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The Relation Between Water Salinity With Some Soil Characteristics And Soil Salinity Potential estimated By Using The Salt Concentration Factor

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ABSTRACT

One of the consequences of irrigation by saline water is the salty soil while the water and salty soil sources in arid and semiarid regions influence agriculture and have created some problems; such unfavorable influence in arid regions with high evaporation has made us seriously worry. Essentially this study is to examine the soil effective factors on the accumulation of salts in the soil, leaching and suggest a new method for estimating of soil salinity potential that effected of irrigation with different quality of wells water. Therefore, 10 land transects with different quality of irrigation was sampled at intervals of 6 (15 samples) meters. Parameters of Electrical conductivity, field moisture content and saturation water content were measured for each sample, and then the salt concentration factor (SCF) was evaluated. The results showed that there is a polynomial relationship between ECe and ECw, saturation water content and field moisture content in all of the lands. The results also showed there is a polynomial relationship between the SCF and saturation water content with high correlation in all of the lands that they were sampling by transect.
KEYWORDS: Soil saturation water content, field moisture content, soil salinity potential and irrigation water salinity

1. INTRODUCTION

Daily increasing population and life level standards have led to competition in consuming fresh water especially in arid and semiarid regions; such conditions have led to limitations regarding fresh water consummation in agriculture using a lot of accessible water. Also considering increasing fresh water preparation costs it has become important to use saline water to irrigate the regions suffering from lack of water. One of the consequences of using saline water may be soil salinity (20). Salinity after drought is one of the most frequent and important environmental tensions throughout the world including Iran (6). A considerable part of natural and farming ecosystems throughout the world has been influenced by salinity tension (8) and the soils influenced by salinity exist in more than 100 countries with different qualities and rates (15). Considering Tot's et al. (19) reports the soils influenced by salinity are about 1,000,000,000 hectare while the sources of water and saline soil have influenced agriculture in arid and semiarid regions and led to some problems (2); related solutions need to take into consideration the soil salinity stability in different steps of irrigation and decreasing deliberately the salinity effects (2). Different studies done in relation to the influence of the irrigation with different qualities on the soil salinity and some physical specifications. Having used saline water for irrigation Zartrmanand Jicharo (21) indicated that the soil salinity process is often slow and depending on the water salinity may be hidden for years after irrigation. In their 30 months study Franco et al. (5) indicated the saline water irrigation (4.26 deciSiemensper m) consummation is more effective in soil salinity than the water with low salinity (0.80 deciSiemens per m).In their study Ghadir et al. (13) examined the effect of saline water superficial irrigation with saline water (2.90 deciSiemens per m) and having examined the soil salinity and acidity after one season they announced that the salinity was more in 15 cm of the upper soil. Rahimian et al. (2013) examined the salinity profile due to underground water salinity in Azadeganplain; their results indicated that the soil profile salinity depends considerably on the underground water salinity and such dependency increases in deeper layers. Sajadi et al. (17) assessed the effect of the irrigation water quality on the soil qualities in Robat (Babak Shahr) plain; their results indicated that the soil chemical properties were influenced more by the irrigation water qualities than the physical and fertilization parameters. Gretan et al. (7) studies the waters with high electric conductivity and concluded that if their conductivity was more than 3 deciSiemens per m, they would be highly limited in view of irrigation; of course, it is possible to use the waters with high salinity according to the conditions special to the product, soil properties, irrigation direction methods, climatic situation and soil direction methods. In their study regarding the effects of irrigation with inappropriate waters Dalton and Poos (4) concluded that the most important effects of the water salts on soil is physical

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led to water permeability decrease in the soil; such physical changes have secondary effect in the soil chemical changes as sodium absorption by the soil. The inappropriate quality of the irrigation water and its salinity may decrease the water permeability into the soil and influences indirectly the product rate (18). In their study Miyamoto and Chacon (10) assessed the lands' salinity by virtue of the soil and irrigation water properties by the factor SCF and experimental equations; they used soil physical factors such as soil field moisture and saturation moisture in order to estimate the soil salinity potential and concluded that there is a relation with high correlation between the salt concentration factor and the soil saturation moisture. By virtue of their studies Moran et al. (11) concluded that the irrigation with inappropriate water, depending on the quality and rate of the consumed water and irrigation system, has different effects on the soil physical and chemical properties. The tests conducted on the soils irrigated with saline water with high percent of sodium indicated that if the salinity increased, the sodium and calcium concentration would increase in the soil saturation extract and the soil electric conductivity would decrease. In a study a great space of a region irrigated with saline water and the results indicated that high amounts of salinity in the irrigation water has considerable effect on the soil properties such as its salinity and the latter decreases the product operation (12). Arakoes et al. (3) examined the soil salinity in relation to soil physical properties and irrigation direction in four irrigated Mediterranean regions and their results indicated that the soil salinity is mostly influenced by the irrigation water salinity and quality and the drainage water salinity is mostly influenced by the soil salinity and irrigation water quality.This study is to examine the irrigation effect with different qualities on the soil properties changes process in the superficial soil layer and lands. Deine the experimental equation of the correlation between the salt concentration factor and the saturation moisture percent for the data collected from all cultivable lands.

2. MATERIALS AND METHODS

Study area:

This study was done in Khonj Plain in 300 Km from Shiraz in south of Fars Province located in eastern longitude53° 38' 35" to 53° 55' 30" and northern latitude 27° 51' 23" to 27° 45' 24" with about 1,044 altitude and yearly raining mean is 250 – 300 mm. In the northern part of the Plain there is the Khonj seasonal lake with 2,500 hectare area receiving seasonal floods due to the channels led water to the Plain. The lake water is saline because of high temperature and evaporation and this has influenced the underground water sources in a way that the agricultural lands irrigated with the regional wells have become saline over time; on the other hand, the Bighard dam was studies and executed by Agricultural Jihad Organization in 2008 and may reserve 500,000 m^3 per each filling reservoir with the seasonal floods (Figure 1); whenever the dam opens to the inferior lands the aquifer table becomes full, the agricultural lands are irrigated and the soil is convenient to be washed and reformed (9). It should be noted that the quality of the water in the regional wells is better when nearer the floodway (1).

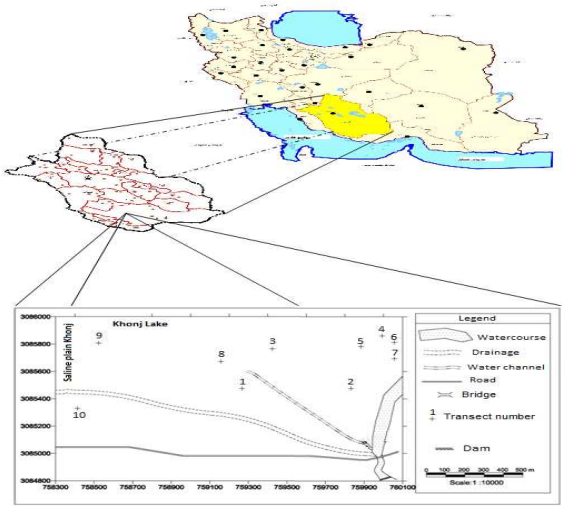


Figure 1: Geographical Situation, dam's construction place and the wells in Bighard dam.

Study method:

The case study water and soil were sampled in order to achieve the study goals and the samples were analyzed. The samples were selected and the parameters were measured as follows:

A) Examining the water quality:

By virtue of the dispersed water sources in the case study region with different qualities to be used to irrigate the nine wells and Bighard dam waters were sampled after 45 minutes pumping in order to define their qualities; the samples were put into plumbed bottles with opaque glass to be transferred to the laboratory after some hours and the EC_w of each sample was measured by conduct meter.

B) Soil sampling:

The agricultural soils (Seven transects of land for wheat and three ones for date) to be irrigated with the wells and dam were sampled to measure some soil properties in a way that a strip of 90 m formed in each transect and the samples were prepared in 6 m intervals from the depth of 0 – 20 cm (15 samples per strip) and then having transferred the samples to the laboratory some soil chemical and physical properties were measured as follows: PH, EC_e, conduct meter (16), SWC and FM by pressure disc device.

The salt concentration factor was measured by following Miyamoto and Chacon, 2006):

$$SCF = \frac{EC_e}{EC_w} \quad (1)$$

Where:

SCF = Salt concentration factor

EC_e = Extract electrical conductivity

EC_w = Irrigation water conductivity

Then the relations between the irrigation water salinity and soil properties, the changes process of each measured parameter was analyzed in each transect; finally the data from all the transects were examined in order to have an experimental correlation equation between the salt concentration and saturation moisture percent. Also the data were analyzed by SPSS and Excel software.

3. RESULTS AND DISCUSSION

Table 1: Data concerning the qualities of irrigation water and the parameters measured in the cultivable lands:

Land No.	Farm	EC	Saturation moisture				
		EC_w (dSm^{-1})	)Kg Kg^{-1}(	CV(%)	EC_e (dSm^{-1})	Max.C	CV(%)
1*	Wheat	1.75	0.469	10.82	4.61	5.12	6.67
2	Wheat	5.08	0.405	2.038	8.48	9.68	2.09
3	Wheat	5.21	0.481	3.19	9.03	10.01	6.37
4	Wheat	6.68	0.393	4	8.92	10.49	5.55
5	Date	7.17	0.334	2.85	6.79	8.30	10.49
6	Wheat	6.48	0.391	1.09	9.66	10.43	3.94
7	Date	6.44	0.33	3.17	4.60	5.10	9.81
8	Wheat	5.49	0.436	2.02	9.2	9.88	3.55
9	Wheat	9.91	0.519	1.81	15.67	17.01	4.39
10	Date	9.62	0.565	4.74	8.55	9.15	3.93
Mean		6.38	0.38	3.6	5.9	12.8	5.76

*Dam irrigation source.

Table 1 shows the results gained through analyzing the samples of the soils and the irrigation water quality to be used in each transect; the table data indicate the changes coefficient mean 3.60 percent for the soil saturation moisture percent and the changes coefficient is 5.76 percent for the soil salinity. The results indicate the most rate of soil salinity (EC_e) was in the transect No. 9 because it was near the Khonj saline lake and having irrigated it with the saline water the salinity (EC_e) increased in the superficial layers of the soil that was in accord with the Kamali's et al. (9) results in relation to examine the effect of torrential irrigation on the soil properties inferior the Bighard dam; the least soil and irrigation water salinity was in the transect No. 1 because it was near the dam and relatively its water quality and quantity were better (1). Besides, the results from analyzing the irrigation waters quality indicate generally the mean irrigation waters salinity is 6.38 deciSiemens per m in the region under examination namely 5.08 and 9.91 deciSiemens per m. The results from analyzing the irrigation waters indicate most of them are more salty than the grade permitted for agriculture in a way that some are seriously limited for wheat growth and production.

4. Analyzing the correlation between the soil parameters:

The transect No. 6 was used to assess and examine the correlation between the soil parameters because it had a monotone field and irrigated with the regional wells; the analysis results are as follows:

Table 2: Correlation coefficients matrix between the soil parameters:

	Soil EC	FC	Saturated moisture content	PH
Soil EC	1			
FC	0.71 **	1		
Saturated moisture content	0.75 **	0.86 **	1	
PH	- 0.42 *	- 0.24	- 0.24	1

* Statistical significance correlation in the 1 percent confidence rate and** Statistical significance correlation in the 5 percent confidence rate.

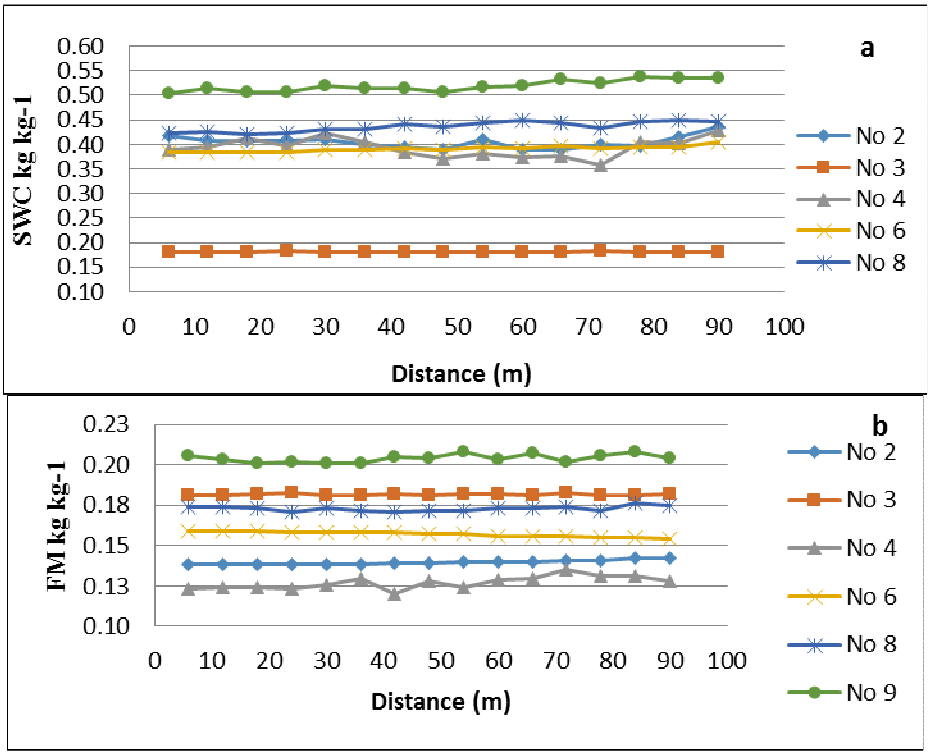
Having analyzed the correlation between the soil properties it was indicated that the positive correlation between the soil salinity with saturation moisture percent and fieldcontent is in the 1 percent confidence rate and also there is a negative correlation in 1 percent confidence rate between the soil PH and salinity (Table 2).

Table 3: The results from analyzing statistically the soil parameters:

Cultivated land No.	2	3	4	6	8	9
EC(dSm^{-1})	8.48b	9.03b	8.92b	9.66b	9.2b	15.67a
FC($Kg\ Kg^{-1}$)	0.14e	0.18b	0.13f	0.16d	0.17c	0.20a
θs* ($Kg\ Kg^{-1}$)	0.405cb	0.481b	0.393d	0.391d	0.436c	0.519a
PH	6.35d	7.79a	7.81a	6.99c	7.50b	6.33d

The similar letters indicate the significance indifference in the 1 percent confidence rate.
* Saturated Moisture Content.

Table 3 states the results from analyzing statistically the soil parameters and also the difference of the parameters mean gained between the cultivable lands; the results from the table indicate there is a significant difference between the soil saturation extract electrical conductivity parameters mean, field content and cultivable soil saturation moisture percent of the land No. 9 and others. Also there is a significant difference between the cultivable content mean of all the lands in one percent confidence rate.



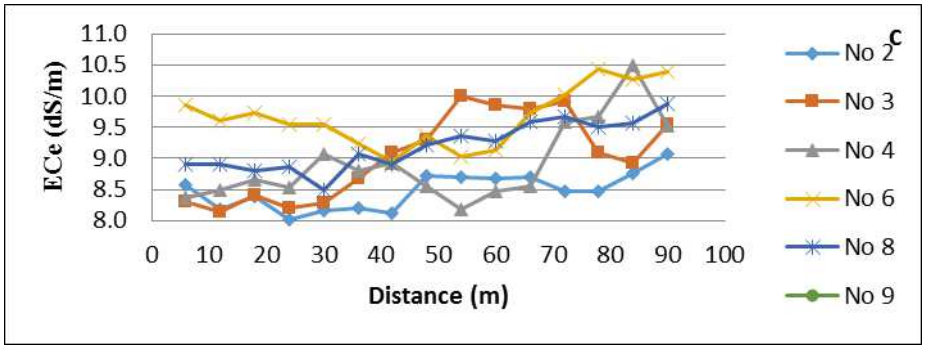


Figure2: The soil parameters changes process in the length of the strip for the cultivable lands (Nos. 2, 3, 4, 6, 8 and 9) where the date field was monotone and irrigated with the regional wells. A) Soil saturation moisture percent, B) Soil field content and C) Soil saturation extract electrical conductivity.

Figure 2 shows the soil parameters changes process in the length of the strip for each transect of the six lands which are monotone in view of the field (Date) and irrigation source (well). By virtue of the Figure 2 (A and B) the saturation moisture percent changes and the soil field content had not any considerable change in the length of the strip regarding the lands indicating the same parameters in the lands. Also the soil electrical conductivity changes indicate its rate fluctuations and increasing process in the length of the strips. In their study Miyamoto and Chacon (10) examined the field content changes process, saturation moisture percent and soil electrical conductivity and their results indicated that the changes process is gained differently in the lands with different applications.

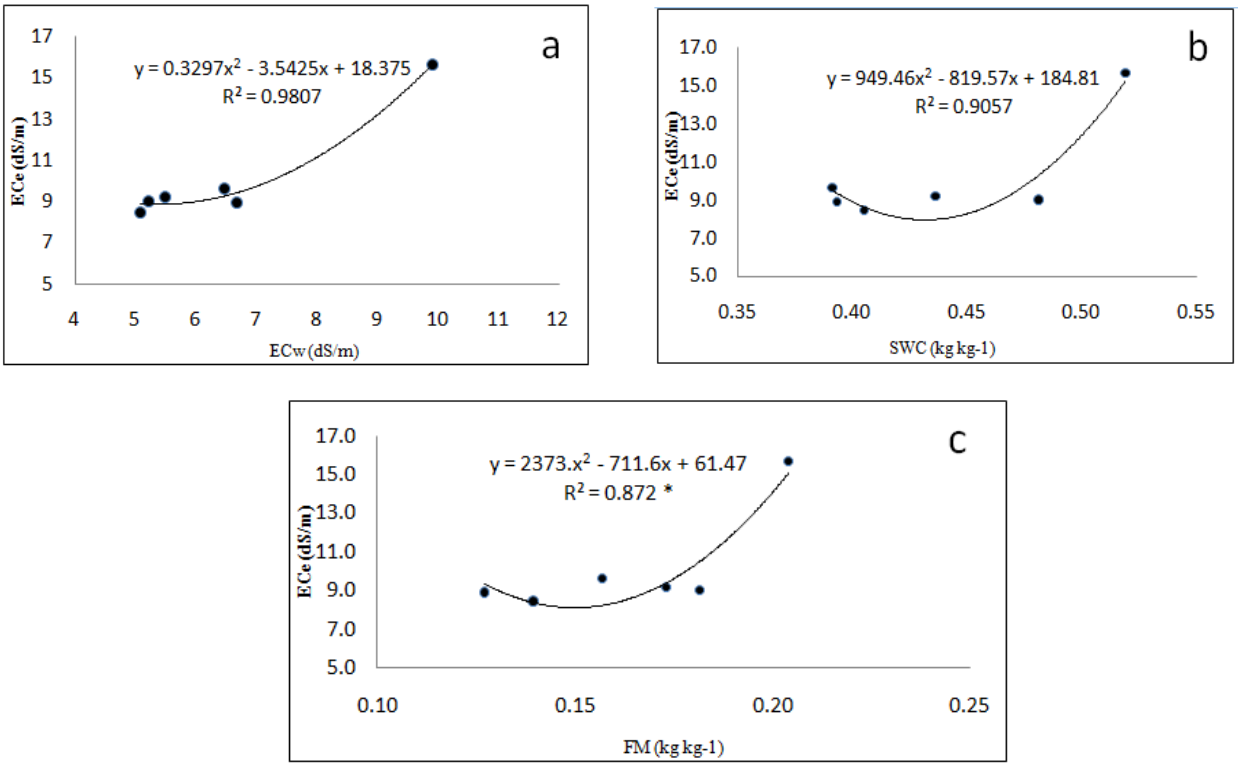


Figure3: The correlation between the soil saturation extract electrical conductivity and irrigation water salinity, saturation water content and soil's FM.

Figure 3 indicates The correlation between the soil saturation extract electrical conductivity and irrigation water salinity, saturation moisture percent and soil's field content were the same for all the six lands in view of the field (Date) and irrigation source (Well); so it may be concluded that there is a second grade significant relation between the data concerning the soil saturation extract electrical conductivity and irrigation water salinity, saturation moisture percent and soil field content in the 0.05 percent confidence rate with correlation coefficient of 98, 90 and 87, respectively that was as an exponential relation in the Miyamoto's and Chacon's (10) studies.

The correlation between the salt concentration factor and soil saturation moisture:

Figure 4 shows a good relation between the salt concentration factor and soil saturation moisture and also states there is a significant relation between their data in the 0.001 rate. By virtue of the relation between the salt concentration factor and soil saturation moisture an experimental equation was gained with strong correlation (R^2: 0.93).

$$SCF= a(SWC)^2+b(SWC)+c \quad (2)$$

Where:

A, b and c = Coefficients

SWC = Soil's saturation moisture

SCF = Salt concentration factor

Miyamoto and Chacon (2006) stated a relation between SWC and SCF and their results indicated that there is an exponential relation between soil's saturation moisture percent and the salt concentration factor.

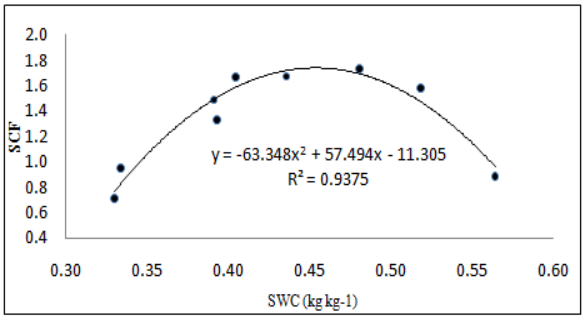


Figure 4: The correlation between the salt concentration factor and soil's saturation moisture.

5. CONCLUSION

Having analyzed the data of each strip and defined the equations between the soil salinity and physical properties measured into the soil no special paradigm was observed in the region under examination while Miyamoto and Chacon (10) sampled from the golf grounds covered with grass as strips in Texas region and finally graded the strips

based on the field moisture changes process, saturation moisture and soil electrical conductivity into four paradigms by virtue of the distance and the presence or absence of the significance between the data; besides, having examined the effect of the irrigation water quality on the soil properties in Rabat (Babak city) plain Rahimian et al. (14)concluded that the soil salinity is essentially influenced by the irrigation waters quality and irrigation with inappropriate water has not any considerable effect on the soil's physical properties change. By virtue of present data FM of all strips had no change in the field moisture; also the data indicated that one of the causes of the low salt concentration in depth is the regional light soil namely the regional soil composition which is sandy and loamy - sandy. The soil salinity increased in approximately most of the strips when the distance increased; the increase may be due to two factors: (1) The water concentration time is different in different parts and when the distance increases the concentration time increases, too so the water does not reach equally all the field parts and when the parts are nearer the water source they receive more water; (2) the salts are washed from the first of the strip by the irrigation water and transferred to the end of the strip. Also there is a second grade significant relation between soil salinity and saturation moisture in 0.05 rate namely if the saturation moisture increases more than 0.45, the soil salinity increases, too. There is a significant relation between the soil salinity and field content in 0.05 rate indicating if the field moisture is more than 0.18 (With field content increase), the soil salinity increases, too. There is a second grade significant relation between the salt concentration factor indicating the soil salinity and soil and the soil saturation moisture percent in 0.001 rates.

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