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The Effect of Well Depth on Water Quality in Neiboring Zone of Zayandehroud, Iran

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Abstract: The location of a well related to surface drainage ways is important in determining the potential for groundwater contamination from surface water flow. Locating a well in a safe place needs careful consideration and planning.To determine the effects of well depth on water quality, the wells up to 4 m. depth and 100 m. far from river were selected in Isfahan. Geologically, the earth in this zone composed of clay (more on surface) and sand (particularly in depths higher than 1 m.). Flow direction of river with comparison static level of wells and bottom of river is toward wells. The parameters were measured according to the standard method. Finally, a total of 100 samples were taken and analyzed. Results of this study showed that Total Coliform, Fecal Coliform, COD, NO_3, Total Dissolved Solid and Electrical Conductivity showed a rang of 3-460 and 0-29 MPN/100 mL, 2-12, 1.39 - 4.15, 320-783 mg/L and 571-1350 µmoh/cm, respectively. Finally, we observed that NO_3, Electrical Conductivity and Total Dissolved Solid increased and Total Coliform, Fecal Coliform decreased with increasing well depth.

Key words: Chemical parameters · Coliform · Electrical conductivity · Isfahan · TDS · well depth · Zayanderoud

INTRODUCTION

Rivers are the major transporting means for different contamination into other resources like groundwater and lake [1]. By passing water through groundwater, its quality will change. These changes may be related to human or nature phenomena. Generally, shallow groundwater is affected more by contamination compared with deep groundwater [2]. Groundwater moves downward due to the pull of gravity. But it can also move up because it will flow from higher- pressure areas to lower pressure areas. The rate of groundwater flow is controlled by two properties of the rock: porosity and permeability (Pore space) [3]. The ultimate distance to which the pollution will be carried is dependent upon a number of complex and interlocking factors, namely wet and dry weather, with two resulting rise and fall of groundwater; the length of each of these periods; the rate of the groundwater flow (depending upon the head, which in turn is dependent on the rainfall) [2] and also the factor of the viability of the organisms under conditions of moisture, pH, food supply, etc. If agricultural land is located near a well, pesticides and nutrients (such as nitrate) are contaminants potentially found at land surface which could be transported to the subsurface along a deficient well seal. Pathogenic bacteria associated with agricultural waste that are of concern include *E. coli, Salmonella, Campylobacter* and *Shigella*. Pathogenic protozoans of concern include cryptosporidium parvum and Giardia [4].

A review presented by Gerba *et al.,* [5] reported that survival times of enteric bacteria in soil and groundwater ranged from 2 to 4 months. Filip *et al*., [6] examined the survivability of several organisms in simulated conditions of saturated soil and observed that most organisms tested for, including E.coli, survived for over 100 days at 10°C. Against Hydraulic limit or efficient radius of hydrous well layer that only

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depends on dynamic and static level, slope of earth, permeability coefficient of soil and the amount of water intake from well, the healthy limit of well in addition to reminded factors depends upon other variables such as the kind of contaminant, primary concentration of contaminant in hydrous layer, contaminating source and time on the basis of American Institute Public Health Service announcement in North Carolina in observation wells with low flow rate in soils with microlithic gravel bed with 0.014mm efficient diameter and 1.8 uniformity coefficient, coliform bacteria had 70m movement and chemical contaminant that detected with colored oranin had 137m movement from injunction place [7].

Bacteria can move faster in coarser soils such as sand [8]. Mubiru *et al*. [9] stated that as well as enhancing moisture retention, fine soil particles could increase bacterial survival because of an increased ability to retain nutrients.

Rahe *et al*. [10] evaluated the movement of E. coli that had been injected into the leach lines of septic tank disposal systems, that were inundated with groundwater in two different soil types (well drained and poorly drained). Movement rates of 15m/h were observed at the well drained site.

Contamination mechanisms of groundwater include penetration, recharge by surface water, direct transportation and exchange between aquifers [3]. Basically contaminants in groundwater move horizontal and hydraulic gradient detects movement rate [3]. The total coliform (TC) group includes the aerobic and facultative anaerobic, gram - negative, non - spore - forming, rod - shaped bacteria that ferment lactose with gas production within 48h at 35°C. This group includes *Escherichia coli, Enterobacter, Klebsiella* and *Citrobacter*. These coliforms are discharged in high numbers (2×10^9 coliforms/day/capita) in human and animal feces, but not all of them are of fecal origin. Fecal coliforms (TTC) or thermotolerant coliforms include all coliforms that can ferment lactose at 44.5°C.

The presence of fecal coliforms indicates the presence of fecal material from warm-blooded animals. However, human and animal sources of contamination cannot be differentiated [11]. This research has tried to measure microbial contamination with the use of both total coliforms and fecal coliforms indicators and measure of Electrical Conductivity (EC), Total Dissolved Solid (TDS) and NO_3 contents of well to find the effect of well depth on those parameters in neighboring zone of Zayanderoud.

MATERIALS AND METHODS

Description of Zone: Falavarjan, a small province, is located on the west of Isfahan (is located on the center of Iran) province having 221762 populations and 315.9Km^2 area. Most of Falavarjan residents are rural. Zayanderoud passes from the margin of this city. Water sources in this zone depend on Zayanderoud and most of these sources are shallow wells.

Agriculture productions in this zone are rice, wheat, potato and vegetables. Agricultural waters provided by shallow wells (in Zayanderoud margin)

Description of the Zone Selected for Sampling: In this study, 10 agricultural wells were selected on the margin of Zayanderoud which are up to 100m far from river. Generally, the soil of this zone is a mixture of sand, gravel and clay. Regarding the subject of this study, those wells were chosen in different distance from Zayanderoud (Table 1).

Sampling Method: The sampling was performed approximately once every fortnight at different times. Sampling was performed according to the standard methods. Sterile glass bottles of 250mL volume and polyethylene bottles of 1.5L volume were used for microbial samples and chemical samples, respectively. Each parameter was measured 10 times.

Testing Methods: Three-tube fermentation technique (MPN) was applied to detect total and thermotolerant bacteria. Beside, COD with Spectrophotometer (absorption at 600 nm wavelength), nitrate with Spectrophotometer, EC with use of CONSORT K620 and TDS with standard method were measured [12].

The results of this study were analyzed, using statistical methods, SPSS and Excell Software and Pearson correlation test and regression model.

RESULTS AND DISCUSSION

The average MPN/100mL of total coliforms in all of these wells was 4o.32. The maximum number, related to the 1st well, was 157.9 MPN /100 mL. The average MPN/100mL of thermotolerant coliforms in all of these wells was 3.74 and the maximum number, related to 1st well, was 12.95 MPN /100 mL. The average EC in all of these wells was 899.54 µmoh/cm and the maximum and minimum values, related to the 10th and the1st were 1026 and 7147.2 µmoh/cm, respectively. The average nitrate in

Table 1: Average depth and distance from Zayanderoud

Well number	1	2	3	4	5	6	7	8	9	10
Average depth (m)	2/5	2/8	2/9	3	3/2	3/5	3/7	3/9	4	4
Distance from Zayanderoud (m)	16	19	23	27	30	34	41	51	65	77

Table 2: Average of measured parameters at various sampling stations

Well No.	1	2	3	4	5	6	7	8	9	10
TC (MPN/100mL)	157.9	81.9	52.8	23.41	14.83	16.73	13.5	13.09	14.23	14.83
TTC (MPN/100mL)	12.95	5.27	3.56	3.36	2.52	2.89	2.36	1.68	1.8	1.02
NO_3 (mg/L)	1.76	1.58	1.9	1.74	1.87	3.05	2.94	3.23	3.47	2.66
COD (mg/L)	17.21	5.94	4.95	4.95	3.83	3.68	3.46	7.1	8.43	7.62
TDS (mg/L)	408	433.7	469.2	518.6	511.4	551.1	566.2	592.6	590.3	600.9
EC(µmoh/cm)	714.2	745.8	810.4	873	906	942	969	1003	1006	1026

Table 3: Relationship between well depth with measured parameters

Parameter	TC (MPN/100mL)	TTC (MPN/100mL)	NO_3 (mg/L)	COD (mg/L)	TDS (mg/L)	EC(µmoh/cm)
Average depth (m)	-0.567	-0/572	0.815	0.18	0.562	0.536

*The numbers that shown are coefficient's Pearson correlation

all of these wells was 2.42 mg/L. The average TDS in all of these wells was 524.2 mg/L and the maximum and minimum values, related to the 10^{th} and the 1^{st} were 600.9 and 408 mg/L, respectively. The average depth of wells and their distance from Zayanderoud are shown in Table 1. The average of the measured parameters in different wells is shown in Table 2. The relation between wells depth with measured parameters are shown in Table 3.

According to the existing standard, water in these wells did not pose any problem for agricultural uses [13]. WHO stated maximum 1000 MPN/100mL of thermotolerant coliforms for agricultural uses. Thus according to this standard, water in these wells posed no problems for agricultural uses. However according to WHO and EPA standards, well waters are unsuitable for drinking use, regarding to their number of total and thermotolerant coliforms.

Comparison static level of wells with height bottom of river shows that the farther the well is from the river, the deeper the well would be and therefore wells were recharged from the river. Moreover, with increasing depth of wells, the number of total and thermotolerant coliforms decreased and this decrease up to 3.2m was completely observable and the reason is the decrease of penetration ability of bacteria with the increase of wells depth [14]. Evaluating of TDS and ES values showed that the more the well depth, the higher the TDS and EC values, because TDS load of an aquifer is a function of various factors including aquifer mineralogy, residence time (i.e., how long the water has been in contact with aquifer materials) and how fast the groundwater is moving. In a given aquifer, waters with longer residence times, or with lower velocities, will have higher conductivity. According to the existing standards, water in these wells was suitable for agriculture regarding their EC and TDS [15].WHO did not propose any standard about COD for agriculture and irrigation uses, but about nitrate value, stated <5 mg/L and >30 mg/L for agriculture uses without limitation and agricultural uses with strong limitation, respectively. For drinking use EPA stated 10 mg/L as nitrate maximum concentration. Thus, according to these standards, water in the wells posed no problem for drinking and agricultural uses regarding their nitrate contents.

In a primary examination using Pearson correlation test we see that TC (total coliform) and TTC (thermotolerent coliform) had reversed relation and NO_3, TDS and EC had direct relation with well depth. Also a direct relation between well depth and well distance from Zayanderoud was observed. Therefore, considering the reversed relation between TC and TTC with well depth and well distance, one of those relations was probably affected by another relation. Thus the regression model was applied to control the confounding effect of depth and distance. Here TC and TTC had relations with depth and distance, but the relation of TC (P-value<0.001) and TTC (P-value <0.001) with depth was stronger than the relation of TC (P-value <0.001) and TTC (P-value= 0.045) with distance. The COD values did not show any significant relation with wells depth, but with increasing of wells depth (up to 4 m) nitrate contents of water

increased, further studies are necessary to detect the relation between nitrate content and depth in wells with depth more than 4 m. (because of anaerobic condition). About groundwater quality in Iran there are many researches that noticed to chemical parameters or relation of chemical parameters with health [16, 17]. In many studies it was shown that groundwater quality influenced by infiltration from river or rainfall [18-20].

Therefore, as a conclusion, to determine the well depth and distance from surface water contamination it is important to notice the local condition for the prevention of water well from contamination for different uses and we can not state a general criterion in all situations and it is necessary to perform a separate test in different places.

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REFERENCES

1. Karbassi, A.R. and G.O. Ayaz, 2007. Flocculation of Cu, Zn, Pb, Ni and Mn during mixing of Talar River water with Caspian Seawater, Intl. J. Environ. Res., 1(1): 66-73.
2. Kinzelbach, W., 1989. Groundwater modeling: An Introduction with sample program in basic, Elsevier Pub, N.Y.
3. EPA, 1994. Groundwater: methodology, Vol II, Washington Dc. USA.
4. Landry, M.S. and M.L. Wolfe, 1999. Fecal bacteria Contamination of surface waters associated with land application of animal waste, ASAE paper No. 994024. St Joseph, MI: ASAE.
5. Gerba, C.P., C. Wallis and J.L. Mmelnick, 1975. Fate of wastewater bacteria and Viruses in soil, Journal of Irrigation and drainage engineering, 101: 157-174.
6. Filip, Z.D., Kaddu-mulindwa and G. Midle, 1988. Survival of some pathogenic and facultative pathogenic bacteria in groundwater, water science and technology, 20: 227-231.
7. Butler, Oroob, Meguhy, 1954. Underground Movement of Bacterial and Chemical Pollution of Well Svia groundwater and the factors involved, US Public Health Service Bull, No.147, Dep of HEN, Washington DC,
8. Jamieson, R.C. and R.J. Gorden, 2002. Movement and persistence of fecal bacteria in agricultural soil and subsurface drainage water, Canadian biosystems engineering, Vol 44.
9. Mubiru, D.N., M.S. Coyne and J.H. Grove, 2000. Mortality of Escherichia coli 0157:H_7 in two soils with different physical and chemical properties, Journal of Environmental Quality, 20: 620-627.
10. Rahe, T.M., C. hagedorn, E.L. Mccoy and G.F. Kling, 1978. Transport of antibiotic-resistant Escherichia coli through western Oregon hillslope soils under conditions of saturated flow. J. Environ. Quality, 7: 487-494.
11. Gabriel Bitton, 1999. Wastewater Microbiology, John Wiley sons Publication, 2nd Edition.
12. AWWA, 2005. Standard Method for the Examination of Water and Wastewater, AWWA publication.
13. Iranian National Committee of Irrigation and Drainage, 2001. Reuse of wastewater treatment in agricultur.
14. Harry Von huben, 1991. Surface water treatment: the new rules, AWWA.
15. Ghanehian, Mesdaghi nia, Ehrampoosh., 2001. Principle of wastewater reuse, Tebgostar publication, 1st edition.
16. Taghizadeh Mehrjardi, R., M. Zareian Jahromi, Sh. Mahmodi and A. Heidari, 2008. Spatial Distribution of groundwater quality with geostatistics (Case study: Yazd- Ardakan plain). World Appl. Sci. J., 4(1): 09-17.
17. Dbaradaran, S., A.H. Mahvi, S. Dehdashti and D. Ranjbar Vakilabadi, 2008. Flouride., 41(3): 220-226.
18. Mahvi, A.H., J. Nouri, A.A. Babaei and R. Nbizadeh, 2005. Agricultural activities impact on groundwater nitrate pollution. Intl. J. Environ. Sci. Technol., 2(1): 41-47.
19. Nouri, J., A.H. Mahvi, A.A. Babaei, G.R. Jahed and F. Ahmadpour, 2006. Investigation of heavy metals in groundwater. Pakistan J. Biological Sci.., 9(3): 377-384.
20. Ngounoun, N.B., J. Mudy and R.J. Sarrol, 2007. Groundwater recharge from rainfall in the Southern border of lake Chad in Cameroon.