*Asian Journal of Chemistry* Vol. 19, No. 1 (2007), 616–620

# Determination of Groundwater Quality in Hatay Province, Turkey

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In this study, groundwater quality of Amik Plain and its surrounding areas is illustrated. A total of 59 groundwater wells located throughout Hatay Province were examined in this study. It was found that the water quality of wells is to a certain extent good for irrigational use; on the other hand, some wells, situated downstream Asi River after Antakya (Hatay Province center), have relatively low water quality even for irrigational use.

**Key Words: Amik plain, Hatay, Turkey, Groundwater quality, Asi river.**

## INTRODUCTION

Hatay Province occupies 5403 km$^2$ area in Turkey and is situated between 35°52′ and 37°04′ N latitudes and 35°40′ and 36°35′ E longitudes. The province can be characterized by two plain areas, which are a group of coastal plains next to the Mediterranean Sea and Amik Plain and a mountainous line (Amanos Mountains) in between. About 60% of the provincial population is employed in the agricultural sector in the province. Amik Plain, which is located in Hatay Province in the southernmost corner of Turkey, has a special importance in agriculture due to subtropical climate, long, hot and dry summer season, high quality and suitable for cotton sowing soil texture and easiness of irrigation in agriculture. Amik Plain is highly dependent on groundwater during its long and hot summer months. This plain occupies 34% of the total area in the province. Amik Plain has a total area of approximately 12000 hectares. A 60 m deep alluvial, silty, calcareous and sandy soil layer was determined below this plain. The most important agricultural products cultivated here are listed primarily as cotton and wheat grain and secondarily as corn, pepper, onion and okra. Asi River, which runs through the plain, is a vital source feeding the groundwater resources in the

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region. Two important towns, Antakya (population density over 500 capita $km^{-2}$) and Samandağ (population density more than 280 capita $km^{-2}$) are located downstream Asi River, after the Plain. However, the quality and quantity of this river has been declining due to increasing urbanization and industrialization in the area. Özdilek[1] reported that abundant safely pumped groundwater is used in agriculture in the province. While, on average, 800 mm annual precipitation occurs in the province, only less than 50 mm of it is from June to August, when most of the agrarian production takes place. Throughout the province, 59 groundwater samples were examined to draw a comparison in the area.

## EXPERIMENTAL

Acidity of water was determined by Hanna® Instruments pH 211 microprocessor acidity-meter. Electrical conductance was measured using Hanna® Instruments EC 214 conductivity-meter. Water hardness was quantified using titration. For hardness determination, 10 drops buffer (ammonium chlorideammonium hydroxide) was added into 5 mL water and then 2 drops Black-T indicator was added to this solution. Until achieving light-transparent blue colour, ethylene diamine tetraacetic acid (EDTA) was added into the cup containing the solution. Furthermore, a 5 mL water reference sample was also titrated. Finally, water hardness on French Scale was computed by putting values in the following equation:

$$\text{Ca + Mg hardness (French)} = (A–B) \times N \times 1000$$

where A = EDTA spent for water sample (mL), B = EDTA spent for water reference (mL) and N = normality of EDTA

The lab devices necessary for determination of pH, water hardness and electrical conductance are situated in Mustafa Kemal University (MKUFAM), Central Laboratory of Science and Research Application, Tayfur Sökmen Campus, Antakya, Hatay. The samples were collected and immediately analyzed after the sampling within the first two months of 2005.

## RESULTS AND DISCUSSION

Only 8.5% of the examined sampling sites were determined to have slightly acidic water. This can be explained by the basic water specification of the River Asi. Indeed, the alkaline structure of water in the river is a positive factor for metals and some contaminants due to the fact that solubility, and therefore harmfulness, of metals in alkaline waters is minimal. Table-1 summarizes the properties of examined wells.

According to electrical conductivity measurements, about 7% of samples were found to have significantly high electrical conductance value (EC > 2000 $\mu S$ $cm^{-1}$) based on Turkish Irrigation Water Standards.

32% of well water samples had remarkably hard water (over 50 French

hardness scale) based on the Turkish Irrigation Water Standards. Sawyer *et al.*[2] noted that water that has more than 300 mg $L^{-1}$ as $CaCO_3$ is classified as very hard. Based on this classification, 86% of the examined ground water samples fall under very hard water. This remarkably hard water could be problematic in plant growth in spite of the fact that hard water in surface water resources is noted to be good in terms of metal toxicity for fish[3–5].

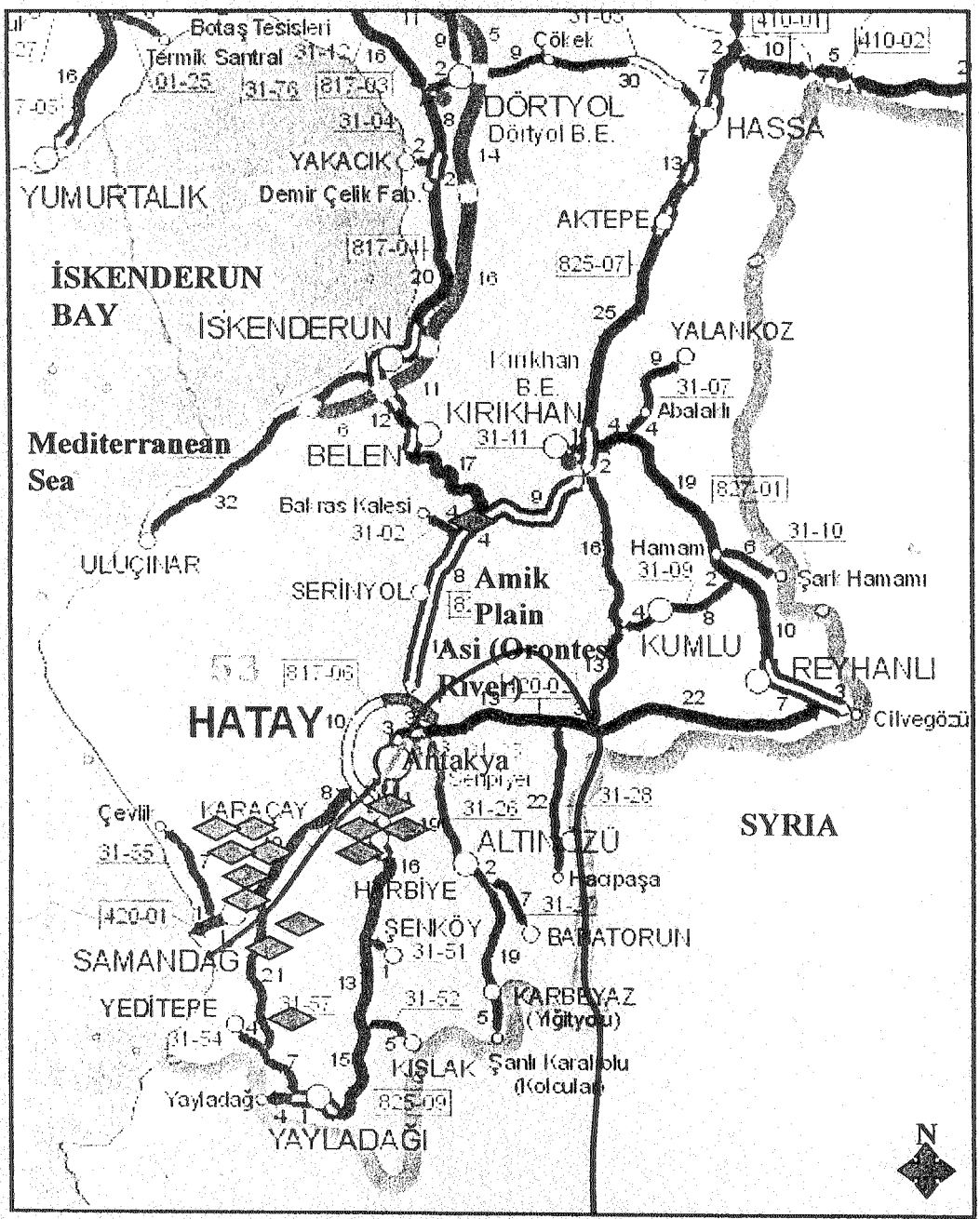


Figure 1. The study area ( represents the impaired wells) (no scale).

TABLE-1
WELL WATER QUALITY PARAMETERS IN HATAY, TURKEY (N = 59)

| Parameter | Min. | Max. | Range | S.D. | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| Hardness | 24.04 | 144 | 119.96 | 31.42 | 987.09 | 1.1759 | 1.5318 |
| Electrical conductance | 347 | 2510 | 2163 | 546.6 | 298787 | 0.6080 | 1.2455 |
| pH | 6.86 | 8.75 | 1.89 | 0.3874 | 0.1501 | 0.7454 | 0.2781 |

It is an interesting point to note that all hard waters, except one well (based on Turkish National Standards) were found to be situated after Antakya (Province Center of Hatay) with respect to the river flow direction. While all other well waters, with the exception of one (Maraşboğazi) that is located 35 km north of Antakya, were found to be on the safe side for irrigational use, locations, such as Gümüşgöze, Değirmenyolu and Aşağiokçular (within Antakya district), Mizrakli and Vakifli (within Samandağ district) and Sebenova (within Yayladağ district), were determined to have impaired well waters to use in irrigation for agricultural cultivation. Taking into consideration the sampling period, the seasonal effect on groundwater quality should not be ignored. As Nkhuwa[6] pointed out, wet season has great impact on groundwater quality in aquifers situated in Lusaka, Zambia.

Due to the fact that the Plain is an important production center for cotton, specific measures might be taken to reduce hardness in order to increase irrigational water quality. Such measures could be listed as resting of water for some time to settle hardness causing agents, more specifically, calcareous particles, prior to irrigation, heating water using solar ponds and maybe filtration. However, such techniques should be used after careful investigations to minimize expense and to maximize net gain. Therefore, site specific controls for hard groundwater should be developed under well-equipped supervisors because of the fact that groundwater resources play a significant role in the overall water balance[7], in many regions of the globe, including Middle East, where Hatay Province belongs. Özdilek[8] noted that Asi River delta (Samandağ) is a biologically rich area, as being a nesting habitat of endangered green sea turtles, and untreated sewer discharge could cause problems in the future years in this location.

## ACKNOWLEDGEMENTS

The authors are greatful to TEMSU Company and Kemal Yeşiloğlu that provided well waters. The staffs of MKUFAM Central Laboratory of Science and Research Application, Seher Erişen Misirlioğlu (M.Sc. in Chemistry) and Engineer Hidayet Duman are also appreciated. The authors are also thankful to UNESCO Turkey and UNESCO for its kind support of the project.

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(*Received*: 10 January 2006; *Accepted*: 30 June 2006) AJC-4986

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