Mesopot. J. Mar. Sci., 2020, 35(1): 43 - 50

Determination of Trace Elements Lead, Nickel and Cadmium in Ground Water from Wells near Southern Refineries, Basrah-Iraq

B.M. Younus[1] and B.Y. Al-Khafaji[2]
[1]Marine Sciences Center, University of Basrah, [2]Collage of Sciences, University of Thi-Qar, Iraq
e-mail: buthmahdi2000@gimal.com

(Received: 29 January 2020 - Accepted: 16 June 2020)

Abstract - The current study was conducted to estimate the concentrations of three trace elements; nickel, lead and cadmium in the groundwater of eight wells, the six wells from w_1 to w_6 were close to the refineries at about half a kilometer to three kilometers and w_7 and w_8 wells were about 12.5 km away from the area (control wells) in the surrounding area of Southern Refineries (Al-Shuaiba), Al-Zubair district, Basrah Governorate, southern Iraq. Water samples were collected quarterly. The highest concentrations of lead was 0.933 µg/l in well W_1 in spring whereas the minimum concentration of the lead was 0.208 µg/l in well W_7 in summer while the rates of nickel concentrations ranged between the highest concentration of 0.445 µg/l in well W1 in winter and the lowest concentration 0.055 µg/l in well W_8 during the fall. Cadmium recorded the highest concentration of 0.496 µg/l in well W_3 in spring while the lowest concentration was 0.053 µg/l in well W8 in summer. It was concluded from the study that the oil refineries have a significant impact on pollution events. The hydrocarbon pollutants in the nearby wells water originated from these refineries.

Key words: Trace elements, Groundwater, Southern refineries.

Introduction

The study of ground water is an important aspect in the study of water resources, especially in areas that lack other water resources as well as due to the decline in the quality of groundwater in a wide range within the lands of Al-Zubair district-Basrah Governorate (Rahim, 2008).

The study of water has become one of the basic necessities that must be done, therefore, the study of water resources of all kinds attracts a lot of interest among researchers, especially in areas where the economy focuses on agricultural activity, which contributes to the optimal and effective investment of water resources, as water is one of the strategic resources identified for economic development (Al-Khafaji, 2016).

The lack of rain has made groundwater the main source of irrigation in areas with no surface water. As for the sources of groundwater feeding, it depends on what is leaked from the rain water (Al-Janabi, 2015).

The identification of ions of trace elements in the system is useful in controlling pollution with this type of pollutant, especially since it is not soluble and breakable and is transported through the food chain through multiple pathways and has the ability to accumulate in the tissues of different organisms (Gulfraz *et al.*, 2001) and elements.

The trauma is either of direct importance and correlation with the processes of growth, development, and reproduction in the organism that can become toxic in high concentrations, or have a limited biological value and have clear toxicity even in low concentrations such as lead, cadmium, nickel and others (MDE, 2003). Trace elements are an important class of pollutants that have lethal effects and sub-lethal effects in living organisms, which have recently taken increasing interest because of their harmful effects on the environment as they have harmful effects on the health of both human and living communities in the aquatic and terrestrial ecosystems as well as effects on the ecosystem itself (Boyd, 2010).

These harmful effects of trace elements result from being highly toxic and non-degradable and have a long vital half-life in addition to their ability to bioaccumulate in different parts of the body as well as accumulation across levels of the food chain, which is called biomaplification and its ability to cause cancerous tumors, as well as their ability to union with other elements that may make up new more toxic compounds (Dermentzis *et al.*, 2011).

The Study Area:

The study area is located within the geological teddy bear formation, which consists of sand and gravel, which is characterized by its high ability to store water and free horizontal movement, as 8 wells were elected and 6 of these wells were close to the source of pollution, represented by a lake of liquid and solid waste that is discarded and leaks from transport pipes and tanks consisting of a contaminated area surrounding the southern refineries with an area of 10 Km^2 and two control wells far from the source of pollution in an area almost empty of factories and industrial companies and not surrounded by any waste within Al-Zubair district (Fig. 1).

Materials and Methods

Water samples were collected quarterly from the studied wells, and the standard methods of collecting, transporting and storing the samples were approved for the analysis according to the American Public Health Association (APHA, 2005) standard methods. Samples for measuring trace elements were collected with 1 liter polyethylene bottles and all the bottles were kept in a refrigerated box to ensure the preservation of the nature of the samples until reaching the laboratory and performing laboratory analyzes. In the laboratory, 100 milliliters of the sample are taken after shaking the packaging well, then adding 5 milliliters of concentrated nitric acid and heating them. After that, 5 milliliters of concentrated nitric acid are added again to ensure the sample is completely digested and then left to cool and transfer to special packages made of polyethylene after dilute it to 50 ml with distilled water free of ions (APHA, 1995) and then measure the absorbance with the Flame Atomic Absorption Spectrophotomete (Phoenix 986 spectrum device), expressing the result in units of µg/l as three replications were measured for each sample.

Results and Discussion

Tables (1, 2 and 3) show the seasonal and localized rates of concentration of trace elements dissolved in lead, nickel and cadmium water, respectively as the highest lead value Pb µg/l was 0.933 in well W1 during the spring of 2016 and the lowest rate was 0.208 µg/l in well W7 in Summer 2016.

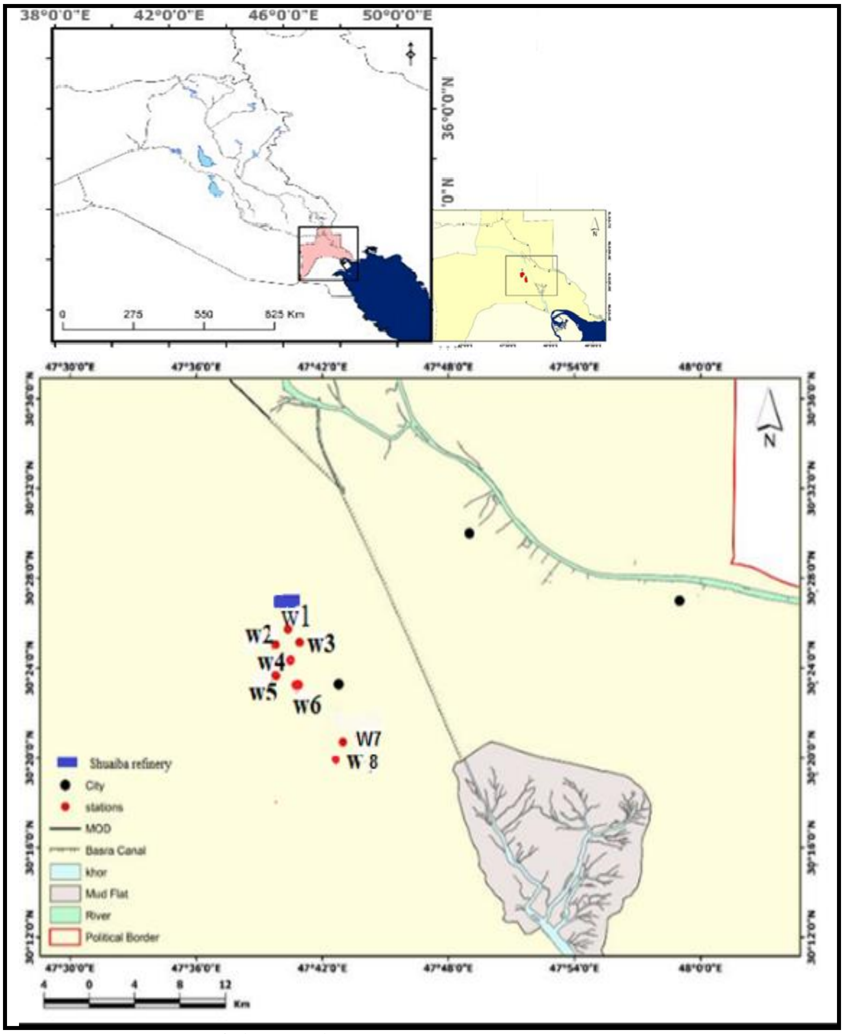

Figure 1. Location map of the study area.

The results of the statistical analysis showed that there are significant differences at the probability level $P < 0.05$ between all wells close to the source of pollution with the control wells W7 and W8 that are far from the source of pollution except for well W6 which did not show any significant difference between it and the control wells. Meanwhile, no significant difference between control wells W7 and W8, and the results of statistical analysis at the same level of significance showed the presence of significant differences between all seasons.

The highest rate of nickel element was 0.445 µg/l in well W1 in winter 2016 and the lowest value was 0.055 µg/l in well W8 fall 2015 and the results of statistical analysis showed that there were significant differences at the probability level $P < 0.05$ between seasons except winter and spring as there was no significant difference between them and the fall and summer seasons, while there were significant differences between all the study wells close to the source of pollution and the control wells W7 and W8 which are far from the source of pollution except for well W6 where there was no significant difference between it and well W7 at the same probability level.

Cadmium, highest rate was 0.496 µg/l in well W3 in spring 2016 and the lowest value was in well W8 where it reached 0.053 µg/l in summer 2016. It appears from the results of the statistical analysis that there were significant differences between the seasons except winter, as there was no significant difference between it and the spring and autumn seasons at the probability level ($P < 0.05$).

Also, there were significant differences between all the wells near the source of pollution and the remote control wells away from them except for the W5 well. There was no significant difference between it and well W7, as well as well W6, there was no significant difference between it and wells W7 and W8 at the probability level ($P < 0.05$).

Table 1. Lead Element (pb) concentration rates (µg/l) at the studied wells during the (2015-2016) seasons, at Al-Zubair district.

Well NO.	Seasons								
	Autumn	S.D	Winter	S.D	Spring	S.D	Summer	S.D	Mean
W1	0.812	0.10	0.835	0.11	0.933	0.98	0.617	0.10	0.799
W2	0.703	0.12	0.823	0.10	0.901	0.10	0.598	0.13	0.756
W3	0.534	0.99	0.659	0.99	0.705	0.11	0.366	0.21	0.566
W4	0.611	0.10	0.601	0.97	0.766	0.88	0.433	0.50	0.602
W5	0.367	0.89	0.474	0.10	0.529	0.10	0.306	0.11	0.419
W6	0.357	0.21	0.305	0.22	0.410	0.21	0.321	0.32	0.348
W7	0.219	0.11	0.395	0.13	0.390	0.32	0.208	0.14	0.285
W8	0.209	0.12	0.313	0.10	0.333	0.10	0.293	0.20	0.287
Mean	0.476	0.33	0.550	0.34	0.620	0.35	0.392	0.21	0.507

Table 2. Nickel element (Ni) concentration rates (µg/l) at the studied wells during the (2015-2016) seasons, at Al-Zubair district.

Well NO.	Seasons								
	Autumn	S.D	Winter	S.D	Spring	S.D	Summer	S.D	Mean
W1	0.276	0.15	0.445	0.33	0.414	0.16	0.206	0.10	0.337
W2	0.201	0.11	0.402	0.11	0.395	0.11	0.186	0.32	0.296
W3	0.197	0.21	0.404	0.10	0.311	0.30	0.180	0.15	0.273
W4	0.220	0.10	0.168	0.24	0.330	0.10	0.168	0.17	0.256
W5	0.193	0.12	0.295	0.19	0.317	0.28	0.149	0.81	0.238
W6	0.159	0.13	0.207	0.10	0.295	0.12	0.152	0.93	0.203
W7	0.127	0.62	0.109	0.25	0.191	0.10	0.122	0.12	0.137
W8	0.055	0.44	0.139	0.12	0.131	0.42	0.065	0.10	0.097
Mean	0.178	0.09	0.271	0.14	0.298	0.12	0.153	0.09	0.225

Table 3. Cadmium element (Cd) concentration rates (µg/l) at the studied wells during the (2015-2016) seasons, at Al-Zubair district.

Well NO.	Seasons								
	Autumn	S.D	Winter	S.D	Spring	S.D	Summer	S.D	Mean
W1	0.295	0.10	0.388	0.51	0.484	0.12	0.212	0.36	0.344
W2	0.235	0.13	0.367	0.10	0.416	0.10	0.206	0.11	0.306
W3	0.250	0.11	0.276	0.17	0.496	0.15	0.193	0.15	0.303
W4	0.222	0.32	0.289	0.14	0.298	0.23	0.108	0.10	0.229
W5	0.223	0.58	0.186	0.78	0.196	0.10	0.148	0.10	0.188
W6	0.153	0.22	0.160	0.99	0.190	0.11	0.126	0.24	0.157
W7	0.126	0.47	0.103	0.14	0.117	0.43	0.128	0.13	0.118
W8	0.121	0.12	0.131	0.50	0.109	0.10	0.053	0.52	0.103
Mean	0.203	0.203	0.238	0.128	0.288	0.173	0.147	0.09	0.219

The increase in industrial and agricultural activities was a cause for the noticeable increase in the quantity of materials offered to the environment, including trace elements and levels of pollutants and their ranges that can reach rivers and other water bodies, causing undesirable changes in the water environment (Gbaruko and Friday, 2007). Modern societies use different chemical compounds that are dangerous for humans, animals and plants in industry and agriculture, and some of these compounds are of high toxicity, including trace elements (Abed, 2004).

In the current study, the highest rate of lead Pb in well W1 during the spring of 2016 and the lowest rate in well W7 in summer 2016, may explain the contribution of waste oil refineries in the Shuaiba Refinery to groundwater pollution because the six wells w6-w5-w4-w3-w2-w1 are close to the pollution area in the southern refineries while the two control wells are far from this area (Al-Hassen, 1998).

Al-Saadi (2004) attributed the decrease in lead concentrations due to the decrease in industrial pollutants, and this may explain the increase in lead concentrations near the southern refineries because it is an area surrounded by industrial waste.

The results of the statistical analysis showed that there were significant differences between the seasons, as the lead concentration increased in the spring and decreased in the summer due to the rains that are the main source for the groundwater in the region and the transfer of pollutants to the groundwater (Al-Kubaisi, 1996) and what the atmosphere adds to the lead compounds that fall and collect in the environment Hydro (Qazar, 2009).

The high values of Pb may attribute to the anthropogenic activities such as using the hydrocarbon fuel and soil fertilizer which contained Pb as a result of the agriculture activities in the studied area (Al-Tememi, 2015) and due to the lack of rain in summer and high temperatures led to lower concentrations.

As for the nickel element and its high concentrations in nearby wells especially in well W1, it may be due to the geological nature of the Earth (Kattab and Taqah, 2005) or may be the result of industrial pollutants in the region (Alkam and Kazem, 2011) represented by the southern refineries and their effluents of liquid and solid wastes.

The reason for the high concentrations of nickel may be the pollution of the region with oil, which can be used as evidence of oil pollution (Al-Saad, 1983) and because rain is a source of nourishing groundwater and the transport of pollutants from the soil and the surface due to the high permeability of the soil of Al-Zubair (Al-Ubaidi and Salman, 2011) may be due to high concentrations in winter and low in autumn, while cadmium reached its highest rate in the spring of 2016 in well W1 and its lowest value in well W8 in summer 2016, may be due to concentrations of cadmium increased in spring and decreased in summer.

To wash the resulting lands due to rain and the eventual arrival of that water to the aquatic environment when it moves, it dissolves a portion of the material and transports it with it through the geological layers and the groundwater does not remain stable in its place and this may give an explanation of the high cadmium concentrations in Wells near the source of pollution and their decrease in control wells.

Conclusion

The groundwater in the wells of the study area is not suitable for human consumption and irrigation as compared with the standards of the World Health Organization (WHO), because it is contaminated with hazardous trace elements such as lead, nickel and cadmium and that the wells closest to the source of pollution (refineries) are more concentrated with trace elements because they are affected by the pollutants presented from those refineries.

References

Abed, A. 2004. Fundamental of Ecology. First edition. Wael Publishing and Printing House, Amman Jordan, 445p. (In Arabic).

Al-Hassen, S.I. 1998. Industrial pollution of the water environment in Basra Govrnorate. MSc. Thesis, College of Arts, University of Basrah, 198p. (In Arabic).

Al-Janabi, M.F.A. 2015. The effect of water resources on productivity of some agricultural lands in the district of Al-Salman, Al-Muthanna Province, Iraq. MSc. Thesis, College of Education, University of Basrah, 131p. (In Arabic).

Al-Khafaji, B.Y. 2016. Principles of Ecology-Ministry of Higher Education and Scientific Research, University of Thi-Qar, South office for printing, publishing and distribution, 200p. (In Arabic).

Alkam, F.M. and Kazem, A.A. 2011. Concentration of some trace elements in the groundwater of four wells in Al-Khider City, Al-Muthanna Governorate Iraq. Journal Al-Qadisiyah of Pure Sciences, 16(3): 51-61. (In Arabic).

Al-Kubaisi, Q.Y.S. 1996. Hydrogeology of Dabdabah Basin, in Safwan-Zubair area southern Iraq. M.Sc. Thesis, College of Science, University of Baghdad, 173 p. (In Arabic).

Al-Qarooni, I.H. 2011. Determination of concentrations of some heavy metals in water and sediments and their biological accumulation in some invertebrates of the Shatt Al-Arab River and the Shatt Al-Basrah Canal in southern Iraq. Ph.D. Thesis, College of Education. University of Basrah, Iraq, 243 p. (In Arabic).

Al-Saad, H.T. 1983. A baseline study on petroleum hydrocarbons pollution in Shatt Al-Arab river. M.Sc. Thesis, College of Science, University of Basrah, 170p.

Al-Saadi, M.A.S. 2004. Study of physical and chemical properties and the possibility of contamination of groundwater in Al-Rahhaliya area, Al-Anbar Governorate. MSc. Thesis, College of Science, University of Baghdad, 127 p. (In Arabic)

Al-Tememi, M.K. 2015. Groundwater quality and origin within Dibdibba aquifer near Jabel Sanam area southern of Basrah Governorate, Iraq. Mesopotamian Journal of Marine Science, 30(1): 47-56.

Al-Ubaidi, H.K. and Salman, M.S. 2011. A study of the quality and amount of groundwater in Al-Anbar Governorate and its suitability for human and agricultural uses. Al-Nahrain Journal of Science, 14: 8-16. (In Arabic).

APHA (American Public Health Association) 1995. Standard methods for examination of waste water, Washington, DC 20036, 1193 p.

APHA (American Public Health Association) 2005. Standard methods for examination of water and waste water, 21st Edition. Washington, DC. USA.

Boyd, R.S. 2010. Heavy metal pollutants and chemical ecology: Exploring new frontiers. J. Chem. Ecol., 36: 46-58.

Dermentzis, K., Christofordis, A. and Valsamidou, E. 2011. Removal of Nickel, Copper, Zinc and Chromium from synthetic and industrial waste water by electrocoagulation. Int. J. Environ. Sci., 1(5): 697-710.

Gbaruko, B and Fridary, U. 2007. Bioaccumulation of heavy metals in some fauna and flora. J. Environ. Sci. Tech., 4(2): 197-202.

Gulfraz, M., Ahmad, T. and Afzal, H. 2001. Concentrate and trace metals in the fish and relevant water from Rawal and Mangla lakes. Online Journal of Biological Science, 1(5): 414-416.

Kattab, M.F.A. and Taqah, A.H.M. 2005. Study quality of Groundwater. 1st ed., University of Cairo, Egypt.

MDE (Maryland Department of Environment) 2003. Water quality analysis of heavy metals for the Loch Raven Reservoir impoundment in Baltimore County, Maryland. U.S. Environmental Protection Agency.

Qazar, I.A. 2009. Determination of some trace minerals in the environment and three types of lining of the foot blanket in the East Hamar marsh. MSc. Thesis, College of Science, University of Basrah, 118 p. (In Arabic).

Rahim, N.A. 2008. Geographical study of the quality of groundwater in the district of Zubair and some of the effects of agricultural. Journal of ADAB Al-Basrah, 47: 190-205 (In Arabic).

تقدير العناصر النزرة الرصاص والنيكل والكادميوم في المياه الجوفية للآبار القريبة من مصافي الجنوب، البصرة-العراق

بثينة مهدي يونس[1] و باسم يوسف الخفاجي[2]

[1] مركز علوم البحار، جامعة البصرة، [2] كلية العلوم، جامعة ذي قار، العراق

المستخلص - أجريت الدراسة الحالية لتقدير تراكيز ثلاثة عناصر نزرة هي النيكل والرصاص والكادميوم في المياه الجوفية لثمانية آبار (الآبار الستة من w1 الى w6) قريبة من منطقة المصافي حوالي نصف كيلو متر الى ثلاثة كيلومتر و (البئرين w7 وw8) بعيدان عن المنطقة حوالي 12.5 كم (آبار سيطرة) في المنطقة المحيطة بمصافي

الجنوب (الشعيبة) قضاء الزبير في محافظة البصرة جنوب العراق. جمعت عينات الماء فصليا وكانت نتائج تركيز عنصر الرصاص 0.933 مايكغم/لتر في البئر W1 خلال الربيع وأدنى تركيز لعنصر الرصاص 0.208 مايكغم/لتر في البئرW7 خلال الصيف بينما تراوحت تراكيز النيكل بين أعلى تركيز 0.445 مايكغم/لتر في البئر W1 خلال الشتاء واقل تركيز 0.055 مايكغم/لتر في البئر W8 خلال الخريف. سجل الكادميوم أعلى تركيز له 0.496 مايكغم/لتر في البئر W3 خلال الربيع في حين سجل ادنى تركيز 0.053 مايكغم/لتر في بئر W8 خلال الصيف. استنتج من الدراسة الحالية ان مصافي النفط لها أثر كبير في احداث تلوث آبار المياه القريبة ببعض الملوثات الهيدروكربونية.