Effect of indiscriminate removing ground water on irrigation water's salinity in arid area, central Iran

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Abstract

Irrigation water quality in arid areas is important, because Iran is located in arid and semi-arid areas in the world. due this issue, strategies and guidelines of operation of saline soil and water should be encountered with a special priority. Wrong managements, successive droughts and indiscriminate removing from ground water tables in recent years, have caused the reduction in water table level and thus make poor water quality in arid areas. So there is a necessity for extensive research works to solve this problem. This research was performed to study the effect of indiscriminate removing from groundwater on the quality of irrigation water in pistachio orchards in arid area, in Iran. In this research, sampling from 30 selected wells is accomplished. Also, sampling with selected well's water was done from depth of 0-50 cm. For statistical analysis, required parameters including EC, SAR from 1991 until 2008 were appointed that some parameters of soil and water analysis were evaluated based on standard methods, particularly FAO standards. The results of this research showed that the salinity and SAR parameters from 1991 until 2008 have had increasing water salinity and with increasing water salinity, soil salinity has also been added.

Keywords: salinity, irrigation water quality, indiscriminate removing, pistachio orchards, Iran

Introduction

Irrigation water quality in arid areas is important because Iran is located in arid and semi-arid areas in the world. due this issue, strategies and guidelines of operation of saline soil and water should be encountered with a special priority. Wrong managements, successive droughts and indiscriminate removing from ground water tables in recent years, have caused the reduction in water table level and thus make poor water quality in arid areas. So there is a necessity for extensive research works to solve this problem. Because of the vast Loot deserts and Kavir plain's dry climate and extremely desert conditions, border areas climate also have been impressed. This dry climate is caused a critical area with salt and sodium.

Water and soil in these areas that are two important factors in agricultural production and development have poor quality and exploitation of them would be very difficult and expensive. Therefore, cultivating each plants in low water conditions and poor quality of soil and water resources is not practical so we should select plants which their cultivation in these circumstances are economic. One of the most efficient plants is pistachio which is the major product in Kerman province. Because Kerman province is located in the both sides of the circuit with 30 degrees, it has extremely dry climate which this dryness effects on the province's agriculture severely. The wise Kerman's farmers have received that economic product of this region can be pistachio. Rapid increase in pistachio cultivation areas in northwest of Kerman province and increasing number of wells and indiscriminate removing (over limitation) from water tables caused severe loss in ground water resources, thus reducing wells recharge as the only source of water supply in pistachio orchards and their poor quality. Comparison the results of analysis of water samples between the past three decades and recent years shows that trend to poor quality water in these areas is so fast that if this rubric continues, not long ago these resources and used investment in establishing one hundred thousand hectares of pistachio orchards will waste because of decreasing water resources and poor quality of water and its horrific outcome will damage the region and the country's economy. Since the saline and drainage water, and so on in the past agricultural water went to waste, have now been considered. Due to this issue in two recent decades using of this group of waters for irrigation in dry areas has increased. Experience has proven that these waters not only

should not be released that caused adverse effects on environmental factors but we should pay attention to these groups of water for irrigation (Abedi, 2002).

The most important determinative components of the quality characteristics of irrigation water, is salinity and there is a close relationship between the salinity of irrigation water and salinity of lands under cultivation of these waters. Salinity factors, the situation of sodium about permeability, cation and anion types, their amount and proportion, trace, toxic and heavy elements are major components which are determining important quality criteria of evaluating salinity waters in relation with the growth of products. Salinity is the most important and most common chemical inhibitors of plant growth and, water and soil salinity is the most limiting factor for agricultural development in arid area (Abtahi, 1992). (Abrol *et al.,* 1988) in a study said that using saline and brackish waters is the reason of salinity for agricultural lands. When the only source of available water for irrigation is ground water, high salinity of this resource, will cause the accumulation of salts in the roots expanding area. This phenomenon will be intensive when the levee tissue and thus soil drainage was limited and leaching by irrigation water and rainfall is negligible.

(Bennetts et al., 2007) in a research showed that, topographic position, land form and human activities such as irregular irrigation without proper management in use of saline irrigation water, are major sources for soil salinity.

Guiti (1999) in the study about the trends of groundwater salinity in northern plains in Kashan showed that the average of water table level during 1965 until 1997 has a drop of 16 meters and also the electrical conductivity by this region has been increased from 4350 $\mu s/cm$ to 6930 $\mu s/cm$ in the same period. In his opinion, irregular withdrawal is a major reason for this topic. Velayati (2005) in the study entitled the effect of a withdrawal of wells water on the salinity of Jangal plain's aquifer (Torbat Heidariye) showed that increasing of electrical conductivity in Janat abad village from 500 $\mu s/cm$ in 1987 to 6000 $\mu s/cm$ in 1996, was due to irregular withdrawal from aquifer. In the past three decades in different parts of Kerman province, pistachio cultivation has shown very significant development which increased the economic value of water in these areas, but unfortunately, too much increasing the number of motor pumps, successive droughts, severe evaporation (due to being adjacent to Loot Desert and Kavir plain), improper

management and indiscriminate withdrawal of groundwater is caused decreasing the stable level and eventually fall down to poor quality of irrigation water so the pistachio production is very low and uneconomic in some areas and has led very undesirable economic effects to this area's farmers . Because of these points doing this study seems necessary in this area.

Materials and Methods

Study Area:

The area under research is turned from northwest to southeast and is located between latitudes of 30°43′15″ and 30°51′56″ N and between longitudes of 55°16′ 44″ and 55°23′17″ E at northwest of Kerman province (Fig.1). At first from 450 wells, 30 wells were selected and from each selected motor pump the water sampling was performed. Also from 30 orchards soil that was irrigated with those selected wells water, the sampling was done from 0-50cm depth. Soil and water samples for analysis were sent to the laboratory the same day. Then, from every 3 selected wells which are located in study area, one of them were selected that its water and soil salinity was medium. The analysis of soil and water samples from the same motor pumps and selective orchards (10 selective motor pumps) from previous years (1991 to 2008) was done. Table 1, shows the orchards name and selective pumps.

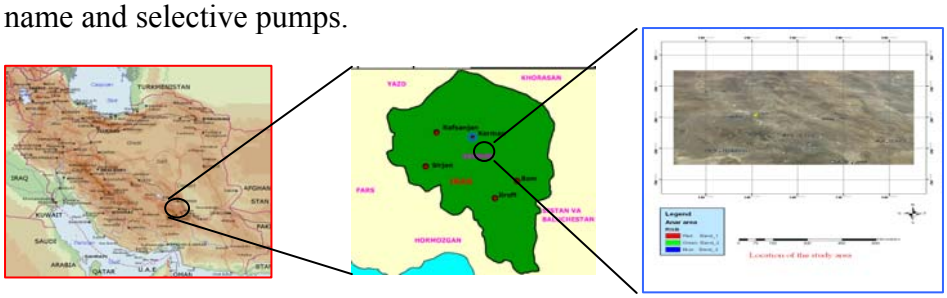

Fig. 1: Location of the study area

In selecting the sampling field we were tried to select from under pistachio cultivation soils which being sodium is more serious. One of the problems in sampling was the selection of under cultivation soil that was irrigated with a motor pump's water during the growing season.

Table 1: The orchards and motor pumps name

longitudes	latitudes	motor pumps name	No.
55°20′ 16″	30° 48′08″	Jamshid abad	1
55°20′29″	30° 47′45″	Golestan	2
55°22′ 05″	30° 45′07″	Mahmoud abad	3
55°20′ 52″	30°46′ 57.2″	Hojatieh	4
55°17′ 02″	30°51′41″	Deh reies	5
55°19′ 59″	30° 44′10″	Jalalieh	6
55°22′ 07″	30° 45′05″	Mjidieh	7
55°18′02″	30° 53′30″	Ahmad abad	8
55°20′ 16″	30° 48′47″	Naserieh	9
55°17′ 21″	30° 52′ 45″	Fath abad	10

As a result, the water and soil sampling was done after a research from the farmers about the soil of under pistachio cultivation and being ensured about irrigation of the desired soil with specific water. The water quality reports should be based on laboratory measurements of the water samples. The sample is removed for tests should be an overall represent of using water. Some parts of the under cultivation soil that were between two rows of pistachio trees were selected which they weren't affective by animal and chemical fertilizers in previous days and then the samples will selected from 50cm depth and each depth will be put into plastic bag and complete soil profile like depth and location of sampling will be written on card and transferred to the laboratory for analyzing and there, should be beaten dry and then be tested.

Measured parameters from the analyzing soil and water samples:

Salinity parameters of water and soil (EC) and (SAR) were measured for notification of the effects of water and soil parameters in different years and also the effect of water on soil in laboratory. Also the values of parameters for all samples were collected from previous years and the regression was determined with using Excel software in different years and the line which has the most correlation was drawn with equation. Also these parameters were evaluated based on standard methods particularly FAO standards. The

methods of assessment water and soil parameters based on FAO guidance of irrigation water quality, America laboratory for water salinity and Iran's qualitative categorized was performed.

Results and discussion

Figure 2 shows water EC Changes in different years (1991-2008) in Jamshid abad. As can be seen, because the slope of line is 0.19 (Y= 0.1937X+5.0654) and is higher than zero so the trends of water EC changes has upside mode in different years.

With due attention to figure 2 in the rest of the spots, the water EC changes has had ascending mode. Figure 3 shows the Changes of soil salinity in Jamshid abad region during different years (1991-2008). As can be seen, the trend of the changes of soil EC in different years has ascending mode because the slope of line was 0.21 (Y=0.2144X+10.668) and its more than zero. For other regions the soil salinity is the same too.

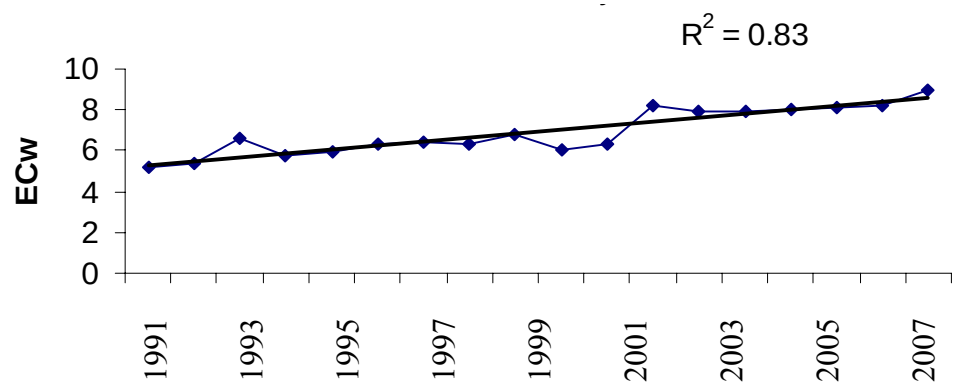

Fig 2: water EC in different years in Jamshid abad area

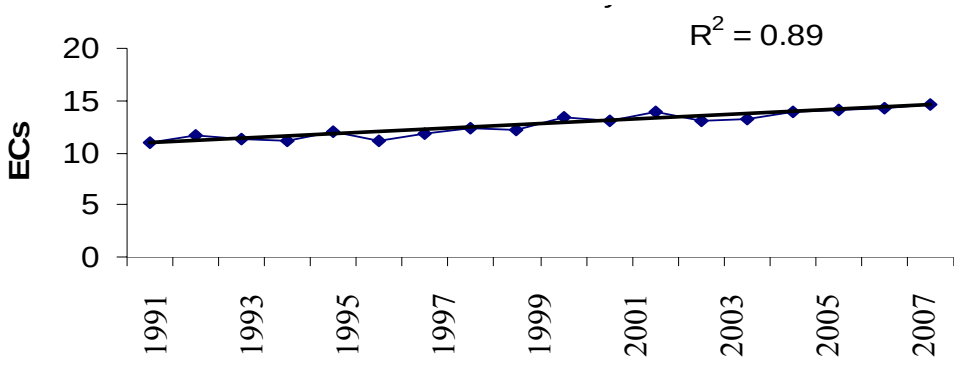

Fig 3: soil EC in different years in Jamshid abad area

Figure 4 shows the Changes of waters SAR in different years (1991-2008). As can be seen, the trend of the changes of water SAR has ascending mode in different years because the slope of line was 0.22 (Y=0.2233X+8.213) and it's more than zero.

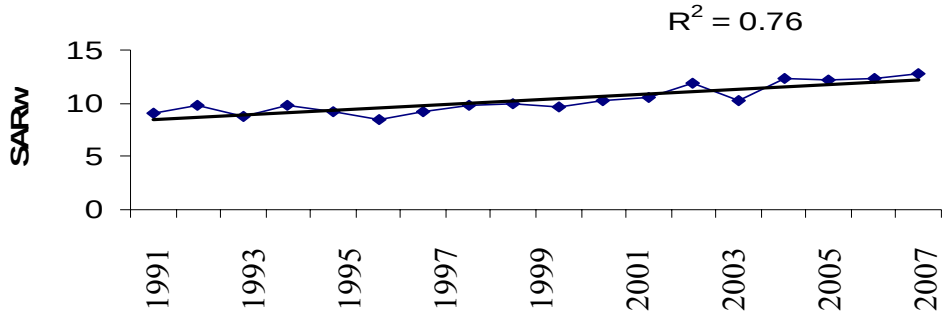

Fig 4: water SAR in different years of Jamshid abad motor pump

Figure 5 shows the changes of soils SAR in different years (1991-2008). As can be seen, the trend of the changes of soil's SAR has ascending mode because the slope of line was 0.19 (Y= 0.1925X+12.766) and it's more than zero.

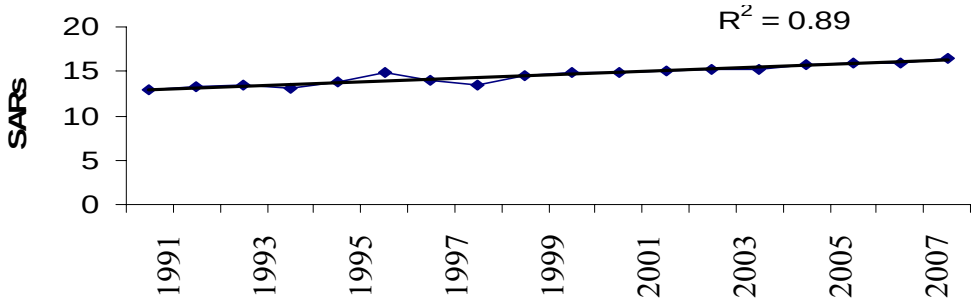

Fig 5: Soil SAR in different years of Jamshid abad motor pump

Figure 6 shows the effect of water SAR on soil SAR in different years (1991-2008). As can be seen, a significant correlation exists between water and soil SAR because the slope of line was 0.99 (Y= 0.9929X+4.1567) and it's more than zero.

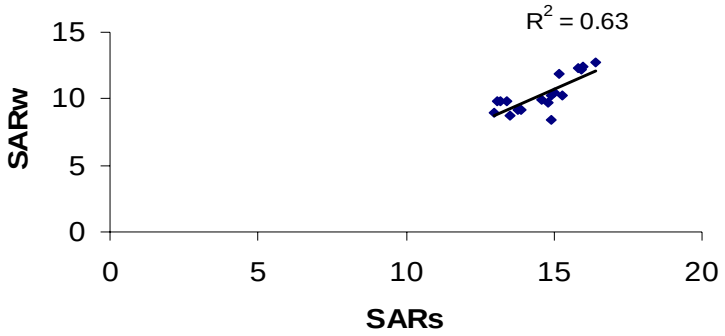

Fig 6: The effect of water SAR on soil SAR in different years of Jamshid abad motor pump

So the trend of soil SAR with increasing water SAR has ascending mode which indicates that increasing water SAR caused increasing in soil SAR.

Qualitative evaluation of the samples in terms of salinity:

According to FAO Irrigation Water Quality Instruction in Jamshid abad, all of the samples in terms of suitability for irrigation are inadequate (Non-Suitable). For the other areas which are specified in Table 2, all regions water is in Non-Suitable group.

According to the salinity laboratory of America water, most water samples in Jamshid abad region is put into C6 group. It means that water with high salinity which salinity-resistant plants should be planted and with considering the washing, prevent reduction in products. For other regions is indicated in Table 3. According to qualitative categorized of Iran, all of the water samples of Jamshid abad region are in the brackish group so will be suitable for most plants but in sensitive plants it's with decreasing product. For other regions is indicated in Table 4.

Table 2: The regions and determining the water salinity limit in these regions according to FAO irrigation water quality instruction

Water salinity limit	Regions
Non-Suitable	Jamshid abad
Non-Suitable	Golestan
Non-Suitable	Mahmoud abad
Non-Suitable	Hojatieh
Non-Suitable	Deh reies
Non-Suitable	Jalalieh
Non-Suitable	Mjidieh
Non-Suitable	Ahmad abad
Non-Suitable	Naserieh
Non-Suitable	Fath abad

Table 3: The regions and determining their water salinity group according to America water salinity laboratory

water salinity group	Region
C6	Jamshid abad
C6	Golestan
C4	Mahmoud abad
C6	Hojatieh
C6	Deh reies
C6	Jalalieh
C6	Mjidieh
C6	Ahmad abad
C6	Naserieh
C6	Fath abad

Table 4: The regions and determining their water salinity group according to Iran's qualitative categorized

water salinity group	Region
Modetare to Severe	Jamshid abad
Moderate	Golestan
Modetare to Severe	Mahmoud abad
Moderate	Hojatieh
Moderate	Deh reies
Moderate	Jalalieh
Moderate	Mjidieh
Severe	Ahmad abad
Severe	Naserieh
Severe	Fath abad

Conclusion

with due attention to the results and drawn graphs, each year due to successive droughts, intensive evaporation, improper management and irregular withdrawal, water and soil salinity has been added. If without proper management, the irregular water withdrawal and reduced rainfall continues, not long ago we will face low pistachio production in some regions and the adverse economic effects will be compiled to farmers of this area. with due attention to the low annual rainfall in Kerman province and thus low potential of production of the surface stream and poor nutrition of ground water in Kerman region, optimal using of all available capacity is necessary in order to preserve agricultural investment, social expediency and restitution of shortage of ground water. Therefore, understanding the potential of water resources of the Province and the problems that occurred from the current exploitation system from water resources can be helpful to principal programming for sustainable development. The changes of Province rainfall are enormous. These changes caused severe fluctuations of surface stream production which mainly is shower and occurred flood or drought. Therefore exploitation management of water resources in Kerman region is more difficult than humid regions and this management should be a way that makes optimal the needs of each consumer in various parts of drinking, industry and agriculture at the time, place, and amount of quality. This

optimization is caused to less water loss, less pollution and imposed costs to consumers will have a logical procedure. According to studies, the major stream of Kerman province was flood and its time and space distribution isn't conformed to plants water need. Lack of surface streams, lack of proper nutrition of ground water table and increasing population in Kerman which makes the use of water harder, with due attention to stable water resources and increased agricultural cultivation in recent years caused increased exploitation of ground water resources so most of the province plains especially northern plains like Anar and Rafsanjan are faced with severe problem of loosing ground water level and changing the quality because of continuing this trend (Sepaskhah. 1982). Development and increasing exploitation in these plains are impossible so these waters may not be used for pistachio production or even don't have any other users. Therefore, we can balanced the plains situation with controlling the amount of exploitation of ground water resources and fed the plains through optimum utilization of all potential of surface water resources and transfer the water from internal state of province (with the aim of drinking and nutritious) or from the outside states of province, clouds reproductivity plan and increasing irrigation efficiency for reducing withdrawal. In this regard for optimum use of ground water resources and increasing extraction of surface water and minimizing casualties of water, following points are recommended.

Suggestions:

- Proper management of irrigation water to reducing the login of salts to soil
- Running the right operation for leaching the salts of soil in winter
- Cultivation resistant bases of pistachio to salinity by farmers for new orchards
- Controlling the amount of exploitation of ground water resources and nutrition of these areas
- Increasing the amount of surface water resources extraction and doing some projects for transfer water to pistachio cultivation plain
- Install a volume counter to control the withdrawal from wells according to permission
- No permission for exploiting ground water resources

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