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Ground water quality assessment of Iranshahr for use in urban areas

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Abstract

With increasing population and decreasing per capita of stored water resources as well as increasing physico-chemical pollutions, the water crisis has become one of the greatest problems of the world. With regard to the fact that all the structural shapes and biochemical activities of cells depend on physico-chemical characteristics of water, pollution hazards might cause numerous diseases, especially among children, the elderly, and the ones whose immune system is weak; therefore great economic costs would have been imposed on society. For this reason, it is especially important that water consumed by population is surely safe. The use of an index of the water quality in the measurement of the physico-chemical features of water has been an important method in determining water quality, given the lower cost and being ensured of the results obtained. Water quality index is a method which is able to determine water quality based on raw laboratory data. To evaluate the quality of groundwater resources of Iranshahr plain in this project, after the sampling, eight pH physico-chemical parameters including total dissolved solids, total hardness, total alkalinity, Calcium, Magnesium, Chlorine and electrical conductivity were calculated using standard methods. Water quality index of these areas was calculated in accordance with World Health Organization standards. The results of the analysis show that the water wells of Sarkahuran zone have the best quality and Rikapout and Mohammad Abad wells have highly unsuitable quality and are not drinkable at all.

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Introduction

Water is the elixir of life and is one of the Inevitable resources. Water is one of the most abundant compounds in live organisms which constitutes more than 70% of their weight. Water is an environment in which all biological processes such as enzymatic processes, metabolism, the transfer of materials and energy production are performed. It is impossible to live on this planet without water (Goel, 2000).

Only three percent of fresh water resources are sufficient to solve the requirements of all people of the world for three million years. But the most important problem caused by water pollution, as a result of human activities or industrialization (Kudesia, 1980).

A lot of problems of the health in developing countries is due to lack of the safe drinking water. The drinking water quality has been highly affected the health of human societies for a long time (Goel, 2000).

According to the World Health Organization reports 600 million cases of diarrhea and 4600000 cases of children's deaths in each year are due to drinking polluted water (Sahu, 2006); Studies have shown, 97 percent of the earth water is saltwater, and only 2.8 percent of it is freshwater, which of this, 20 percent is groundwater (Goel, 2000).

The use of water for different purposes such as drinking, domestic, irrigation and industria, mainly depends on its intrinsic quality. So, It is necessary to examine quality and quality of water resources available in the region (Mohrir, 2002).

These days, peoples around the world have used groundwater as a source of drinking water. The reports show that today more than half of the population of the world use groundwater as their only drinking water source (Proceeding of the international conference on water).

Simultaneously, As mentioned above, industrialize-tion and the rapid growth of urban areas and also improper waste disposal methods has resulted in ground water quality change (Mohrir, 2002). Also it should be mentioned, groundwater exchanges various matters with earth due to passing of underground layers.

So, Assessment of Water quality is very important to know whether it is safe or not.

One of the main problems in the laboratory analysis of the water quality is the high number of parameters, which makes it both expensive and time-consuming. Water Quality Index (WQI) is a method for the evaluation of water quality using laboratory data through which water quality value can be categorized by topic (Nasrallah Zadeh, H. and Varedi, S. 1381).

The water quality index method was developed for the first time in 1970, can be used to analyze water quality changes in a water resource over time and also it can compare a water resource with other water resources. The water quality index method quickly replaced other methods of water quality evaluation (Rajankar, 2009).

In United States National Sanitation Foundation guidelines is used for Water Quality Index. It is a weighted linear system of the sub indices or a weighted product aggregation function. In other countries similar methods to those used for water quality index (Ashok W, 2000).

In this study, the quality of drinking water of Iranshahr city and its surrounding villages was measured using WQI in accordance with the standards defined by the World Health Organization (WHO). Regarding the fact that there is not considerable surface water in Iranshahr plain zone and most of its water resources is groundwater, a number of nine wells in Iranshahr and its surrounding villages which mainly supply the

drinking water for the inhabitants of these areas have been evaluated according to world standards.

Material and methods

Study Area

Sistan and Balochistan province in the Southeast of Iran is among the driest areas of the country; in a way its average annual rainfall is 116.14 mm. Iranshahr with 9,440 square kilometers is located in the center of Sistan and Balochistan Province. It has 49 villages, has hot and dry climate, and its average annual temperature is 26.5 C. Generally, the type of soil is sand and becomes tinier in the form of clay as we move further to the west (Bampour). The vegetation of this area is mainly and then, tamarisk and mesquite. February is the coldest and July is the warmest month of the area. Iranshahr catchment is hydrolytically a part of Jazmoorian catchment in which the entrance of groundwater is from east to west. This area is between the longitudes of 60°, 25′-61′ and latitudes of 26′, 45′-28°N. The area of this district is 9440 square kilometers, out of which 4145 km2 of it comprise alluvial areas and plains and the rest is highlands. The highest point in the far northeast of the area is 2740 m high and its lowest point in the far side of Bampour River is almost 500 m high from the sea level. Generally, northeast heights of the zone are highest while eastern and southern heights are lower. There are two rivers of Daman and Bampour in this zone with basic water which are supplied by groundwater flows, and other watercourses are seasonal having water when flooding. The main water resource for drinking water of the inhabitants is groundwater in Dalgan, Bampour, Rikapout, Sarkahouran, Shams Abad, as well as the wells in Iranshahr city (General Office of Water and Wastewater of Iranshahr and statistical calendar of Sistan and Balochistan province).

Experimental

The collection of water samples was conducted of the wells of Rikapout (sample no. 1), the well no. 2 of Sarkahouran (sample no. 2), the well no. 9 of Iranshahr (sample no. 3), the well no. 4 of Shams Abad village (sample no. 4), the well no. 2 of Mohammad Abad, Bampour (sample no. 5), the well no. 4 of Mohammad Abad, Bampour (sample no. 6), the well no. 3 of Sarkahouran (sample no. 7), the well no. 7 of Iranshahr (sample no. 8) and the well no. 2 of Dalgan Golmurti (sample no. 9). The analysis of the physico-chemical properties such as pH, Total dissolved solids, total hardness, total alkalinity, Calcium, Magnesium, Chlorine and electrical conductivity was done in cooperation with Iranshahr Water Office using of standard methods. WHO Standard for Drinking Water is given in Table 1.

Table 1. Water Quality parameters used in the study.

Sr. No	Parameters	Unit	Standard WHO	Weight Wt	Weight Unit Wi
1	PH	–	8.5 to 7	4	0.182
2	EC	µmhos/cm	-	-	-
3	TDS	mg/L	1500-500	4	0.182
4	TH	mg/L	1500-500	2	0.091
5	Total alkalinity	mg/L	<120	3	0.136
6	Calcium	mg/L	200-75	2	0.091
7	Magnesium	mg/L	150-30	2	0.091
8	Chloride	mg/L	600-200	2	0.091

An example of calculating method for sample no. 7 WQI according to the above formula is given in Table 4:

Table 4. Example of how to calculate water quality index.

Result and discussion

The amount of physic-chemical properties for each well as well as the calculated WQI is given in Table 2.

WQI Calculation

To obtain WQI, formulas 1, 2 and 3 were used. First the two factors of quality scaling (qi) and weight unit of parameters (Wi) were determined. Qi amount for

the eight physico-chemical parameters is given in Table 3. Qi is parameter that shows in what condition is water quality to a parameter. As such, qi was divided into four ranges including allowable, slight pollution, average pollution and severe pollution. Qi ranges from 0 to 100. To obtain Wi, at first the weight of each parameter was determined based on its importance in total water quality. The weight of parameter is Wt. The maximum weight of 4 was assigned to parameters such as pH and TDS which had more importance in determining water quality, while the weight of 1 was assigned to other parameters such as calcium and magnesium which had less importance in determining water quality. The weight Unit (Wi) for each parameter was determined according to the following formula (Purandara, 2003 & Ubale, 2005).

(1) $W_i = \frac{(W_2)_i}{\sum(W_2)_i} as \sum W_i = 1$

To calculate the WQI, at first the SI value for each parameter was determined according to the equation SI = qi Wi. Then WQI was calculated using the following formula.

(2) $WQI = \frac{\sum(SI)_i}{\sum W_i}$

(3) $WQI = \sum q_i W_i as \sum W_i$

Calculating WQI the Sub index (SI) is first found out for each parameter which is, $WQI = \frac{\sum(SI)_i}{\sum W_i}$

Therefore $WQI = \sum q_i W_i$

As an example, the WQI for S-3 has been calculated from the above formula (Table 4)

Table 2. Physico-Chemical Characteristics of ground water samples.

Parameters	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9
PH	7.5	7.7	7.65	7.8	7.6	7.5	7.7	7.59	7.7
EC	3340	846	1886	1991	2550	1979	785	2020	1691
TDS	2137	451	1207	1089	1411	1080	422	1292	1082
TH	180	152	188	152	288	260	144	220	164
Total alkalinity	180	160	206	268	320	200	220	252	200
Calcium	59.2	44.8	32	59.2	260	576	368	346	256
Magnesium	68	10	27	35	35	29	13	33	25
Chloride	386	162	150	270	260	234	140	160	158
WQI	49.14	7098	61.88	58.24	49.14	70.98	60.06	49.14	61.88

Table 3. The quality scale for water quality parameters (qi).

Parameters	Degree of pollution Rating (qi)			
	Remissible 100	Slight 80	Moderate 50	Serve 0
PH	7 to 8.5	8.6 to 8.8	8.9 to 9.2	>9.2
EC	500	500-1000	1000-1500	
TDS	100	100-300	300 -500	>1500
TH	50	50-85	85-120	>500
Total alkalinity	75	75-137	137-200	>120
Calcium	30	30-90	90-150	>200
Magnesium	200	200-400	400-600	>150
Chloride	200	200-400	400-600	>600

Table 4. Sample calculation of water quality index.

Parameters	Walue of Water Sample 7	Quality rating (q_i)	Unit weight (W_i)	Sub Index (W_iq_i)
PH	7.7	100	0.182	182
EC	785	–	-	-

Parameters	Walue of Water Sample 7	Quality rating (q_i)	Unit weight (W_i)	Sub Index (W_iq_i)
TDS	422	100	0.182	182
TH	144	80	0.091	7.28
Total alkalinity	220	0	0.136	0
Calcium	36.8	100	0.091	9.1
Magnesium	13	100	0.091	9.1
Chloride	140	100	0.091	9.1
WQI				70.98

Conclusion

The results indicated that Iranshahr groundwater was significantly polluted in all areas except in Sarka-houran wells (samples no. 2 & 7). WQI results showed that the well of Rikapout, the well no. 4 of Shams Abad village, the well no. 2 of Mohammad Abad, Bampour (samples no. 1, 4 and 5). whose WQI are 14, 49, 24, 58, 14 and 49, respectively are polluted and are not drinkable at all. In addition, the well no. 9 of Iranshahr, the well no. 4 of Mohammad Abad, Bampour, the well no. 7 of Iranshahr, and the well no. 2 of Dalgan Golmurti (samples no. 6, 8 and 9) are also polluted, but their pollution is to the extent that makes them drinkable after treatment. All the physico-chemical parameters effective in water quality have not been used in this research. In regard to the fact that the water quality index of Iranshahr was evaluated with most of the parameters and similar results were obtained which makes the present study in line with the research done by Gunvant *et al.* (2010), it seems that this method is suitable to evaluate water quality given the few physico-chemical parameters used in determining water quality index and the subsequent less cost.

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