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Heavy Metals Pollution Assessment of the Water in Al-Quds Power Plant in Baghdad

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Abstract

Sixteen water samples were collected from the operation units of the Al-Quds power plant, north Baghdad city and the surrounding trocars, surface and groundwater, and analyzed to assess the resulting pollution. The samples were analyzed for heavy metals (As, Cd, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, U and Zn) by using inductively coupled plasma- mass spectrometry (ICP-MS). The results were compared with local and international and standard limits. Heavy metals analysis of the water samples shows that water of operation units and trocars have mean concentrations of As, Cd, Cr, Cu, Mo, Pb, Sb, Se, U and Zn were within or lower than the national and world limits, while Mn and Ni were higher than these limits. Concentrations of these elements in the surface water were within the safe limits. In the groundwater samples As, Cd, Cr, Cu, Mo, Sb, Se, U and Zn were within the permissible limits while Ni, Mn and Pb were higher than the permissible limits indicating the effect of anthropogenic activities. The collected samples submitted to health risk assessment to evaluate the actual adverse effects of contaminants to humans, the results of HQs ingestion of all elements (except As for child) are smaller than 1, suggesting little hazard. In addition, HQs dermal in all studied elements for adult are below1, indicates no hazards for dermal absorption. Overall, HI of As and Mn for child exceeded 1. Comparison between values of HQ ing for adults and children shows that children are more susceptible to adverse to health effects than adults. These results necessitate a search of the means of treatment and reduce pollution with heavy metals in the industrial areas.

Keywords: Heavy metals, local and international standard limits, health risk .(assessment, Al-Quds power plant, hazard Quotient (HQ), Hazard Index (HI

تقييم تلوث الفلزات الثقيلة للمياه في محطة كهرباء القدس في بغداد

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الخلاصة

تم جمع 16 عينة ماء من وحدات التشغيل في محطة القدس الكهربائية شمال مدينة بغداد والمبازل والمياه السطحية والجوفية المجاورة، وتم تحليلها لتقييم التلوث الناتج. تم تحليل العينات للعناصر الثقيلة (الزرنيخ والكادميوم والكروم والنحاس والمنغنيز والموليبدنوم والنيكل والرصاص والأثمد والسيلينيوم واليورانيوم والخارصين) بإستخدام تقنية الطيف الكتلي. تم مقارنة النتائج مع محددات محلية وعالمية. تحليل الفلزات الثقيلة لعينات الماء لوحدات التشغيل والمبازل تبين بأن معدل تركيز كل من العناصر(الزرنيخ والكادميوم والكروم والنحاس والموليبدنوم والرصاص والأثمد والسيلينيوم واليورانيوم والخارصين) ضمن أو أقل من المحددات

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المحلية والعالمية بينما (المنغنيز والنيكل) أعلى من هذه المحددات. تراكيز هذه العناصر في المياه السطحية كانت ضمن الحدود المقبولة، أما في عينات المياه الجوفية كانت العناصر (الزرنيخ والكادميوم والكروم والنحاس والموليبدنوم والأثمد والسيلينيوم واليورانيوم والخارصين) ضمن الحدود المسموحة بإستثناء (المنغنيز والنيكل والرصاص) كانت أعلى من الحدود المسموحة مشيرةً الى تأثير الفعاليات الصناعية البشرية. العينات المجموعة خضعت الى تقييم الخطر الصحي لتقدير الآثار السلبية الفعلية للملوثات على البشر. بينت النتائج مقدار خطر الهضم لكل العناصر (ماعدا الزرنيخ للطفل) أقل من 1 مشيرتاً الى خطر قليل. وبالإضافة إلى ذلك، مقدار خطر الجلد في جميع العناصر المدروسة للبالغين هي أقل من 1 مشيرا إلى عدم وجود مخاطر لامتصاص الجلد. وبصورة عامة، مؤشر الخطر لعنصري (الزرنيخ والمنغنيز) للأطفال تجاوزت 1. وتبين المقارنة بين قيم مقدار خطر التنفس للأطفال والبالغين أن الأطفال أكثر تأثرا بالآثار الصحية الضارة من البالغين. وتستلزم هذه النتائج البحث عن وسائل العلاج والحد من التلوث بالمعادن الثقيلة في المناطق الصناعية.

Introduction

Water pollution is defined as the change in the physical, chemical and biological properties of water, restricting or preventing its usage for various applications[1]. Polluted water consists of Industrial discharged effluents, sewage water and rain water pollution and polluted by agriculture or households cause harm to human health or the environment [2] Heavy metals, such as copper, lead, mercury and selenium, get into water from many sources, including industries, automobile exhaust, mines and even natural soil can pollute the water resources [3].

The aim of this study is to assess environmental pollution by heavy metals in the water of the Al-Quds power plant.

Study Area

The study area represented by Al-Quds power plant, which is locate in the northern border of Baghdad capital city. The area of study is lying within the Mesopotamian basin of the unstable shelf [4] The area lies between (33° 30´ 0" – 33° 27´ 45" N and 44° 18´ 0"- 44° 26´ 18"E), Figure-1. The study area is characterized by flat topography and is covered by the quaternary deposits of the flooding periods of Tigris and Euphrates Rivers. No any rock units are exposed in the area, where the sedimentary rocks are covered by very thick layers of recent sediments reaches up to 600 m thick]5[.Agriculture Farms and villages are distributed in the surrounding areas of the Al-Quds Electrical power plant with moderate populations.

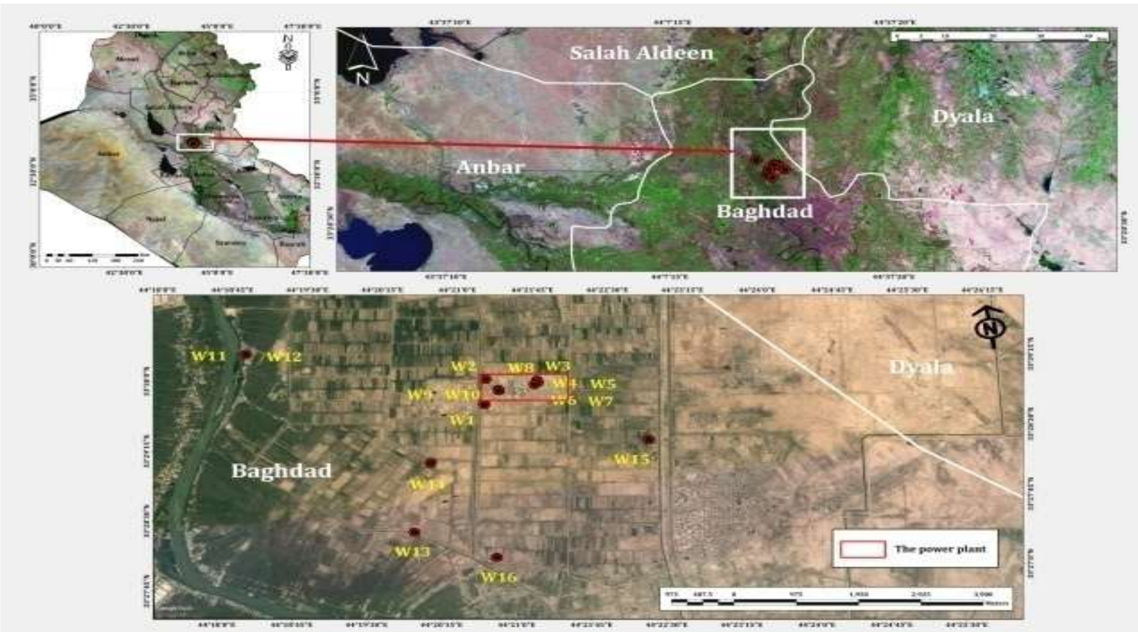

Figure 1- Location map and sampling site of the study area

Materials and Methods

Sixteen water samples were taken from the field from the upper 30 cm depth, these samples were collected from the operation units of the station, trocars, river water and groundwater as show table-1. The samples acidified by two drops of 10% Nitric acid for trace elements tests. The heavy metal contents of water determined by using ICP-MS techniques in ALS Group Labs. in Spain and the results were compared with the local IQS (2009) [6] and worldwide WHO (2011) [7] USEPA (2011) [8] limits as shown Table -2.

Table 1-Sites of the water samples from Al-Quds power plant.

Symbols	Location
W1	The trocar
W2	The trocar
W3	After Treatment
W4	Before Treatment
W5	Treatment
W6	Treatment
W7	Demi water
W8	Surface water (before treatment)
W9	Pool orc
W10	Pool
W11	River water
W12	River water
W13	Groundwater
W14	Groundwater
W15	Groundwater
W16	Groundwater

Table 2- Concentrations of trace elements in the water samples and comparing with (IQS, 2009), (WHO, 2011) and (EPA, 2011) limits

Station No.	As	Cd	Cr	Cu	Mn	Mo	Ni	Pb	Sb	Se	U	Zn
W1	5.71	0.03	2.4	5	189.5	1.32	23	5.66	1.1	0.23	0.91	39.8
W2	9.51	0.01	0.9	1.9	910	0.87	6.1	0.31	1.34	1.21	3.52	12.7
W3	0.61	0.02	0.6	8.9	9.33	0.43	2.2	3.69	3.44	<0.05	0.03	190.5
W4	0.06	0.02	0.3	5.8	7.33	0.22	2.2	1.08	0.91	0.13	0.06	15.6
W5	0.19	0.01	<0.5	1.3	1.46	0.26	0.4	0.57	0.64	0.09	0.01	6.6
W6	<0.05	0.05	<0.5	4.1	5.9	0.05	34.1	1	1.39	0.12	0.02	344
W7	<0.05	0.02	<0.5	1.9	1.72	<0.05	0.5	0.62	0.96	<0.05	0.01	14.4
W8	0.08	<0.005	0.5	3.9	2.94	2.27	1.1	0.43	0.77	0.38	0.76	262
W9	1.46	0.03	9	4	306	5.01	146.5	1	0.91	0.15	0.51	49.6
W10	0.61	0.02	3.1	3.6	689	0.74	46.8	1.66	0.79	0.06	0.15	46.8

W11	<10	0.1	3	2.5	5.8	2	6.4	1.3	0.9	<10	1.06	15
W12	<10	0.1	1	3.4	3.2	3	6.5	1	1	<10	1.07	33
W13	<10	0.6	2	11.8	26.3	28	59.1	29.1	0.9	20	16.05	533
W14	<10	0.3	1	3.3	2.5	5	11.9	5.5	0.7	<10	5.22	187
W15	<10	0.9	1	14.1	22.8	3	73.2	26.2	0.7	<10	3.04	670
W16	<10	1.3	1	11	432	29	58.4	12.6	1	<10	16.55	418
IQS (2009)	10	3	50	1000	100		20	10				3000
WHO (2011)	10	3	50	2000	400	70	70	10	20	40	30	3000
EPA (2011)		5	100	1300				15	6	50	30	5000

Health risk assessment

Risk assessment is a method to evaluate the actual or potential adverse effects of contaminants to animals and plants, which concentrate on the damage that has been or will be done by contaminants[9]. Risk assessment is obtained from USEPA, Risk Assessment Guidance for Superfund (RAGS). The equation below adopted from USEPA (2010) [10] was used to determine the dose received through the individual pathways.

$$ADD\ ing = \frac{Cw*IR*EF*ED}{BW*AT} \quad \ldots\ldots 1$$

$$ADD\ drm = \frac{Cw*SA* \quad Kp*ET*EF*ED*CF}{BW*AT} \quad \ldots. 2$$

ADD is an average daily dose by ingestion (ADDing) .
ADDdrm is dermal absorption, unit in µg/kg/day.
BW is average body weight (70 kg for adults and 15 for children).
EF is exposure frequency (days/year, 350).
ED is exposure duration (years, 70 for adults and 6 for children).
IR is ingestion rate (l/day, 2.2 for adults and 1.8 for children).
Cw is concentration of the estimated metal in water (µg/l).
SA is exposed skin area (cm2, 18000 for adults and 6600 for children).
Kp is dermal permeability coefficient in water (cm/h).
ET is exposure time (h/day, 0.85 for adults and 1 for children).
AT is averaging time (days, for non-carcinogenic ED * 365).
CF is unit conversion factor (l/cm3, 0.001).

Risk characterization was quantified by non-carcinogenic risks.Potential non-carcinogenic risks, reflected by the Hazard Quotient (HQ) by using equation (3). HQ exceeds 1.0 indicates unacceptable risk of adverse non-carcinogenic effects on health, and HQ < 1.0, indicates an acceptable level of risk [11]. To estimate the total potential non carcinogenic risks posed by more than one pathway, the hazard index (HI) was introduced, which is the sum of the HQs from all applicable pathways. HI >1 indicates a potential for an adverse effect on human health or the necessity for further study[12].

$$HQ = \frac{ADD}{RfD} \quad \ldots\ldots 3$$

HQ is hazard quotient via ingestion or dermal contact (unit less), and RfD is reference dose via ingestion or dermal in (µg/kg/day) [13]. For this study, HQ and HI were applied to trocars, surface and groundwater for the possibility of using them to irrigate the agricultural areas surrounding the power plant.

Results and Discussion

In the water samples of operation units and nearby trocars, concentrations of trace elements As, Cd, Cr, Cu, Mo, Pb, Se, Sb, U and Zn in these samples are within or lower than the standards of IQS(2009) [6], WHO(2011) [7] and USEPA(2011) [8] except Mn and Ni that are higher than the limits in stations W1, W2, W9 and W10.These trace elements are concentrated in the hydrocarbons of crude oil, which is used in combustion for power plant operation.

In surface water (river water), concentrations of trace elements As, Cd, Cr, Cu, Pb, Se, Mn, Mo, Ni, Sb, Sn, U and Zn in the surface water are lower than the standards of IQS(2009) [6], WHO(2011) [7] and USEPA(2011) [8].

In groundwater, which represent the wells in the agricultural areas surrounding the power plant. As, Cd, Cr, Cu, Se, Mo, Sb, U and Zn concentrations are within the permissible limits of drinking water according to IQS(2009) [6], WHO(2011) [7] and USEPA(2011) [8]. Whereas the concentrations of Ni and Pb are higher the allowable limits at W13, W15 and W16 respectively, while the concentration of Mn is higher than the permissible limits at W16 indicating anthropogenic activities in the study area and the combustion of crude oil in the power plant.

In the groundwater, **HQs** ingestion of all elements for adult are smaller than 1, suggesting that these elements posed little hazard. In addition, **HQs** dermal all studied elements for adult are allbelow1, which indicates no hazards via dermal absorption.

For child HQs ingestion of As element is higher than 1 indicating serious health concerns. For HQ dermal of the studied elements for child was below unity. Overall, HI of As and Mn for child is exceeded1.

Conclusion

The mean concentrations of trace elements in the water samples are within the national limits except Ni, Mn and Pb, which are higher than world limits indicating the effect of anthropogenic activities. The health risk model for trocars, surface and ground water shows that As and Mn have adverse health effects.

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