Journal of Green Engineering (JGE)

Volume-10, Issue-9, September 2020

Analysis of Toxic Metals in Soil Effect Health near Industrial Activities using Risk Assessment Approach

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Abstract

This paper deals with the effect of pollutants emitted to areas close to industrial activities and the imaginable health risk associated with soil pollution through ingestion, soil particles inhalation, and dermal contact. Samples were taken from sites close to a range of industrial activities such as dates canning, asphalt, brik factories and thermal power plant. The noncarcinogenic hazard index for (Fe, Ni, Cu, Cr, Cd, Pb and Zn) and the cancer risk for (Cr, Cd and Pb) were calculated. The result showed that the HI was acceptable for adults and greater than the allowable limit at Al-baladeya asphalt factory, Brick factory and Al-Musayyib thermal power plant for children, while the Risk was greater than the allowable limits in all locations for adults and children and the maximum value was at Al-Musayyib thermal power plant. These results indicate that the population was at the non-carcinogenic and cancer risk health problem especially for children.

Key words: industrial pollution, soil pollution, health risk assessment, toxic heavy metal, Cancer risk.

Journal of Green Engineering, Vol. 10_9, 6217–6229.

Alpha Publishers

1 Introduction

One of the principal environmental effects of industry was the gradual change in the chemical composition of ecosystems which found about the effusion sources. The continual releasing of solid mineral from anthropogenic sources produces significant changes in the biogeochemical cycle of those elements. Mineral toxicity ,consist of cadmium or lead, that can be penetrated easily the harvest and be merged in the food chain. A wide prohibition of essential enzymes in the metabolizing pathways explain the presence of toxic mineral in living organisms, that guides to many metabolite diseases[1].There is a correlation between the processing which created in certain waste and the sort of the metals that present on this waste [2]. In General, the nature of parent materials, climate and their relative mobility which depends on soil parameter, such as mineralogy, texture and classification of soil was effected on the distribution of these metals that are toxic to human beings[3,4].These metal can be effected directly on human health through air or water or food entrance, or by accumulation in the human body in concentration during the long periods of time [5]. Because of the heavy metal are no degradable and there is no known homeostasis system for them, any elevated level of this contamination may influence the human wellbeing influencing the typical working of organs, liver, kidney, focal sensory system, bones, and so forth, or going about as cofactors in different infections.[6,7]. Heavy metals in soil pose possible threats to the environment and can damage human health through a variety of absorption pathways such as direct ingestion, dermal contact, weight loss plan through the soil–food chain, inhalation, and oral consumption[8].

The objective of this study is to assess the risks of effluents emissions for industrial activities and their impact on soil in adjacent areas and surrounding areas, and to limit the doable health risks of heavy metals as cumulative non-carcinogenic and carcinogenic risk , This technique has opened up new challenges in the risk assessment theory.

2 Description of Study Area

The study was conducted in cooperation with the Directorate of Environment in Babylon. Five sites were selected for industrial activity. Each site was taken a point away from the industrial activity site as shown in table (1).These sites were studied on the basis of a complaint by residents living near the source of the broadcast for adverse effects on themselves and the surrounding environment. All location of industrial activates located at Babylon governorate as shown in fig(1).

Table 1: Details of the study site.

Industrial activities	location	Sample number	Location of sampling points
Dates canning factory	N32 25 57.1 E044 26 00.5	1	N32 26 02.2 E044 25 50.3
Al-Baladeya asphalt factory	N32 26 0.8 E044 26 34.7	2	N32 25 35.5 E044 27 37.5
Ashur asphalt plant	N32 25 59.8 E044 27 19.7	3	N32 25 16.6 E044 27 45.9
Brick Factory	N32 12 50.7 E044 30 20	4	N32 12 35.1 E044 31 20.2
Al-Musayyib thermal power plant	N32 50 33.5 E044 16 29.7	5	N32 49 25.4 E044 16 24.7

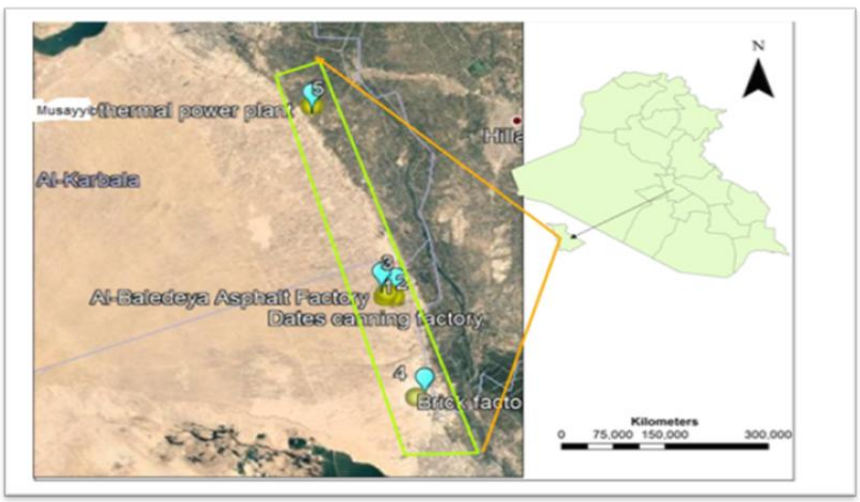

Fig 1: location of industrial activates located at Babylon governorate

3 Sampling and Analytical Chemistry

Soil sampling sites with a distance of approximately 1.5-3Km were selected near industrial activities, soil samples had been combined with three subsamples collected from three depths about 0-30cm. first the top surface soil cleaned, then combined samples were taken from different depth (0, 15,30 cm). Second soil samples were air-dried in the laboratory and sieved< 2mm. They were stored in polyethylene baggage before analysis.Prior to dedication of the heavy metals concentrations, sieved soil samples had a combination of $HNO_3$and HCl_4 acid answer applied to them, then analyses of heavy metal elements had been carried out by Using the atomic absorption method[9].

4 Risk Assessment Theory

This approach allows a more detailed analysis of some aspects of the data .The process to assessment a human health risk should be know the nature and probability of their risk which effects in humans health who might be subjected to chemical exposure in the contaminated media of environment , in present or in later .And must be know what the different between hazard and risk , when explain the risk assessment[10].

• a hazard is a causable from anything that leads to be harmful, such as chemicals, electricity, working from ladders, an open drawer etc.

• risk is, that somebody subjected to one or more hazards and could be harmful by chance , in both about how much the harm could be seriously.

Human health risk assessment includes 4 basic steps:

Step1: Hazard Identification: check if a stressor might be harm to humans and/or ecological systems, and if occur, what the conditions was used. Human, animal and mechanistic evidence have been used as the information to explain in hazard identification; so as, the quality of the evidence, the severity of the impacts, and if the mechanisms of toxicity in animals are related to humans must be evaluated for the risk assessor [11].

Step 2: Dose-Response Assessment: describe the effectiveness occur on the health of (sensory dissection) depend on the doses that are administered this step also known as “Toxicity Assessment”[12]. Chemicals have different types of effects. Generally, when thinking about human health, chemicals are divided into two big groups: chemicals that may cause poisonous health effects but do not cause cancer (non-carcinogens) and chemicals that may cause cancer(carcinogenic). Sometimes a chemical can have both a poisonous and a cancer causing effect. The poisonous effect can be acute (short-term extreme health effect) or long lasting (longer-term constant health effect). Poisonous quality is often obvious in a shorter length of time than the cancer-causing effect.

The possible health effects of non-carcinogens range from skin irritation to life shortening. (cancer-causing things) cause or increase the (number of times something happens) of cancers. Poisonous quality refers to a bad effect of a chemical on human health. Not all chemicals are poisonous. Every day we eat chemicals in the form of food, water, and sometimes medicines. Even those chemicals usually thought about poisonous are usually nontoxic or harmless below a certain concentration. These concentration limits can be used to calculate a chemical dose that would not harm even people who are especially sensitive to the chemical [13].

Step 3: Exposure Assessment: mean the evaluation of the extent, prevalence, period, and course of exposure. The aim of this step is account the concentrations of contaminant and the doses effect on the populations at risk.The first tasks in exposure assessments specifically include: [14]

(1)diagnoses the probability of exposed populations,

(2)distinguish the track of exposure as possible,

(3)Evaluation the concentrations of exposure, and

(4) Determine the chemical consumption.

The equation for soil media that explained the specific intake at different exposure track (ingestion, inhalation, and dermal in (mg/ kg.day)). are shown below, and the Standards values of this equations that are using in the consumption are designate in table (2) [15, 14].

Soil ingestion may be occur by the ignored intake of soil on hands or food components.

As the health assessor, you should also noticed the dusts that are inhaled from the soils contamination. In both children and adults, the dose that results from oral ingestion of a soil contaminant is probable to be over than the dose resulting from dust inhalation [16].

$I\_ing=(CS\times IR\times CF\times FI\times EF\times ED)/(BW\times AT)$

As health adviser, dusts are inhaled from the soils contamination. The dose results from oral ingestion of a soil contaminant are probable to be over than the dose resulting from dust inhalation in both children and adults. [17].

$I\_inh=(CS\times IR\times FI\times EF\times ED)/(BW\times PEF\times AT)$

Potential for exposure is acknowleged through dermal absorption of chemicals from this soil. Dermal absorption of contaminants from dust or soil is based on contact area, contact duration, physical and chemical attraction between contaminant and soil [18].

$I\_der=(CS\times SA\times CF\times AF\times ABS\times EF\times ED)/(BW\times AT)$

Step4: risk characterization: the last step of risk assessment was found in risk characterization, the details from the consumption or exposure evaluation and the hazard characterizations have been completed into advice similar as a decision-making of management the risk. Under various exposure scenarios human health subjects to the potential risk, the benefits of risk characterization provides an assessment to this risk. So it should be including all the key of expectations, the extent and relevancy of the risks to human health, and the nature characterizations [19].

The generic equations were used in EPA methods correlate with in the chemical if a non-carcinogen or a carcinogen, which makes the basic line of risk assessment difference.

Table 2: standards values using to calculated chronic daily intake.

Parameter	Standard values	
	Adult	Child
CS= chemical concentration in soil (mg/kg)	Contaminant specific	
IR= ingestion rate (L/day) water, (mg/day) soil = inhalation rate(m^3/h)	100	200
CF= volumetric conversion value	0.000001	
FI= fraction ingestion (dimensionless)	1	
EF= exposure frequency (day/year)	350	
ED= exposure duration (years)	30	6
BW= body weight (kg)	70	15
AT= average time (day).	=ED ×365 for noncarcinogens = 70×365 for Carcinogens	
SA= skin surface area available for contact(cm^2)	5700	3300
AF= soil to skin adherence factor (kg/ cm^2)	0.07	0.2
ABS = adsorption factor for soil contaminant(dimensionless)	0.001 for Cd , and 0.01 for other metal	
PEF = particle emission factor m^3/kg	1.36×10^9	

The Hazard Index (HI) indicated for non-carcinogens, and Risk (Risk) indicated for carcinogenic [20].

The hazard index (HI) describes the potential non-carcinogenic risk for an individual heavy metal. The HI is define as the relation between the chronic daily intake (mg/kg/day) and the reference dose (RfD, mg/kg/day) and is an assessment of daily exposure to the human population which is not similar to describe as a noticeable risk of harmful effects during a lifespan [21]:

HI= CDI/RfD

For carcinogens, risk is evaluated the possibility of gradual developing of the cancer for an individual over a lifespan which result from the exposure to the potential carcinogenic risk. Potential carcinogenic risk can be rate using the following equations [22, 15]:

Risk= CDI ×SF

Hazard Index <1.0 provides acceptable risk; however, the cumulative acceptable risk for all contaminants and routes of exposure must be <1.0. If the hazard index is <1.0, the receptors are exposed to concentrations that do not present a hazard.

EPA sums the hazard indexes for each constituent as follow:

Hazard Index T = Σ HIi

For multiple pathways:

Hazard Index T = Σ HIij

Where: i=the compound and j= pathways [23,15].

In a like manner, the risk for multiple substances and pathways is estimated as:

$Risk_T = \Sigma\, risk_{ij}$

Where: i=the compound and j= pathways

U.S. EPA determined the acceptable limit For carcinogenic chemicals during lifetime, equals 1×10^{-6}

Table 3: The reference dose (RfD) and slop factor (SF) using for risk characterization [24, 25]

Metal	Oral RfD (mg/kg.day)	Inhalation RfD (mg/kg.day)	Dermal RfD (mg/kg.day)	Oral SF $(mg/kg.day)^{-1}$	Inhalation SF $(mg/kg.day)^{-1}$	Dermal SF $(mg/kg.day)^{-1}$
Fe	0.7	-	-	-	-	-
Ni	2×10^{-2}	-	4×10^{-3}	-	-	-
Cu	4×10^{-3}	-	1.2×10^{-2}	-	-	-
Cr	2×10^{-2}	1×10^{-4}	1×10^{-3}	0.5	41	-
Cd	5×10^{-4}	5×10^{-5}	1×10^{-4}	-	6.3	-
Pb	3.6×10^{-3}	-	3.5×10^{-3}	8.5×10^{-2}	4.2×10^{-2}	-
Zn	0.2	-	0.6	-	-	-

5 Results and Discussion

Table (4) recorded the average concentrations of heavy metals in all location for two periodic tests at 2017. It can be noted that the concentration of iron (Fe) was the highest in all locations followed by Nickel (Ni), Zinc (Zn) and Chromium(Cr), while there was a disparity in the concentration of Copper (Cu) and Lead (Pb) where the concentration of Pb was greater than Cu in Dates canning and Al-Baladeya asphalt factories and vice versa in the rest of the sites. cadmium (Cd) recorded the lowest concentration in all locations. The emission of heavy metal from industrial activities increasing anthropogenic influences on the environment, specially air pollution loadings, have brought on negative changes in herbal ecosystems, reduced biodiversity, simplified shape and reduced productivity[26].

Table 4 : average concentration of heavy metals in soil near industrial location.

Location	Average Contaminants Concentration(mg/kg)						
	Fe	Ni	Zn	Cr	Cu	Pb	Cd
Dates canning factory	20380	152	83.2	56.6	22.6	23.3	1.7
Al-Baladeya asphalt factory	20646	173	71	55	39	42	0
Ashur asphalt plant	14850	116	124	64	35	19	1
Brick Factory	21312	163	96	70	31	19	1.3
Al-Musayyib thermal power plant	19980	286	103	98	28.6	8	0

Firstly: the chronic daily intakes were calculated to metal (Fe, Ni, Cu, Cr, Cd, Pb and Zn) for noncarcinogenic and carcinogenic effect at deferent routes. Secondly the Hazard index (HI) was calculated for noncacinogenic chemicals (Fe, Ni, Cu, Cr, Cd, Pb and Zn), while the risk was calculated for carcinogenic chemicals (Cr, Cd and Pb) , the result were listed in table (5) . Depending on these results can be observed that the greater proportion of HI and risk contributed by the iron (Fe) and chromium (Cr) metal respectively that due to high concentration of this metals at all locations as shown in table(3), and the ingestion pathways appears to be inherent contributor to intensification life time noncarcinogenic effects and cancer risk followed by dermal presentation. While the inhalation exposure is the littlest as shown in table (5).

A- For noncacinogenic effect, the results explain that the total (HI) caused by chronic dialy intakes for all rout in soil for adult were less than the allowable limits which must not exceed (1). While the total (HI) for child at same locations was greater than allowable limit at Al-baladeya asphalt factory, Brick factory and Al-Musayyib thermal power plant and It was close to the allowable limit at Dates canning factory and Ashur asphalt plant.

In this manner, the potential health risk for children and adult can be disregarded. Then, the health danger for adults used to be decrease compared to the risk for children. The HI estimations of these metals for kids were approximately 10 times higher than those for adult.

B-For Carcinogenic effects: The results show that the cancer risk caused by chronic daily intakes at different routes for Cr, Cd and Pb was greater than the allowable limits in all locations for adult and child and the maximum risk recorded at Al-Musayyib thermal power plant These results are listed in table)6(.Possibility human carcinogenic risks related to exposure for chemicals are expressed in concept of an increased probability of cancer development through a person's lifetime. that there is additional cancer case through lifetime in a population of a million persons.For example, a 10-6 increased cancer risk reflects an increased lifetime risk of 1 in 1,000,000 for cancer development [27].This may lead to inappropriate escalation in the potential adverse health risks posed by Cr, Cd and Pb were greater than the permission limit of EPA indicating that it remained unsafe for the local population

6 Conclusion

Based on results the following points can be concluded:-

- The degree of overwhelming metals is step by step expanding near the industrial activities, Therefore, substantial metals are entering the natural way of life and causing environmental unevenness.
- Soil contaminated with hazardous elements such as lead, cadmium, arsenic and others metals pose significant risks to human health.

- Soil pollution impact on the food we eat, the air we breathe, and the health of our ecosystems. Because the limited ability of soil to deal with industrial pollution, the prevention of soil pollution must be highest global priority.
- Soil pollution poses a worrying threat due to industrialization, war and mining processes , with no systematic assessment of soil pollution.
- In addition, people's cognizance of the unsafe impacts of heavy metals in the soil need to be raised.
- The risk assessment approach can help the decision making to analyze risks and taking precautionary measures to reduce risk.

Table 5: The noncarcinogenic hazard index at different pathways at industrial site.

Site	Adult				$\sum$ HI_{ing}+ HI_{inh} + HI der	Child			$\sum$ HI_{ing}+ HI_{inh} + HI der
	Metal	HI_{ing}	HI_{inh}	HI_{der}		HI_{ing}	HI_{inh}	HI_{der}	
Dates canning factory	Fe	0.039882583	-	-	0.039882583	0.372237	-	-	0.372237
	Ni	0.010410959	-	0.002077	0.012487945	0.097169	-	0.016033	0.113202
	Cu	0.008367271	-	0.000103	0.00847021	0.078095	-	0.000795	0.078889
	Cr	0.003876712	0.000119283	0.007734	0.011730037	0.036183	0.000278	0.023881	0.060342
	Cd	0.002328767	7.16544E-06	0.000929	0.003265111	0.021735	1.67E-05	0.007173	0.028924
	Pb	0.008866058	-	1.75E-05	0.00888359	0.08275	-	0.000135	0.082885
	Zn	0.000569863	-	7.58E-05	0.000645655	0.005319	-	0.000585	0.005904
		$\sum\sum$ HI_{ing}+ HI_{inh} + HI_{der}			0.08536513	$\sum\sum$ HI_{ing}+ HI_{inh} + HI_{der}			0.742383
Al-baladeya asphalt factory	Fe	0.040403131	-		0.040403131	0.263967	-		0.37709589
	Ni	0.011849315	-	0.002364	0.014213253	0.002212	-	0.018247945	0.128841553
	Cu	0.014439097	-	0.000178	0.014616734	0.000499	-	0.001371233	0.136136135
	Cr	0.025114155	0.000115911	0.003006	0.028236231	0.000703	0.00027046	0.023205479	0.257874722
	Cd	0	0	0	0	0	0	0	0
	Pb	0.015981735	-	0.004331	0.020313087	0.000537	-	0.0033435	0.152506361
	Zn	0.000486301	-	6.47E-05	0.000550979	0.000908	-	0.000499269	0.005038082
		$\sum\sum$ HI_{ing}+ HI_{inh} + HI_{der}			0.118333	$\sum\sum$ HI_{ing}+ HI_{inh} + HI_{der}			1.057492743
Ashur asphalt plant	Fe	0.029060665	-		0.029060665	0.271233	-		0.271233
	Ni	0.007945205	-	0.001585	0.009530274	0.074155	-	0.012236	0.086391
	Cu	0.012958164	-	0.000159	0.013117581	0.120943	-	0.001231	0.122173
	Cr	0.029223744	0.000134879	0.003498	0.032856705	0.272755	0.000315	0.027003	0.300072
	Cd	0.001369863	2.10748E-05	0.000547	0.001937513	0.012785	4.92E-05	0.004219	0.017054
	Pb	0.007229833	-	0.001959	0.009189254	0.067478	-	0.015125	0.082604
	Zn	0.000849315	-	0.000113	0.000962274	0.007927	-	0.000872	0.008799

Brick factory		**$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$**			0.096654267	**$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$**			0.8883260
	Fe	0.041706458	-		0.041706458	0.38926	-		0.38926
	Ni	0.011164384	-	0.002227	0.013391678	0.104201	-	0.017193	0.121394
	Cu	0.011477231	-	0.000141	0.011618429	0.107121	-	0.00109	0.108211
	Cr	0.03196347	0.000147524	0.003826	0.035937021	0.298326	0.000344	0.029534	0.328204
	Cd	0.001780822	2.73973E-05	0.000711	0.002518767	0.016621	6.39E-05	0.005485	0.02217
	Pb	0.007229833	-	0.001959	0.009189254	0.067478	-	0.015125	0.082604
	Zn	0.000657534	-	8.75E-05	0.000744986	0.006137	-	0.000675	0.006812
		$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$			0.115107	**$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$**			1.058655
Al-Musayyib thermal power plant	Fe	0.039099804	-		0.039099804	0.364932	-		0.364932
	Ni	0.019589041	-	0.003908	0.023497055	0.182831	-	0.030167	0.212998
	Cu	0.010588671	-	0.00013	0.010718938	0.098828	-	0.001006	0.099833
	Cr	0.044748858	0.000206533	0.005356	0.05031183	0.417656	0.000482	0.041348	0.459486
	Cd	0	0	0	0	0	0	0	0
	Pb	0.000296187	-	0.000825	0.001121206	0.002764	-	0.006369	0.009133
	Zn	0.000705479	-	9.38E-05	0.000799308	0.006584	-	0.000724	0.007309
		$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$			0.125548141	**$\sum\sum HI_{ing}+HI_{inh}+HI_{der}$**			1.15369046

Table 6 : The cancer risk for chemicals in soil at different pathways at industrial activities

Site		Adult			**$\sum R_{ing}+R_{inh}+R_{der}$**	Child			**$\sum R_{ing}+R_{inh}+R_{der}$**
	Metal	R_{ing}	R_{inh}	R_{der}		R_{ing}	R_{inh}	R_{der}	
Dates canning factory	Cr	1.66145E-05	2.09598E-07	0	1.6824E-05	3.10137E-05	9.7812E-08	0	3.11115E-05
	Cd	-	9.67334E-10	0	9.6733E-10	-	4.5142E-10	0	4.51423E-10
	Pb	1.16272E-07	8.83878E-11	0	1.1636E-07	2.17041E-06	4.1247E-11	0	2.17045E-06
		$\sum\sum R_{ing}+R_{inh}+R_{der}$			1.6941E-05	**$\sum\sum R_{ing}+R_{inh}+R_{der}$**			3.32824E-05
Al-baladeya asphalt	Cr	3.76712E-05	2.03673E-07		3.7874E-05	3.0137E-05	9.5047E-08	0	3.0232E-05
	Cd	0	0		0	-	0	0	0
	Pb	4.89041E-07	1.59326E-10		4.892E-07	3.91233E-06	7.4351E-11	0	3.9124E-06
		$\sum\sum R_{ing}+R_{inh}+R_{der}$			3.8364E-05	**$\sum\sum R_{ing}+R_{inh}+R_{der}$**			3.41444E-05
Ashur asphalt plant	Cr	4.38356E-05	2.37001E-07		4.4072E-05	3.0137E-05	1.1060E-07	0	3.51791E-05
	Cd		5.6902E-10		5.6902E-10	-	2.6554E-10	0	2.65543E-10
	Pb	2.21233E-07	7.03598E-11		2.2130E-07	3.91233E-06	3.3635E-11	0	1.7699E-06
		$\sum\sum R_{ing}+R_{inh}+R_{der}$			4.4294E-05	**$\sum\sum R_{ing}+R_{inh}+R_{der}$**			3.69493E-05
Brick factory	Cr	4.7945E-05	2.5922E-07		4.8204E-05	3.83562E-05	1.2096E-07	0	3.84771E-05
	Cd		7.39726E-10		7.3972E-10		3.4520E-10	0	3.45205E-10
	Pb	2.0648E-06	7.20759E-11		2.0649E-06	1.76986E-06	3.3635E-11	0	1.7699E-06
		$\sum\sum R_{ing}+R_{inh}+R_{der}$			5.0270E-05	**$\sum\sum R_{ing}+R_{inh}+R_{der}$**			4.02474E-05

Al-Musayyib thermal	Cr	6.7123E-05	7.54701E-05		0.000142593	5.36986E-05	1.6935E-07	0	5.3868E-05
	Cd	0	0		0		0	0	0
	Pb	9.3150E-08	3.03477E-11		9.3181E-08	7.45205E-07	1.4162E-11	0	7.4522E-07
		$\sum\sum$ **R$_{ing}$+ R$_{inh}$+ R $_{der}$**			0.000142687	$\sum\sum$ **R$_{ing}$+ R$_{inh}$+ R $_{der}$**			5.4613E-05

Refrences

[1]P.Miskowiec, A Laptas, K Zieba. ," Soil pollution with heavy metals in industrial and agricultural areas: a case study of Olkusz District" Journal of Elementology, Vol.20, no.2, pp. 353-362, 2015.

[2]J.K.Adesodun , J.S. Mbagwu. " Distribution of heavy metals and hydrocarbon contents in an alfisol contaminated with waste-lubricating oil amended with organic wastes", Bioresour., Vol.99, no. 8, pp.3195-3204, 2008.

[3]A. K.Krishna. , P. K. Govil, "Soil contamination due to heavy metals from an industrial area of Surat, Gujarat, Western India" , Environ. Monit. Assess, Vol.124, no.1, pp. 75-263, 2007.

[4]K. Joanna. et.al, Z., " Pollution indices as useful tools for the comprehensive evaluation of the degree of soil contamination–A review ", Environ. Geochem.Health, Vol. 40, pp. 2395–2420,2018.

[5]Kumar A, Seema, " Accumulation of heavy metals in soil and green leafy vegetables, irrigated with wastewater", IOSR Journal of Environmental Science, Toxicology and Food Technology, Vol.10, no.10, pp 8-19, 2018.

[6]TY.Tong, KC Lam. "sweet home? A case study of household dust contamination in Hong Kong", Science of The Total Environment, Vol .256, no.2, pp.115-123, 2000.

[7]M.Boban et.al, " Children's health risk assessment based on the content of toxic metals Pb, Cd, Cu and Zn in urban soil samples of Podgorica, Montenegro", Vojnosanit Pregl, Vol.72,no.9, pp. 807–812, 2015.

[8]Xingmei Liu, Qiujin Song, Yu Tang, Wanlu Li, Jianming Xu, Jianjun Wu, Fan Wang, Philip Charles, "Human health risk assessment of heavy metals in soil–vegetable", Science of the Total Environment, Vol. 463, no. 464, pp. 530-540, 2013.

[9]J. Benton Jones, "Laboratory guide for conducting soil tests and plant analysis", CRC Press, pp. 384, 2001.

[10]EPA,(http://epa.gov/riskassessment.htm).

[11]Guido Sonnemann, Michael Tsang, Marta Schuhmacher, "Integrated Life-Cycle and Risk Assessment For Industrial Processes" CRC Press, pp. 433, 2018.

[12]S.S. Nehaba ,A.Wadi A, "Risk assessment of water supply system in Babylon govenorate: A stochastic approach", Journal of Babylon University/Engineering Sciences Vol. 21, no.3, pp.1-19, 2013.

[13]International Programme on Chemical Safety. Principles and methods for the assessment of risk from essential trace elements. World Health Organization,2012. Available online: https://apps.who.int/iris/handle/10665/42416.
[14]M. L. Davis, S.J Masten, "principles of Environmental of Engineering and Science", Michigan state university-East Lansing , book, 2004.
[15]EPA "Risk assessment guidance for Superfund, Volume I: human health evaluation manual", Part E, supplemental guidance for dermal risk assessment: Interim, Review Draft--For Public Comment, 2001.
[16]Ohio Environmental Protection Agency, "Application of Bioavailability in the Assessment of Human Health Hazards and Cancer Risk", Columbus,
[17]J., Hawley, "Assessment of health risk from exposure to contaminated soil" , Risk analysis an international journal. Vol.5, no. 4, pp. 289-302, 1985.
[18]EPA, "Exposure factors handbook". Available at: http://www.epa.gov/ncea/pdfs/efh/front.pdf, 1997.
[19]FAO&WHO "Environmental Health Criteria 240 Principles and Methods for the Risk Assessment of Chemicals in Food", 2009.
[20]J. S. Hammonds, F. O. Hoffman, S .M. Bartell "An introductory guide to uncertainty analysis in environmental and health risk assessment" Es/Er/Tm 35,1994.
[21]Available online: www.epa.gov/ncea/iris/index.html
[22]Bifeng Hu, Jiayu Wang, Bin Jin, Yan Li,Zhou Shi "Assessment of the potential health risks of heavy metals in soils in a coastal industrial region of the Yangtze River Delta", Environmental Science and Pollution Research , Vol.1, no.11, pp. 19816–19826, 2017.
[23]"Regional Screening Level Table (RSL) for Chemical Contaminants at Superfund Sites", U.S. Environmental Protection Agency, 2011.
[24]Available online: http://rias. Ornl.gov.
[25]Available online: www.epa.gov.
[26]Siti Norbaya Mat Ripin, Sharizal Hasan, Mohd Lias Kamal, NorShahrizan Mohd Hashim "analysis and pollution assessment of heavy metal in soil, Perlis", The Malaysian Journal of Analytical Sciences, Vol.18, no.1, pp.155 – 161, 2014.
[27]Available online: http://www.epa.gov/osa/mmoaframework/pdfs/.

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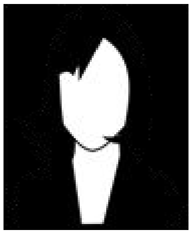

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