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Sources of Chemical Contaminations and Classification with Emphasis on Drinking Water

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Abstract

Groundwater contamination is a serious problem facing the countries. Because groundwater is vulnerable to contamination from a variety of sources, and, once contaminated, it is very difficult to restore to its original quality. The main objective of this study was evaluation of groundwater quality in Shahrekord aquifer and finding the source of the groundwater contamination. Some of the chemical parameters such as Cation, Anion, Electrical Conductivity (EC), Total Hardness (TH) and Total Dissolved Solids (TDS) were measured in four times including spring and autumn of two years. The results show that the chemical contaminant concentration in North-Western part (NWP) of the aquifer was lower than Southern part (SP). Bicarbonate in the Anions and Calcium in the Cations has the maximum value. However they are lower than the standard limits. The TH in the wells varies from 150 [1]to 300 (mg/lit/CaCo3). The water quality is classified in hard water category base on TH. The result shows that there wasn't considerable difference in TH and TDS values on spring and autumn seasons. The maximum nitrate concentration was almost 37 mg/lit in the northern parts. The result shows that TH and TDS in the southern parts and Nitrate concentration in the northern parts were maximum values concentration. This subject shows that the source of these contaminants is different. The agricultural lands produce Nitrate contamination and the urban wastewater is source of chemical concentration and TDS.

Keywords: Groundwater, Water quality, mapping, Shahrekord plain.

Introduction

It is necessary to care the quantity and quality of the water resources especially in arid and semi-arid regions. Most of the pollution such as Sodium, Sulfate and Nitrate in the groundwater is source by the human impacts like as agriculture and industry (Jalili, 2007). Tabatabaei et al. (2006) in a research on Isfahan aquifer, show that the aquifer is critically polluted by Nitrate and microbial indexes. Latif et al. (2005) with sampling from the Mashhad plain in duration of 6 month (July to December 2001) chemical material amount such as NO3, EC, TDS, CO4, HCO3 and … is assessed and compared of international standards where EC varied from 0.4 to 3.2 dS/m, TDS from 230 to 1995 mg/lit and total hardness from 152 to 1037; and obtained contamination source is urban wastewater infiltration into groundwater. Chan and Ahn (1999) with studying on the contamination groundwater and water quality, topography, geology, landuse and pollution resource relationship are investigated. From two landuse (agriculture and industrial) groundwater samples is collected and chemical parameters is measured. Results showed that significant season difference in SiO2, Calcium and Carbonate volume in the agricultural lands and difference in the

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Calcium volume in the industrial part. Pollution by NO3, Cl, Fe, Mn, SO4 and Zn in the industrial groundwater samples and NO3, SO4 and Zn in the agricultural land was higher than standard limits.
Gupta and Gurunadha (2000) calculated and solved TDS moves from the source in the mass transport model MT3D by Advection-Dispersion equations. Calculation of flow line and TDS concentration contour indicated that the pollution motion from the source to wells lasted 365 days. Fetouani et al. (2008) investigated the irrigated lands influence on groundwater quality in Marrakesh and was modeling the nitrate of groundwater by kriging technique. Peters et al (2004) to studying seasonal variations in nitrate and sulfate concentrations developed a transient groundwater model for the period May 1998–May 2002 and advective transport simulations carried out using this model. Due to the variations in groundwater flow direction and to the extraction of groundwater, zones of higher solute concentration exist of which the position and extension vary both spatially and temporally.
The main objective of this study was mapping of groundwater quality and comparison with the drinking water standard limits in Shahrekord aquifer.

MATERIALS AND METHODS

Shahrekord plain with 551 km2 area is in the Chaharmahal & Bakhtiari province located in the central part of Islamic Republic of Iran. Also set in stance 35° 50" to 35° 95" latitude and 46° 70" to 50° 35" longitude. Shahrekord aquifer is including 493 depth wells, 321 semi-depth wells, 171 qanats and 93 springs where about 255 MCM from this resource is discharged. Figure1 indicated Shahrekord aquifer position, geology and Piezometeric wells in Iran.

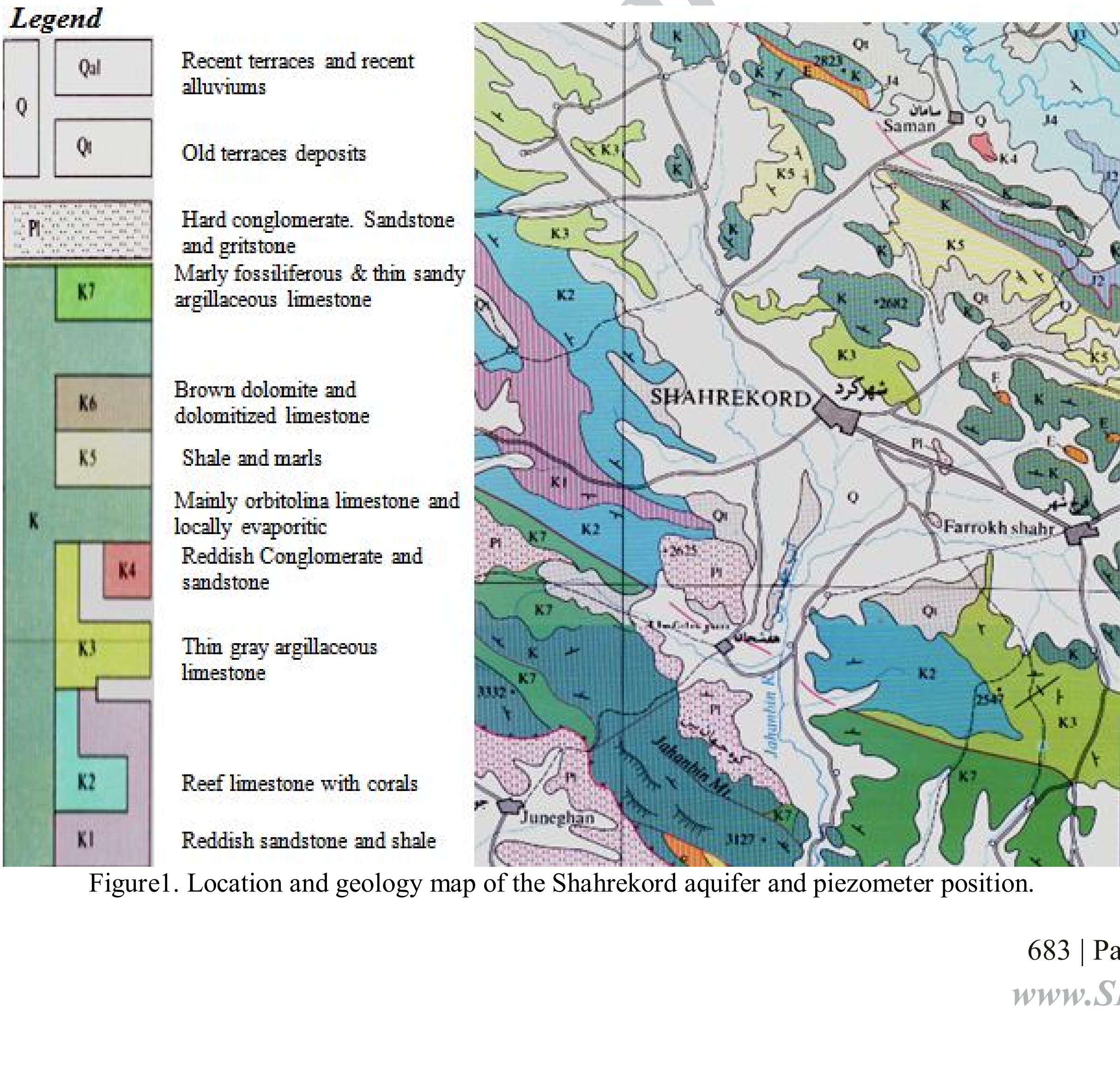

Figure1. Location and geology map of the Shahrekord aquifer and piezometer position.

In this research 18 Piezometer selected out of 36 was selected for groundwater level measurement. Contour lines of water table draw by interpolating and using of kriging method. Then five observed wells (Well no 1-6) in the northern part and six wells in the southern part (6-11) were selected for water sampling (Fig. 2). Then position of the wells measured with GPS and import to Mapinfo9 software. Water sampled was collected from the 11 well in spring and autumn 2004 and 2005. The sample analyzed for total hardness, total dissolve solid, electrical conductivity, Cation and anion (such as: Carbonate, Bicarbonate, sulfate, chloride, calcium, potassium, magnesium and sodium). Also the nitrate measured in 17 water samples in summer 2004.

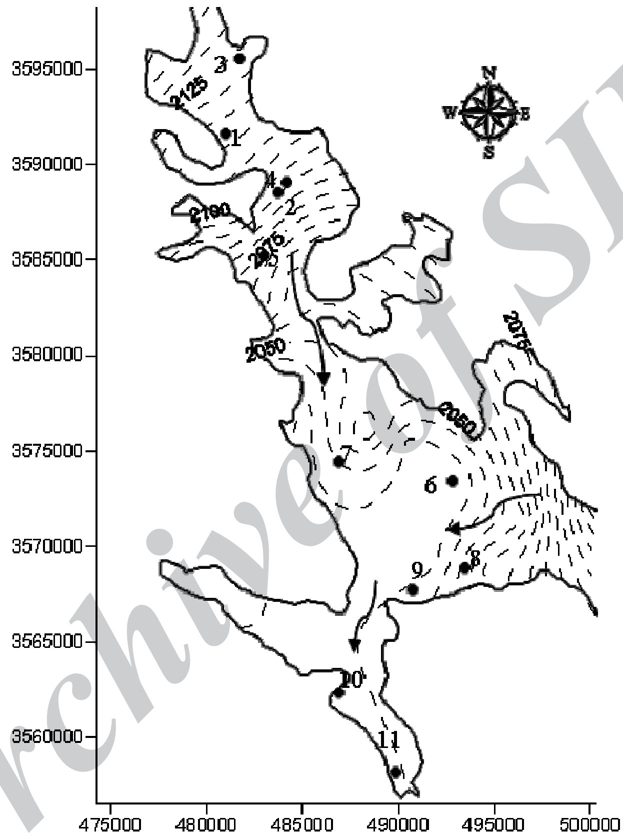

Figure2. Groundwater flow in the Shahrekord aquifer

RESULTS AND DISCUSSION

Total Dissolved Solid

TDS is mapping on total of plain by kriging method and field interpolator tools of PMWIN5.3 model. For this job divided the plain to grid with different size. According to figure3 maximum of TDS concentration is happen on well number 9 where that concentration is about of 500 ppm (international standard limits for drinking water). So we can to predict that this point is a pollution source. Wells no.9 located in a village where urban wastewater wells set on surround. Groundwater flow can be moved the contaminant on southern aquifer. This process is happen in 4 season where is analyzed (spring and autumn 2004, 2005). The other positions of aquifer don't have a pollution risk. Electrical conductivity by to have linier relation with TDS has the like results.

Total Hardness

If was an available ions concentration on mg/lit according to the below equation total hardness (TH) is obtained:

$$TH = 2.5 * Ca^{++} + 4.1 * Mg^{++}$$

Fig.4 indicated the TH concentration mapping at spring (2005) where almost uniformity distributed related to TDS. Also in this case such as TDS, well no.9 has a maximum concentration in the aquifer. TH values of total wells are lower than the standard limits. The TH in the wells varies from 150 to 300 (mg/lit/CaCo3). On this base the Shahrekord groundwater quality classified in hard water category.

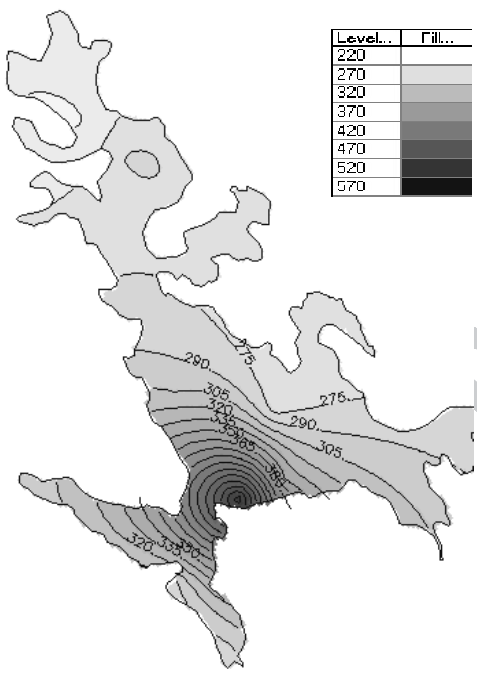

Figure3. Total Dissolved Solid in spring (mg/l)

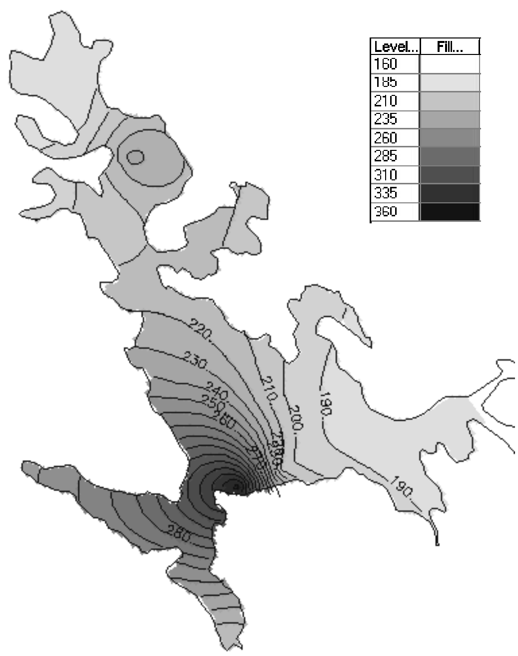

Figure4. Total Hardness in spring (mg/l)

Calcium and Magnesium

Calcium mapping indicated that the concentration in southern parts of plain is higher than northern area. It can be by geology structure or mass transport from the upstream lands. In the wastewater discharging point (well no.9) isn't high concentration such as TDS or TH where is transported the calcium contaminant immediately (fig.5).

Fig6. Show the Mg distribution in plain. According to figure Magnesium is distributed in aquifer uniformly related than Ca, TDS and TH. But such as previous case well no.9 have a highest concentration equal to 39 mg/lit in aquifer. Well no9 can be the contamination resource with existence wastewater wells.

Chloride and Sodium

Cl and Na resources refer to wastewater wells (fig. 7, 8). In south of plain and around of well no.9 have the maximum concentration. Interpolating map of chloride and sodium generally is same like together.

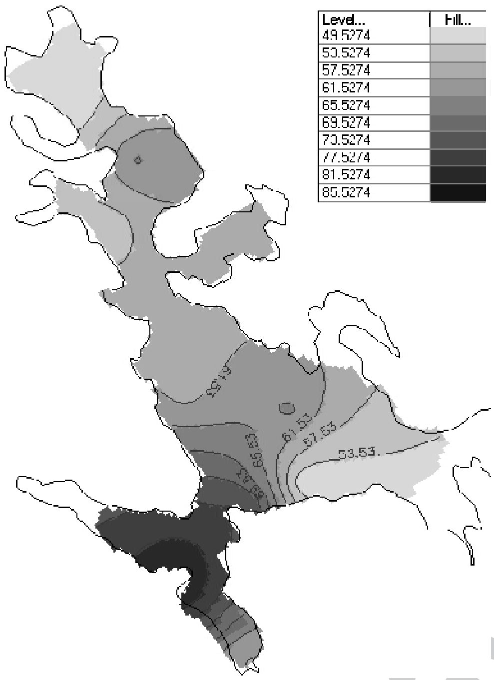

Figure5. Calcium Mapping in spring (mg/l)

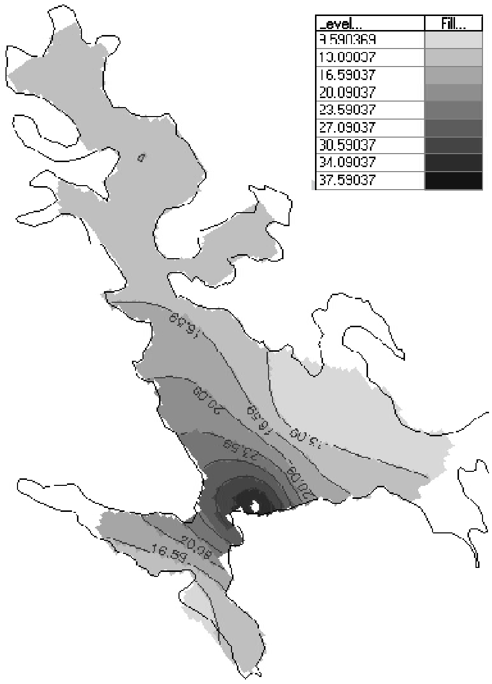

Figure6. Magnesium in spring (mg/l)

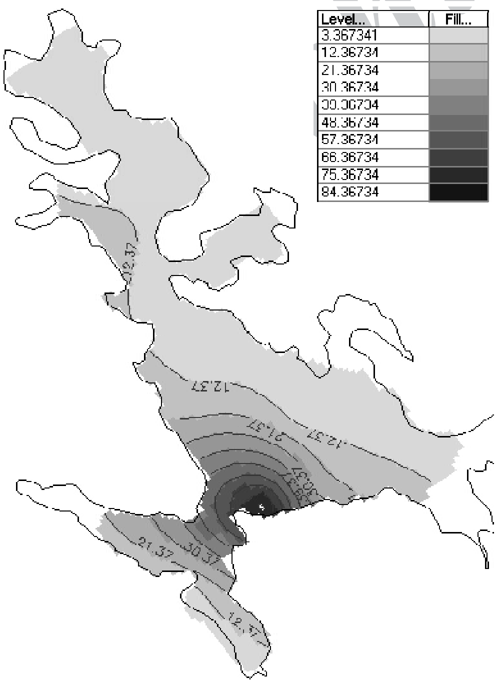

Figure7. Chloride in spring (mg/l)

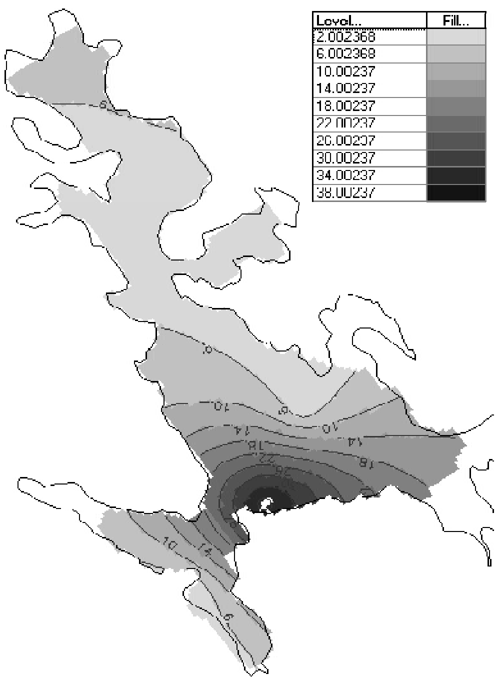

Figure8. Sodium in spring (mg/l)

Bicarbonate and Sulfate

Bicarbonate (HCO3) is distributed in larger area of plain rather than other contaminant (fig.9). Maximum concentration of HCO3 is happen in eastern south area. Bicarbonate mapping is indicated that this parameter don't related to the wastewater. Geology structure can be reason for this subject. Maximum concentration is equal to 286 mg/lit in the outlet of aquifer.

Sulfate such as many contamination sourced from wastewater wells (well no.9). So sulfate source of Shahrekord aquifer is wastewater and within south plain (fig.10).

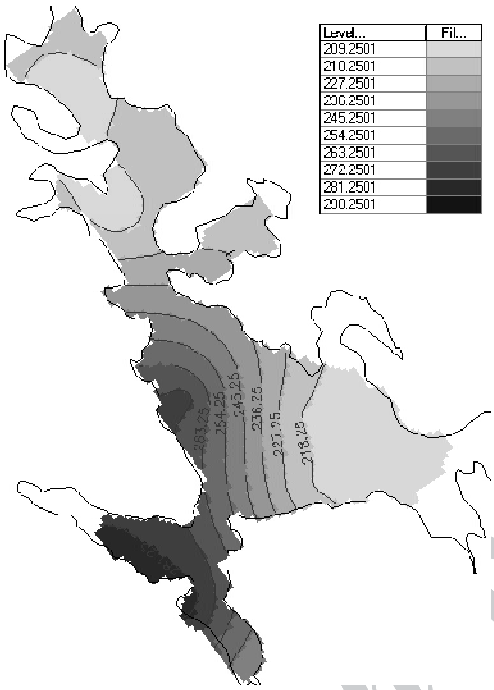

Figure9. Bicarbonate in spring (mg/l)

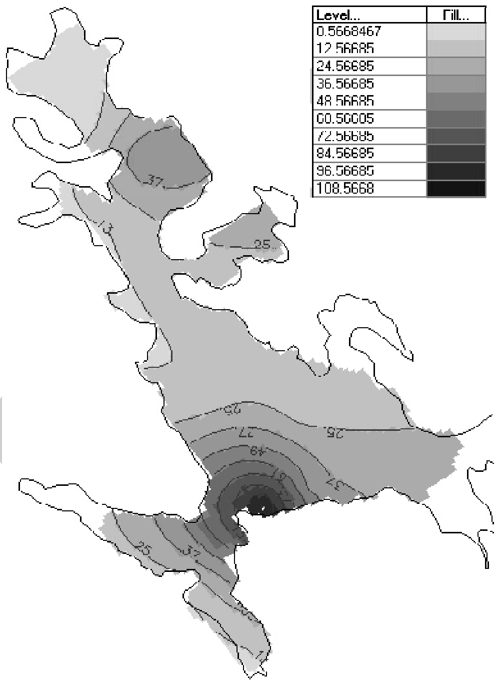

Figure 10. sulfate in spring (mg/l)

Nitrate

Katz (2004) calculations indicate that nitrate in groundwater discharging from Wakulla Springs originated from five main sources (in order of decreasing contribution): treated wastewater effluent; atmospheric deposition; wastewater residuals; fertilizers; and on-site waste disposal systems. Nitrate mapping is presented in fig. 11.

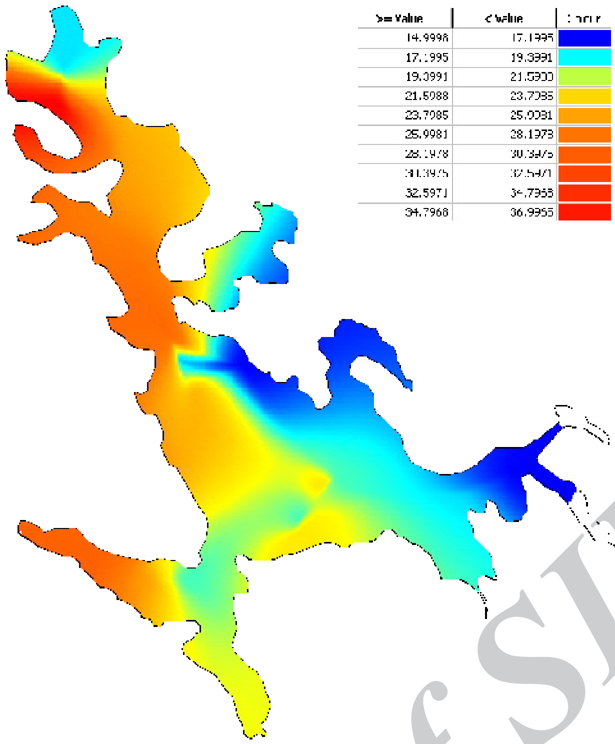

Figure11. The nitrate concentration in the Shahrekord aquifer

The maximum of nitrate concentration is about 37 mg/lit where is in northern parts of aquifer. The main factor of nitrate contamination increasing is agricultural runoff and azotic fertilizer consumption in these activities. Northern lands including the agricultural landuse where the accession water is return to groundwater resources. This runoff leached the nitrate and infiltrate to the groundwater. Nevertheless the total concentration is lower than standard limits.

Conclusion

The result shows that TH, TDS, Na, Cl, SO4, Ca and Mg in the southern parts and nitrate concentration in the northern parts were maximum values concentration. This subject shows that the source of these contaminants is different. The agricultural lands produce nitrate contamination and the urban wastewater is source of chemical concentration and TDS. The results showed that the groundwater generally flow through the north to the south (Fig 2). Figure3 showed that maximum TH can be found in southern part of the aquifer where the groundwater if flowing out. It means that the water in the flowing path was solved the solute and it caused TH increasing. The results show that the chemical contaminant concentration in North-Western part (NWP) of the aquifer was lower than Southern part (SP). The water quality was classified in hard water category base on TH. The result shows that there wasn't considerable difference in TH and TDS values on spring and autumn seasons. The maximum nitrate concentration was almost 37 mg/lit in the northern parts (Fig.11).

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