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Investigation of drought effect on water quality variations of Karoon river (Khouzestan) using Aq.Qa software

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Key words: Iran, Karoon river, Aq. Qa software.

Abstract

One of kinds of the natural disasters is drought. Our country, Iran, about every five years experiences a 2-3 year period of drought. The study area is a basin of Karoon River with average annual rainfall 515.5 mm. In this research, the data of a ten year period interval obtained from hygrometry stations at the Gotvand dam, Ahwaz and Bahmanshir River in Abadan was used. Next the data was analyzed by Aq.Qa software package. The results showed that at the downstream of Ahwaz and Bahmanshir station, the water was found as C_4S_4 Class in some months that are unsuitable for agriculture and drinking uses. The Piper chart indicated that the water quality is not steady along the course and the dominant cations in most of the years are Na+ K>Ca>Mg and the dominant anions in the Gotvand station are Cl > HCO_3 >SO_4 and at Ahwaz and Bahmanshir stations are Cl>So_4>HCo_3. The dominant type at the all stations is choloro- sodic Na-Cl.

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Introduction

Water is a vital factor for survival of humans, plants and animals. However, some parts of the globe are being subjected to water deficiency as the result of increasingly growing population. The running waters, particularly the rivers, have long been considered by human as a basic resource to satisfy its biological needs. For this reason, the great ancient civilizations were established near the rivers by which they were able to meet their needs and supply the water for agriculture and transport purposes and by loss of their productivity capability, the neighboring civilizations were declined as well (Alizadeh, 1995).The drought has an extensive effect on such ecosystem elements as soil, plants, animals as well as human life. It also disrupts the water cycle strongly, which first contributes to water drought and then by intensify the need for water and increasingly stressed plants, it ultimately results in cropping drought.

The drought in the crucial regions widely affects the lives and socio-economic planning due to convenience of degradation and difficulty of reconstruction and compensation, leading to a critical and emergency situation.

In sum, drought has many consequences including decreased surface flows, static level drop, decrease of soil and atmosphere moisture, increase of evaporation rate and water deficiency in the agriculture and industry sectors, soil erosion, urban problems, loss of crops and animals, increase of weeds, invasion of insects, decrease of food products, poverty are the consequences of severe and cyclic drought (Islamian, 2000).

In spite of their very similar meaning, the “aridity” and “drought” are not synonyms. The former is a characteristic feature of arid and semi-arid regions and represents the conditions in which the average rainfall or available water is steadily too low as it is the case in the deserts, whereas the letter is a condition where decrease and irregularity of rainfall are such that disturb the normal growth trend and interrupt the already balanced conventional human-environment relation (Islamian, 2000).

To determine the water quality, there are various techniques that have resulted from chemical analyses. Representing as graphs, these analyses take a more understandable form which includes the Piper, Schoeller and Radial plots (Mohsenifar, 1999).

Firouzbakhat (1997) has studied the contamination of Karoon River and Khuzestan plain and its temporal and spatial variations. The results obtained on some parameters, though have a relative increment in recent years, show that the pollutant average amount is desirable and up to allowable limit.

Sultani Mohmmadi (2006) has examined the quality of Karoon’s water agriculturally. In his study, Sultani (2006) by investigating in all the stations from Ahwaz to Khoramshahr, assigned the quality water based on exchangeable sodium ion to class 1 and the salinity to class 2. Azen (2007) by examining the springs, surface and groundwater at the Troia region in Turkey for 25 samples through drawing the Piper, Schoeller and Wilcox plots determined the types of sampled water, for most of samples, as Mg-Cl-HCO_3 and for three samples as Na-HCO_3.

The Karoon River is the longest and fullest one in Iran. It has 950 km long and the extent of its watershed basin is 6000 km^3 (Power ministry guide, 2010). Karoon’s watershed basin with 42574 km^2 area is situated between longitude, 48°4´, 51°55´ east and altitude 30°17´ , 32°04´ north (Zarei and Akhonzadeh, 2006).

The Karoon River and the branches flowing into it have established the greatest river system in Iran and it is a basic resource supplying water for throughout Khuzestan province. This river originating from Zagros and Zard koh Mountains about 3500 meters above sea level, after traveling a long distance flows down in Gotvand 100 meters above sea level and runs in to Khuzestan plain.

It travels 250 km across Khuzestan plain before flows into Persian Gulf. The northern part is thoroughly mountain area and the south part is the main area of Khuzestan plain. It is a perpetual river and having snow and rain regime; hence its discharge varies by seasonal changes and strongly depends on rainfall level and seasonal weather (in spring time the melted snow induces flooding). This river has the highest water-delivering in the country. The average annual long term water- delivering in the dam facilities is 300 m^3/s and its volume is over 10 billion m^3 (power ministry guide, 2010).

The aim of this study is to examine the drought effect on trend of water quality variations of Karoon River using Aq.Qa software in ten past years.

Materials and methods

Study area

To determine the water quality of Karoon, the data of three stations setup along the river related to the years 2001, 2009, and 2011 adapted from Khuzestan Water & Power Authority was used which has been from origin to end: Gotvand, Ahwaz, Bahmanshir. labratory methodIn order to determine the water quality, the parameters of electrical conductivity in ds/m and the sodium adsorption ratio were used and the water class was specified. In addition to it, the electrical conductivity (ds/m) and pH, water quality and water type for drinking were determined by drawing Piper plot using Aq.Qa software and incorporating such parameters as calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chlorine and solfate in mmol/l.

Results and discussion

Determination of River `s Water Class

According to this classification, the water of Gotvand station falls into three classes C_3S_1 (dominant class), C_2S_2 and C_2S_1 (Table 1). At the Ahwaz station dominant classes are C_3S_2 and C_4S_2 (Table 2). As fallen into C_4S_2 and C_3S_2 classes, the Bahmanshir station is subjected to high salinity and sodic risk and has the lowest quality for irrigation (Table 3). In the case of salinity risk, three classes were obtained: intermediate, high and very high classes. In 2011 the salinity risk at Gotvand and Ahwaz from intermediate reached to high C_3 and at Bahmashir reached to very high class and three stations are facing with very high risk.

Type and Classification of Water Using Aq.Qa Software

The dominant type of water in the stations is choloro-sodic NaCl. As shown in table (4) at Gotvand station in 2009 and 2011 the water facies in two months is calcic and in 2001 and 2011 at Ahwaz station the water type is sulfate and bicarbonate (Table 4).

Classification of Water Using Piper Chart

At Gotvand station in 2001 (Fig. 1) and 2009 (Fig.2) the dominant types of water were sodium, potassium and chloro, but in 2011 (Fig.3) the dominant type was sulfate and without any specific type.

At the Ahwaz station in 2001 (Fig.4) and 2009 (Fig. 5), the dominant types of water were sodium, potassium and choloro, but in 2011 (Fig.6) the dominant type was sulfate without specific type similar to Gotvand. At Bahmanshir station in 2009 (Fig.7) and in 2011(Fig.8) sodium, potassium and chloro were dominant types of water. Therefore, totally, with respect to plots the dominant type of Karoon's water in all the stations are Na+ K and Cl. As mentioned above, Sutani Mohammadi(2006) has examined the quality of Karoon River agriculturally and found that in all the stations from Ahwaz to Khoramshahr the quality of water exchangeable sodium ion is fallen to class 1 and the salinity to class 2, whereas this study showed that at the downstream of Ahwaz station the exchangeable sodium ion is extremely increasing and the water quality declines due to discharge of wastewater effluent from industries, factories and refineries, being saline and sodic of surrounding lands and so on (Mohammadi Asaad Abad *et al.*, 2010). Thus the salinity of water along the river route has less incremental trend (the dominant class in Gotvand C_3S_1 and in Bahmanshir

C_4S_1) but the exchangeable sodium ion is increasing strongly, even it can be said that beyond Ahwaz it is impossible to use the river's water for agriculture purpose (Ying 2007).

Table 1. Determination of water class in Gotvand station.

Month site	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Gotvand 2001	C_3S_2	C_2S_1	C_3S_1	C_2S_1	C_2S_1	C_3S_1	C_3S_1	C_3S_2	C_3S_1	C_2S_1	C_3S_1	C_3S_1
Gotvand 2009	C_3S_2	C_3S_1	C_1S_1	C_2S_1	C_3S_1	C_3S_1	C_3S_2	C_3S_2	C_4S_3	C_3S_2	C_3S_1	C_3S_1
Gotvand 2011	S_2C_3	C_3S_1	C_3S_2	C_3S_2	C_3S_1	C_2S_1	C_3S_1	C_3S_1	C_3S_1	C_3S_1	C_3S_1	C_3S_1

Table 2. Determination of water class in Awaz station.

Month site	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
2001 Ahwaz	C_3S_2	C_3S_2	C_3S_2	C_3S_2	C_3S_2	C_3S_2	C_3S_2	C_3S_1	C_3S_2	C_3S_1	C_3S_1	C_4S_2
Ahwaz 2009	C_4S_2	C_4S_3	C_4S_2	C_4S_2	C_4S_2	C_4S_3	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_3S_2	C_3S_2
Ahwaz 2011	C_3S_2	C_3S_1	C_3S_1	C_3S_1	C_4S_2	C_3S_1	C_4S_2	C_3S_2	C_3S_1	C_3S_2	C_3S_2	C_4S_2

Table 3. Determination of water class in Bahmanshir station.

Month site	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Bahmanshir 2009	C_4S_4	C_4S_4	C_4S_3	C_4S_4	C_4S_2	C_4S_3	C_4S_3	C_4S_3	C_4S_3	C_4S_4	C_4S_2	C_3S_2
Bahmanshir 2011	C_4S_3	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_2	C_4S_3

Type and Classification of Water Using Aq.Qa Software

The dominant type of water in the stations is choloro-sodic NaCl. As shown in table (4) at Gotvand station in 2009 and 2011 the water facies in two months is calcic and in 2001 and 2011 at Ahwaz station the water type is sulfate and bicarbonate (Table 4).

Table 4. Type and facies of Karoon water using Aq.Qa software.

Month site	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar
Gotvand 2001	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl
Gotvand 2009	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Ca-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl
Gotvand 2010	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Ca-HCO_3	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl
2001 Ahwaz	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-HCO_3	Na-Cl	Na-Cl
Ahwaz 2009	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl
Ahwaz 2010	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-So_4	Na-So_4	Na-Cl	Ca-So_4	Na-Cl	Na-Cl	Na-Cl
Bahmanshir 2009	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl
Bahmanshir 2011	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Na-Cl

Classification of Water Using Piper Chart

At Gotvand station in 2001 (Fig. 1) and 2009 (Fig.2) the dominant types of water were sodium, potassium and chloro, but in 2011 (Fig.3) the dominant type was sulfate and without any specific type.

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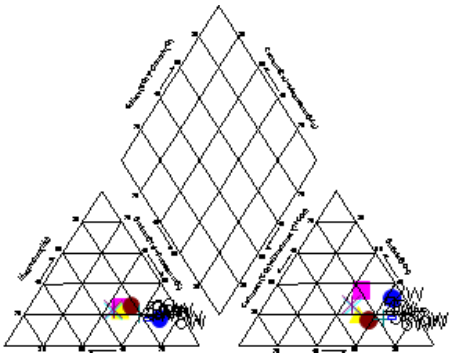

Fig. 1. Gtvand station (2001).

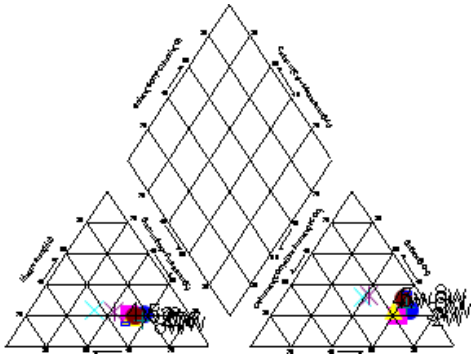

Fig. 2. Gotvand station (2009).

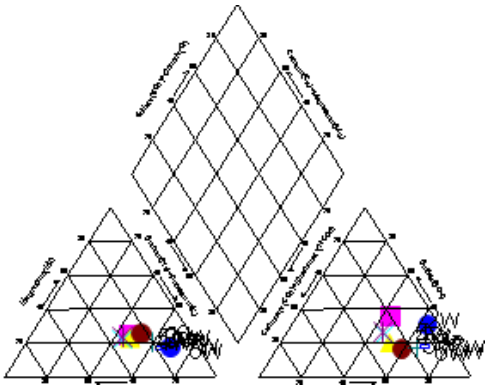

Fig. 3. Gotvand station (2011).

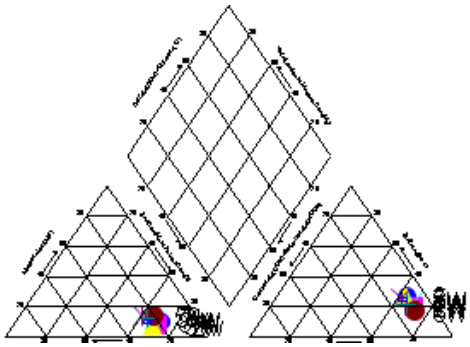

Fig. 4. Ahwaz station (2009).

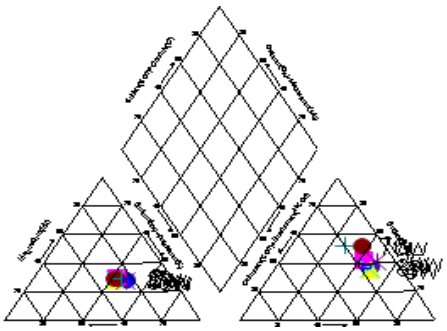

Fig. 5. Ahwaz station (2009).

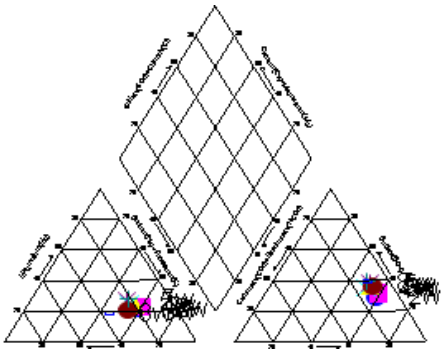

Fig. 6. Ahwaz station (2011).

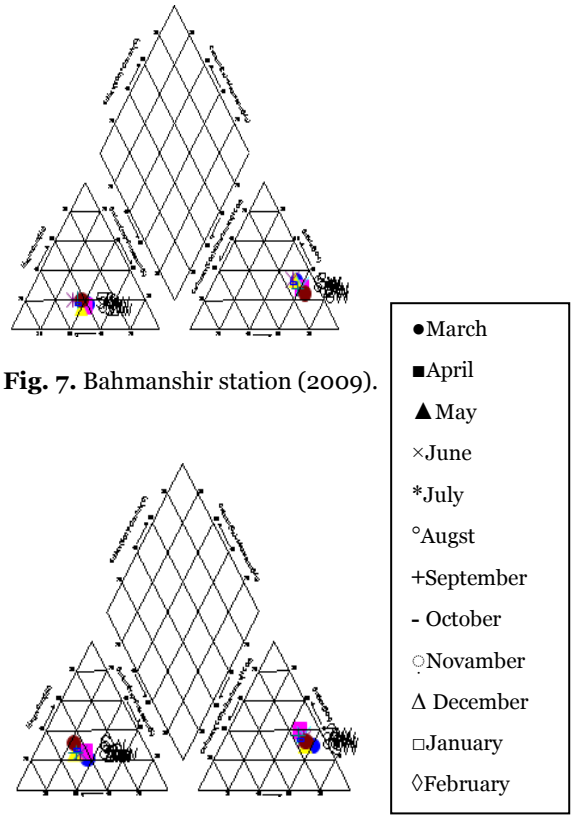

Fig. 7. Bahmanshir station (2009).

Fig. 8. Bahmanshir station (2011).

Conclusion

This study shows that the quality of Karoon's water is decreasing as the rainfall decreases. Also the concentration of dominant cations in most of the years at all the station is Na+K> Ca >Mg. Being sodium dominated, has made the water Cholro sodic Na+K and CI. If various pollutions are entered in to rivers and in respect to recent droughts, in the coming years it is accepted the quality of water to be extremely decreased. Therefore it is recommended the pollutions to be controlled through accurate management and planning and the exploitation of the rivers is done in respect to rainfall amount and the quality of water.

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