ORIGINAL ARTICLE

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Surveying drinking water quality (Balikhlou River, Ardabil Province, Iran)

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Abstract

Considering the importance of Balikhlou River as one of the most important water sources of Ardabil, Nir and Sarein cities, maintaining water quality of this river is the most important goals in provincial and national levels. This river includes a wide area that provides agricultural, industrial and drinking water for the residents. Thus, surveying the quality of this river is important in planning and managing of region. This study examined the quality of river through eight physicochemical parameters (SO_4, No_3, BOD_5, TDS, turbidity, pH, EC, COD) in two high- and low-water seasons by international and national standards in 2013. For this purpose, a review along the river has been done in five stations using t test and SPSS software. Model results showed that the amount difference in TDS and EC with WHO standards, and TDS rates with Iran standards in low-water seasons, pH and EC with WHO standards in high-water seasons, is not significant in high-water season; but for pH and SO_4 parameters, turbidity and NO_3 in both standards and EC value with WHO standard in low-water season and pH, EC, SO_4 parameters and turbidity and NO_3 in high-water season have significant difference from 5 to 1%, this shows the ideal limit and lowness of parameters for different usage.

Keywords Balikhlou River · Physicochemical · Iran and WHO standards

Introduction

In several years and during the past decades, at various levels, due to extensive human intervention, attitudes changed towards sustainable management of water resources (Meybeck 2003). The river as vital role in all aspects of human life and health has great impact in future of humanity. The need for water in agricultural, industry and drinking water demand has been increased by population growth and water demand; that imposed many pressure to water resources, while wate is needed for any development (Sedaghat 2008).

Water quality characteristics are components that considered the necessity of water resource management and the health of aquifer areas (Khadam and Kaluarachchi 2006). Nowadays, the water quality is the main issue in the case of surface water. Due to the use of the river waterway in the transfer of industrial sewage, agricultural and fruit plantations, these sources are imposed by different pollutions. Increase in the information about the quality of drinking water for public health and quality of raw water for aquatic life increased the need to survey the quality of surface water (Ouyang, 2005). The quality of surface water in a region is under influence of two agents: natural processes (rate of sedimentation, soil and water conditions and soil corrosive) and human processes such as agricultural and industrial activities (Huang and Chen 2009).

Today, the necessity of qualitative studies of water resources due to the wide variety of contaminant arrivals is inevitable and in most parts of the world is one of the most important challenges faced by humankind during recent years. During the recent decades, several solutions at different stages, identification, prevention and corrective actions, are presented by various researchers to increase the quality of the water resources. Rajaee and et al. studied drinking

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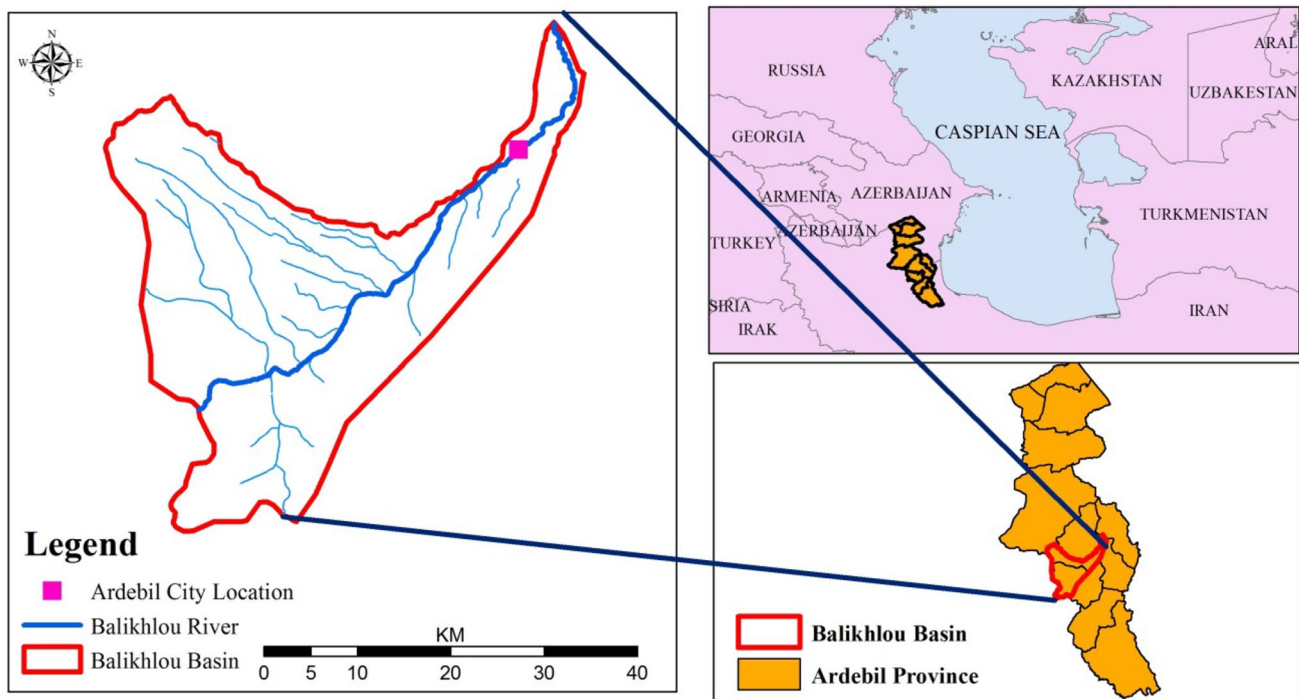
Fig. 1 The location of the study area in Ardabil Province and Iran

water wells quality on Ali Abad Katoul plain, they measured significant relationship between metal concentration and did not view any correlation between them on national and international standards (Rajaei et al. 2012). Miranzadeh et al. (2011) to study the concentrations of heavy metals (chromium, copper, zinc, lead, cobalt, silver, nickel, cadmium) in the five areas of water distribution network of Kashan city (in 2010) measured 35 samples in three seasons of spring, summer, autumn that approximately measured 105 samples which were higher than national and international standards.

Among them, identification and informative stage of the status of water resource quality as the first step in the direction of a healthy environment and access to water is a major source of studies and enough attention can be appropriate for the prevention and remedial measures to increase the quality of water resources (Nouri et al., 2011). In addition to the increasing world population, increased water usage has not only reduced the quantity of water available and has met with more restrictions, but also caused pollution and reduction in the quality of water resources (Hajian nejad and Rahsepar 2010).

Various human activities around rivers' privacy led to the entry of many pollutants into water canvas and affected the quality of river waters (Chen and Chen 2001). Considering the importance of the Balikhlou River as one of the most important sources of drinking water supply in Ardabil, Nir

and Sarein cities, maintaining the water quality is one of the most important objectives of this non-notable alternative source. The most important action and management necessity in this regard is continuous knowledge about water quality of different stations. That means that with continuous measurements of index parameters of water quality for drinking consumption, and even its prediction for the future, must be sure the quality of these parameters in comparison with specified standards and if identified a non-authorized pollutants, timely find the source and recovery it. This river includes a wide area and provides agricultural and industrial water for the residents; thus, qualitative studies of the river are necessary for planning and optimum management of water resources.

Methods

Study area

The Balikhlou River is one of the most important rivers of Ardabil Province and is the most important and main branches of Gharesou River. Natural springs, rivers, snow water and rain water are main feeding sources of the river. This enters into the Ardabil city from the east. The north scope of the area is the Sabalan Mountain, in the west and south are Bozghosh
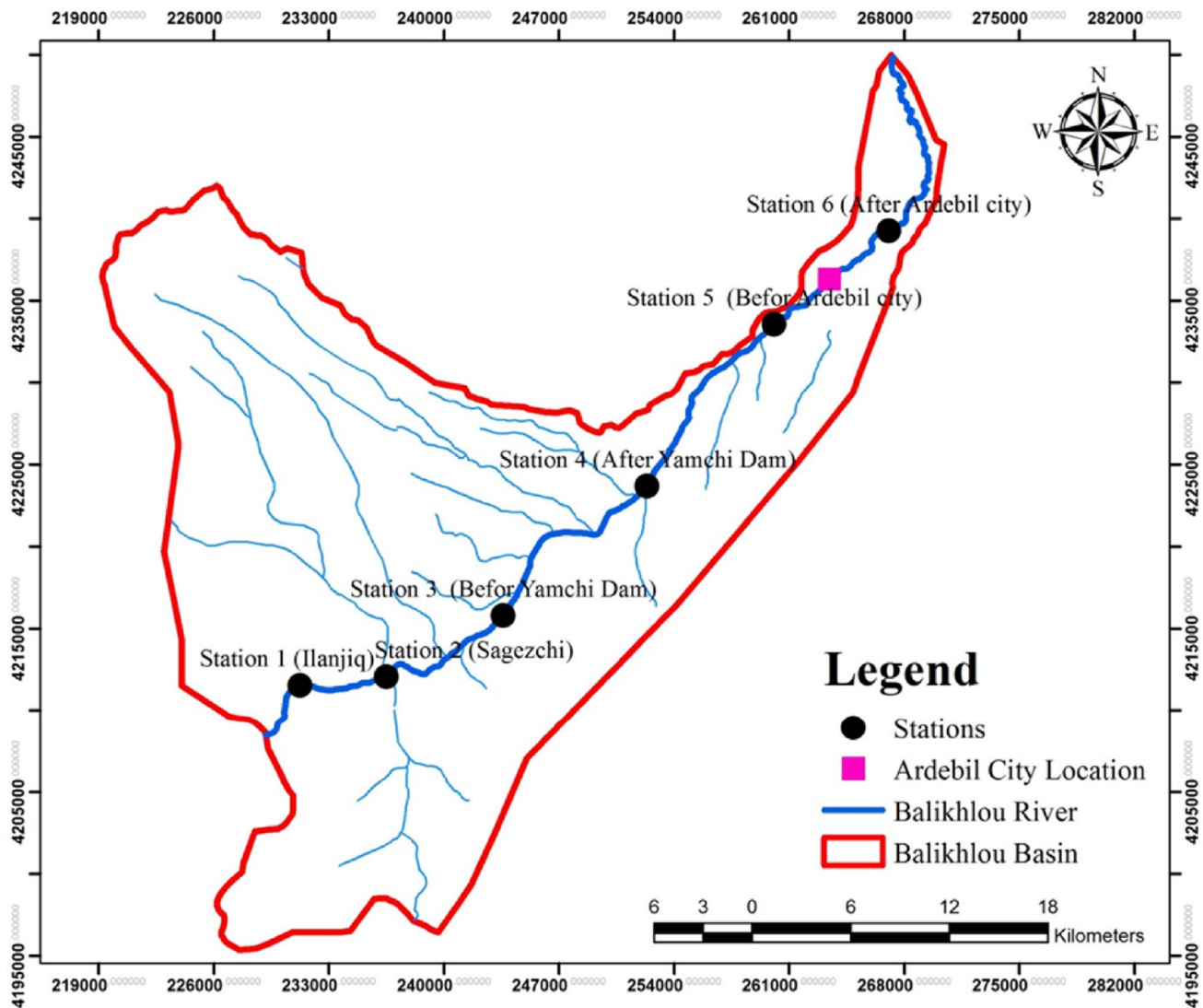
Fig. 2 The location of the five sampling stations in the study area

Table 1 Summary of statistical parameters in the area

Parameters	Statistical			
	SD	Max.	Min.	Mean
BOD_5	5.2632	16	4	6
No^3	0.9345	3.9	0.8	1.8
TDS	800.22	3710	42	714
So^4	10.407	45	12	32
EC	701.58	2130	96	765
COD	5.0558	31	10	17
Turbidity	3.134	25	10.5	16
pH	0.7194	8.9	6.9	7.8

Mountains and in the east are parts of the plain because Ardabil originates from the mountains that have greater elevation

levels. So 72 percent of the total watershed area of the river has 1500–2500 m height (University of Tehran 1996).

The riverbed is from the above regions to the Illangigh village (range entering field of Ardabil geography) that is mountainous; it is in the bed between plains which bolt out from its full path. River length is 87 km, its watershed is 1600 km and is largely mountainous. The average annual discharge of Balikhlou River water volume is 116.5 million cubic meters.

The Balikhlou River is considered the head of the main branch of the river, it goes to North after joining Aharchai in Dostbaighlo, the river is called Dare road and is interconnected to the Aras River from the east part.

Ardabil, Nir and Sarein Cities as three major urban areas are in the range of Balikhlou River watershed. These cities are a collection of rural area, thats life and culture depend

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Table 2 Different values of physicochemical parameters in different stations of year 2012

Data	Station	Measurement amount of parameters							
		BOD 5 (mg/l)	CO D (mg/l)	Turbidity (NTU)	NO^3 (mg/l)	TDS (mg/l)	E.C (µs/cm)	pH	So^4 (mg/l)
2013.4.8	Ilangigh	6	10	13	1.5	42	96	8.6	12
2013.7.3		5	10	13	1.5	144	277	6.9	12
2013.12.9		4	14	14.5	1.3	148	310	7	14
2013.1.4		2	12	10.5	1.3	125	248	7.1	14
2013.4.8	Borjlou	3	15	15	1.9	258	535	8.3	24
2013.7.3		10	19	18	1.9	3710	342	7.2	24
2013.12.9		6	18	17	1.8	1120	218	7.9	25
2013.1.4		10	18	15	1.5	854	1805	7.3	22
2013.4.8	Saqezchi	4	16	15	3.6	264	551	8.5	42
2013.7.3		21	31	25	3.6	264	551	8.5	42
2013.12.9		5	12	16	2.8	730	1500	7.3	45
2013.1.4		5	13	13	3.9	612	1293	7.2	32
2013.4.8	Almas	11	19	18	0.9	802	1648	8.7	32
2013.7.3		11	19	18	0.9	802	1648	8.7	32
2013.12.9		4	18	18	0.8	714	1470	7.3	32
2013.1.4		16	14	14	2.6	368	765	7.5	34
2013.4.8	Ardabil city entrance	15	17	18	2.3	912	1848	8.9	35
2013.7.3		15	17	18	2.3	912	1848	8.9	35
2013.12.9		7	25	18.2	1.6	1010	2130	7.8	38

on the environmental potentials of this area. The numbers of these villages, on the basis of contained information in the culture of the Ardabil Province, are 108. Figure 1 shows the position of Balikhlou River and its related field.

Research parameters

In the present research, the analysis of the water quality has been done with eight quality parameters and its quality is compared with the World Health Organization standard. Therefore, for the analysis of water quality of the river, one-way *t* test is used. It shows the significant differences between two groups (Salehi and Porasghar Sangachin 2012). In this study, the first group contains the data which related to the samples and the second group related to national and international standards. For the research are used the water quality data of five stations that have been measured by Ardabil Province Department of Environmental Protection (Department of Environment Ardebil Province 2014). Figure 2 represents the position of the stations in the area:

For this research, eight qualitative parameters (SO^4, No^3, BOD5, TDS, turbidity, pH, EC, and COD) are used. Table 1 shows a quick overview of statistical analysis such

as minimum, maximum, deviation and average values of each parameter.

The statistical information relating to different periods of study stations and statistical different values is as follows (Table 2).

Results

The results of the comparison about different value measurements of 5 stations, Balikhlou river of Ardabil, in terms of WHO and IRAN standards (Standard Nos. 1091, 2010; WHO 1996; Khosto 2007; Farhadi 2013) has been shown in low-water seasons in Table 3.

As can be observed from Table 3, the average values of pH parameters (8.32) and turbidity (17.1) are more than WHO and Iran standards and other values of the parameters (SO^4, No^3, BOD5, COD, TDS, EC) in terms of national and international standards are low.

One-sample *t* test results regarding physicochemical parameters in terms of WHO and IRAN standards in the low-water season are shown in Table 4.

The surveying results showed that measured mean difference on TDS and EC values on WHO standard and only TDS on Iran standard has more significant difference

Table 3 Comparison of mean values of physicochemical parameters with national and international standards in summer and spring (low-water season)

	WHO	Iran standard
TDS		
Standard	500	1000
Mean	811	811
BOD5		
Standard	–	50
Mean	10.10	10.10
No^3		
Standard	10	50
Mean	2.04	2.04
EC		
Standard	1000	1800
Mean	934.4	934.4
COD		
Standard	–	100
Mean	17.3	17.3
Turbidity		
Standard	0.1	1
Mean	17.1	17.1
pH		
Standard	6.5–8.5	6.5–8.5
Mean	8.32	8.32
SO^4		
Standard	250	250
Mean	29	29

Table 4 One-sample t test to compare the physicochemical values of Balikhlou River with national and international standards in low-water season

	WHO	Iran standard	Mean	Confidence	
				Lower	Upper
TDS					
t value	− 0.557	− 0.557	− 189	578.69	− 956.69
Sig	0.591ns	0.591ns			
BOD5					
t value	–	− 21.894	− 39.9	− 35.77	− 44.02
Sig	–	0.000**			
No^3					
t value	− 26.333	− 158.657	− 47.96	− 47.37	− 48.68
Sig	0.000**	**0.000	−7.96	−7.27	−8.64
EC					
t value	− 0.289	− 3.817	− 865.6	− 352.66	− 1378.53
Sig	0.779ns	0.004*	−65.6	447.33	−578.53
COD					
t value	–	− 44.553	− 82.7	− 78.5	− 86.89
Sig	–	0.000**			
Turbidity					
t value	15.455	14.636	16.1	18.5	13.61
Sig	0.000**	0.000**	15.45	19.48	14.51
PH					
t value	3.719	2.585	0.57	1.06	0.0712
Sig	0.005*	0.029*	0.82	1.31	0.32
SO^4					
t value	− 64.518	− 64.518	− 221.74	− 213.25	− 228.74
Sig	0.000**	0.000**			

* 5% difference level probability is meaningful. ** The difference in 1% probability is meaningful. ns The mean difference is not significant

(sig > 0/05). The results showed that measured means of So^4, turbidity and No^3 on both standards have low significance with standard amount (sig > 0/01). Also, for pH values on both standards and EC on IRAN standard the mean difference is not significant (sig < 0/05).

The comparison results of physicochemical parameters from WHO and IRAN standards in high-water season are shown in Table 5.

As can be observed from Table 5, the average values of the EC parameters (1082.11) and turbidity (15.133) are more than WHO standard and turbidity value is high only in Iranian standard and the values of other parameters (SO^4, No^3, BOD5, COD, pH, TDS) are low in terms of national and international standards.

One-sample t test result regarding physicochemical parameters in terms of WHO and IRAN standards in high-water season is shown in Table 6.

The surveying result showed that measured mean difference on pH and EC is more significant in terms of WHO standard (sig > 0/05). Also the results showed that measured means of So^4, No^3 and turbidity on WHO standard and BOD_5, COD, So^4, No^3 and turbidity on IRAN standard have

low significance with standard amount (sig > 0/01). Also for EC and pH in terms of WHO standard, the mean difference is not significant (sig < 0/05).

Based on the obtained values of the sample analysis results that are determined with national and international standards, in the low-water season, the parameter values (pH, turbidity) exceed maximum specified standards and also in high-water season corresponding values (EC, Turbidity) are more than national and international standards. Figure 3 represents the number of parameters with significant and non-significant difference in high- and low-water season.

Conclusion

In this study to survey the quality of Balikhlou River as drinking water source, sampling of the physicochemical parameter changes (SO^4, No^3, BOD5, COD, pH, EC, TDS, turbidity) in two low-water season (spring and summer) and

Table 5 Comparison of physicochemical values with national and international standards in the fall and winter seasons (high-water season)

|	WHO	Iran standard
TDS		
Standard	500	1000
Mean	631.22	631.22
BOD5		
Standard	–	50
Mean	6.56	6.56
No^3		
Standard	10	50
Mean	1.956	1.956
EC		
Standard	1000	1800
Mean	1082.11	1082.11
COD		
Standard	–	100
Mean	16	16
Turbidity		
Standard	0.1	1
Mean	15.133	15.133
pH		
Standard	6.5-8.5	6.5-8.5
Mean	3.378	3.378
SO^4		
Standard	250	250
Mean	28.44	28.44

Table 6 One-sample t test to compare the physicochemical values of Balikhlou River water with national and international standards in high-water season

	WHO	Iran standard	Mean	Confidence	
				Lower	Upper
TDS					
t value	− 3.117	− 3.117	− 368.77	− 95.92	− 641.63
Sig.	*0.014	*0.014			
BOD5					
t value	–	− 31.131	− 43.44	− 40.22	− 46.66
Sig.	–	** 0.000			
No^3					
t value	− 24.988	− 149.238	− 48.04	− 47.30	− 48.78
Sig.	** 0.000	** 0.000	−8.04	−7.3021	−8.7848
EC					
t value	0.343	− 2.998	− 717.88	− 165.64	− 1270.13
Sig.	ns 0.741	*0.017	82.11	634.25	−470.13
COD					
t value	–	− 59.814	− 84	− 80.76	− 87.23
Sig.	–	** 0.000			
Turbidity					
t value	18.116	17.032	14.13	16.04	12.21
Sig.	** 0.000	** 0.000	15.03	16.94	13.11
PH					
t value	− 1.209	− 3.683	− 0.3722	− 0.1391	− 0.6053
Sig.	ns261/0	*0.006	−0.122	0.1109	−0.35553
SO^4					
t value	938/62−	− 62.938	− 221.55	− 213.43	− 229.67
Sig.	** 0.000	** 0.000			

* 5% difference level probability is meaningful. ** The difference in 1% probability is meaningful. ns The mean difference is not significant

high-water season (fall and winter) in five different stations of river was conducted. For this, national and international standards were used. The Iranian standard organization used standard 1053 reagent as the national standard and the World Health Organization standard was used as an international standard.

Based on results, on IRAN standard in low-water season, means of five parameter values are lower than standards and ideal (SO^4, No^3, COD, BOD5, turbidity), and two parameter values (pH, EC) are close to standard and danger level and only amount of TDS are more than standard levels. In high-water season, five parameters (SO^4, BOD$_5$, No^3, COD, and turbidity) are lower than standard and three parameters (TDS, EC, and pH) are close to standards. In low-water seasons on WHO standard, cleared that 3 parameters values (SO$_4$, No$_3$, Turbidity) are significant in 1% and their amount are much lower than standard and

parameter values (pH) at 5 percent is close to the standard and risk threshold, But (TDS, EC) parameters are much higher than standard and show the danger limit. In general, it can be stated that the different measurement of TDS and EC in terms of WHO standard and TDS on Iran standard in low-water season and pH and EC parameters in terms of WHO standard on high-water season are not significant. Therefore, it represents high and closeness of average parameters to the standards and shows the risk limit of river water. The pararmeters which are higher than the standards in the region, these reason can be the contaminants sources, that derived from agricultural activities and human sewage (Ardabil, Nir and Sarein cities) absorbed

Fig. 3 The number of parameters and quality changes based on national and international standards during different seasons
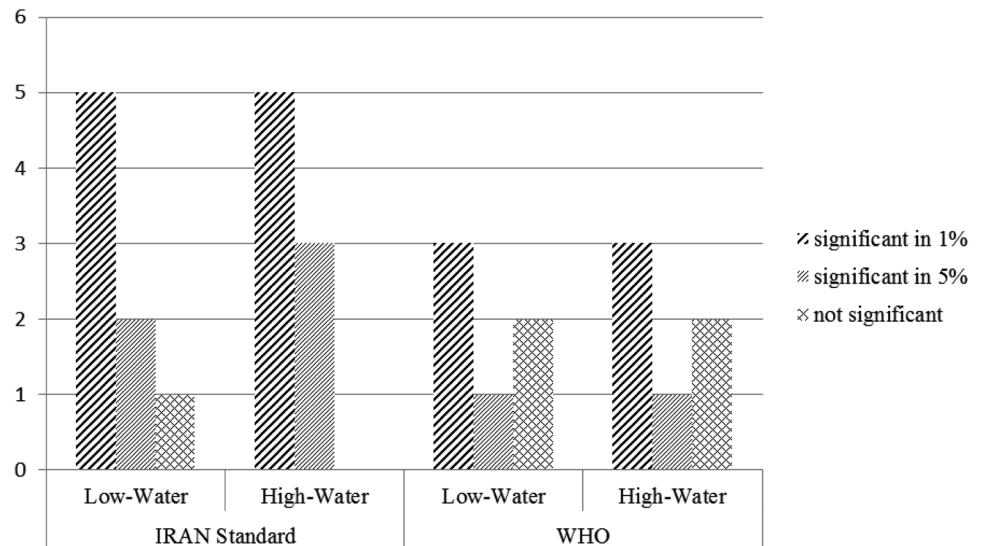
through the area wells that in low-water season because of decrease of water capacity and increase their amounts.

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