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Investigation of the role of industry in polluting the groundwater aquifers (Case study: Urmia aquifer, Northwest of Iran)

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Abstract

A huge part of water utilization all around the world, especially in drinking section, supplied from groundwater sources. In many situations, groundwater contamination is recognized when the purification of the aquifer is quite inconceivable. Thus the conservation of water quality is very significant subject. Recognizing places vulnerable to contamination, is one of the best methods to prevent contamination of groundwater. In this investigation, in order to evaluate the pollution of Urmia aquifer, one of the most important aquifers in northwest of Iran, numerous wells were sampled near the industrial centers. The main targets of this investigation are alterations in quality of parameters of groundwater resources and recognizing areas which are vulnerable to pollution. Consequences demonstrate that water quality of selected wells for most parameters of anions and cations are much lower than standard limits.

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Introduction

One of the greatest challenges of today's world is water crisis which can be source of both positive and negative conversions (Fakayode, 2005). Certainly, all catastrophes that threaten the earth, deficiency and water contamination will become big tragedy as an unrecognized crisis in current century and its detriment is likely much more than AIDS and war deceases which occur in the world, today (Buchholz, 1998). The United Nations has forecasted that by 2050, about four and half billion people all over the world maybe more will be subject to damages and detriments caused by deficiencies and contaminations (Currie, 1998). Many specialists have come to believe that during the twenty-first century, water will be raised as a political matter among Asian countries and the Middle East. And economic worthiness of water in following years will be much more than today's valuable materials (Chester, 2000). Population boosts, improving standards of living, climatic changes and lack of proper management of water resources are the main reasons of water shortages (Mariolakos, 2007). It is also prognosticated that in the years after 2031, Iran will be among world's arid lands. A huge part of water utilization in the world, especially in drinking, is provided from groundwater sources and it is indispensible to discuss water quality and contamination here.

The aquifer purification is quite inconceivable when groundwater contamination is discovered. So the conservation of water quality is very significant. Recognizing areas vulnerable to groundwater pollution and exploitation of water resources and land use management are the best ways to prevent groundwater contamination. Urmia aquifer for this study is selected. The main reasons for this selection are: placed in the arid and semiarid climate, increasing requisitions for water in drinking, industry and agriculture, industrial waste water evacuated without treatment into the aquifer, water deficiencies in this region, enhancing population and requirements for maintainable development and regional balance between population and water.

Therefore, preserving and returning ground water quality is a serious subject as well as quantity. In this study, influences of industrial contamination on groundwater status in Urmia aquifer were analyzed. For this target using the results of experiments on sampled wells in this area, infection statuses of anions and cations parameters are determined.

Materials and methods

Selected area

West Azerbaijan province with 43660 km² located in northwest of Iran, accounted for 2.65% of the whole area of the country (including lake). Geographically located in 44° 3′ to 47° 23′ east longitude and 37° 58′ to 39° 46′ north latitude, has a common boundary with Turkey and republic of Azerbaijan from north, Turkey and Iraq from west, from the south by Kurdistan province and with East Azerbaijan province from east. In fig. 1, location of Urmia aquifer is shown.

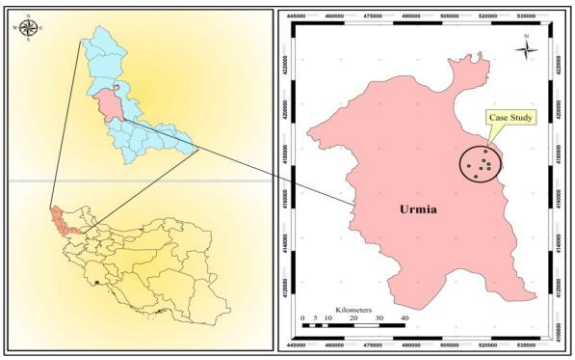


Fig. 1. location of Urmia aquifer is shown.

In order to investigate the parameters variation (anions, cations, TDS, PH, EC, TH, SAR), 8 wells were sampled. In this study, to assess the quality of groundwater, samples were taken from wells near rural and industrial centers. The locations of these wells are shown in fig. 2. Sampling has done at dry season in 2013 and ultimately experimental consequences were distinguished. All data have been

analyzed by using statistical demonstrators and WHO, and EU standards. Then zoning maps were prepared by using GIS package. Based on experiments, deposits that formed the aquifer layers are often clay, silt, and very fine grained gravel.

Fig. 2. locations of wells near rural and industrial centers.

Results and discussion

Parameters at various stations were assessed in dry season and compared to standards according to table 1.

Table 1. Statistical analysis of anions and cations in dry season (Microgram per liter).

Parameter	Standard values				
	Min	Max	Mean	WHO	EU
Cl	0.2	6.5	2.16	600	---
Na	0.8	2.7	1.56	200	175
K	0.1	0.4	1.29	---	12
Ca	1.5	7	3.36	200	---
Mg	1.5	16	5.77	150	50
So4 $^{-}$	0.8	12	2.77	450	250
Hco3^{-}	3	11.5	6	---	---
PH*	4.6	8.4	7.2	6.5	9.5
TDS**	240.5	1512	645.2	1500	1500
EC***	370	2400	1010	---	---
TH****	150	1150	456.8	500	---
SAR*****	0.4	1.5	0.81	---	---

*(---)

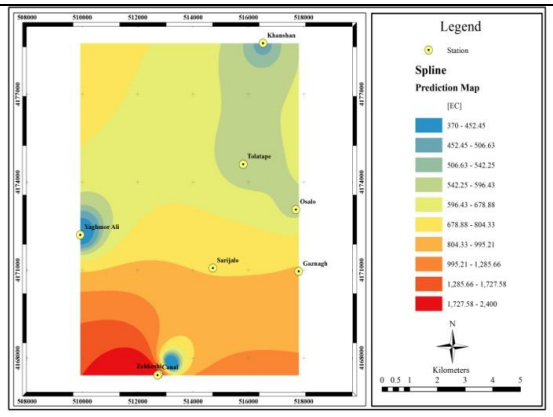
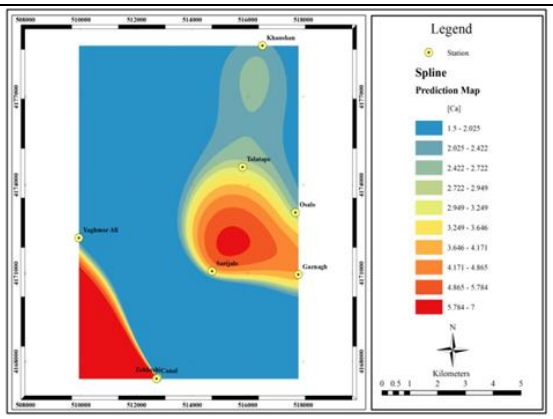
** (mg/l)

*** (µs/cm)

**** (mg/l)

***** (---)

In this investigation, statistical analysis of measured anions and cations and other mentioned parameters, in order to assess contamination of Urmia aquifer, Excel software is used. Also maximum, minimum, average and standard deviances of all data were computed. Then by using parameters which were taken from wells, zoning maps were prepared with GIS package and ground statistics techniques. Maps are shown in fig. 3.

Cl	Ca
	

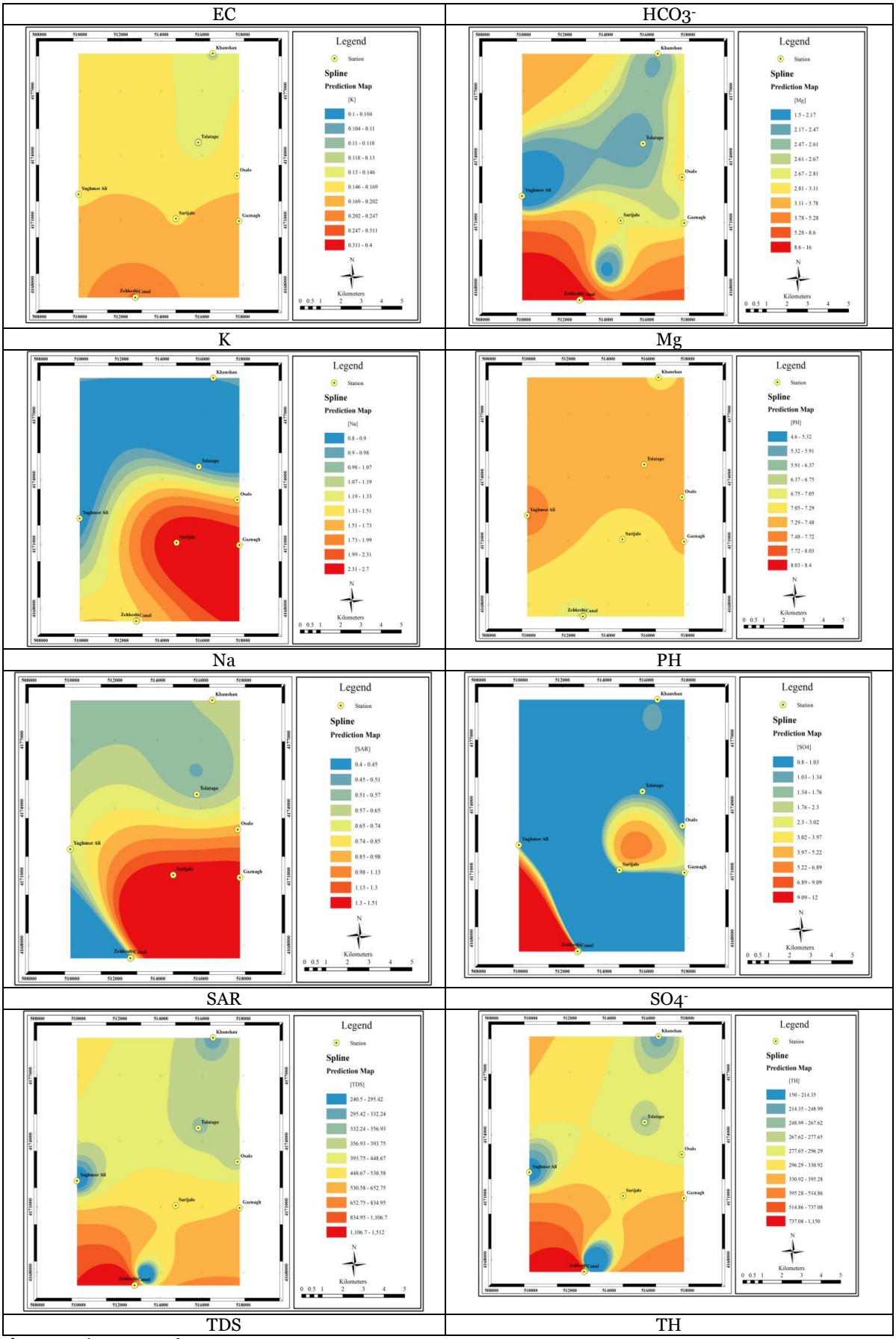


Fig. 3. zoning maps of parameters.

While wastewater discharges to the canal, water changes to acidic form, however it becomes alkaline farther we get to the north. Based on analysis, concentration of Potassium and Chloride gradually become less to the north. Total hardness has the same status. Reduction of Bicarbonate to the north and west parts of studying area is detectable. Those wells situated in south and central parts of plain, contain more Calcium than other wells. Gradual reduction of Magnesium in central parts is also remarkable. The increment of this element near industrial centers results from wastewater discharges. Generally, decrement of electrical conductivity from south to north is obvious. It should be noted that the reduction of this parameter is an indicator of low anion and cation dissolution in the water. So the quality of water would be better. Results demonstrate that dispersion process of Total Dissolved Solid is similar to electrical conductivity. Maximum amount of Sodium is concentrated in the northern parts of studying area. It is distinguished that we have the most Sodium Absorption Ratio in the south and southeast and reduction of Sulfate concentration recognized from south to north.

Based on experiments on soil, XRD, it is distinguished that the soil forming the aquifer layers, contains minerals such as: Smectite, Illite, Kaolinite and Quartz. It is shown in fig. 4.

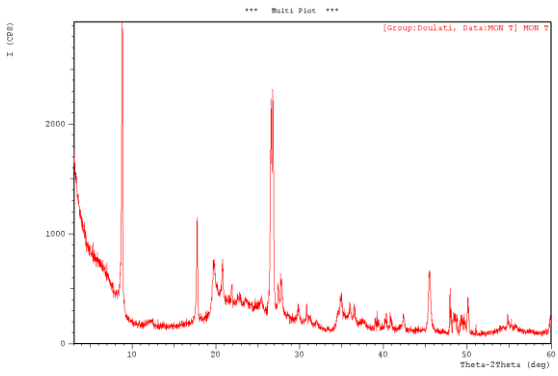


Fig. 4. results of XRD.

Conclusion

After analyzing all aspects of this investigation results demonstrate that water quality of selected wells approximately for all parameters of anions and cations is much lower than standard limits. Researches also showed that the concentration of anions and cations in sampled wells can be different and it would change over time (Geen *et al*, 2003). In this study, concentration of anions and cations are directly related to soil texture of studying area. The texture of soil is almost clay that plays a role as a geochemical barrier. So most of the contaminant factors would be absorbed by soil due to ion-exchange properties of clay minerals.

On the other hand, clay with reducing the permeability, prevent the spread of contamination to the surrounding areas. Also, plants around the canal absorb the elements of the wastewater. Concisely, some important factors which have great effects on increasing contamination and values of parameters are:

- ✓ Three main categories of agricultural, residential and industrial that caused by human activities.
- ✓ Waste production comprises construction and destruction wastes, sludge of discharge wells tankers, domestic and healthcare center wastes.
- ✓ Industrial centers and factories which have great impacts on groundwater pollution.
- ✓ Soil texture is a factor that plays significant role in prevalence of contaminants.

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