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Trend of groundwater quality change in two basins in North Lake Urmia (Case Study: Shabestarand Tasuj Plain)

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Key words: Groundwater, North of Lake Urmia, Water quality, Simple kiriging, Geostatistics

Abstract

Nowadays, water resources scarcity has become one of the most important issues in arid and semi-arid regions including Iran which makes it necessary to optimize the utilization of the limited resources. The present study investigates the changes in the quality of groundwater using geostatistical methods in the Shabestar and Tasuj plain during a 10-year period. In this study, after selecting the appropriate spatial interpolation method to draw water quality parameters such as Total dissolved solids, Sodium absorption ratio, Chlorine and Electrical conductivity, zoning maps of two plain were provided for three periods of time: the first period (2002-2005), an intermediate period (2006-2009) and the final period (2010-2012) using ArcGIS 10.1. The best model (simple kiriging) with the lowest estimated error was selected for zoning water quality parameter. Comparison of quality parameters of spatial zoning maps showed that the in Tasuj rate of TDS had an increasing trend in plain Southern boundaries (Lake Urmia adjoining) for a 10-year period, and also the rate of EC was developing in the core shape to the Southeast and Western Region But there were no significant changes in the region for SAR parameter. Also witness increasing trend of CL, SAR and EC in western and southern parts of the Shabestar basin, The Eastern part of the region located at unsuitable condition in terms of the above factors, so that water quality was poor in all three study periods. So, the factors had an increasing trend in plain Southern boundaries (Lake Urmia adjoining) in both basin

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Introduction

Excessive increase in population, due to the limitation of surface water resources and the excessive exploitation of aquifers cause irreparable damage to the country natural resources including groundwater resources (Zehtabian *et al.*, 2010). Determining the quality of water is particularly important in water resources management, and monitoring and zoning it are considered as a significant principle to be taken into account in planning. Groundwater is the primary source to supply agriculture and drinking water hence recognition and awareness of ground water quality and the water classification based on the number of various elements of them will assist us in making management decisions and decline groundwater pollution (Babakhani *et al.,* 2016).

Dash *et al.* (2010) discussed Chemical properties of groundwater quality spatial variations in Delhi, India. They used Ordinary Kriging estimation and analysis of spatial variations and for zonation and used Indicator Kriging method mapping Features (chlorine, electrical conductivity, metal, magnesium, ammonium nitrate).

Many studies have been conducted by different researchers in recent years with the aim of modeling water quality variations (Baalousha *et al.*, 2010), (Fu-quan NI *et al.*, 2010), (Lee *et al.*, 2007), (Sarukkalige, 2012), (Samia, 2016).

The aim of this study was to determine trend of groundwater quality Change in North basin of Lake Urmia Because the Lake Urmia is in critical condition we selected this basin for study.

Materials and methods

Study area

Shabestar is one of the counties of East Azerbaijan province. It has two basins (Tasuj and Shabestar-Soofyan). It is located in 45° 05' to 46° 09' eastern longitudes and 37° 42' to 38° 24' northern latitudes. The County covers an area of 2750 square kilometers.

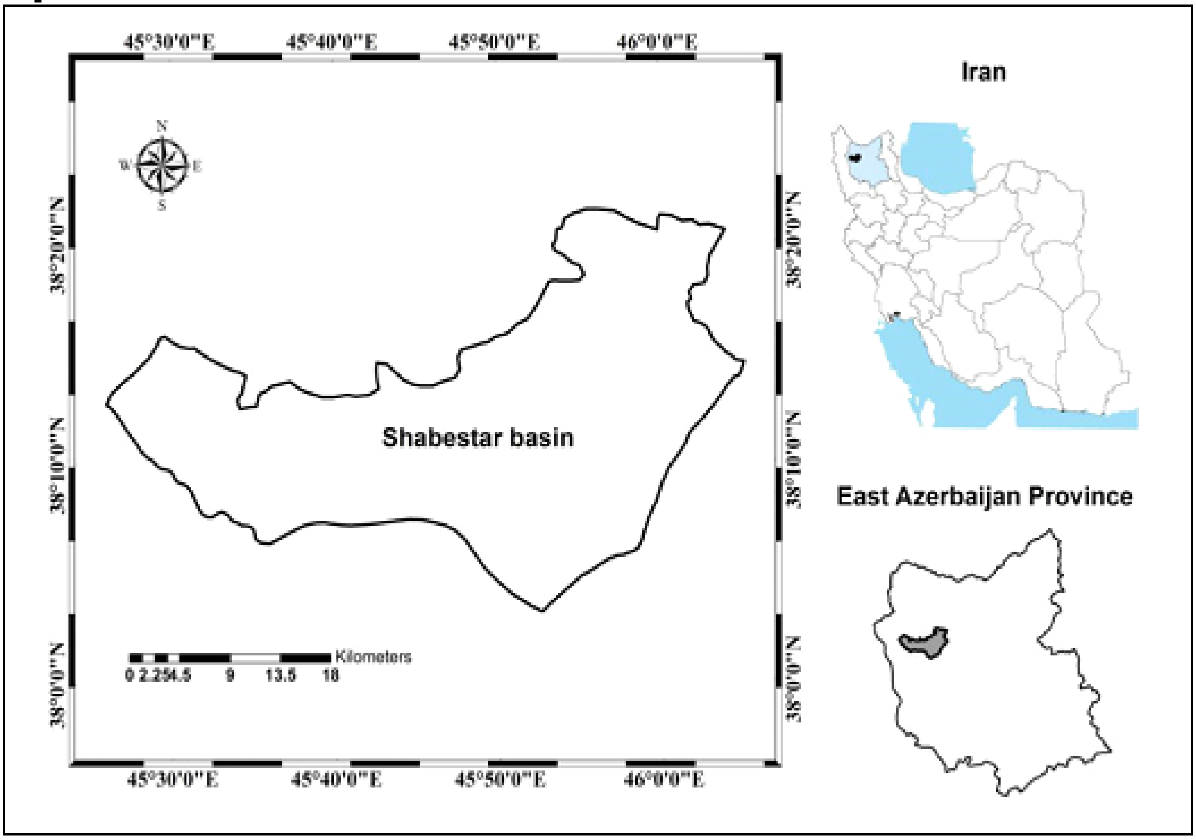

Fig. 1. Geographical location of the Shabestar-Soofyan basin.

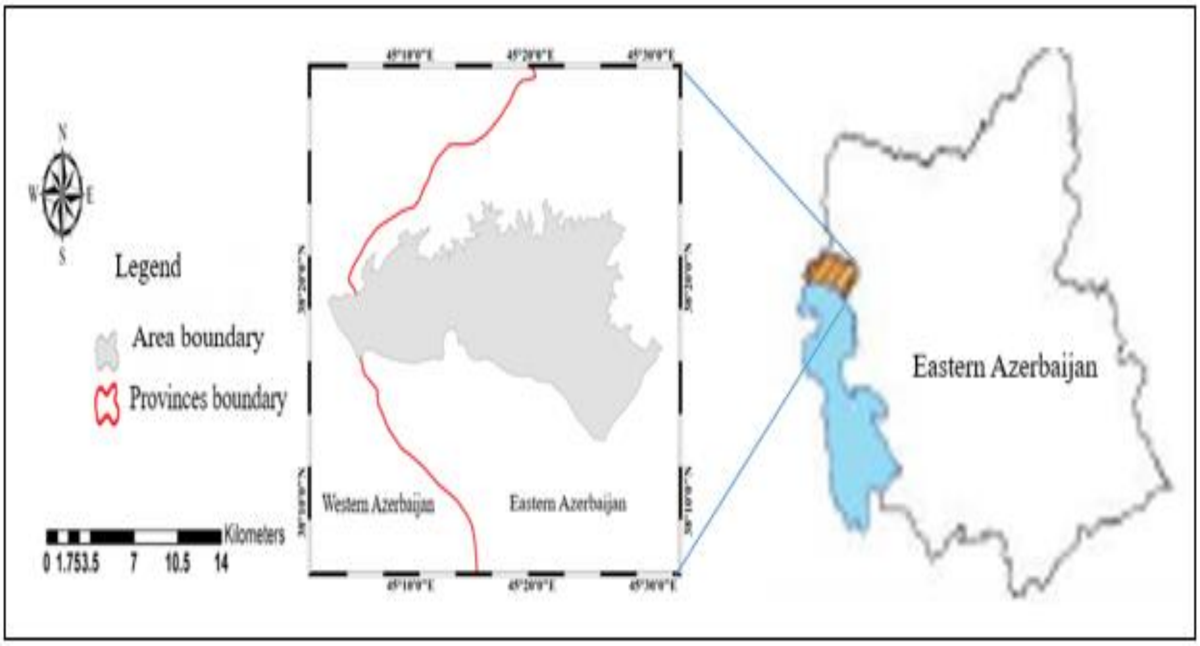

Fig. 2. Geographical location of the Tasuj basin.

It is limited to Tabriz city and Urmia Lake from northwest and northeast respectively. The maximum and minimum height of the area is 3155 to 1280 meters above sea level. Fig.1and 2 shows geographical location of study areas.

Search method

In order to evaluate changes in groundwater quality, zoning maps of qualitative parameters including Electrical conductivity, sodium absorption ratio, Total Dissolved Solid, chloride, for 21 piezometeric wells in Tasuj and 40 piezometeric wells in Shabestar-Soofyan in a decade (2002 to 2012) were plotted using geostatistical methods.

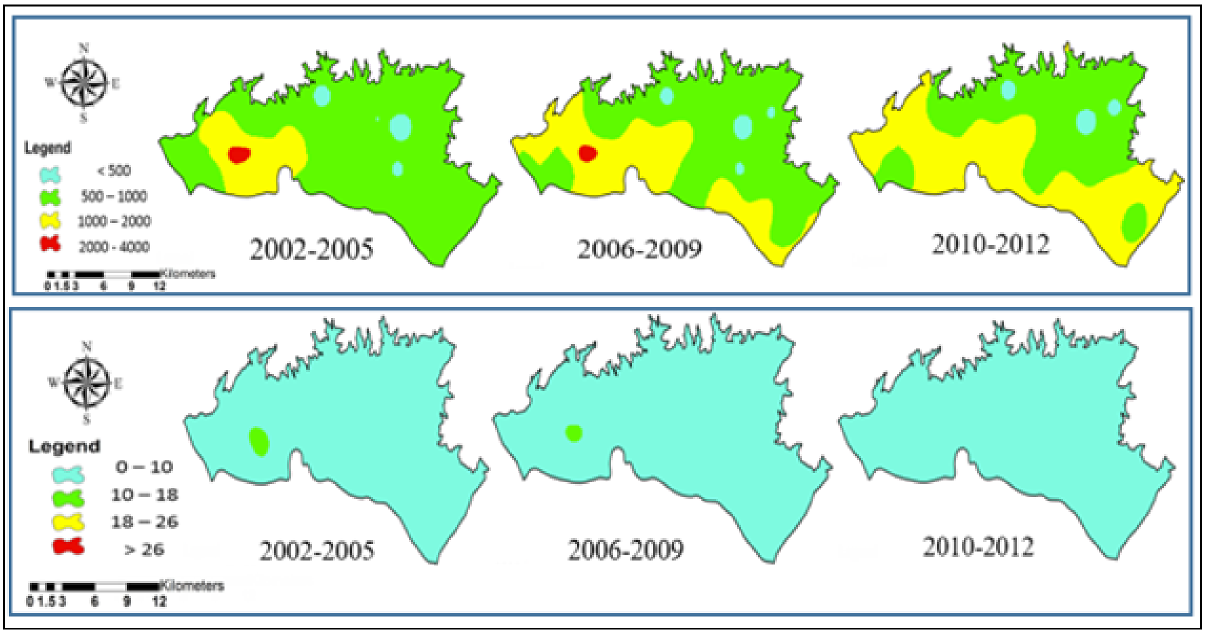

Fig. 3. Spatial variations of sodium absorption ratio of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012.).

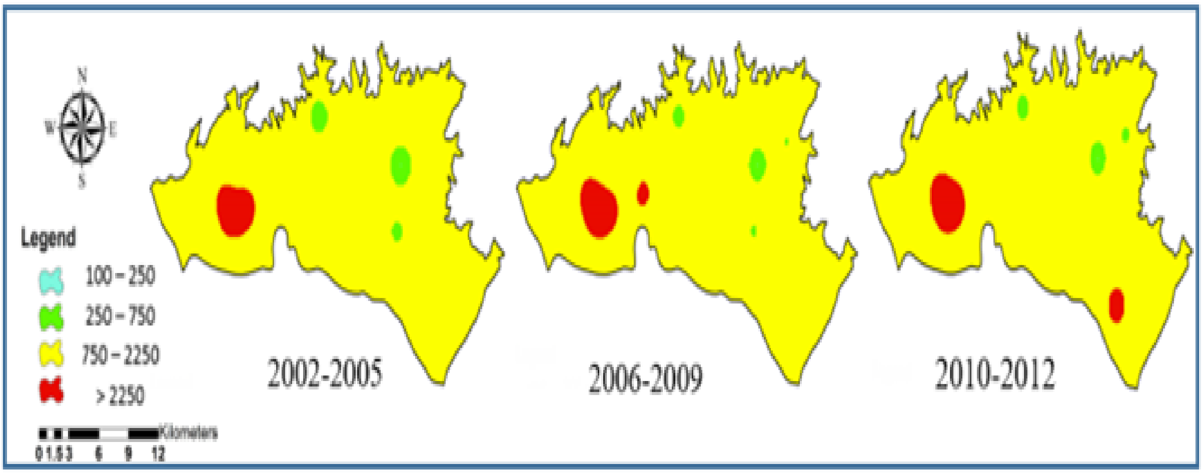

Fig. 4. Spatial variations of Total dissolved solids of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012).

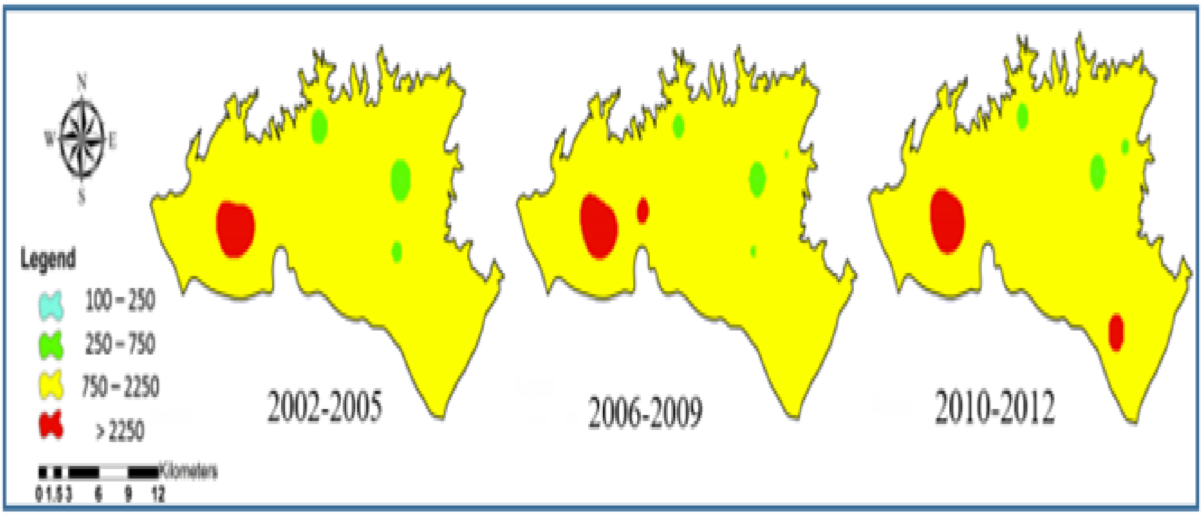

Fig. 5. Spatial variations of electrical conductivity of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012).

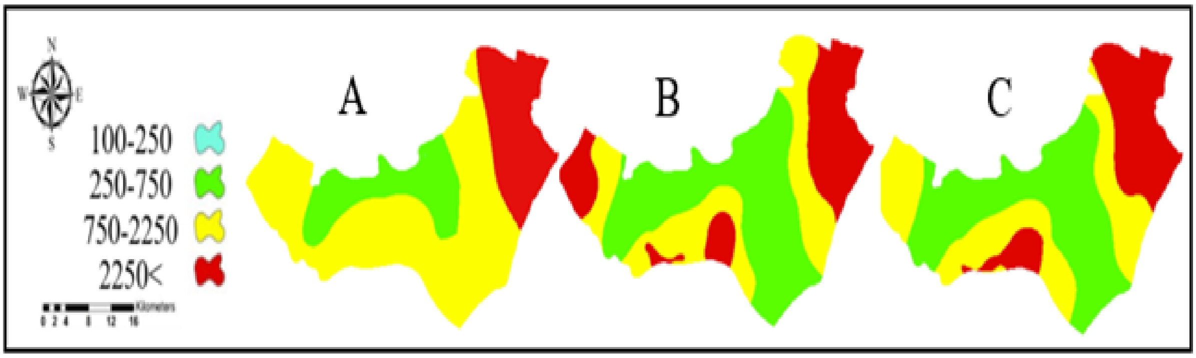

Fig. 6. Spatial variations of electrical conductivity of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012).

The best model (simple kiriging) with the lowest estimated error was selected for zoning water quality parameter.

For classification parameters SAR and EC used of (Wilcox diagram) and for parameters TDS and CL was used Schuler Classifieds.

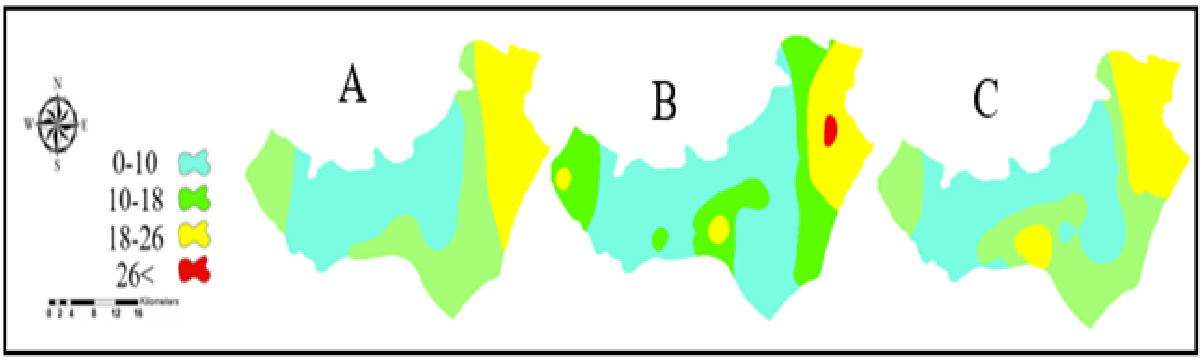

Fig. 7. Spatial variations of sodium absorption ratio of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012).

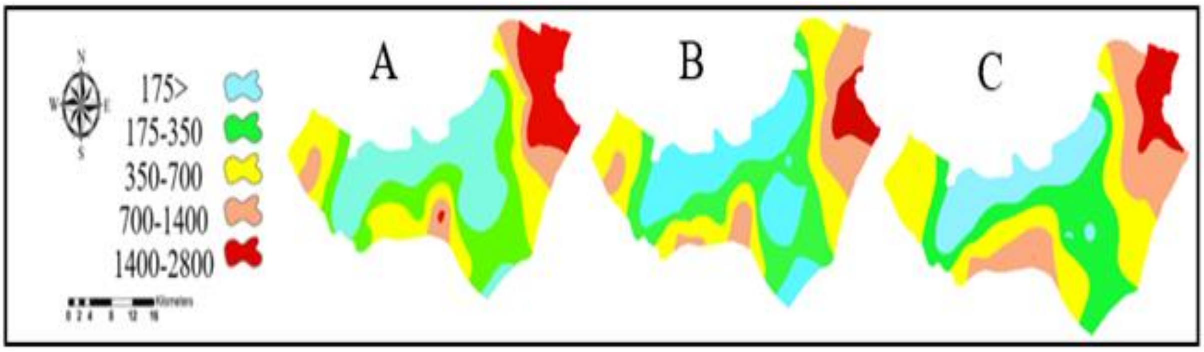

Fig. 8. Spatial variations of chlorine of groundwater A: The years (2002-2005), B: The year (2006-2009), C: The year (2010-2012).

Results

Sodium absorption ratio

According to Fig.3, the large part of the area has very good quality in terms of SAR in all three periods. Area doesn't have any alkalinity problem. According to Table 1 in all three study periods most of area was taken into 0-10 (very good).

Total dissolved solids

According to Fig. 4and Table 2, the large part of the area has good quality in all three period, but amount of TDS had an increasing trend in the second and third period. The amount of CL had an increasing trend in the southern parts of the region which located in the vicinity of the Lake and Water in these parts was Average in terms of drinking.

Electrical conductivity

According to Fig. 5, the large part of the area has Average quality in all three period and also the rate of EC was developing in the core shape to the Southeast and Western Region but there were no significant changes in the region. According to Table 3, Ninety-five percent of the region has Condition average of salinity in all three period.

Electrical conductivity

According to Fig. 6, groundwater quality has been improved in terms of EC during the period which represents the amount of EC reduced. The amount of EC increased in southern and western parts of the area in the vicinity of Lake Urmia and water quality was unsuitable for agriculture.

Table 1. The area devoted to classes, studied sodium absorption ration.

Classification of SAR	Wilcox classification	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
0-10	Very good	98.83	99.44	100
10-18	Good	1.17	0.56	0

The Eastern part of the region located at unsuitable conditionin terms of EC, so that water quality was poor in all three study periods. According to Table 4, Moderate quality class has allocated more surface area of the region in the first period. Most of the area has water with good quality in the second and third period. Also in the second and third period the amount of water with unsuitable quality have increased in southern and western parts of the region than first period.

Table 2. The area devoted to classes, studied total dissolved solids.

Classification of TDS	Scholar class	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
<500	Very good	2/43	2/04	1/81
500-1000	Good	82/09	63/11	50/46
1000-2000	Average	14/63	34/13	47/73
2000-4000	Not suitable	0/85	0/72	0

Sodium absorption ratio

Fig.7 shows zoning maps of SAR which in all three studied periods, most area has water with low SAR (0-10 class) in terms of farming. Water quality has improved in the second period compared to the first and third period so that more surface area of the region has good water quality. Water quality has decreased in southern and western parts of the region during the study period.

Most classes of SAR in all three study period was taken between 18-0 and have good quality. Worst quality in all three study period was related to eastern part.

Table 3. The area devoted to classes, studied electrical conductivity.

Classification of electrical conductivity	Wilcox Classification	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
100-250	Very good c_1	0	0	0
250-750	Good c_2	2.03	1.2	1.22
750-2250	Average c_3	95.22	95.42	95.18
2250<	Not suitable c_4	2.75	3.38	3.60

The amount of SAR has increased from North to south and from West to east of the region, according to Table 5 .In all three study periods almost 80% of the region was taken into 0-18 class. More surface area was taken in this class in the second period compared to the first and third period and the amount of farming water with moderate quality has decreased.

Table 4. The area devoted to classes, studied electrical conductivity.

Classification of electrical conductivity	Wilcox Classification	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
100-250	Very good c_1	0	0	0
250-750	Good c_2	18	43	42
750-2250	Average c_3	61	31	33
2250<	Not suitable c_4	21	26	25

Chlorine

According to Fig. 8,in the first and second period, greater area of the region has good water quality and in the third period largest area has moderate quality. The amount of CL had an increasing trend in the southern and western parts of the region which located in the vicinity of the Lake. Water in these parts was unsuitable in terms of drinking.

Table 5. The area devoted to classes SAR studied area.

Classification of SAR	Wilcox classification	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
0-10	Very good	14	54	42
10-18	Good	37	28	37
18-26	Average	22	17	21
26<	Not suitable	0	1	0

The Eastern part of the region located at unsuitable condition in terms of CL, so that water quality was unsuitable and quite unsuitable in all three studied periods.Table6 shows the amount of CL in Groundwater of the study area. In the first and second period about 55% of the area has water with good and acceptable quality, but in the third period 43% of the area has suitable quality and 57% has moderate and absolutely unsuitable water quality. It represents the increasing trend of CL in western and southern parts of the region during this period.

Table 6. Levels of area devoted to chlorine classes in study area.

Chlorine classes	Scholer class	Area (percent) 2002-2005	Area (percent) 2006-2009	Area (percent) 2010-2012
<175	Very good	31	29	17
175-130	Good	24	26	26
350-700	Average	21	24	30
700-1400	Not suitable	11	16	20
1400-2800	Quite unsuitable	13	5	7

Discussion

The results showed that in Tasuj rate of TDS had an increasing trend in plain Southern boundaries (Lake Urmia adjoining) for a 10-year period, and also the rate of EC was developing in the core shape to the Southeast and Western Region But there were no significant changes in the region for SAR parameter. Also witness increasing trend of CL, SAR and EC in western and southern parts of the Shabestar basin, The Eastern part of the region located at unsuitable condition in terms of the above factors, so that water quality was poor in all three study periods. So the factors had an increasing trend in plain Southern boundaries (Lake Urmia adjoining) in both basin .

Reason for this issue is water level drop caused by overuse of groundwater for watering gardens (Ranjpishe *et al.*, 2016). Dropping water table was lead to intrusion of saltwater into aquifers of Lake Urmia, especially in the southern and central parts of the region and a large number of wells have been unused. (Asghari Moghaddam and Mohammadi, 2003), (Jafari and Eftekhari, 2012) were found similar results on examining the intrusion of lake's saltwater into aquifers of Shabestar plain.

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