RESEARCH ARTICLE

•Arch Hyg Sci 2016;5(3): 166-71.
•Journal Homepage: http://jhygiene.muq.ac.ir

Monitoring of Heavy Metal Concentration in Groundwater of Qorveh County, Kurdistan Province, Iran

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A-R-T-I-C-L-EI-N-F-O

Article Notes:
Received: Mar 1, 2016
Received in revised form: May 20, 2016
Accepted: June 26, 2016
Available Online: July 9, 2016

Keywords:
Heavy Metals, Kurdistan, Groundwater, Monitoring, Iran.

A-B-S-T-R-A-C-T

Background & Aims of the Study: Nowadays, the quality of water is a very important concern. High levels of heavy metals in drinking water may cause some health problems such as cancer. The aim of this study is determination of some heavy metal concentrations in groundwater of some parts of Qorveh county, Kurdistan, Iran.

Materials & Methods: In this study 25 water samples were analyzed, using Inductively Coupled Plasma for determining the concentrations of iron, chromium, copper and zinc. As a case study, the groundwater contamination in some parts of Qorveh county, Kurdistan, Iran, was investigated and compared to the maximum contaminant level specified by the World Health Organization (WHO) and Iranian Standard Institute (IS: 1053), using ANOVA test.

Results: Obtained results showed that in some cases the concentration of heavy metals were above WHO and IS: 1053.

Conclusions: Heavy metals contamination can enter the food chain and cause various health problems. Thus, according to the obtained results, it is necessary to launch water management programs in the study area.

Please cite this article as: Yousefi N, Jahangard A. Monitoring of Heavy Metal Concentration in Groundwater of Qorveh County, Kurdistan Province, Iran: Arch Hyg Sci 2016;5(3):166-71.

Background

Groundwater is a main source of drinking water for people, and even more than half of the world's population uses groundwater for daily necessities now. The good quality of groundwater is a very important factor, which makes it an ideal source of drinking water. In recent years, the studies about the groundwater quality are increased. The constituents of soil, rocks, and plants might contaminate the groundwater because it is directly in contact with these sources (1,2,3). Heavy metals are one of the most important environmental concerns (4,5). High concentration of heavy metals in groundwater are related to the industrial activities such as mining. Vertical displacement and leaching of heavy metals may occur in the soil profile and contaminate the groundwater (6,7). Many diseases resulted from polluted water are responsible for 80% of all illnesses/deaths in developing countries (8,9). So, it is necessary to assess the quality of ground water sources. The World Health Organization (WHO) (10) and Iranian Standard and Industrial Researches Institute (IS: 1053) (11) present a specified maximum contaminant level for heavy metal levels in water.

Aims of the study:

The aim of this study was to determination the concentration of some heavy metals in the ground water sources in some parts of Qorveh county. Therefore, using Inductively Coupled Plasma (ICP), the concentration of four heavy metals (iron, chromium, copper and zinc) were determined and the results compared to the maximum contaminant level specified by the World Health Organization(WHO) and Iranian Standard Institute(IS:1053), using ANOVA test.

Materials & Methods

Site characterization

The samples which were used in this study, collected from the Qorveh county. Qorveh is located in the eastern part of the Kurdistan province of Iran. It is restricted to the provinces of Hamedan, Bijar, Kermanshah and Sanandaj. Its center is the city of Qorveh which is located in a large plain 93 km east of Sanandaj and northwest of Hamadan and has expanded in the direction of the Sanandaj road towards Hamadan, Iran (Figure 1).

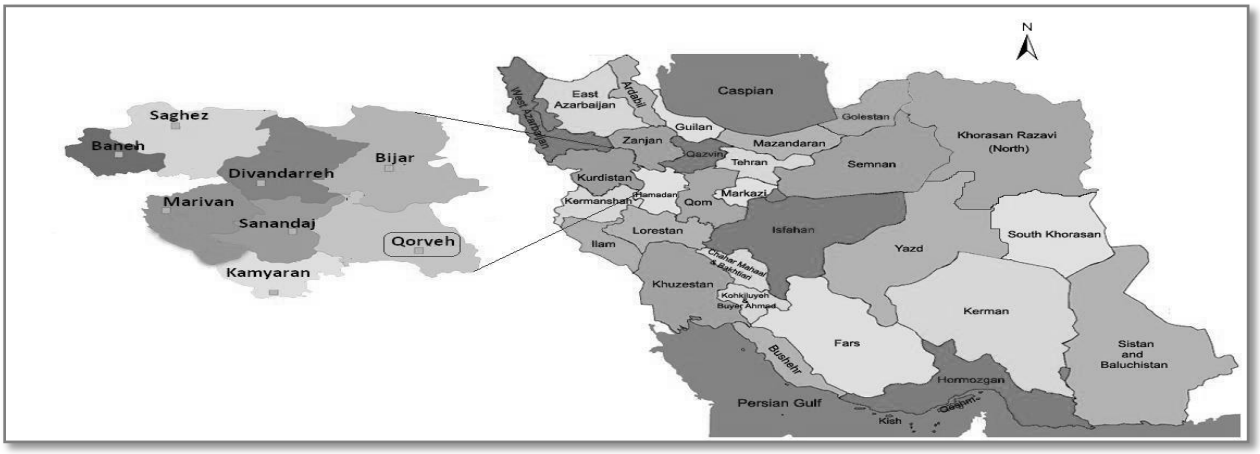

Figure 1) Location of the study area

Table 1) Geographical position of the 25 groundwater sampling stations

Y	X	Sample No.	Y	X	Sample No.
N 3889232	E 76 89 26	13	N 3878861	E 11 78 78	**1**
N 3889363	E 76 80 94	14	N 3880279	E 77 99 60	**2**
N 3889613	E 76 69 91	15	N 3879977	E 77 92 71	**3**
N 3891483	E 76 37 94	16	N 3879616	E 77 84 55	**4**
N 3892068	E 76 42 98	17	N 3881805	E 78 00 74	**5**
N 3892617	E 76 48 95	18	N 3882505	E 77 98 61	**6**
N 3892433	E 76 46 66	19	N 3882880	E 77 97 14	**7**
N 3891543	E 76 31 60	20	N 3883322	E 77 95 27	**8**
N 3892041	E 76 20 51	21	N 3884295	E 77 90 43	**9**
N 3892280	E 76 12 68	22	N 3885535	E 77 81 76	**10**
N 3892595	E 76 05 06	23	N 3885999	E 77 77 77	**11**
N 3893750	E 75 91 12	24	N 3886679	E 77 70 82	**12**
N 3894485	E 75 96 50	25			

Water sampling and analysis

To determine the concentration of heavy metals, 25 sampling locations were selected at the studied area. Geographical positions of the sampling stations are listed in table 1.

Data were collected from drinking water wells in villages and settlements from the Qorveh county, Kurdistan, Iran. New 100- ml high-density polyethylene (HDPE) bottles were used for sampling. Different brands of plastic bottles had previously been thoroughly checked for possible contamination (12). Before sampling, in the field, the bottles were rinsed three times with running water and then filled to the top.

The samples were acidified with 2 ml of concentrated nitric acid (Merck, Ultrapure). The acid was tested for its heavy metal content, using the same analytical procedure for water samples. Finally, the samples were stored in a cool box and transferred to the laboratory. Total levels of iron (Fe), chromium (Cr), copper (Cu) and zinc (Zn) were measured by Inductively Coupled Plasma (ICP-710 Varian, Australia). Three replicate samples were analyzed from each station.

Statistical analysis

The mean levels of heavy metals were compared with 4th edition of World Health Organization (WHO), in 2011 (11) and Iranian Standard and Industrial Researches Institute (IS:1053) (11), using a two-way Analysis Of Variance (ANOVA) test. Probabilities less than 0.05 were considered as significant, statistically ($p<0.05$). All statistical analyses were performed, using the SPSS 15.0 (SPSS Inc., Chicago, IL, USA).

Results

The concentration of measured heavy metals are shown in table 2.

According to table 2, the total levels of chromium in the collected samples have been ranged from 0.057 to 0.092 mg/l with the maximum concentration in station number 3. The maximum of an acceptable limit for chromium as per WHO guidelines is 0.05 mg/L. Chromium concentrations in all studied samples are exceeding than WHO standards. The guideline value is not given by IS: 1053 for the chromium content.

Iron levels in the collected water of different wells differed from 0.025 to 0.096 mg/l with the maximum content in station number 23. The maximum of an acceptable limit for iron as per IS: 1053 and WHO is 0.3 mg/L. The observed concentrations of iron at the studied site were within the permissible given by the IS: 1053 and WHO.

The minimum and maximum concentrations of copper at the studied site were 0.015 to 7.618 mg/l, respectively. The maximum concentration of copper has been observed at the station number 2. The maximum of an acceptable limit for copper as WHO guidelines are 2.0 mg/l. Copper levels in all collected samples, except stations 2, 6 and 9 are lower than WHO standards. The maximum of an acceptable limit for copper as per IS: 1053 is 1 mg/l. Copper levels in all collected samples, except stations 2, 6, 9 and 24 are lower than the IS: 1053.

The minimum and maximum levels of zinc were 0.024 to 1.572 mg/1, respectively. The maximum level of it had been reportedin the station 12. No guideline value is given by the World Health Organization for zinc content. The maximum of an acceptable limit for zinc as per IS: 1053 is 3.0 mg/l. Zinc concentration levels in all studied samples are lower than the IS: 1053.

The comparison levels of studied heavy metals in that area are shown in Figures 2-5.

Table 2) Heavy metal concentrations in sampled groundwater (mean±S.E.)

Zn	Fe	Cr	Cu	Sampling No.
0.043±0.153	0.050±0.002	0.079±0.001	0.278±0.001	**1**
0.024±0.176	0.053±0.001	0.084±0.001	7.618±0.011	**2**
0.025±0.005	0.053±0.005	0.092±0.005	0.496±0.007	**3**
0.099±0.001	0.041±0.256	0.057±0.001	0.15±0.005	**4**
0.103±0.002	0.051±0.001	0.080±0.219	0.132±0.153	**5**
0.094±0.145	0.043±0.209	0.079±0.001	3.618±0.144	**6**
0.035±0.006	0.048±0.145	0.077±0.176	0.093±0.234	**7**
0.267±0.238	0.046±0.001	0.082±0.123	0.443±0.143	**8**
0.062±0.003	0.050±0.005	0.079±0.145	2.238±0.176	**9**
0.267±0.005	0.047±0.216	0.082±0.132	0.451±0.003	**10**
0.052±0.003	0.055±0.001	0.080±0.002	0.015±0.129	**11**
1.572±0.002	0.042±0.003	0.072±0.003	0.634±0.001	**12**
0.462±0.006	0.051±0.153	0.080±0.009	0.258±0.009	**13**
0.571±0.234	0.042±0.002	0.074±0.005	0.246±0.341	**14**
0.057±0.153	0.057±0.006	0.082±0.216	0.474±0.005	**15**
0.871±0.001	0.038±0.006	0.078±0.235	0.750±0.154	**16**
0.061±0.231	0.051±0.002	0.077±0.001	0.320±0.006	**17**
0.065±0.176	0.050±0.145	0.079±0.003	0.186±0.421	**18**
0.048±0.005	0.046±0.005	0.081±0.005	0.240±0.243	**19**
0.047±0.145	0.045±0.176	0.079±0.176	0.019±0.005	**20**
٠.078±0.005	0.085±0.147	0.085±0.219	0.241±0.243	**21**
0.089±0.001	0.054±0.235	0.075±0.003	0.274±0.241	**22**
1.247±0.004	0.096±0.007	0.074±0.001	0.211±0.239	**23**
0.785±0.241	0.041±0.256	0.065±0.003	1.124±0.172	**24**
0.541±0.352	0.025±0.004	0.084±0.001	0.521±0.175	**25**

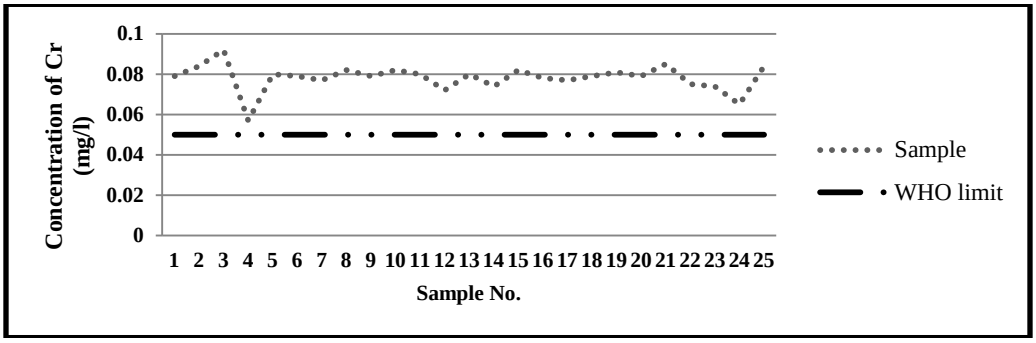

Figure 2) Concentrations of Cr in sampled groundwater and WHO

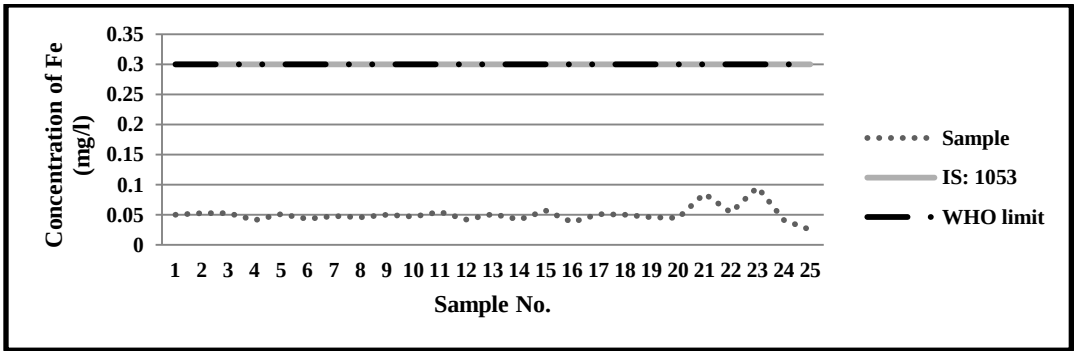

Figure 3) Concentrations of Fe in sampled groundwater, WHO and IS

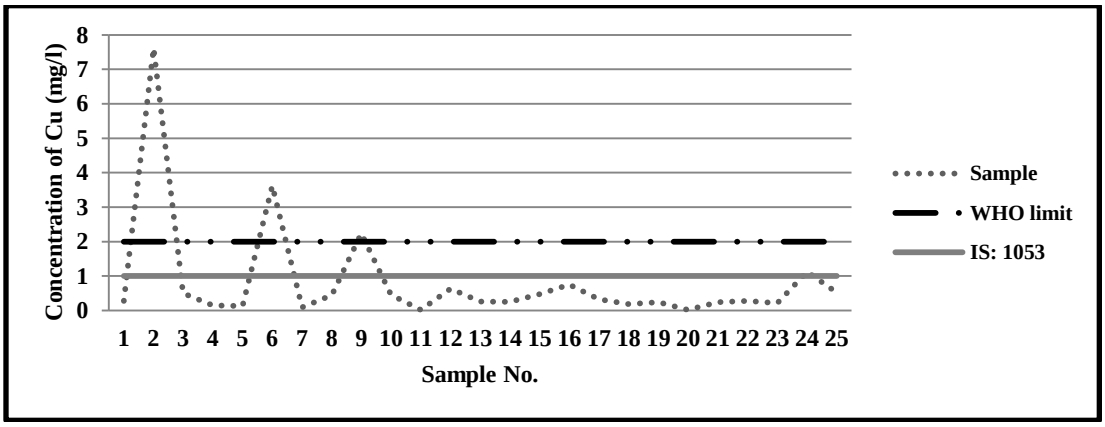

Figure 4) Concentrations of Cu in sampled groundwater, WHO and IS

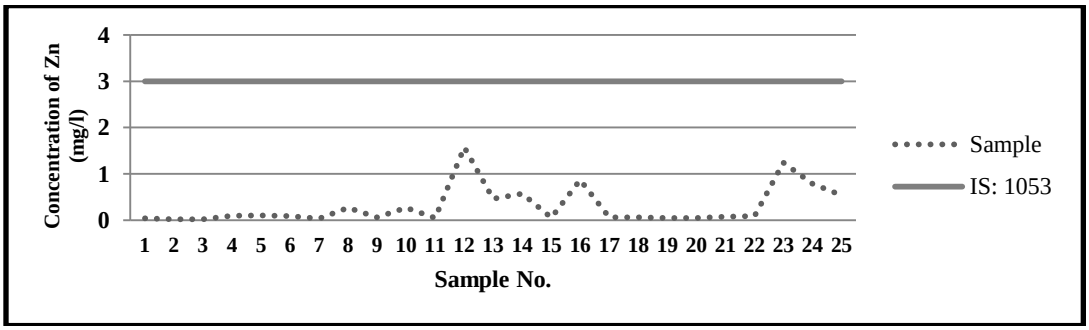

Figure 5) Concentrations of Zn in sampled groundwater and IS

Discussion

Nowadays, the ground water contamination is one of the most important environmental issues (13); also among different contaminants, heavy metals have particular concern because of their strong toxicity even at low levels (14).

The aim of the present study is determination of some heavy metal concentrations of the groundwater in Qorveh county, Kurdistan province, Iran. Therefore, 25 groundwater samples were collected and analyzed for Fe, Cu, Zn and Cr by ICP.ICP technique is the most useful one for the determination of heavy metal concentration up to parts per billion levels.

Obtained results showed that in some cases the concentrations of heavy metals were above WHO and IS: 1053 (Cr concentrations in all stations were above WHO, and Cu levels in stations 2, 6 and 9, and stations 2, 6, 9 and 24 were above WHO and IS: 1053, respectively). High concentration of heavy metals in water and soil environment are as result of corrosion products, using liquid manure, composted material and agrochemicals (9,15,16).

According to the obtained results, it is necessary to launch water management programs in the study area.

Conclusion

Among all findings, it can be concluded that the concentration of heavy metals which have been measured in some cases is very high than the WHO and IS: 1053. Heavy metals contamination can enter the food chain and cause various health problems. Thus, according to the obtained results, it is necessary to launch water management programs in the study area.

Footnotes

Acknowledgments:

This study is partially supported by the Islamic Azad University, Hamedan branch.

Conflict of Interest:

The authors declared no conflict of interest.

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