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Environmental sustainability assessment of the risks of some heavy elements associated with the dust storms that struck Baghdad in 2022

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Abstract

The results were obtained through a study of three samples of three dust storms that struck the Baghdad Governorate in 2022. The following results were obtained by analyzing the grain sizes, showing that silt and clay are the main parts where the silt portion is occupied. The silt fraction occupies first place with a percentage ranging between 31.8%-51.9% with an average value of 43.22%. The clay fraction comes in second place with a percentage ranging between 31.8%-59.5% with an average value of 48.98%. In contrast, the sand percentage comes Finally, with a relative distribution ranging between 5.6%-11.6 and an average percentage of 7.78%. It was found that the organic matter in the samples of the study area was 1.78 and in the range 1.33 - 2.28 and was classified as medium-humic organic matter. The acidity values of the study area samples ranged between 7 - 8 and at a rate of 7.3, they range from neutral to slightly basic. The percentage of loss on ignition for samples in the study area ranged between 11.6 - 18.66% and 14.44%. The reason for the presence of materials lost in combustion is the presence of various materials, including organic materials, calcium oxides, and sulfates. The presence of silica transported in dust storms in a very small percentage, and the health risks of metals (Cr, As, Ni, and Cd) were evaluated according to USEPA method. Hazard quotient (HQ) and Hazard index (HI) results take the descending order Cr>As>Ni>Cd for children and adults, While the values of carcinogenic hazards (CR) and total cancer risks (TCR) take descending order Cr > Ni >Cd >As.

Key words: Environmental, Sustainability, Risks, Dust storms; Heavy Elements, Struck.

تقييم الاستدامة البيئية لمخاطر بعض العناصر الثقيلة المرتبطة بالعواصف الترابية التي ضربت بغداد عام 2022

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الخلاصة

تم الحصول على النتائج من خلال دراسة ثلاث عينات من ثلاث عواصف ترابية ضربت محافظة بغداد في العام 2022. وتم الحصول على النتائج التالية من حيث تحليل أحجام الحبوب فقد تبين أن الطمي والطين هما الأجزاء الرئيسية حيث الطمي الجزء مشغول، ويحتل كسر الطمي المركز الأول بنسبة تتراوح بين 31.8%-51.9% بمتوسط قيمة 43.22%، ويأتي كسر الطين في المركز الثاني بنسبة تتراوح بين 31.8%-59.5% % بمتوسط قيمة 48.98%، فيما تأتي أخيراً نسبة الرمل بتوزيع نسبي يتراوح بين 5.6%-11.6% وبنسبة متوسطة 7.78%. وتبين أن المادة العضوية في عينات منطقة الدراسة بلغت 1.78 وفي المدى 1.33 - 2.28 وتم تصنيفها على أنها مواد عضوية متوسطة الدبالية. تراوحت قيم الحموضة لعينات منطقة الدراسة بين7 – 8 وبمعدل 7.3 وهي تتراوح بين المحايدة إلى القاعدية قليلاً. وتراوحت نسبة الفقد في الاشتعال للعينات في منطقة الدراسة بين 11.6 – 18.66% ويمعدل14.44%. ان سبب وجود المواد المفقودة في الاحتراق هو وجود مواد مختلفة منها المواد العضوية وأكاسيد الكالسيوم والكبريتات ووجود السيليكا المنقولة في العواصف الترابية بنسبة قليلة جدا المخاطر الصحية للمعادن (Cr, كما تم تقييم Ni و Cd) وفقًا لطريقة USEPA. تأخذ نتيجة حاصل الخطر (HQ) ومؤشر الخطر (HI) الترتيب التنازلي الكادميوم- النيكل- الزرنيخ- الكروم للأطفال والبالغين، بينما تأخذ قيم المخاطر المسرطنة (CR) ومخاطر السرطان الكلية (TCR) الترتيب التنازلي الكروم–النيكل–الكادميوم–الزرنيخ.

1. Introduction

In recent decades, Iraq and the Middle East region have been exposed to regional dust storms, causing health problems for humans with various diseases, including asthma, bronchitis, lung diseases, and eye allergies. The reason is due to the presence of bacteria, fungi, viruses, and others that are transported with storms, and it has been found from various studies that the transported microorganisms survive and move with storms to different distant places [1]

It is known that some heavy metals pollute the environment and become toxic if their concentrations exceed the permissible limit, as they have dangerous health effects that include humans and other living organisms, as they are concentrated and accumulate inside human bodies and bioaccumulate to remain in the atmosphere for a long period [2]. Dust storms carry radioactive elements with them, which have many health effects., there was a study by [3] in which the average absorbed dose of uranium concentration and the average external effective dose of dust for severe storms (2009 and 2010) in the cities of Baghdad and Ramadi were calculated, and all results were less than the critical dose level.

Dust storms are considered a measure of the quality of the urban environment [4]. They are dangerous to humans because some transported particles are small and move with the storms. Therefore, humans may be exposed directly through inhaling or swallowing dust, or indirectly due to contact with dust exposed to skin and outer clothing [5]. There is a study in Kirkuk City to know the values of toxic heavy elements in the dust falling from selected sites. It was found that zinc is one of the highly polluted elements. The hazard quotient and hazard index of the elements showed that there are non-carcinogenic health risks, including children for arsenic and lead. The results indicate the need to implement strategies to mitigate exposure and potential health effects of these toxic elements on the local population and the environment. (Qadr, Rami M . et al., 2023).

Dust often contains elevated amounts of potentially toxic elements (PTEs) and organic pollutants such as anthropogenic polycyclic aromatic hydrocarbons (PAHs) [6]. Accumulation of PTEs can also result from industrial discharge and the use of lubricants, automobile parts, corroded building materials, asphalt, road paint, and concrete [7,8,9].PTEs

are non-biodegradable and can remain in dust for long periods [10]. High concentration of PTEs leads to harmful effects on various terrestrial organisms and humans [11].
There are also organic compounds (PAHs) found in dust, and they are considered pollutants; their properties are semi-volatile [12,13], and some consider them major pollutants. Polycyclic aromatic hydrocarbons have diverse sources and can be divided into two main groups: pyrogenic and petrogenic. The pyrogenic group comes from various sources: petroleum derivatives, natural gas, coal-burning products, and traffic products. As for the petrogenic group, their pollution sources are directly from petroleum products [14]. The presence of polycyclic aromatic hydrocarbons in dust in high concentrations that reach the level of toxic pollutants will impact human health [15].To reduce the risks associated with POHCs, the source of these contaminants must be controlled, so a quantitative understanding of the sources of POHCs is essential [16]. The study included studying the grain size and the physical properties of acid function and organic materials in the dust and calculating the percentage of materials loss on ignition (L.O.I. %). The study also included some heavy metals polluting the environment in dust collected from some areas of Baghdad. A study collected street dust in Baghdad in the Rusafa area in August 2020. It included heavy and light metals, some heavy elements, and dust texture, and its sources were either of natural origin or from various human processes. (Jassim. Huda Hadi, et al., 2021).

1.1. Study area:

Baghdad is located in central Iraq; the Tigris River passes through the city, at latitude 33.33^{o}N and longitude 44.43^{o}E. Its area is about 660 square kilometers, and this site is important to the city. It is far from sources of natural disasters such as floods and close to sources of water and natural resources, in addition to the fact that the city represents an important link and station between countries of the world, Southeast Asia, Turkey, India, and Syria [17].

1.2 Topography of the study area

It is divided topographically into a floodplain area (lowlands) and a semi-desert area (relatively highlands). The floodplain is a slight slope from north to south, where the area drops from an altitude of 56 meters to an altitude of 26 meters above sea level. The area is flat with some site elevations that result from the construction of old and new irrigation peaks and ancient river paths. As for the semi-desert region, which covers the northwestern part, the area's elevation is approximately 75 meters in the northwestern parts and reaches approximately 34 meters above sea level in the parts close to the floodplain. The region is characterized by a flat surface with wide and shallow depressions and valleys with drainage systems. This area is intermittent and with slight erosion from the north and west [18].

1.3 Sampling Collection

The method of collecting samples was used during storms, by spreading a layer of nylon in the raised areas of tall buildings, which served as stations for collecting samples. The area of land covered with nylon was one square meter to collect the dust falling on it, and the sample collection period depended on the length of the storm until its end.

1.4 collection stations

Three local stations were created within Baghdad Governorate to collect dust samples. The areas were selected according to the following Table 1.
Table 1: Geographic coordinates of the study area where samples were collected for some of the storms hitting Baghdad in 2022.

Table 1: Geographic coordinates of the study area which collected samples for some of the storms hitting Baghdad in 2022.

Station No	Quarter Mane	Location	latitude	Longitude
1	Hay Ur	North West	33 41 14 N	44 41 09 E
2	Al-Mashtal	South East	33 33 01 N	44 49 94 E
3	Hay Al-Shabab	South west	33 14 06 N	44 20 05 E

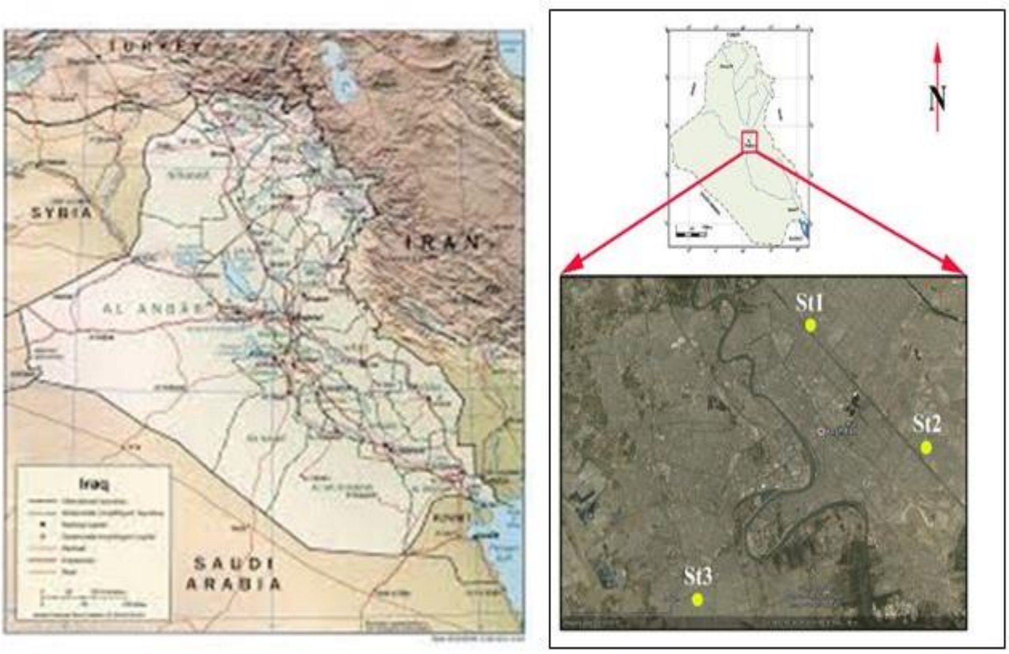

Figure 1: representing the locations of modelling stations in Baghdad Governorate

Grain size analysis and grain size distribution are key factors in sedimentology. In this study, the pipette analysis was carried out; this method is [19]. Dust storms in Baghdad in the present study are included the parts of; silt fraction occupy the first order ranging between 31.8 % -51.9% with an average value of 43.22%, clay fraction comes in the second order ranging between 31.8%- 59.5% with an average value of 48.98%, while sand fraction comes in the latter in relative distribution ranging between 5.6%-11.6 with an average percentage of 7.78% Table 2. The result of grain size analysis for the present study was plotted on a ternary diagram of [20]. This type of fabric structure of the study area samples depends on the energy and speed of the wind to carry these different materials when the dust storm blows.

Table 2: Grain size analysis of dust storms in Baghdad – May/ 2022 according to [17]

City	Date of Storm	Station Number	Location	Sand %	Silt%	Clay %
Baghdad	5/5/2022	1	North	6.2	45.9	47. 9
		2	South East	8.7	31.8	59.5
		3	South West	7.2	37.5	55.3
	16/5/200	1	North	5.6	47.9	46.5
		2	South East	7.4	43.8	48.8
		3	South West	6.9	41.5	51. 6
	23/5/2022	1	North	7.1	42.4	50.5
		2	South East	9.4	58.9	31.7
		3	South West	11.6	39.3	49.1
Range				5.6 -11.6	31.8- 58.9	31.7- 59.5
Mean				7.78	43.22	48.98

The texture of dust storms depends on their source; some of them are of natural origin, and others are formed through human activities, such as manufacturing containers of building materials and the exploitation of agricultural lands etc.

2. Physical properties

Some physical properties of models of the study area were studied, including the protective function, organic materials, total dissolved salts, and Loss on ignition (LOI).

Table 3: Some physical properties of samples of the study area

City	Date of Storm	Station Number	Location	Organic Matters %	Ph	TDS Ppm	L.O.I %
Baghdad	5/5/2022	1	North	1.33	7.4	412	17.56
		2	South East	1.87	7.0	488	14.16
		3	South West	1.74	7.2	477	11.12
	16/5/200	1	North	1.48	8.0	487	12.30
		2	South East	2.04	7.4	511	16.38
		3	South West	1.88	7.3	502	18.66
	23/5/2022	1	North	1.44	7.9	488	14.23
		2	South East	2.28	7.2	587	12.36
		3	South West	1.98	7.1	675	13.21
				1.33 – 2.28	7 - 8	412 – 675	11.12 - 18.66
				1.78	7.3	541.1	14.44

2.1. Organic Matter (O.M)

The method of [21] was used to calculate organic matter. Organic matter is a wide range of carbon molecules in soil created by plants, microorganisms, and other species [22]. Soils are categorized as organic or mineral, depending on the quantity of organic stuff they contain. The majority of agricultural land on the planet is covered in mineral soils, which might include as little as a tiny amount of organic matter or as much as 30% of it. Because of climatic considerations, organic soils are naturally rich in organic compounds. They are not necessarily cropping soils since they contain more than 30% organic material [23]. The organic matter in the samples of the study area reached 1. 78 and in the range 1.33 – 2.28 in Table 3. When comparing what is in Table 4 it is classified as moderate organic Humic according to [24].

Table 4: Soil division depending on humus and according to [24].

Degree	Humic	Humus	Degree	Humic	Humus
1	Very low	0.5<	4	High	2.5 – 6
2	Low	0.5 – 1.5	5	Very high	6- 15
3	Moderate	1.5 – 2.5	6	Extremely high	15- 30

2.2. Concentration of Hydrogen Ion (pH)

Note from Table 3 that the acidity values for the samples of the study area range between 7 - 8 and at a rate of 7.3. When comparing the results obtained with Table 5, the acidity results range from neutral to slightly basic.

Table 5: Soil classification based on pH [25].

pH	Soil class	pH	Soil class
<3.5	Ultra-acid	6.5 -7.3	Natural
3.5 – 4.4	Extremely acid	7.4 -7.8	Slightly alkaline
4.5 – 5	Very strongly acid	7.9 –8.4	Moderately alkaline
5.1 – 5.5	Strongly acid	8.5 - 9	Strong alkaline
5.6 – 6	Moderately acid	9>	Very strongly alkaline
6.1 – 6.5	Slightly acid		

The reason is that the dust samples are of different types according to Table 5, because they contain oxide minerals, hydroxides, and carbonate minerals.
Bicarbonate contains essential elements such as calcium and magnesium, which are transported from various sources found in the samples of the study area.

2.3. Loss on ignition (LOI)

The samples are burned at a temperature of 1000 °C for two hours to calculate the percentage of materials lost during the firing process. These materials include volatile substances (Cl, F, SO_3, and CO_2), crystallization water, and the water content (H_2O^+, H_2O^-) in addition to the organic matter [26]. The calculation is done using the following equation:

L.O.I% = $Sample\ weigt\ before\ firing - sample\ weight\ after\ firing\ sample\ weight\ before\ firing$ x100 -------------1

The percentage of burning losses for the study area samples, as in Table 3, ranged from 11.6 – 18.66 % and a rate of 14.44 %.
The presence of materials lost in burning is due to the presence of various materials, including organic materials, calcium oxides, and sulphates, and the lack of silica content transported with the dust storms that were studied. This is consistent with what was found by [27] when they studied in the Al-Tanf region - Western Sahara, where the presence of materials lost in the burning of organic materials, calcite, and minerals containing elements (F, Cl) and water found in clay minerals, where heating led to the disintegration of some compounds, especially carbonite, which contains water molecules in its structure.

3- Health risk assessment model

In this research, the US Environmental Protection Agency (USEPA) method was adopted to determine the risks of cancer from the presence of some heavy and non-carcinogenic elements in dust, where the average daily dose of some heavy elements (ADD) was calculated, as well as calculating intake, inhalation, and skin pathways using equations2,3,4 [28,29]:

$$ADD\ (_{\text{Ingestion}}) = \frac{C*Ring*EF*ED*1.0E-6}{BW*AT} \qquad \text{-------------2}$$

$$ADD\ (_{\text{Inhalation}}) = \frac{C*Rinh*EF*ED}{PEF*BW*AT} \qquad \text{-------------3}$$

$$ADD\ (_{\text{Dermal}}) = \frac{C*SA*SL*ED*EF*ABS*1.0E-6}{BW*AT} \qquad \text{------------4}$$

ADD Ing means daily absorption by ingestion, ADD Inh by inhalation, and ADD Dermal by skin absorption in units (mg/kg. day).

Table 6: shows the exposure standards used to evaluate health risks through different exposure methods [30, 31].

Landmarks	Definition	Units	Adults	Children
C	Heavy metals concentration	ppm	The current study (table 7)	
R_{ing}	Ingestion rate	Mg day^{-1}	100	**200**
EF	Frequency of exposure	Day/year	350	**350**
ED	Exposure period	in a year	30	**6**
BW	Weight of the exposed individual	Kg	70	**15**
AT	Time rate	Days	365×ED	**365×ED**
R_{inh}	Inhalation rate	M^3 day^{-1}	20	**10**
PEF	Particle emission factor	M^3 day^{-1}	1.36×10^9	**1.36×10^9**
SA or AF	Exposed skin surface	Cm^2	5700	**2800**
SL	Skin adherence factor	mg/cm3 per day	0.07	**0.2**
ABS Or R_{dermal}	Dermal absorption facto Absorption factor from the skin r	Unit less	0.03for and 0.001for rest of metals	**0.03forAs and 0.001for rest of metals**

Table 7: Average concentrations of metals for three times (in ppm)

Metals	North location	South east location	Southwest location
Cr	280.3	328.933	341.366
Ni	237.133	235.6	251.333
As	8.433	6.8	7.666
Cd	2	2	1.666

3.1. Evaluation of non-carcinogenic risks

In order to know the non-carcinogenic health effects due to the presence of heavy metals in dust in the city of Baghdad, where the Hazard Quotient (HQ) and the Hazard Index (HI) that were calculated when studying the heavy metals were studied, it is possible to calculate the non-carcinogenic Hazard Score (HQ) by a modified division method. The daily dose for the three pathways (ADD) is divided into the indicated dose (RFD) (mg/kg per day) and HI by the sum of the main HQ for the three pathways as given in USEPA 1989 [32].

$$HQ= ADD/RFD \qquad \text{------------------------5}$$

$$HI = \int HQ \qquad \text{-------------------------6}$$

It was found that when the values of both HQ and HI are less than 1, this means that there are no effects of significant non-carcinogenic risks. In contrast, there is an expectation that there are no non-carcinogenic effects when HQ and HI are greater than 1. Therefore the probability increases with the increase of the value of both HQ and HI.

RfD_{Ing} ,RfD_{Inh} ,RfD_{Der} values were obtained from [33,34] in table (8).

Table 8: RFD values for non-carcinogenic risk of heavy metal for different exposure routes [33, 34].

Heavy elements	RfD_{Ing}	RfD_{Inh}	RfD_{Der}
As	3×10^{-4}	3×10^{-4}	1.23×10^{-4}
Cd	1×10^{-3}	1×10^{-3}	1×10^{-5}
Cr	3×10^{-3}	2.86×10^{-5}	6×10^{-5}
Ni	2×10^{-2}	2.06×10^{-2}	5.4×10^{-3}

3.2. Assessing the risks leading to cancer

Individuals are likely to develop different types of cancer when exposed to carcinogenic substances throughout their lives [35]. This is done by using the following equations7,8 [33].

$$CR=ADD_{CA} \times SF \quad\text{------------------7}$$

$$TCR=\int CR \quad\text{-----------------8}$$

ADDCA means exposure to daily dose for three pathways, (SF) regression factor for cancer and is measured in units (mg kg−1 day−1). As for the TCR, it is the total sum of the factors that cause cancer (CR) in the three pathways in general according to the US Environmental Protection Agency (USEPA) has recommended that if the values of CR, TCR are <1.0 E-6, they are hardly mentioned, but if the values of CR, TCR are >1.0E-4, it is expected that there will be harm to humans. The permissible and acceptable risks fall within the average values of 1.0E-6to1.0E-4 until we obtain the cancer regression factor (SF) used in the study by [36,37]. As in Table (9)

Table 9: SF values for carcinogenic risk

Heavy elements	SF_{Ing}	SF_{Inh}	SF_{Der}
As	1.5	1.5×10-1	3.66
Cd	1.5	6.3	3.66
Cr	0.5	4.2	2
Ni	0.5	8.40×10-1	2

Generally, in the present study, order Cr>As>Ni>Cd for children and adults, while the values of CR and total cancer risks TCR take descending order Cr > Ni >Cd >As.

Table 10: Health risk indexes in the present study

	Pathway	North		South East		South West	
		Adults	Children	Adults	children	adults	Children
Chromium	HQ_{ing}	0.127990	1.19458	0.1501977	1.401845	0.1558447	1.45455
	HQ_{inh}	0.138206	0.069101	0.1621853	0.0810909	0.1682832	0.0841398
	HQ_{derm}	0.025533	0.1672416	0.0281433	0.1962583	0.03109166	0.20363666
	HI	0.291729	1.4309226	0.3405263	1.6791942	0.35521956	1.74232646
	CR_{ing}	0.000191	0.00179	0.0002252	0.0021027	0.0002337	0.0021818
	CR_{inh}	0.0000166	0.0000083	0.0000194	0.00000974	0.00002021	0.0000101
	CR_{derm}	0.00000306	0.00002006	0.00000337	0.00002355	0.00000373	0.00002443
	TCR	0.00021164	0.00182024	0.00024797	0.00213599	0.00025764	0.00221633
Arsenic	HQ_{ing}	0.038507	0.3593973	0.03105033	0.289802	0.03500466	0.32670933
	HQ_{inh}	0.0003963	0.00019819	0.00031963	0.00015981	0.00036034	0.00015314
	HQ_{derm}	0.0112422	0.07363252	0.00906504	0.05937398	0.01021951	0.06693577
	HI	0.0501455	0.43322801	0.040435	0.89379763	0.04558451	0.39379824
	CR_{ing}	0.00001732	0.00016172	0.00001397	0.00013041	0.00001575	0.0001470
	CR_{inh}	1.783E-8	8.91886E-9	1.4385E-8	7.1917E-9	1.62153E-8	6.8915E-9
	CR_{derm}	0.00000506	0.00003314	0.00000408	0.00002672	0.00000460	0.0000301
	TCR	0.00002239	0.00019486	0.00014379	0.00015713	0.00002036	0.00017710
Nickel	HQ_{ing}	0.01624198	0.1515918	0.01613698	0.15061187	0.01721438	0.1606675
	HQ_{inh}	0.00016232	0.0000811	0.00016127	0.00008064	0.00017204	0.00008602
	HQ_{derm}	0.00024001	0.0015720	0.0002384	0.00170177	0.00025438	0.00166618
	HI	0.01664431	0.1532449	0.0165366	0.01684359	0.0176408	0.1624197
	CR_{ing}	0.00016241	0.00151591	0.0001613	0.00150611	0.00017214	0.00160667
	CR_{inh}	0.00000280	0.00000140	0.00000279	0.00000139	0.00000297	0.00000148
	CR_{derm}	0.00000259	0.00001697	0.00000257	0.00001837	0.00000274	0.00001799
	TCR	0.0001678	0.00153428	0.00016666	0.00152587	0.00017785	0.00162614
Cadmium	HQ_{ing}	0.0027397	0.0025570	0.0027397	0.0025570	0.00007607	0.0213005
	HQ_{inh}	0.00002820	0.0000141	0.00002820	0.0000141	0.00002349	0.00001170
	HQ_{derm}	0.00001093	0.0006136	0.00001093	0.0006136	0.00090731	0.00099402
	HI	0.0027788	0.0031848	0.0027788	0.0031848	0.01006881	0.02230622
	CR_{ing}	0.0041095	0.0000383	0.0041095	0.0000383	1.14109E-7	0.00003199
	CR_{inh}	2.820E-11	8.8839E-8	2.820E-11	8.8839E-8	1.4800E-7	7.3736E-7
	CR_{derm}	4.0009E-8	2.2461E-8	4.0009E-8	2.2461E-8	3.32077E-8	3.6381E-8
	TCR	0.0041095	0.0000384	0.0041095	0.0000384	2.9532E-7	0.0000321

The data in Table 11 indicate higher non-carcinogenic risks of chromium metal for children than adults. There is no non-carcinogenic risk of arsenic metal to children and adults, while data indicate the presence of carcinogenic risks to both adults and children. Data for nickel indicate that there is no non-carcinogenic risk to adults and children. At the same time, there is a potential carcinogenic risk to adults and a significant carcinogenic risk to children. In the case of cadmium metal, there is no non-carcinogenic risk for either adults or children on the three sides, whilst there is a high carcinogenic risk on the northern and southern sides for adults; in contrast, the southwestern side is free of this danger; while there is Possibility of cancerous infections to children for three sides.

Table 11: Non-cancerogenic risk (HI) and cancerogenic risk (TCR) in the study area.

Metals		Factor		N	SE	SW	Health risk assessment
Chromium		HI	Adult	0.29***	0.34***	0.35***	*Represent danger (harmful to human beings) HI>1 TCR>1.0E-4 **Possibility of cancerous infections TCR (1.0E-4 to 1.0E-6) *** No significant health risks HI<1 TCR< 1.0E-6
			Child	1.43 *	1.67*	1.74*	
		TCR	Adult	2.11E-4**	2.47E-4**	2.21E-3*	
			Child	1.82E-3*	2.13E-3*	2.21E-3*	
Arsenic		HI	Adult	0.050***	0.040***	0.045***	
			Child	0.433***	0.893***	0.393***	
		TCR	Adult	2.23E-5**	1.43E-4**	2.03E-5**	
			Child	1.94E-4**	1.57E-4**	1.77E-4**	
Nickel		HI	Adult	0.016***	0.016***	0.017***	
			Child	0.153***	0.016***	0.162***	
		TCR	Adult	1.67E-4**	1.66E-4**	1.77E-4**	
			Child	1.53E-3*	1.52E-3*	1.62E-3*	
Cadmium		HI	Adult	0.0027***	0.0027***	0.010***	
			Child	0.003***	0.003***	0.022***	
		TCR	Adult	4.10E-3*	4.10E-3*	2.95E-7***	
			Child	3.84E-5**	3.84E-5**	3.21E-5**	

4. Conclusions

Dust storms in Baghdad in the present study include the following parts: silt fraction occupies the first order, clay fraction comes in the second order, while sand fraction comes in the latter. The organic matter in the samples of the study area is classified as moderate organic Humic. The acidity values for the samples range from neutral to slightly basic. Higher non-carcinogenic risks of chromium metal for children than for adults. There is no non-carcinogenic risk of arsenic metal to children and adults, while data indicate the presence of carcinogenic risks to both adults and children. Data for nickel suggest that there is no non-carcinogenic risk to adults and children, while there is a potential carcinogenic risk to adults and a significant carcinogenic risk to children. In the case of cadmium metal, there is no non-carcinogenic risk for adults and children on the three sides. At the same time, there is a high carcinogenic risk on the northern and southern sides for adults, while the southwestern side is free of this danger, and there is a possibility of cancerous infections in children.

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