QUANTITY AND QUALITY STUDIES FOR CONTAMINATED UNDERGROUND WATER IN ABHAR PLAIN (NW OF IRAN)

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Abstract: The studied area is placed between 48°, 48′ to 49°, 30′ east longitude, and 35°, 57′ to 36°, 36′ north latitude. Human pollutants are mainly home and human sewage which is discharged by absorbent wells that seems to be one of the best ways of discharging sewage. On the other hand in the places where the underground water recharges the river, there is a possibility of having some environmental problems in the nearly future. From the bacteriological point of view, Abhar Roud River is highly contaminated. Although, in the underground water is more found sulphate type near the recharge place, but there are no evaporative layers and in all probability, this change has been made as a result of discharge urban and factory sewage by absorbent wells. Necessary from the bacteriological point of view, no pollution has been reported from the wells in Abhar plain. But with due attention to the critical point, growth in population, in parallel with using more farm lands and different kinds of chemical fertilizers and the growth in the number of industrial sites, it is believed that in the nearly future, under ground water of Abhar plain would be polluted, too.

Key-word: Abhar plain, pollution, Escherichia and total coli form, absorbent well, BOD, COD.

1 Introduction

The general goal of this research is to determine the amount of underground and surface water pollution of Abhar plain and several other specific goals have been pursued in this frame work which is studied as follows [7]:

-Recognition of underground and surface water of the studied area both quantitatively and qualitatively.

-Recognition of the present condition and determination of the physical and chemical state of underground and surface water and their changes in the chronological and local points of views in relation to the contaminant sources with the help of sampling.

-Recognition of the contaminant sources of underground and surface water of Abhar plain.

-Presenting suitable solutions for controlling the rate of pollution and water sources of the studied area.

Generally, Zanjan province and specifically Abhar plain have not been studied thoroughly. During the recent years, only two researches have been made on this area. The first one that was done by general environment administration of Zanjan province in 1997 was about analyzing pollution and contaminant sources of Abhar River [5]. The second one was a B.A thesis in the natural sources faculty of Tehran University. This studied the contaminant sources of underground water of Abhar River and was done in 2002[8].Both have paid a great attention to preserving underground water sources and have expressed that surface water is contaminated and warned about the spread and penetration of contaminated water into the underground water.

2 Methodology and Procedure

The studied area is located in Zanjan province (North West of Iran) and is bordered by the water-shed basin of Ghezel Ozan River to the north and Khar Rood River to the south and is limited to the basin of river to the west. The total area of the watershed is 1960 km^2, which 45.5% of the area is located in the plain and the rest is mountainous. The basin is placed between 48°, 48′ to 49°, 30′ east longitude and 35°, 57′ to 36°, 36′ north latitude[6] (Fig. 1).

Many different methods have been used to determine the climatic type of the basin of Abhar

River. De Martonne and Emberger were the two most important methods that were used and according to the calculations, the area is considered a partially dry and cold region [1]. Alizadeh suggests an equation between altitude and precipitation as follows [1] (Equation 1):

$$P=aH-b \quad (1)$$

By using the meteorological data from the stations, raining equation and the height of Abhar plain is calculated by equation (2):

$$P=0.23H-205 \quad (2)$$

Where; P: average precipitation in mm, H: altitude of mean sea level, m.

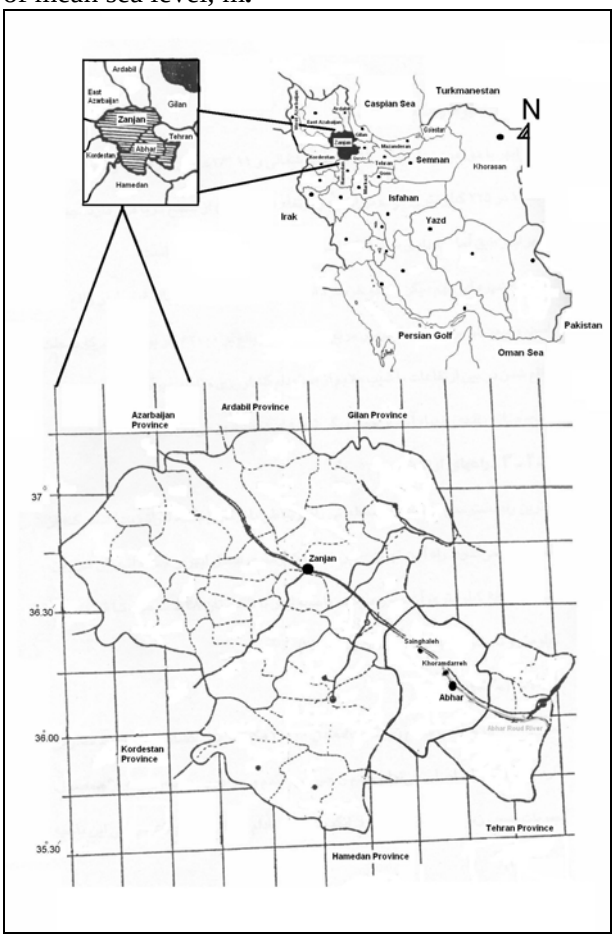

Fig. 1 Location and the local access to Zanjan province and Abhar basin

So, annual precipitation of Abhar plain is 299.4 mm , that the maximum and minimum amounts was in February and August months(1985-2001).Annual mean of potential evapotranspiration(1999-2000) in the studied area was 949mm. According to the Tornthwhite method, real evaporation was estimated 132.1 mm [3, 8].

Underground water is the most important source for providing water for agricultural, industrial, and drinking purposes of Abhar plain. The studied area very rich in underground water sources, due to the good porosity, hydraulic conductivity, storage coefficient, and transmissibility of the alluvial sediments [2, 3]. It is proved that at least one alluvial aquifer is located in the studied area. This idea is proved by using the stratiographic column data of the observation and exploratory wells. On the other hand, with the help of pumping test data, it is understood that the transmissibility varies between"350 to 550" m^2/day and the amount of hydraulic conductivity varies between 5 to 10 m/day [3, 4]. From the mentioned amounts, it can be concluded that the saturated zone is 30 to110 m depths.

In order to determine the contaminant sources of Abhar plain in the water year 2001-2002, sampling operations were regularly done from the determined places within a year [4](Fig.2).Regarding the mentioned goals in the introduction, in this part we study and analyses the amount of water pollution in Abhar Roud basin. In these researches, the focus is on local and times exchanges and the effective parameters of contamination.

In the water year 2001-2002, nitrate contour lines (Fig. 3), chlorine and sulphate contour lines (Fig. 4) were drawn. These are related to the maximum and minimum periods of underground water level in the mentioned water year.

One of the most important factors is measuring the electric conductivity (EC) which varies between 344 to 1012µmho/cm and shows the suitability of underground water. The other important factor is the amount of TDS or the sum of the solid substances in water (except, suspended load, collides and solution gases).The relationship between EC and T.D.S is calculated by equation (3);

$$TDS = 0.59\ EC + 0.19 \quad (3)$$

In this equation; TDS is total dissolve solid (mg/L) and EC is electric conductivity (µmho/cm). Regarding these factors, all surface and underground water sources are located in the sweet water zone. One of the most important factors of water quality, from the microbiological point of view is to determine the number of Escherichia and total coli forms bacteria. The other one is determining the density of biologically required BOD_5 (Biological Oxygen Demands) and the concentration of the COD (Chemical Oxygen Demands). For example, higher the amounts of coli form bacteria show that water is mainly polluted by the unfiltered human sewage or BOD_5, which is used to show the required amount of oxygen necessary for the aerobic bacteria, and separated them.

3 Conclusions

In order to evaluate physical, chemical, and bacteriological characteristics of Abhar Roud River, 22 waters sampling wells were used along the river. Surface and underground sampling places along with the landfills were drawn on a map (Fig. 2).The quality of drinking water was satisfactory in sampling stations. But it must be stated that using the river water without doing the purification is impossible. According to the hydrological map and lime sediment outcrops, underground water is ranges as hard water on the right part of the river and samples from other parts are ranged from slightly hard to partially hard. Regarding Schoeller diagram, drinking water is classified good and very good. Contaminant sources of Abhar plain have been studied under the two following titles**:**

3.1 Natural Contaminants

The most important contaminating factors in here are the sediments that have been flowed into the river (caused by erosion, rain transmission and flood-water) and consequently muddy it. The average month discharge of Abhar Roud River (statistics of 30 years) is 1.93 m^3 /s and its annual rate is 68.8 million m^3. According to the measurements of, the average muddying amount is almost 5.8g/l and specific destruction (Dg) is 180.93 ton /km^2. Regarding this, the annual depositing rate is 347811.4 ton/year [8]. The total average of the solid substances in the river water is almost 524 mg/l and the amount of sulphate and phosphate are 185 mg/l and 2 to 3 mg/l, respectively. Generally, the fore mentioned values are not just limited to the natural pollutants but they somehow cover the values of soluble materials caused by civic, industrial, and agricultural sewage.

3.2 Human Contaminants

House and human sewage are mainly removed by using absorbent wells in towns and cities around the Abhar Roud River basin. By paying attention to the permeability of the area and the depth of water level, which vary between 5 to 10 m/day and 20 to 100 m, respectively, it seems that the best possible way of removing the sewage is by absorbent wells [3, 7, 8]. In bigger cities like Abhar and khorramdareh, it can be seen that in the dry season, a great deal of flowing water in the main branch of the river is related to the city sewage. This according to the permeability rate can pollute the underground water in the near future.

175 liters of the drinking water is wasted in the form of sewage in the cities near and along Abhar Roud River every day per person [8].This amount of sewage is then pumped into the river by sewers and consequently increase total material concentration of soluble and hardness of the river.

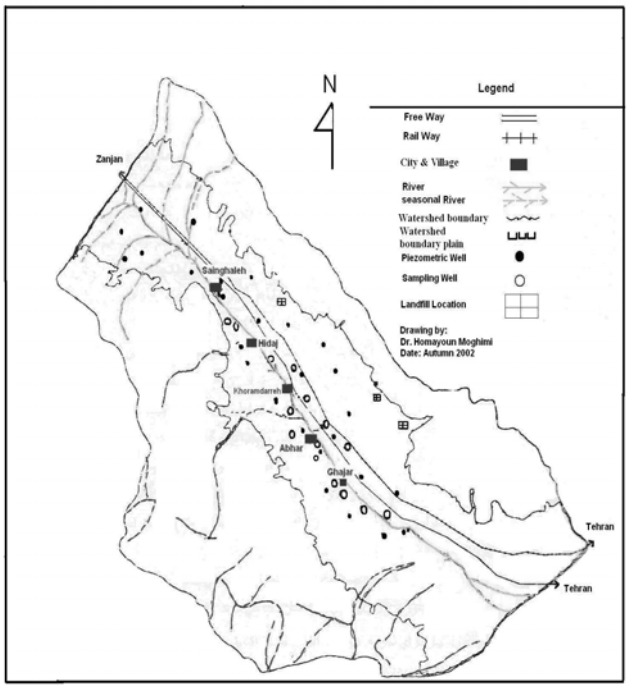

Fig.2 Observation, sampling wells map, and landfills locations**.**

Among these, Abhar and Khorramdareh have the most polluting effect in the form of deposited materials, which are some kind of slime caused by the sewage.

To prevent this to happen, open and long canals in this area must be closed and a decent civic sewage system of transferring the sewage to the purification plant must be designed to enable us to use the sewage in some other necessary ways again. To determine the amount of contamination, BOD_5 and COD are used. The values of BOD_5 and COD vary between 1 to 10 mg/L and 15 to 215 mg/L, respectively. Which show the penetration of the inorganic contaminants from factories and industrial sites and organic contaminants from the civic and industrial sewage into the river. Amounts nitrate and nitrite materials have been found in the Abhar Roud samples, which show the pollution of the river (fig. 3), since these two substances according to table 1, must not be found in the water. Microbiologically, in hundred milliliters minimum and maximum values of total coli form and are Escherichia coli form 240–1100 and 11–1100 numbers, respectively. These values show that the river is highly polluted. When

studying the underground water pollution, one important factor to consider is determining the direction of the underground water. Since according to the direction which is from north west to the south east, polluting sources flow from north west to south east and second time moved from north and north west to south and south west to the irrigation Abhar Roud River. Regarding the flow direction of the river, in the feeding part (the beginning part of the river, North West) water is carbonated type and in the discharging part (south east), water is of sulphate type. This is more visible in the southern part of Sainghaleh (near feeding part) since the amount sulphate is in its highest rate (Fig. 4). Since there are no evaporate layers such as gypsum and anhydrite in the area and the water level is 20 to30 meters, the amount of sulphate in underground water proves that these materials have been created by sewage of the factories around this river. Another important factor of underground water is determining the amount of nitrite and nitrate. According to the drinking water standard (Table 1) [6], the maximum rate of nitrate should not be more than 30 mg/L while its permissible amount is 10 mg/L. Generally, the amount of nitrate for the Min. and Max levels of the underground water is not more than 10 mg/L, so regarding this point of view, water is not polluted. According to the standards Table 1, in drinking water not must be nitrite. Further more, some small amounts of ammonia that varied between 0.001 to 0.02 mg/L were seen in the collected samples in February 2002.Ammonia is capable of being absorbed by clay and organic materials in non-aerobic conditions. But in aerobic situation, due to separation bacteria's and during oxidizing reaction can be changed into nitrate. Nitrite ions can move to the deepest layers of the soil. The existence of these materials (nitrate, nitrite, and ammonia) in water is a proof that the water has been polluted by these materials through using chemical fertilizers.

This is also a proof of human sewage wells being near water sources, which is more crucial in countries with no sewage networks in which most sewage is discharged by absorptive wells. Underground water of the Abhar plain was also tested microbiologically and no Escherichia and total coli form were reported in the samples and it was proved that water was not polluted in this case, too. But since there was a small amount of nitrate in the underground water, more chlorine had to be used for disinfection that resulted in more deposited residual chlorine in the underground water. According to the standards, the maximum amount of residual chlorine in the drinking water should not be more than 0.5 mg/L but the favorable amount is 0.1 mg/L. But the amount of residual chlorine in many local wells varied between0.2 to 1.5 mg/L which is probably caused by nitrite in underground water. Regarding the sampling results and having them compared with quality standard, there's not special underground water pollution. But regarding the fact that surface water is polluted along with the growth in population and the number of farming lands and factories and using more fertilizers, it seems to be possible that underground water would be polluted unless there is a suitable plan for preventing this to happen.

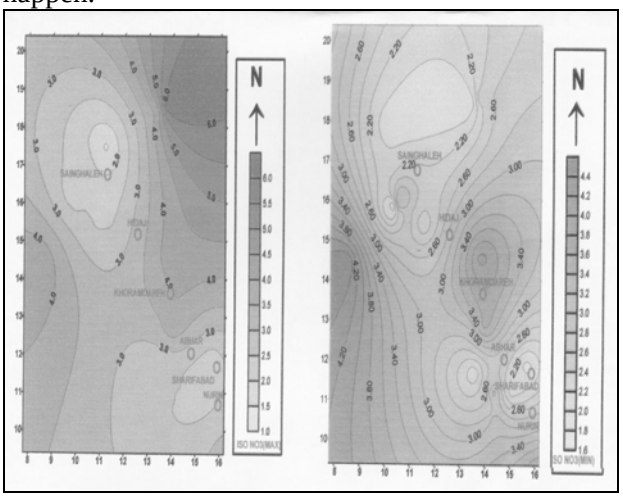

Fig. 3 Map showing nitrate contour lines on the underground water of Abhar plain.

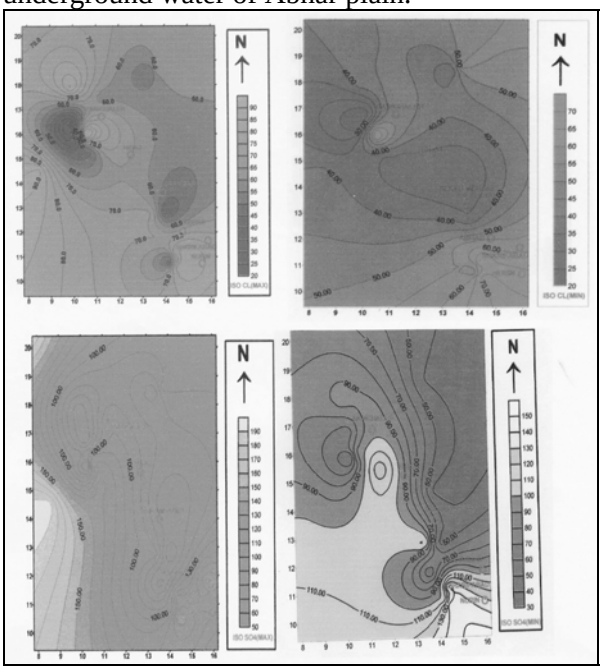

Fig. 4 Maps showing chlorine (up) and sulphate (down) contour lines on the underground water of Abhar plain

Table 1 The ordinary combination refined house sewage (Metcalf and Eddy, 1979)

Materials And Elements	Concentration (mg/L)		
	Strong	Medium	Weak
T.D.S	1200	720	350
T.S.S	850	500	250
Suspended Materials	350	220	100
Solid Deposit Able (ml/L)	20	10	5
BOD_5	400	220	110
COD	1000	500	250
Total Nitrogen (N^+)	85	40	20
Organic	35	15	8
Free Ammonia	50	25	12
Lead (Pb)	0	0	0
Nitrate	0	0	0
Total Phosphorus (PO4)	15	8	4
Organic	5	3	1
Non Organic	10	5	3

4 Suggestion

- It is necessary to have complete and general standard for the quality of surface water of the country. In Iran, there is not a good standard for the quality of raw water (river and lake waters, etc.); consequently, this is the most important weak point for researches surface water quality.
- Because of the great pollution potential of underground water sources, it is important to do sampling operations regularity and continuously to know the concentration of its containing materials.
- Great attentions must be paid to control the concentration of materials and elements of the underground water in areas near Sainghaleh, Sharifabad, and discharge areas.
- Designing and making civic and industrial sewage system in Abhar plain.
- If there is not a possibility to make separate refineries for each factory, it is necessary to make a common refinery for all of them.
- Continuous sampling of industrial sewage must be done and it must be made compulsory for the factories to refine their sewage.
- Regular local and chronological sampling of the surface and underground water must be done have exact and immediate information of elements by the responsible organization.
- Rain sewage removing system must be designed in the cities of Abhar plain.
- Since landfills have been selected without paying attention to be the environmental standards, it is probable that underground water is being polluted by leakages of leach ate. So all incumbent on landfills and the new places must be studied greatly.
- It is necessary to have a well-equipped laboratory in environmental organization of Abhar for doing different analysis on the samples taken from surface and underground water.

Moreover, it is necessary for this organization to have a close relationship either the local water Organization, Jahad Keshavarzi (Agriculture Ministry), Environmental Organization and the local municipalities to obtain good information for analyzing surface and underground water quality removing urban garbage and suitable use of agricultural fertilizers and the information seems to be important form livestock farming, too.

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