Analyzing and studding chemical water quality parameters and its changes on the base of Schuler, Wilcox and Piper diagrams (project: Bahamanshir River)

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Abstract: Water quality characteristics are such components that by considering necessary in planning water resources management is keenly felt but it has less attention in our country. This study is about assessed seasonal changes in water quality parameters of Bahmanshir River in Khuzestan province. In this study, the data recorded by the Regional Water Company in Khuzestan province from 2005 to 2014 has used. Eleven parameters for analyzing seasonal changes and then assess the type and quality of water in the area have been selected. These parameters are: Total dissolved solids, anions (bicarbonate, sulfate, and chloride), caption conductivity, and PH ratio of water. In order to evaluate the chemical quality of water in different years, piper, Wilcox, Schuler diagrams and water quality standards were used. On the base of Wilcox diagrams the river's water is inappropriate for agricultural purposes. . Schuler diagram showed that in the river's water all captions and anions are not in a good range and is inappropriate for drinking in recent years. The results showed that all quality parameters with significant annual changes and all parameters have increased during recent years.

Key words: Water's chemical quality; Schuler index; Wilcox index; Piper index BahmanShir River

1. Introduction

One of important factors in the sustainable development of a region is the availability of adequate water resources for various purposes that in addition to the quantity its qualitative status has special importance too. Nowadays, the property of water quality is one of the components that the necessity of consideration in the planning of water resources management , also evaluate the health status of dock's drainage and administrative changes has completely felt but has not paid attention too much.

Natural and human factors are causing changes in the physical, chemical and biological of water quality, so the science of water quality will be as an issue remain for engineers and scientists for the in next years. Water is not found in nature in its pure form but on other hand always have some salts, suspended solids and dissolved gases and it causes that water has various features in different regions. Some of the minerals in water are essential for human health, while the amount over the limit would endanger human health. There are several compounds in waters that are influenced in the physical and chemical quality. Chemical analysis of

water samples provides a large number of data that must be analyzed for specific purposes.

In the meantime, Checking anions and cations can show many characteristics of the water and by using them other characteristics of the water is determined. The most important physicochemical of water are some parameters such as fluorine, chloride, sodium, sulfate, iron, total hardness, total dissolved solids and electrical conductivity.

Due to the importance of water's quality for drinking, agriculture and industry, much tries has been done in this field. Zehtabian (2004) studied the quality of water in Jajroud and Varamin, Their results showed that as they are closer to the south of plains the river water quality will diminish. Due to the wastewater of municipal, agricultural, industrial, on the one hand and on the other hand is affected by the formation of evaporation. Dashti Mervilyet al (2008) studied the water quality of the Narmab river and assessment the river's water for drinking and agricultural usage. Talaei et al (2007) in order to evaluate the quality of drinking water of Minralize and Altereh area and drawn the results of chemical analysis of water samples on Schuler chart while they have introduced high sulfate ion, sour taste and corrosive of water as the main reason to say that its water is undesirable . Zia (2009) has studied the quality and quantity of artificial recharge brine by using Schuler, Will Cox and Piper diagrams showed

that the water is non-potable , unsuitable for agriculture, and its type is in choler . The propose of This study is to examine annual changes, seasonal, monthly water's quality parameters of Bahmanshir river , determine the type of chemical water quality of the river by using graphical methods such as Piper, Wilcox, Schuler diagrams and international standards of water.

2. Materials and Methods

2.1. The area of studying

Bahmanshir River with approximately 70 kilometers Length has been located in south of Khuzestan province that has been split from Karoon River in a pace which has named HEFAR in KHORAMSHAHAR and after passing through the Abadan and CHUEBDEH cities is connected to the Persian Gulf.

This river is affected by tides of Persian Gulf. The resulting wave of this phenomena will continue to move to the farthest point on the Bahmanshir River.

In this phenomenon salty water of the sea and river's water meet and mixing takes place.

Some of the used water in Abadan is providing from station 11 which has located beside Bahmanshir River. The coordinates of the mentioned station are 88 degrees, 49 minutes and 50 seconds is the length and 30 degrees, 22 minutes and 40 seconds width.the satellite images of Project's location and the location of 11th station has shown.(1)

Fig.1: Location The studied area (station 11 in Abadan)

The analysis of seasonal changes in parameters of quality of water

In this study, the water quality data that has used, collected by the Water and Power organization of Khuzestan which is related to energy department .these data in a period of years from 2005 to 2014 are available. Eleven parameters due to analyze seasonal changes and then assess the type and quality of water of the area have been selected. These parameters are:

Total dissolved solids, anions, bicarbonate, sulfate, chloride, sodium cations, magnesium, calcium, potassium, electrical conductivity, sodium absorption ratio and the acidity of the water. Graphic techniques are presented due to make it easier to interpret and analyze the results of water quality parameters.

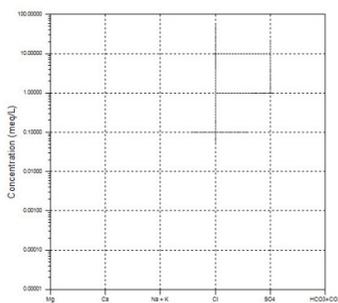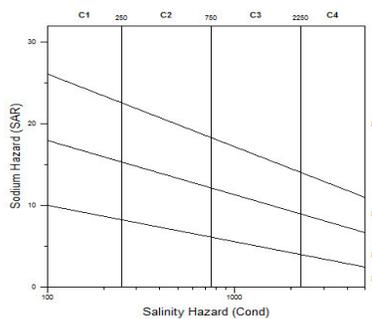The most important of these methods are: Piper, Wilcox, and Schuler diagram

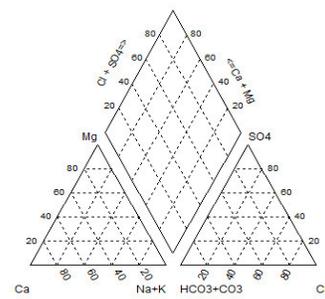

Fig. 2: Schuler

Fig. 3: Will cox

Fig. 4: Piper

2.2. Piper diagram

This chart is using to classify samples and to determine the chemical type of water. The total amount of anions and cations is considered 100 and the percentage of ions marked on the side triangles and the corresponding points on the side of the triangles will show on the middle lozenge. Finally, judging about the quality type of water with Piper diagram is performed in regard to the of focused points area In this classification, Water on the base of cation derived into three phases which are

bicarbonate and full of calcium and sodium and also on the base of anions derived into bicarbonate, sulfate and chloride types .

Quality of water for irrigation is classified by Wilcox Diagram which is on the base of sodium adsorption and electrical conductivity ratio.

2.3. Schuler Diagram

Semi-log diagram is using to show the primary ions on the base of akiovalant millimeter per liter and also to show chemical differences between the

samples used in a diagram. In hydrology reports for classification of drinking water usually Schuler diagram is used. In this study also Schuler diagram is used to assess the quality of drinking water.

Table 1: Water quality classification Schuler

Total Dissolved Solids	Total hardness	So4	Cl	Na	Degree of quality for human drinking
< 500	< 250	< 144	< 177.5	< 115	Good
500–1000	250–500	144–288	177.5–350	115-230	Distinguish acceptable
1000-2000	500-1000	115–576	350-710	230-460	Unsuitable
2000-4000	1000-2000	115-1153	710-1420	460-920	Bad
4000-8000	2000-4000	115-2304	1420-2840	920-1840	Drinking is temporarily
> 8000	> 4000	> 2304	> 2840	> 1840	Non-potable

Table 2: Water quality standards, (Alizadeh, 2005)

Ministry of Power	European Assembly	America Environmental Protection Agency	WHO	Parameter
-	25	-	-	Temperature(° C)
-	-	-	0.7	EC (dS/m)
-	6.5 -9.5	6.5- 8.5	6.5 -8.5	PH
1500	1500	1500	1500	TDS(ppm)
600	600	250	250	cl(ppm)
400	250	250	400	so4(ppm)
200	200	200	200	Ca (ppm)
150	50	150	150	Mg(ppm)
-	150	200	200	Na(ppm)
12	12	12	12	K(ppm)
500	500	500	500	Total hardness as calcium carbonate(ppm)
45	50	45	45	NO_3(ppm)

3. Results and Discussion

Quality and quantity of water is one of the main pillars of sustainable development. On the other hand rivers has been introduced as one of the main available resources for human's needs that in addition to water quantity, the quality water is also an important determining parameter. The annual mean values of water quality parameters is presenting in Table 1.

Table 3: compare it with standards chemical and the water samples of study area

years										Name
1389	1388	1387	1386	1385	1384	1383	1382	1381	1380	
323.3	588.8	464.6	204.4	191.7	198.6	244.1	201.3	224.2	239.1	Na (mg/lit)
350.4	567.52	460.2	267.8	225.4	267.36	274.4	245.6	259.4	245.1	So4 (mg/lit)
197.5	193.2	200.6	193.8	183.4	202.8	203.7	195.9	178.2	158.1	HCO_4 (mg/lit)
504.2	910.7	723.9	305.3	324.5	318.4125	376.9	305.6	350.2	396.3	cl (mg/lit)
52.16	69.4	71.57	42.94	41	35.31	36.2	31.6	41.4	41.6	Mg^{+2} (mg/lit)
126.16	171.43	131.6	94.4	101.1	119.8	115.4	105.3	95.7	93.5	Ca^{+2} (mg/lit)
3.2	9	5.6	2.9	2.8	3.3	2.6	4.6	3.8	3.2	K^+ (mg/lit)
0	0	0	0	34.8	0	0	0	1.1	0	CO_3 (mg/lit)
1629.8	2451.5	1876.1	1082.5	1071	1164.1	1265	1099	1819.6	1223.8	TDC
2395.2	3903.6	3306.2	1731.6	1706.6	1778.75	1956.4	1782	1811.2	1920.8	EC
7.5	7.35	7.35	7.72	7.91	7.75	7.86	7.9	7.96	7.96	PH
530	714	624	413	422	445	438	394	410	405	TH

The classification of water is according to the major amount of water's cations and anions. Due to study the evolution and detection of anions in water supplies surface, the water's type of rivers drainage basin level of Bahmanshir were examined. Concentrate of samples in the Piper diagram (Fig. 5) indicating that the chemical type of water quality in different years is bicarbonate, sulfate and calcium –

sodium. The hardness type of water is a temporary type. Classification of surface water from the point of agriculturally view is on the base two parameters which are electrical conductivity and sodium adsorption ratio.
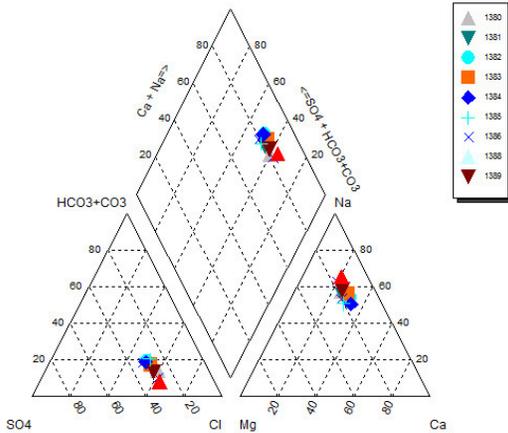
Fig.5: Chemical Brigade Rivers (Piper diagram)

Points of intersection of these two parameters in Wilcox Diagram represents the category of intended Water sample. Wilcox classification method and using its diagrams is the most useful method for classifying the agricultural water in the hydrological studies. The results of the chemical quality of the water that has studied by Wilcox diagram showed that water samples which are related to years 2005 to 2010 and 2013 are placed in (   ) salinity Class situations that is particularly suitable for irrigation. Water samples from the years 2008 and 2009 is in within(   ) limitation and is Unsuitable for irrigation.

And salinity class of 2011(   ) is almost perfect for agriculture. Of course related specific extension of water treatment is necessary.

Fig.6: Chemical Brigade River (Wilcox diagram)

According to Schuler diagram (Figure 7) changes in quality parameters during different years richness

of water from bicarbonate, chlorate, EC, TDC, clearly shows total hardness. According to this diagram we realized that the amount of sodium, chloride, sulfate and total hardness increased which is unfit for human drinking.

3.1. In total dissolved substances (TDS):

Based on drinking water standards, the water that its TDS is greater than 1,000 milligrams per liter is not suitable for drinking which is classified as salty taste water. Industry usually need the water with TDS that is less than 1,000 milligrams per liter. Changes in TDS range in many several years had been maximum 2451.5 ppm in 2013 to at least 1071 mg per liter in 2010. According to the mentioned standards the water of years 2012 to 2014 and 2006 is not acceptable for use in industry and agriculture and drinking.

3.2. PH, bicarbonate and carbonate:

PH of water samples of study years is changing from 7.35 to 7.96. Minimum PH during the year 2013-2012 is 7.35 and maximum ph during the year 2006-2005 is equal to 7.96. PH less than 7 can produce hydrogen sulfide from sulfur and PH less than 6 cause corrosion in the water distribution network that is the main reason of water pollution from heavy metals such as lead and copper.

3.3. Chloride Cl -:

The annual average amount of chloride in water is changing from 305.6 to 910.7 studied in ppm. Large quantities of chloride is related to the year 2013.

The amount of chloride in the years 2012 to 2014is more than standard limitation .Limitation for chloride in drinking water is 600 mg per liter of chloride ion that it is too much caused salinity, which can lead to a restriction for various purposes.

3.4. Sulfate SO4:

During the studied years the annual average amount of sulfate in water samples has been changing between 225.4 and 567.52 ppm per ino so4 -.

By Considering that the study area located in adjacent to the sea and industrial town has been affected by pollution sources and causes of high sulfate in recent years. On the base of standards the maximum amount of sulfate in drinking water is 400 milligrams per liter of sulfate ion. Large amounts of sulfate in water leads to restrictions.

3.5. Calcium and Magnesium:

Considering that the main causes of hardness of water are calcium and magnesium, High amounts of these elements in water leads to increasing water
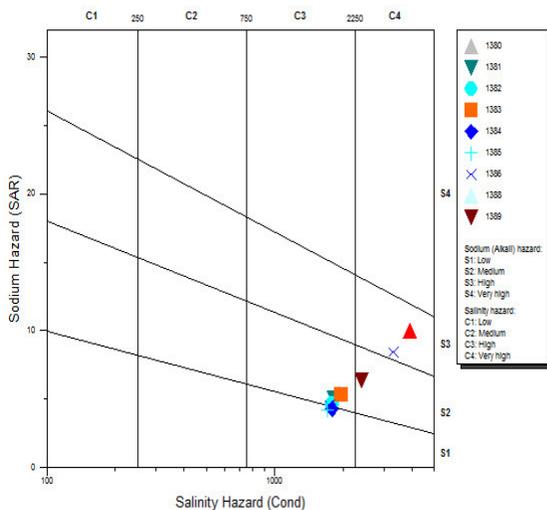
hardness and thus cause water restrictions for different purposes.

Annual average amounts of calcium and magnesium in all the years seems desirable.

3.6. Hardness TH:

Average annual total hardness in water sample is changing from 394 to 714 during the studied years. The minimum total hardness is in 2007 and the maximum is in 2010. Water with hardness greater than 500 mg should be considered among the very hard water. Very hard water do not have any problem for health but may be problematic for certain industrial purposes.
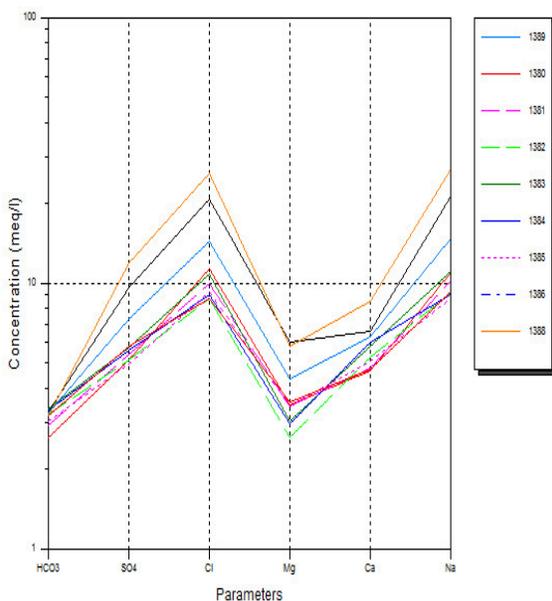

Fig.7: Category river water (Schoeller diagram)

4. Conclusions and recommendations

Enough water with desirable quality is necessary for human survival. Health development and Protection of the environment is always dependent on the supply of clean water. From the beginning of Human civilization, humans lived near to rivers, lakes and natural springs. According to the results of the data, the increasing trend is evident in almost all measured parameters. Annual changes in quality parameters of Bahmanshir River showed that almost all parameters have significant changes.

1-The climate has a huge impact on the quality of water resources, Water in arid and semiarid regions have more salt, Unfavorable climatic conditions in Abadan, Low rainfall, high temperatures and evaporation intensity leads to increase the degree of the solute concentration. In the years 2012 to 2014 the most severe drought has occurred in this region that cause to increasing the alkalinity and changing cations and anions are on the growth of corrosion on the existing structures on the river that these factors cause corrosion on the existing structures on the river.

2- According to Piper diagram the river's water in general is bicarbonate and full of calcium and magnesium, which is placed in temporary hardness of water category.

3- The results of the chemical quality of the water that has studied by Wilcox diagram showed that water samples which are related to years 2005 to 2008 and 2013 are placed in (C_3S_1) salinity Class situations that is particularly suitable for irrigation. Water samples from the years 2011 and 2012 is in within(C_4S_2) limitation and is Unsuitable for irrigation.

And salinity class of 2014(C_4S_1) is almost perfect for agriculture.

Of course related Specific extension of water treatment is necessary.

4- According to Schuler diagram changes in quality parameters during different years richness of water from bicarbonate, chlorate, EC, TDC, clearly shows total hardness. According to this diagram we realized that the amount of sodium, chloride, sulfate and total hardness increased which is unfit for human drinking.by Comparing Three Piper, Wilcox, Schuler diagrams with standards drinking water quality for human it can be realized that the water of Bahmanshir is not suitable for drinking during recent years. Because all the minerals in the water are increasing so that increases alkalinity, TDS, calcium, sodium, magnesium, PH, EC, chlorate and sulfate is not negligible. This survey showed that for prospering utilization of water resources and prevent their degradation It is necessary to determine the scope of the environmental quality of the river .using of animal fertilizers and chemical herbicides, sewage discharge due to weakness and lack of sewerage systems, Discharge of waste due to lack of suitable place for eliminating wastes and the risk of oil pollution in the Persian Gulf and are the main pollutants of the river.

References

Alizadeh, A., 2005, "Principles of Applied Hydrology", publisher Astan Quds Razavi, Seventh Edition, 776 p .

Avarand . Alipur, no. Nasr, M..C, Assess water quality in Ahvaz Karoon River refinery 2. Congress

Dastorani, M. Dastorani CE. Ter.And Abbas b., Chemical Quality of Water Mill Basin White - Yazd world. Fifth National Conference on Science and Watershed Engineering, Iran (sustainable management of natural disasters). Iran 2013

Greenberg AE, Clesceri LS, Eaton AD.Standard method for the examination of water and wastewater. 19th ed.

Khadam, I.M, Kaluarachchi, J.J., Water quality modeling under hydrologic variability and parameteruncertainty using erosion-scaled

export coefficients. Journal of Hydrology, 2006, 330: 354-367.

Mahdavi, M. Applied Hydrology, Volume II, Tehran University Press, 2003

Optimal Utilization of Water Resources of Lorestan province. Persian date Shahrivar2012

PAPHA,AWWA,WPCF(1985) Standard Methods fot the Examination of Water and Wasewater 10-

Piper, A. M., 1994, "A graphic procedure in the geochemical interpretation of water," Transactions of the American Geophisical Union, Vol. 25, 914 pp.

plainMrvyly, M. MhmvdlvNagorno-M. And Pourghasem, p., The quality of river water Nrmab using graphical methods. Ninth National Seminar on Irrigation and reduce evaporation. Tree.2011

Schoeller, H., 1962, "Lexsouterraines", Masson, Paris,642 pp.

Sikdar, P. K., Sarkar, S. S. &Palchoudhury, S, 2001,"Geochemical evolution of groundwater in the Quaternary

Talaei, b. Followers, ex R.. Mineralized and altered zones of impact on the quality of surface water and groundwater from an environmental perspective. Twenty-Fifth Meeting of Geological Sciences. State Geological Survey. 2007

Washington: APHA; 1995..Montgomery J.M(1985)Water Treatment,Principale and Design,John Wiley and Sons.Inc

Wilcox, L.W., 1995, "Classification and use of irrigation water", U. S. Department, Agri. Circular, 969 pp.

Zia H. AsghariMoghaddam, A., Quantitative and qualitative assessment of artificial recharge of Birjand brine.Proceedings of the Eighth SymposiumGeological Society of Iran.1999