clay	CEC (meq/100)	SAR	pH	ECe (ds/m)	sampling	Season of sampling	physico-chemical properties / worked units
Loamy sand	60.1	24.3	15.6	9.5	59.7	8.06	22.8	0-20	Dry season	*(Tamarix ramosissima)* (QC)
Loamy sand	53.3	26	20.5	8.9	50.2	7.95	38.5	20-40		
Clay loamy sand	53.1	27.3	19.7	8.5	36.1	7.9	28.9	40-80		
Loamy sand	57.2	30.8	12	10.2	54.1	8.02	33.1	0-20	Moist season	
Clay loamy sand	52.6	27	20.6	7.5	36.5	8.2	30.0	20-40		
Loamy sand	60.7	24.5	14.8	8.4	28.6	7.88	20.6	40-80		
Loamy sand	52.5	29	18.5	6.8	48.3	8.05	40.2	0-20	Dry season	*(Tamarix ramosissima)* (QM)
Loamy sand	47.1	33.7	19.2	10.3	35.6	7.8	30.5	20-40		
Clay loamy sand	47.5	30.5	20.7	7.5	40.3	7.56	34.6	40-80		
Loamy sand	54.8	30.6	14.6	9.4	20.9	7.08	32.1	0-20	moist season	
Loamy sand	53.3	28	18.7	10.3	35	7.6	24.5	20-40		
Clay loamy sand	53.8	25.8	20.4	8.7	34.1	7.45	19.8	40-80		

Table 1. Continued

Equivalent lime %	Dissolued cations (meq/liter)				Dissolued anions (meq/liter)				Gypsum %	% O.M
	K^+	Na^+	Mg^{2+}	Ca^{2+}	$So4^{2-}$	Cl^-	$Hco3^-$	$Co3^{2-}$		
8.2	14.5	545	164	56	38.5	842	3.1	2.6	14	0.65
10.5	65.5	1173	241	49.2	80.4	1720	2.6	2.1	10.1	0.42
13.6	34.2	1134.5	212	38.0	82.4	1525	2.5	1.00	3.1	0.14
7.9	17.2	680	378	64.6	79.6	1055	2.7	2.5	12.1	0.62
12.4	55	1220.2	155	48.2	75.9	1720	2.6	30.01	8.2	0.35
16.2	39.4	1225	148	28	78.0	1642	2.45	1.8	4.1	0.21
12.4	22	425.2	130.5	87.5	42.5	650	1.4	3.00	20.4	0.0
9.8	46.5	287	118.0	52	30.7	452.3	0.8	1.7	15.6	0.2
16.0	37.4	325	210.5	36	28.2	621	1.2	2.5	12	0.35
14	28.7	398	89.0	90.0	25.0	490	1.4	1.85	14.0	0.42
20.3	34	362.2	143.5	65.0	36.2	642	0.95	2.4	20.3	0.0
`17.6	45.5	400.3	176	47.5	40.0	715	1.4	3.07	16.5	0.35

Table 2. Results of soils physico-chemical experiments in *Nitraria schoberi* (Qm,QC)

Texture	%sand	%Silt	%Clay	CEC (meq/100)	SAR	pH	ECe (ds/m)	Sampling depth	Season of sampling	Physico-chemical properties worked unit
Loamy sand	57.0	30.2	12.8	1.4	34.0	7.15	26.3	0-20	Dry season	*(Nitraria schoberi)* (Qc)
Loamy sand	54.5	29.5	16.0	1.8	33.2	7.08	16.8	20-40		
Loamy sand	58.1	23.9	18	1.65	24.02	7.3	19.6	40-80		
Loamy sand	59.7	27.3	13.0	1.05	29.3	7.11	26.0	0-20	moist season	
Loamy sand	64.5	24	11.50	2.0	31.1	7.05	19.3	20-40		
Loamy sand	55.4	30.5	14	2.22	18.2	7.22	14.7	40-80		
Clay loamy sand	59.3	30.2	10.56	1.00	30.5	7.2	22.3	0-20	Dry season	*(Nitraria schoberi)* (Qm)
Loamy sand	58.8	29.5	12	1.3	20.3	7.40	18.6	20-40		
Loamy sand	63.1	23.9	13.0	1.80	14.2	7.06	12.7	40-80		
Clay loamy sand	62.9	27.3	9.8	1.4	27.6	7.60	20.3	0-20	moist season	
Loamy sand	62	24.0	14	1.77	21.4	7.80	15.6	20-40		
Loamy sand	53.2	30.5	16.0	1.56	12.5	7.30	10.3	40-80		

Table 2. Continued

Equivalent lime %	Dissolued cations (meq/liter)				Dissolued anions (meq/liter)				Gypsum %	% O.M
	K^+	Na^+	Mg^{2+}	Ca^{2+}	$So4^{2-}$	Cl^-	$Hco3^-$	$Co3^{2-}$		
15.0	76.5	895.2	235	246	34.6	1405	2.4	0.20	18.6	1.16
16.2	50.4	302	247	180	45.1	756.7	2.75	0.12	11.0	0.9
17.0	22.1	592	160	110	4.02	835	1.9	0.10	3.4	0.5
15.5	45	854.1	125	250	22.1	1256	2.2	0.22	17.5	1.3
14.2	40.5	1100	145.2	160	24.3	1420	2.0	0.10	12.2	0.58
17.6	35.6	248	135	175.0	30.1	1002	1.85	0.11	2.56	0.65
14.6	64.2	578.1	189	200.5	40.2	987	3.1	1.0	22.1	0.9
16.5	30.1	224.0	221	158	22.1	678.2	1.8	0.56	9.5	0.5
18.2	13.8	438	135	124	18.6	685	0.9	0.12	5.0	0.56
20.1	60.2	362	225.4	215.1	38.7	786.4	1.87	1.05	17.8	1.40
16.8	23.5	306.1	148.2	187.4	18.5	564	1.7	0.78	14.6	0.25
10.8	14.5	512.4	65.2	87	21.4	658.4	1.56	0.5	12.5	0.50

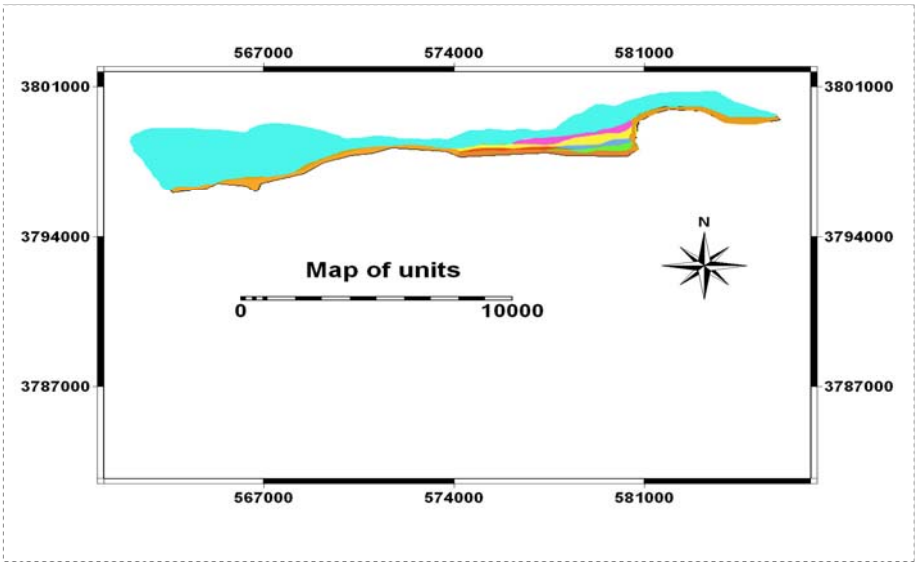

Fig. 5. The region's salinity map

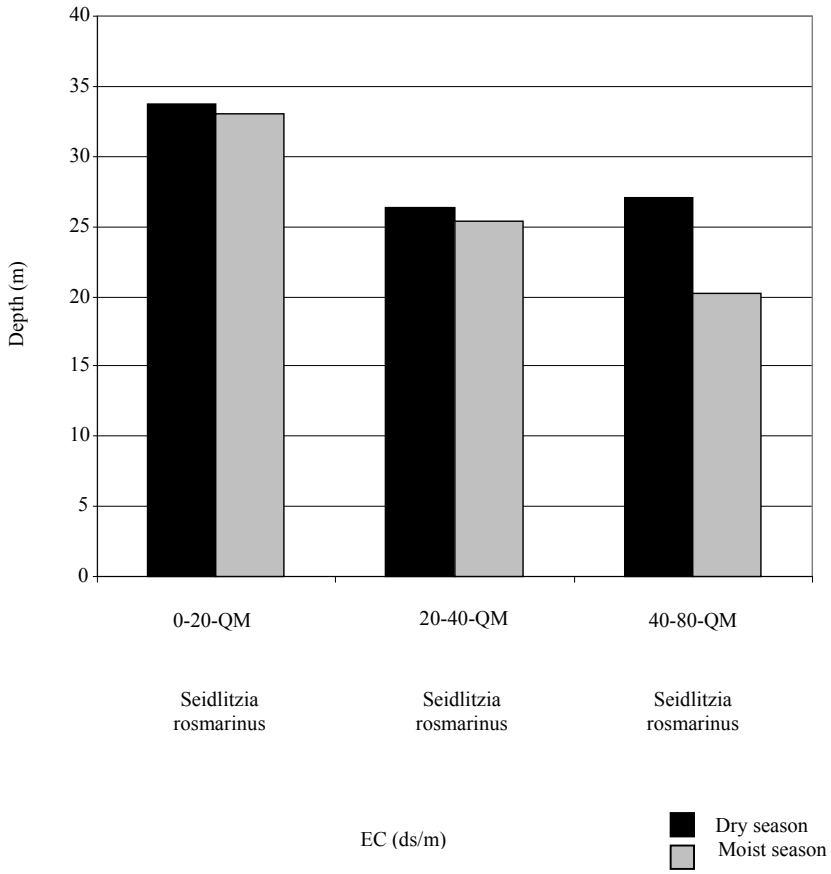

Fig. 6. Relationship of salinity in different depths of *sedlitzia sp*. (Qm) unit in dry and wet season

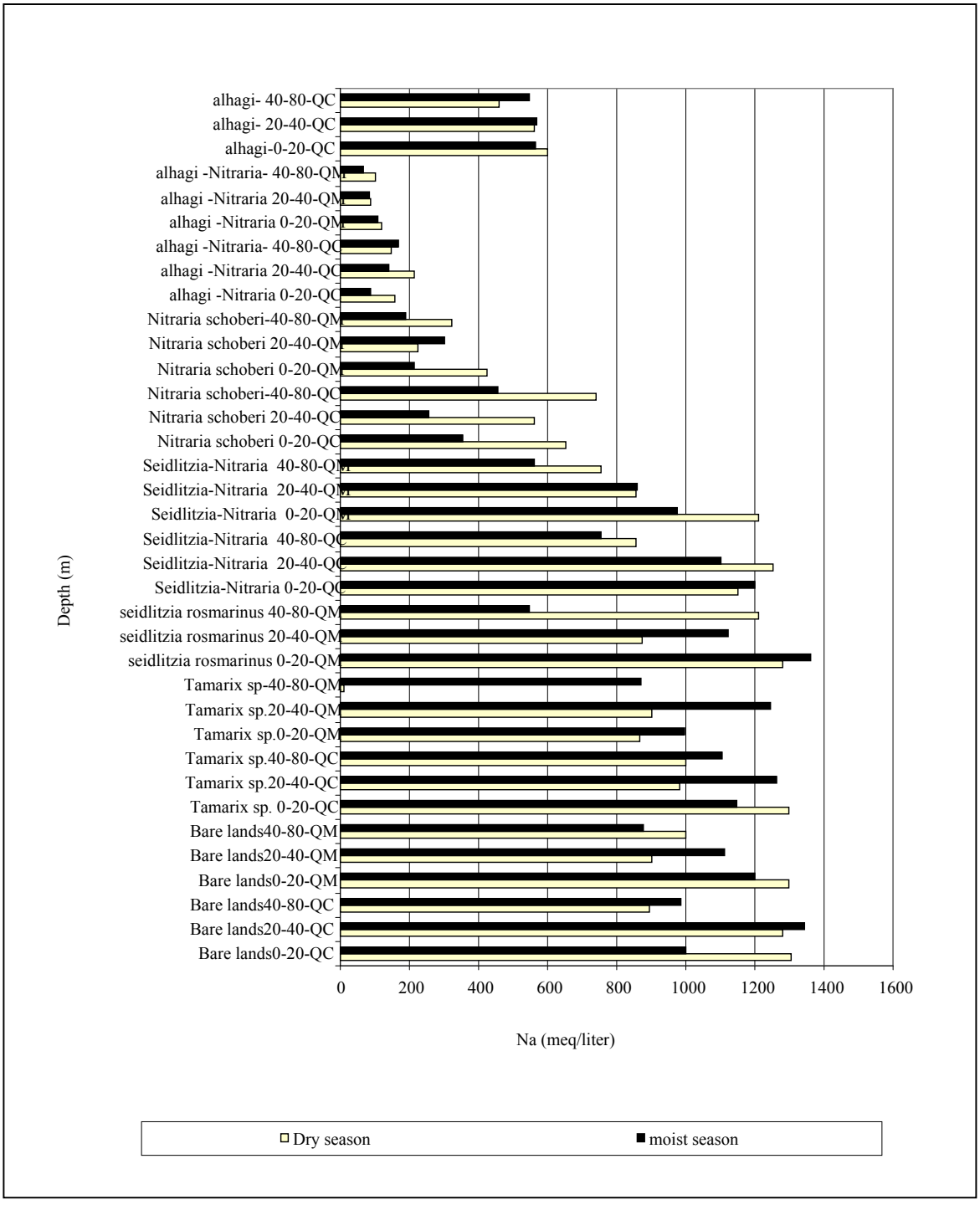

Fig. 7. Na variation in units's different depths in dry and wet season

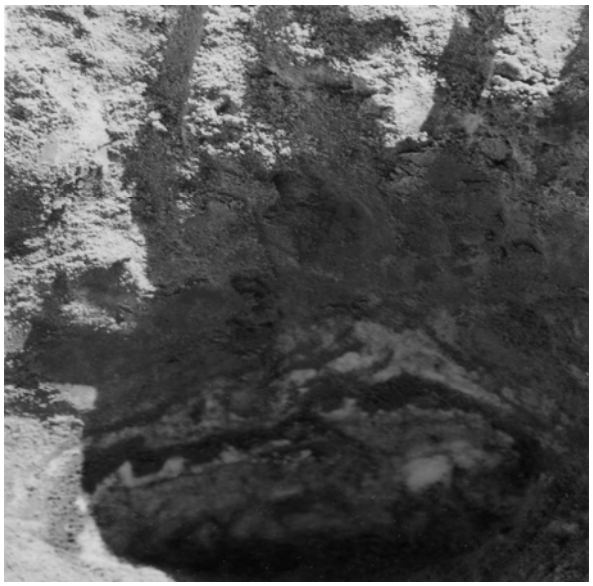

Fig. 8. Soil profile in *sedlitzia-nitraria* (Qc) unit

FIg. 9. Soil profile in bare lands (Qm) unit

FIg. 10. Soil profile in *sedlitzia-nitraria* (Qc) unit

Fig. 11. Soil profile in *Tamarix sp* (Qm) unit

3.2. Profile's description in Tamarix sp. (Qm) type

a) depth 0-20 cm:

The soil's colour in saturated statement, was the fairly dark brown. There were no gravels. soil's aeration was weak, because of the surface salts accumulation. The soil's 0-10 horizon's colour was nearly dark brown (7.5 YR 5/4) in saturated statement. The gypsum crystals were low and it's texture was clay sand loam. The soil in saturated statement, was a little adhesive and plastic. The soil's structure was granular and a little platy. The horizon's edge was wavy and obvious. The amounts of the Cl and Na was very high. The plant's roots density was fairly high.

b) depth 20-40 cm:

The soil's colour in saturated statement was dark yellowish brown (10 YR4/4). There were no gravels. The soil's aeration was weak. The soil's 0-10 cm horizon's colour was nearly dark brown (7.5YR5/4), in saturated statement. The gypsum crystals were low. it's texture was clay sand loam. The soil in saturated statement, was a little adhesive and plastic. The soil's structure was granular and a little platy. The horizon's edge was wavy and more obvious than the above horizon. The amounts of the Cl and Na was very high and the plant's roots density was medium, such as above. There were low mottles with blue and gray colour.

c) depth 40-80 cm:

The water table depth was 62 cm. The soil's colour in saturated statement was dark reddish brown(5YR6/4). There were no gravels. The soil aeration was weak. The gypsum crystals were low. It's texture was clay loam. The soil in saturated statement, was a little adhesive and plastic. The soil's structure was platy. The horizon's edge was pretty vague. The salt amounts was nearly high. The plant's roots density was low. There were no mottles. It's profile was as Az1, Az2, Cz, Czy1, Czy2 . the Z and Y letters are abbreviations of salt and gypsum, respectively. The Profile's description in the Qc unit, was similar the Qm, but the amounts of the Cl and Na salts was further and the water table was 5 cm lower than the above. It's profile was Az1, Az2, Cy, Czy1, Czy2.

3.3. Profile description in Nitraria schoberi (Qm) type

a) depth 0.20 cm:

The soil's colour in saturated statement was light brown. There were no gravels. The soil aeration was better, because of the lower accumulation of the surface salts.The soil's 0-10 cm horizon's colour was fairly light brown (10YR4/4). The gypsum crystals were pretty high.It's texture was clay sand loam. The soil's adhesion was low.The soil's structure was massive. The horizon's edge was fairly obvious. The amounts of the Cl and Na salts was lower. The plant's roots density was fairly high. The salinity was low.

b) depth 20-40 cm:

The soil's colour in saturated statement was dark yellowish brown (10YR4/4). The soil was fairly adhesive and plastic. The soil's aeration was good. The gypsum crystals were little. It's texture was sandy clay loam. The soil's adhesion was fine. The soil's structure was massive. The horizon's edge was wavy and vague. The EC rate was lower. The amounts of the Cl and Na salts was low. The lime amount was low. The plant's roots density was fairly low. There were no mottles.

c) depth 40-80 cm:

water table depth was 76 cm. The soil's colour in saturated statement was redish brown (7.5YR4/4). There were no gravels. The soil aeration was very weak. There were no gypsum crystals. It's texture was clay loam. The soil's was a little adhesive and plastic. The soil's structure was massive. The horizon's edge was vague. The soil's salt amounts was low. The plant's roots density was very low. There were no mottles. It's profile was as Az_1, Az_2, Cz, Czy_1, Czy_2. The Z and Y letters are the abbreviations of the salt and gypsum, respectively. The Profile's description in the Qc unit was similar Qm, but the gupsum amounts was more at depth 10-20 cm and the soil's colour was brown (7.5YR5/4). It's profile was Az_1, Az_2, Czy_1, Czy_2.

4. Discussion and conclusions

According to the chemical-physical experiments' results (according to the Table 1 and 2), the amounts of the SO4, Cl, HCO3, CO3, at *Nitraria sp-Alhaji sp.* And *Alhaji sp.* types was low, but in the other types has increased toward Salt Lake. It is similar to Motamedi Joybari and Jafari's results. But, Cl and SO4 at *Alhaji sp.* And *Nitraria sp.* Communities was similar to Khani results. According to the physico-chemical experiment's results (Tables 1 and 2), the amounts of the Na, K, Mg, lime at *Nitraria sp-Alhaji sp.* And *Alhaji sp.* types was low, but in the other types has increased toward Salt Lake, whereas, Motamedi Joybari's results, the amount of the K in *Alhaji sp.* type, had been doubled, related to our results (30.2). The lime's amount, was increased related to the depth in all plants types, because of the leaching and the dissolution of the lime at the

surface horizons (because of the CO_2) and sedimentation in lower depths (due to the lack of co2).
According to the table 1 and 2, The average amounts of the Ec, of work units was as below (but the jafari's results, didn't have *Alhaji sp.* type):

Barelands > *Tamarix sp. (*100.2) > *Seidlitzia rosmarinus* (42.8) > *Seidlitzia-Nitraria* (33.7) > *Nitraria schoberi* (30.5) > *Alhagi- Nitraria* (26.3) > *Alhagi camelorum* (26.3)

According to the table 1 and 2, The Acidity of the *Alhaji sp.* (Qc unit), *Nitarria sp.(*QC,Qm units) and *Ntraria* (QM,QC units) units, was fairly similar at the three depths, 7.2, 7.34 and 7.40 cm, repectively, but in other communities, toward Salt Lake and from the surface to the depth, had increased (up to 9.2) and decrease(down to 6.9),respectively(similar to sara wood, cherchman et, chukrullah, Matin and Saeedfar results).
According to the table 1 and 2**,** The soil's Salinity type was due to Cl (36%), SO4 (42%) and Gypsum (22%), while Ahmadi A. and Nabati Rahmati, reported the salinity was due to SO4 (68%) and Gypsum (32%). The salinity in first soil's depth of the *Alhaji sp.* Community (QC,QM units) was lower other than the other communities (12.2), because of the leaching and little influence of the capillary force, but in other communities, the surface soil, had the highest salinity (from 14.5 to 100.2) (similar to sara wood results, 10.89, 12 to 86).

The region's soils, with respect to the new taxonomy (2006), was classified as entisol order, aquent suborder, endo aquent greatgroup and typic endoaquent subgroup (similar to the soil's map of the water and soil institute with 1:1000000 scale). There was no B subsurface diagnostic horizon and no block and prismatic or columnar structure.

With respect to the soil's properties's tables, toward Salt Lake, the soil texture became heavier (sandy clay loam). Also, in the all plant community, the soil texture became heavier with depth increase (similar to sarah wood, cherchman et al's results).

5. Suggestions

Each plant's community have shown special response to soil determinative factor. On the other hand, the emergence of the region's spacies are influenced by the special factors, therefore, it will be recommended to perform other investigations, to recognize the typic soil of plant. In other hands, each plant is a specific indicator of the special soil properties. Nowadays, researchers in other countries, use them to recognize the soil conditions.

According to the region's climate conditions, high water table and high salinity, it will be suggested to protect the region by improving native spacies, specially. *Tamarix sp., Seidlitzia sp.* And *Nitraria sp.* to prevent from more salinity. It will be suggested to constitue an institute namely 'investigations about halophytes to perform further attempts and find best strategies about management of the specific region and identification of the resistant plants, changes of their's properties under the influences of the soil properties and influences of different treatments to improve water and soil development. Seeding suggested in uplands, which it's salinity (3.7 mmoh/cm) and water table (78cm) is lower.

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