Risk Assessment Analysis Procedure to Control Pollution Problems in Euphrates Region in Iraq.

Sabreen Lateef Kareem
Babylon University-College of Engineering

Dr. Mohammad A.M. Al-Tufaily
Babylon University-College of Engineering

Abstract:

The present study was submitted an Environmental Risk Assessment process which is based on four steps defined by both National Academy of Science and the EPA. These are: Hazard Identification, Exposure Assessment, Toxicity Assessment, and Risk Characterization. It was taken into account four environmental media (water, industrial waste water, soil and air). At first the concentration of some heavy metal (Hg, Pb, Zn, Ni, and Cd) was measured in water media at two locations(Hilla city, near textile factory intake and at AL-Hashimya city) and concentration of (Hg, Pb, Zn, Cr, , and Cd) in industrial waste water discharged from (Hilla Textile Factory , General Company for Chemical Industries, Hilla Educational Hospital , and Hilla Slaughter), and concentration of (Hg, Pb, Zn, Ni, Cd, C6H6 and C7H8) in soil media at (Hilla city, near oil station at AL-Bakarly and at AL-Hashimya city). Samples of these environmental media were collected and analyzed for period starting from November 2009 until May 2010. For air media the concentration of lead was taken from two previous studied conducted at Hilla city. Based on these test results and data gathered, the potential human health risk assessment based on EPA model was used to calculate different types of Intake through (ingestion, dermal) for water, industrial waste water, and soil media and (ingestion, dermal and inhalation) for air media, noncarcinogen Hazard Index (HI) and carcinogen Risk (R) resulted from these exposure routes was also calculated.

The results showed that for water and industrial waste water media all values of ∑HI obtained are higher than EPA allowable limit (1) and the max.value of ∑ HI in water was 35.5929 (child) at AL-Hashimya city which resulted mainly from dermal contact of mercury in water which was 13.433 and max values of HI was 14.03 at Hilla city also from dermal contact of mercury. For industrial waste water media, max value of ∑HI was 310.5485 (child) at General Company for Chemical Industries this attributed mainly for dermal contact of mercury. In Hilla Textile Factory and Hilla Educational Hospital max value of ∑HI was 33.2386 (child), 45.5625 respectively attributed to dermal contact of chromium which was 13.128, 24.877 respectively. For soil media two types of risk generated and max value of ∑R was $6.38*10^{-6}$ (child) at Hilla city near oil station at AL-Bakarly resulted mainly from ingestion of benzene, For air also two types of risk was found but max value of ∑R inhalation was $161*10^{-6}$ (child) at Benzene station near merjan hospital.

.

Introduction:

Environmental Risk Assessment is the process of evaluating the risks associated with the presence and fate and transport of chemicals in the environment. More specifically, an environmental risk assessment is an analysis of the potential for adverse effects caused by a chemical(s) of concern from a site to determine the need for remedial action or to develop target levels where remedial action is required .It involves analyzing the sources of a release, the mechanisms of chemical transport, and the potential health risks to receptors [2]. Environmental risk assessment (ERA) involves the examination of risks resulting from natural events (flooding, extreme weather events, etc.), technology, practices, processes, products, agents (chemical, biological, radiological, etc.) and industrial activities that may pose threats to ecosystems, animals and people[1].

Environmental Risk Assessments typically fall into one of two areas:

- Human health risk assessment
- Ecological risk assessment

Environmental health risk assessment addresses human health concerns and ecological risk assessment addresses environmental media and organisms. This study deals with human health risk assessment.

Objectives of Study:

The main objectives of this study are:

1-Determination the heavy metals concentration in different environmental media (water and industrial waste water) at some contaminated sites in Babylon governorate.

2- Determination the heavy metals concentration and some semi-volatile organic compound at some contaminated sites in Babylon governorate.

3- To assess human health risks caused by these contaminants from three exposure routes (ingestion, dermal contact and inhalation) by using suitable assumptions and equations.

Environmental media, contaminants, location's name and its number on maps showed in fig (1) illustrated in table (1):

Table (1): Environmental media, contaminants, locations name and its number on maps selected in present study:

Environmental media	Contaminants	Locations name	Number on map
Water	Hg, Pb, Zn, Ni, Cd	Hilla city, near textile factory intake	1
		AL-Hashimya city	2
Industrial waste water	Hg, Pb, Zn, Cr, Cd	Hilla textile factory	3
		Hilla slaughter	4
		Hilla educational hospital	5
		General company for chemical industries	6
Soil	Hg, Pb, Zn, Ni, Cd, C_6H_6, C_7H_8.	Hilla city, near oil station at AL-Bakarly	7
		AL-Hashimya city	8

Framework of Human Health Risk Assessment:

1-Hazard Identification.

Identification of the adverse effect that a substance has an inherent capacity to cause. The human health hazard identification involves an evaluation of whether a pollutant can cause an adverse health effect in humans. The process is a qualitative risk assessment that examines the potential for exposure and the nature of the adverse effect expected. The information used in hazard identification includes human, animal and mechanistic evidence; therefore, the risk assessor must evaluate the quality of the evidence, the severity of the effects, and whether the mechanisms of toxicity in animals are relevant to humans. The result is a scientific judgment of whether a particular adverse health effect in humans is caused by a chemical or process at certain concentrations. This is the work of toxicologists and epidemiologists, who study the nature of the adverse effects caused by toxic agent and the probability of their occurrence. [3].

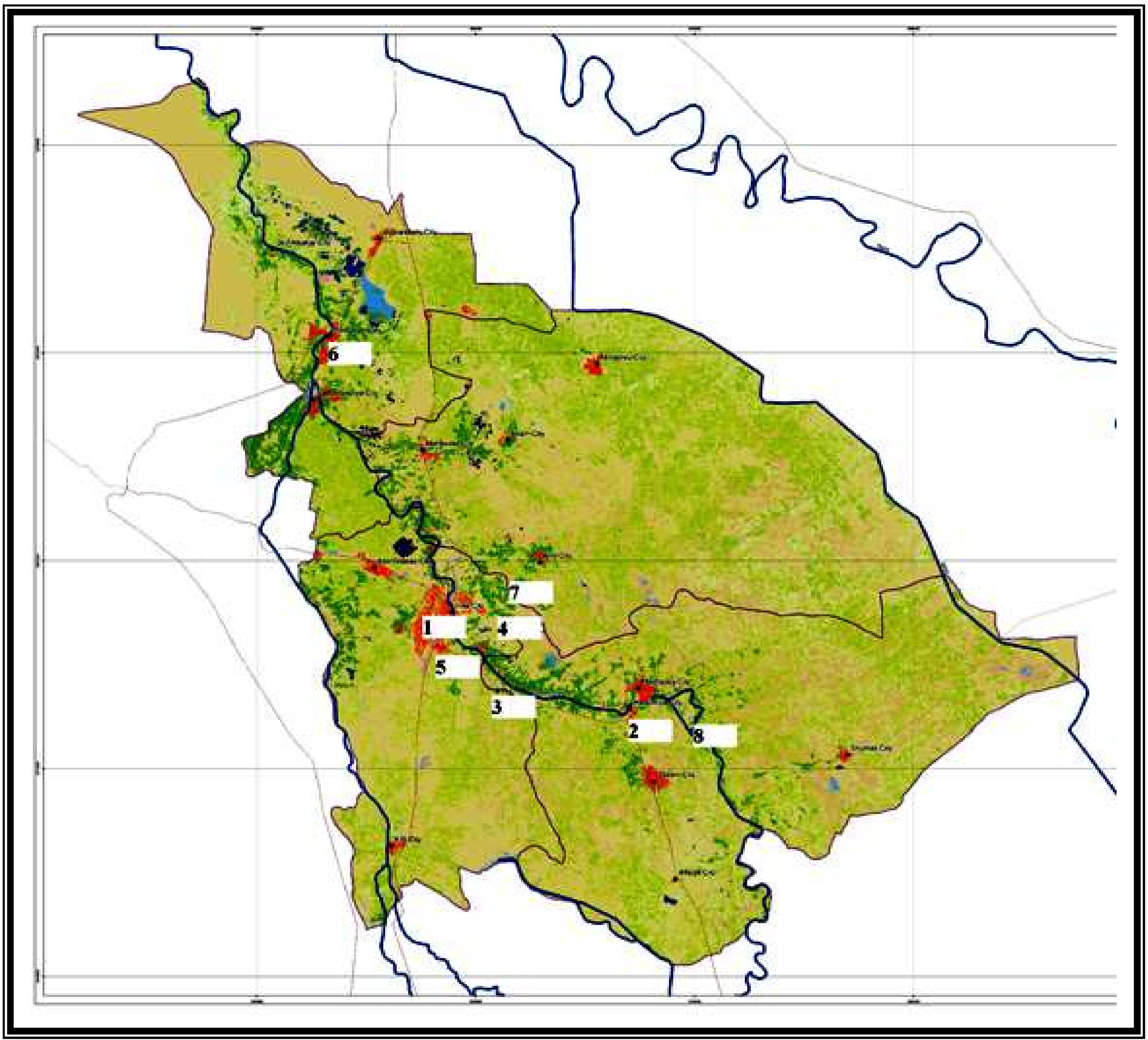

Fig (1): Babylon governorate map. [2]

2-Exposure Assessment.

Exposure is defined as contact of an organism, such as humans or an endangered species, with a contaminant. Exposure assessment is the estimation of the magnitude, frequency, duration, and route of exposure. The purpose of exposure assessment is the estimation of the contaminant concentrations and dosages to the populations at risk. More specifically, the primary tasks in exposure assessments include:

(I) Identifying potentially exposed populations,
(2) Identifying potential exposure pathways,
(3) Estimating exposure concentrations, and
(4) Estimating chemical intakes. [4].

General equation for chemical intake is:

$$\mathbf{I}=\frac{(C)(CR)(EFD)}{(BW)(AT)} \quad \textbf{.......... (1)}$$

Where:

I = intake (the amount of chemical at the exchange boundary) (mg/kg-day).

C = the average exposure concentration over the period (e.g., mg/L for water or mg/m^3 for air and mg/kg for soil).|
CR= contact rate, the amount of contaminated medium contacted per unit time (L/day or m^3/day or mg/day).
EFD = exposure frequency and duration, a variable that describes how long and how often exposure occurs. The EFD is usually divided into two terms:
EF - exposure frequency (days/year).
ED = exposure duration (years).
BW = the average body mass over the exposure period (kg).
AT = averaging time; the period over which the exposure is averaged (days).

Table (2): contaminated media and corresponding routes of exposure selected in this study. [5].

Media	Routes of exposure
Water	Ingestion, dermal contact
Industrial water	Ingestion, dermal contact
Air	Inhalation of airborne chemicals ,ingestion, dermal contact
Soil	ingestion, dermal contact

Table (3): Equations used for calculation of intake for environmental media and exposure route selected in this study. [5]

Environmental media	Exposure route	Equation
Water and industrial waste water	**Ingestion**	I = $\frac{(CW)(IR)(EF)(ED)}{(BW)(AT)}$
	dermal	AD= $\frac{(CW)(SA)(PC)(ET)(EF)(ED)(CF)}{(BW)(AT)}$
Soil	**Ingestion**	I= $\frac{(CS)(IR)(CF)(FI)(EF)(ED)}{(BW)(AT)}$
	dermal	AD= $\frac{(CS)(CF)(SA)(AF)(ABS)(EF)(ED)(EV)}{(BW)(AT)}$
Air	**Ingestion**	I= $\frac{(CA)(IR)(EF)(ED)}{(BW)(AT)}$
	dermal	AD= $\frac{(CA)(SA)(PC)(ET)(EF)(ED)(CF)}{(BW)(AT)}$
	inhalation	I= $\frac{(CA)(IR)(ET)(EF)(ED)}{(BW)(AT)}$

Where:
ABS= absorption factor for soil contaminant, unitless
AD= absorbed dose, mg/kg.d
AF= soil-to-skin Adherence Factor, mg/c m^2 ·event.
AT= averaging time, d
BW= body weight, kg
CA= contaminant concentration in air, mgm^3
CDI= chronic daily intake, mg/kg.d
CF= volumetric conversion factor for water= 1L/1.000 cm^3
= conversion factor for soil = 10^{-6} kg/mg
CR= contact rate, L/h

CS= chemical concentration in soil, mg/kg
CW= chemical concentration in water, mg/L
ED= exposure duration, y
EF= exposure frequency, d/y or events/y
ET= exposure time, h/d or h/event
EV = Event Frequency at location (events/day).
FI= fraction ingested, unitless
IR= ingestion rate, L/d or mg soil/d or kg/meal
= inhalation rate, m^3/h
PC= chemical-specific dermal permeability constant, cm/h
SA= skin surface area available for contact, cm^2 .

EPA assumptions used for each parameter:

1- Water and Industrial Waste Water media:

IR: 2L/day for adult and 1L/day for child. [4]
EF=365 days/year. [4]
ED=30 years (adult) and 5 years (child) [4]
BW= (70kg for adult) and (16 kg for child)*[5]
AT= (365*30) for adult and (365*5) for child. [4]
*16 kg is the average of 10, 14, and 26 kg which was body weight for child with ages <1.5, 1-1.5, and 5-12 year respectively.
SA=18150 cm^2 (adult) and 11940 cm^2 (child) [6].
PC=0.001(cm/hr) [7]
CF=0.001L/cm^3.
*18150 cm^2 is average for 19400 cm^2 and 16900 cm^2 which is skin surface area available for adult male and female respectively. 11940cm^2 is the average of 7200 ,9250, 11600, 14900, 16000 and 17500 cm^2 which is skin surface area available for children with ages 3-6, 6-9, 9-12, and 12-15 (for male and female), 15-18 (for female) and 15-18 years (for male) respectively.

2-Soil media:

IR=200mg/day (child) and 100mg/day (adult) [4]
CF=0.000001kg/mg
FI=1[8].
AF=2.11mg/cm^2*
*2.11mg/cm^2 was the average of 1.45 mg/c m^2 .event and 2.77 mg/c m^2.event which was Skin adherence factor for potting soil and kaolin clay to hands respectively.
EV=1 event/d [9]
CF=0.000001kg/mg.
ABS = absorption factor for soil contaminant, unitless [7].
ABS was 0.01 for mercury, lead, zinc, and nickel, 0.001 for cadmium, 0.0005 for benzene and 0.03 for toluene
The other parameters are the same used in previous item.

3- Air media:

IR=20m^3/day (adult) and 5m^3/day (child) [4].
ET=24 hour/day [4].
ED=70 year (carcinogen) [4].
AT=70*365[4].
The other parameter is the same used in previous items.

3- Toxicity Assessment:

Toxicity assessment is the acquisition and evaluation of toxicity data for each contaminant, a procedure that is performed for both noncarcinogens and carcinogens. Reference Doses (RfDs) are used to quantify noncarcinogenic toxicity; similarly, Slope Factors (SFs) are used for carcinogens. Dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., reference doses and slope factors) are derived that can be used to estimate the incidence or potential for adverse effects as a function of human exposure to the agent. These toxicity values are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels [10].

Table (4): RfD and SF for selected compound [4].

Compound	Oral RfD (mg/kg.day)	Oral SF (kg.day/mg)	Inhalation RfD (mg/kg.day)	Inhalation SF (kg.day/mg)
Mercury	0.0003			
lead	0.006			0.085
Zinc	0.3			
Nickle	0.02			
Chromium	0.005			41
Cadmium	0.0005			6.1
Benzene		0.029		0.029
Toluene	0.2			1.1

For evaluating Dermal Exposure, Oral RfDs converted to Dermal RfDs By multiplying with gastrointestinal absorption fraction (ABSGI), Oral SF can be converted to Dermal SF by dividing the Oral SF by the ABSGI.

When ABSGI values are not available, USEPA recommends the following defaults for ABSGI: 80% for volatile organics; 50% for semi-volatile organics and nonvolatile organics; and 20% for inorganic. [8].

4-Risk Characterization.

Is the calculation of risk for both noncarcinogens and carcinogens for all receptors that may be exposed to hazardous wastes. Some of the general requirements include calculating risk for all of the exposure routes to hazardous chemicals (ingestion and inhalation and dermal) for both noncarcinogens and carcinogens .Noncarcinogenic risk is calculated as Hazard Index (HI), which is the ratio of the daily intake to the reference dose (RfD).

$$HI = I/RfD \qquad (2)$$

Where:

HI = hazard index (dimensionless).

I = intake (mg/kg.day).

RfD = reference dose (mg/kg.day).

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. In such cases, detoxification and other mechanisms allow the receptor exposure to the contaminant with no toxic effects. Note that the quantitative value obtained for the HI is not a value of risk; that is, it does not provide a value for the probability of harm as the result of exposure. Instead, the hazard index quantifies the absence of effects from exposure to noncarcinogens [4].to account HI for multiple substances in one way, EPA sums the hazard indexes for each constituent as follow:

$$\text{Hazard Index}_T = \sum HI_i$$

For multiple pathways:

$$\text{Hazard Index}_T = \sum HI_{ij}$$

Where: i=the compound and j= pathways. [10]

Carcinogenic risk may be defined as the chronic daily intake dose (developed in the exposure assessment) multiplied by the carcinogenic slope factor (selected by the toxicity assessment).

The product is a real term: the probability of excess lifetime cancer from exposure to this chemical. The computation is as follows:

$$\text{Risk} = CDI \times SF \quad\text{………… (3)}$$

Where:

Risk = the probability of carcinogenic risk (dimensionless).

CDI = chronic daily intake (mg/kg.day).

SF = carcinogen slope factor (kg.day/mg).[10]

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

$$Risk_T = \sum risk_{ij}$$

Where: i=the compound and j= pathways. [10].

Sampling and Analysis:

Samples of water and industrial waste water and soil were collected and analyzed from above locations for a period starting from November 2009 until May 2010. Analysis of samples conducted in private laboratory at AL-Dewaniya city by using AAS for heavy metal analysis and GC organic compound anal

Results of Laboratory Test:

As mentioned above water, industrial waste water and soil samples were analyzed in private laboratory at AL-Dewaniya city and the results of test shown in table (5).

Table (5): Max. Ave. Min and St.dev. of contaminants concentration at sample location of present study.

Environmental media	Locations of samples	statistics	Contaminants Concentration							
			Hg	Pb	Zn	Ni	Cr	Cd	C_6H_6	C_7H_8
Surface water	Hilla, near textile factory intake	Max.	0.059	0.136	0.603	0.142	-	0.021	-	-
		Ave.	0.047	0.125	0.491	0.136	-	0.017	-	-
		Min.	0.039	0.119	0.411	0.131	-	0.015	-	-
		St. dev	0.0082	0.007	0.0787	0.0045	-	0.0025	-	-
	Hashimya city	Max.	0.058	0.244	0.667	0.403	-	0.026	-	-
		Ave.	0.045	0.163	0.65	0.335	-	0.019	-	-
		Min.	0.035	0.105	0.63	0.287	-	0.016	-	-
		St. dev	0.0094	0.057	0.0151	0.0476	-	0.0041	-	-
Industrial Waste Water	Hilla Textile Factory	Max.	0.019	0.103	0.052	0.85	0.00143	-	-	-
		Ave.	0.016	0.099	0.038	0.0733	0.001	-	-	-
		Min.	0.014	0.097	0.028	0.65	0.00075	-	-	-
		St. dev	0.002	0.0025	0.0098	0.1096	0.0003	-	-	-
	Hilla Slaughter	Max.	0.004	0.059	0.011	0.028	0.008			
		Ave.	0.003	0.051	0.008	0.015	0.005			
		Min.	0.002	0.046	0.006	0.007	0.0006			
		St. dev	0.0008	0.0054	0.0021	0.0087	0.003			

Table (5): Max. Ave. Min and St.dev. of contaminants concentration at sample location of present study. (Continued).

	Hilla Educational Hospital	Max.	0.0034	0.0825	0.0496	1.653	0.0011	-	-	
		Ave.	0.003	0.057	0.034	1.389	0.001	-	-	
		Min.	0.0023	0.0147	0.0232	1.266	0.0009	-	-	
		St. dev	0.0004	0.028	0.0109	0.1614	0.00008	-	-	
	General Company for Chemical Industries	Max.	0.6	0.004	0.05	0.006	0.006	-	-	
		Ave.	0.592	0.003	0.03	0.005	0.005	-	-	
		Min.	0.58	0.001	0.01	0.003	0.004	-	-	
		St. dev	0.0082	0.0012	0.0163	0.0012	0.0008	-	-	
Soil	Hilla, near oil station at AL-Bakarly district	Max.	0.168	40.038	48.408	38.346	-	1.058	16.579	5.948
		Ave.	0.158	38.18	46.05	35.2	-	1.035	15.65	5.847
		Min.	0.15	35.351	43.205	31.715	-	1.022	14.953	5.761
		St. dev	0.0074	1.927	2.1272	2.7082	-	0.0149	0.6662	0.0764
	Hashimya city	Max.	0.199	59.68	62.309	44.181	-	2.355	9.688	3.825
		Ave.	0.187	53.94	60.64	41.765	-	2.344	9.39	3.733
		Min.	0.179	50.009	58.034	39.904	-	2.335	9.173	3.642
		St. dev	0.0082	3.971	1.7591	1.751	-	0.0082	0.2111	0.0747

4- Air media samples:

Concentration of lead in air was taken from two previous studies conducted in Hilla city as a trial for evaluation of lead in air from variable source at different type of stations as follow: First study evaluated air lead concentration in Hilla city as a result of the industrial expansion and population increase and increasing number of cars at different locations in industrial, traffic, residential and agriculture region. Second study taken into account the effect of home generators on the concentration of lead in air as a result of electric ceasing.

1- Concentration of Lead in Hilla City Air.

Table (6): lead concentration at various station in Hilla city air: [11]

Station num.	Station name	Station type	Conc. of lead (μg/m^3)		Ave. conc. (μg/m^3)
			At (1.5m)	At (3m)	
.1	Third nader industrial district	Industrial	3.102	1.223	2.163
.2	Bab almashhad industrial distict	Industrial	3.223	1.102	2.163
.3	Althawra industrial district	Industrial	2.993	0.992	1.993
.4	Alsafafer soq region	Industrial	2.022	1.002	1.512
.5	Benzene station at bab almashhad	Traffic	2.112	2.232	2.172
.6	Benzene station at althawra	Traffic	2.953	1.772	2.363
.7	Benzene station near merjan hospital	Traffic	3.017	2.023	2.52
.8	Al moahad garage at sixty street	Traffic	2.873	2.001	2.437
.9	Galaj region	Residential	0.892	0.432	0.662
.10	Sahat al boreg region	Residential-	0.973	0.344	0.659
.11	Al ma'aredh region forty street	Traffic	2.332	1.72	2.026
.12	Babylon university region	Traffic	2.137	1.623	1.88
.13	Steel bridge station (front doctors clinics)	Traffic	2.36	1.566	1.963
.14	Althawra intersection station	Traffic	2.077	1.009	1.543
.15	Abo alqasim street	Traffic	1.953	0.932	1.443
.16	Altohmazia intersection at sixty street	Traffic	2.701	1.662	2.182
.17	Al akrad region station	Residential	1.92	0.86	1.39
.18	Alshawy distict station	Residential	2.107	1.332	1.72
.19	Agriculture region near albosultan village	agriculture	0.039	0.012	0.026
.20	Agriculture region near al nikhala	agriculture	0.021	0.008	0.015

2-Effect of Home Generator on Concentration of Lead in Air:
The following concentrations are the average of four readings in study station:

Table (7): lead concentration in air at various stations resulting from using generator. [12]

Station num.	Station name	Station type	Conc. of lead (μg/m^3)		Ave. conc. (μg/m^3)
			At (1.5m)	At (3m)	
.1	**Alshawy district**	District	1.821	1.101	1.461
.2	**Algameia district**	District	1.623	0.822	1.223
.3	**Eskan district**	District	1.223	0.722	0.973
.4	**Alzahraa district**	District	0.322	0.221	0.272
.5	**Agriculture area**	District	0.023	0.007	0.015
.6	**Home at algamea district**	Home	2.01	1.882	1.946
.7	**Home at alkarama district**	Home	2.017	1.923	1.97
.8	**Home at aldhobat district**	Home	1.993	1.733	1.863
.9	**Home at al-easkan district**	Home	2.012	1.973	1.993
.10	**Home at alaskary district**	Home	1.942	1.7	1.821
.11	**Home without generator**	Home	0.065	0.02	0.043
.12	**Beginning of al emam ali street**	Street	2.012	1.662	1.837
.13	**Middle of alemam ali street**	Street	2.212	1.772	1.992
.14	**Near alwelada hospital**	Street	1.91	1.552	1.731
.15	**Alom sahat**	Street	1.532	1.22	1.376
.16	**Court with one generator**	Court	2.11	1.86	1.985
.17	**Court with two generator**	Court	2.432	1.991	2.212
.18	**Court with three generator**	Court	2.834	1.996	2.415
.19	**Court without generator**	Court	0.123	0.066	0.095
.20	**Beginning of an generator repair street**	generator repair street	2.632	1.432	2.032
.21	**Middle of an generator repair street(1)**	generator repair street	2.821	1.552	2.187
.22	**Middle of an generator repair street(2)**	generator repair street	2.891	1.563	2.227
.23	**End of an generator repair street**	generator repair street	2.321	1.332	1.827

Calculations and Results:

Example of calculation of ingestion intake and non carcinogen HI of water (mercury-adult) by using average value of concentration at Hilla city near textile factory intake by using suitable equation and assumption.

$$I = \frac{(CW)(IR)(EF)(ED)}{(BW)(AT)}$$

= (0.047) (2) (365) (30)/ (70) (10950)
=0.0013 mg/kg.day
HI=I/RfD =0.0013/0.0003 =4.465

By the same manner for each contaminants, exposure route and environmental media, the following result were obtained.

Indicators, abbreviations and units for parameters used were shown in table (8).

Note: the following results table (9 to 26) were calculated for ave. value of concentration only.

Table (8): Indicators, Abbreviations and Units for parameter

Indicators	Abbreviations	Units
Ingestion Intake	I_{ing}	mg/kg.day
Absorbed dose from dermal contact	I_{der}	mg/kg.day
Inhalation Intake	I_{inh}	mg/kg.day
Hazard Index for ingestion	HI_{ing}	----------
Hazard Index for Dermal contact	HI_{der}	----------
Hazard Index for inhalation	HI_{inh}	----------
Risk from ingestion	R_{ing}	----------
Risk from dermal contact	R_{der}	---------
Risk from inhalation	R_{inh}	---------
Reference Dose	RfD	mg/kg.day
Slope Factor	SF	kg.day/mg
Concentration	Conc.	mg/l for water, mg/kg for soil, mg/m^3 for air.
Total noncarcinogen Hazard Index	∑HI	-----------
Total carcinogen Risk	∑R	------------

1-Water Media.

Table (9): Noncarcinogen Hazard Index and Carcinogen Risk for adult at Hilla, near textile factory intake.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	4.465	4.875	0	9.34	0	0	0	0
lead	0.594	0.6482	0	1.2422	0	0	0	0
zinc	0.047	0.0509	0	0.0979	0	0	0	0
nickle	0.194	0.2116	0	0.4056	0	0	0	0
cadmium	0.969	1.0579	0	2.0269	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				13.1126	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (10): Noncarcinogen Hazard Index and Carcinogen Risk for water, child at Hilla, near textile factory intake.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	9.792	14.03	0	23.822	0	0	0	0
lead	1.3021	1.8656	0	3.1677	0	0	0	0
zinc	0.1023	0.1465	0	0.2488	0	0	0	0
nickle	0.425	0.609	0	1.034	0	0	0	0
cadmium	2.125	3.0447	0	5.1697	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				33.4422	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (11): Noncarcinogen Hazard Index and Carcinogen Risk for water, adult at Hashimya city

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	4.275	4.667	0	8.942	0	0	0	0
lead	0.774	0.8453	0	1.6193	0	0	0	0
zinc	0.062	0.0674	0	0.1294	0	0	0	0
nickle	0.477	0.5212	0	0.9982	0	0	0	0
cadmium	1.083	1.1824	0	2.2654	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				13.9543	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (12): Noncarcinogen Hazard Index and Carcinogen Risk for child at Hashimya city.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	9.375	13.433	0	22.808	0	0	0	0
lead	1.6979	2.4328	0	4.1307	0	0	0	0
zinc	0.1354	0.194	0	0.3294	0	0	0	0
nickle	1.0469	1.5	0	2.5469	0	0	0	0
cadmium	2.375	3.4029	0	5.7779	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				35.2929	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

2- Industial Waste Water Media:

Table (13): Noncarcinogen Hazard Index and Carcinogen Risk for adult at Hilla Textile Factory.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	1.52	1.659	0	3.179	0	0	0	0
lead	0.47	0.513	0	0.983	0	0	0	0
zinc	0.004	0.004	0	0.008	0	0	0	0
chromium	4.178	4.561	0	8.739	0	0	0	0
cadmium	0.058	0.063	0	0.121	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				13.03	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (14): Noncarcinogen Hazard Index and Carcinogen Risk for child at Hilla Textile Factory.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	3.333	4.776	0	8.109	0	0	0	0
lead	1.031	1.4776	0	2.5086	0	0	0	0
zinc	0.008	0.0113	0	0.0193	0	0	0	0
chromium	9.163	13.128	0	22.291	0	0	0	0
cadmium	0.128	0.1827	0	0.3107	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				33.24	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (15): Noncarcinogen Hazard Index and Carcinogen Risk for adult at Hilla Slaughter.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	0.285	0.311	0	0.596	0	0	0	0
lead	0.244	0.2661	0	0.5101	0	0	0	0
zinc	0.0008	0.0009	0	0.0017	0	0	0	0
chromium	0.086	0.0933	0	0.1793	0	0	0	0
cadmium	0.274	0.298	0	0.572	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				1.8591	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (16): Noncarcinogen Hazard Index and Carcinogen Risk for child at Hilla Slaughter.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	0.625	0.8955	0	1.5205	0	0	0	0
lead	0.534	0.7658	0	1.2998	0	0	0	0
zinc	0.002	0.0025	0	0.0045	0	0	0	0
nickle	0.188	0.2687	0	0.4567	0	0	0	0
cadmium	0.6	0.859	0	1.459	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				4.7405	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (17): Noncarcinogen Hazard Index and Carcinogen Risk for adult at HillaEducational Hospital.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	0.285	0.3112	0	0.5962	0	0	0	0
lead	0.271	0.2956	0	0.5666	0	0	0	0
zinc	0.0032	0.0035	0	0.0067	0	0	0	0
chromium	7.917	8.6437	0	16.5607	0	0	0	0
cadmium	0.057	0.0622	0	0.1192	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				17.8494	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (18): Noncarcinogen Hazard Index and Carcinogen Risk for child at Hilla Educational Hospital.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	0.625	0.8955	0	1.5205	0	0	0	0
lead	0.5938	0.8507	0	1.4445	0	0	0	0
zinc	0.007	0.0101	0	0.0171	0	0	0	0
chromium	17.363	24.877	0	42.24	0	0	0	0
cadmium	0.125	0.1791	0	0.3041	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				45.5262	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (19): Noncarcinogen Hazard Index and Carcinogen Risk for adult at General Company for Chemical Industries.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	56.24	61.4	0	117.64	0	0	0	0
lead	0.0124	0.0135	0	0.0259	0	0	0	0
zinc	0.0029	0.0031	0	0.006	0	0	0	0
chromium	0.0262	0.0286	0	0.0548	0	0	0	0
cadmium	0.285	0.311	0	0.596	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				118.3227	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

Table (20): Noncarcinogen Hazard Index and Carcinogen Risk for adult at General Company for Chemical Industries.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	123.3	176.71	0	300.01	0	0	0	0
lead	0.027	8.8356	0	8.8626	0	0	0	0
zinc	0.006	0.009	0	0.015	0	0	0	0
chromium	0.058	0.0824	0	0.1404	0	0	0	0
cadmium	0.625	0.8955	0	1.5205	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				310.5485	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			0

3- Soil Media:

Table (21): Noncarcinogen Hazard Index and Carcinogen Risk for adult, at Hilla, near oil station at AL-Bakarly.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	0.00075	0.01441	0	0.01516	0	0	0	0
lead	0.0091	0.17406	0	0.18316	0	0	0	0
zinc	0.00022	0.0042	0	0.00442	0	0	0	0
nickle	0.00252	0.048140	0	0.05066	0	0	0	0
cadmium	0.00296	0.00566	0	0.00862	0	0	0	0
benzene	0	0	0	0	6.5E-07	2.5E-07	0	9E-07
toluene	4.2E-05	0.00096	0	0.001	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				0.263	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			9E-07

Table (22): Noncarcinogen Hazard Index and Carcinogen Risk for child, at Hilla, near oil station at AL-Bakarly

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	0.04148	0.00658	0	0.04806	0	0	0	0
lead	0.5011	0.07954	0	0.58064	0	0	0	0
zinc	0.01209	0.00192	0	0.01401	0	0	0	0
nickle	0.13859	0.022	0	0.16059	0	0	0	0
cadmium	0.0163	0.02588	0	0.04218	0	0	0	0
benzene	0	0	0	0	5.67E-6	7.1E-07	0	6.38E-06
toluene	0.00276	0.000365	0	0.003125	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				0.848	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			6.38E-06

Table (23): Noncarcinogen Hazard Index and Carcinogen Risk for adult, at AL-Hashimya City.

Contaminants	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+}R_{der+} R_{inh})$
mercury	0.00089	0.01705	0	0.01794	0	0	0	0
lead	0.01286	0.24594	0	0.2588	0	0	0	0
zinc	0.00029	0.00553	0	0.00582	0	0	0	0
nickle	0.00299	0.05712	0	0.06011	0	0	0	0
cadmium	0.0067	0.01282	0	0.01952	0	0	0	0
benzene	0	0	0	0	3.9E-07	1.49E-07	0	5.39E-07
toluene	2.67E-05	0.00061	0	0.000637	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				0.3628	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			5.39E-07

Table (2): Noncarcinogen Hazard Index and Carcinogen Risk for child, at AL-Hashimya City.

Contaminants	HI(child)(noncarcinogen)				R(child)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh}	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{ing}	R_{der}	R_{inh}	$\sum(R_{ing+} R_{der+} R_{inh})$
mercury	0.00779	0.049	0	0.05679	0	0	0	0
lead	0.112381	0.708	0	0.820381	0	0	0	0
zinc	0.002527	0.01592	0	0.018447	0	0	0	0
nickle	0.026103	0.16445	0	0.190553	0	0	0	0
cadmium	0.0586	0.0369	0	0.0955	0	0	0	0
benzene	0	0	0	0	3.4E-06	4.29E-07	0	3.83E-06
toluene	0.000233	0.00176	0	0.001993	0	0	0	0
$\sum\sum (HI_{ing+} HI_{der+} HI_{inh})$				1.183664	$\sum\sum(R_{ing+} R_{der+} R_{inh})$			3.83E-06

4- Air Media:

Table (25): Noncarcinogen Hazard Index and Carcinogen Risk for selected sites for adults.

Station name.	HI(adult)(noncarcinogen)				R(adult)(carcinogen)			
	HI_{ing}	HI_{der}	HI_{inh} 0	$\sum (HI_{ing+} HI_{der+} HI_{inh})$	R_{inh}	R_{der}	R_{inh}	$\sum (R_{ing} R_{der+} R_{inh})$
Third nader industrial district	0.10298	1.12E-05	0	1.03E-01	0	0	0.000126	0.000126
Bab almashhad industrial distict	0.10298	1.12E-05	0	1.03E-01	0	0	0.000126	0.000126
Althawra industrial district	0.09488	1.03E-05	0	9.49E-02	0	0	0.000116	0.000116
Alsafafer soq region	0.072	7.84E-06	0	7.20E-02	0	0	8.81E-05	8.81E-05
Benzene station at bab almashhad	0.10343	1.13E-05	0	1.03E-01	0	0	0.000127	0.000127
Benzene station at althawra	0.1125	1.23E-05	0	1.13E-01	0	0	0.000138	0.000138
Benzene station near mergan hospital	0.12	1.31E-05	0	1.20E-01	0	0	0.000147	0.000147
Al moahad garage at sixty street	0.11605	1.26E-05	0	1.16E-01	0	0	0.000142	0.000142
Galag region	0.03152	3.43E-06	0	3.15E-02	0	0	3.86E-05	3.86E-05
Sahat al boreg region	0.03136	3.41E-06	0	3.14E-02	0	0	3.84E-05	3.84E-05
Al ma'aredh region forty street	0.09648	1.05E-05	0	9.65E-02	0	0	0.000118	0.000118
Babylon university region	0.08952	9.75E-06	0	8.95E-02	0	0	0.00011	0.00011
Steel bridge station (front doctors	0.09348	1.02E-05	0	9.35E-02	0	0	0.000114	0.000114
Althawra intersection station	0.07348	8E-06	0	7.35E-02	0	0	8.99E-05	8.99E-05
Abo alqasim street	0.06869	7.48E-06	0	6.87E-02	0	0	8.41E-05	8.41E-05
Altohmazia intersection at sixty street	0.10388	1.13E-05	0	1.04E-01	0	0	0.000127	0.000127
Al akrad region station	0.06619	7.21E-06	0	6.62E-02	0	0	8.1E-05	8.1E-05
Alshawy distict station	0.08188	8.92E-06	0	8.19E-02	0	0	0.0001	0.0001
Agriculture region near albosultan	0.00121	1.32E-07	0	1.21E-03	0	0	1.49E-06	1.49E-06
Agriculture region near al nikhala	0.00069	7.52E-08	0	6.90E-04	0	0	8.45E-07	8.45E-07
Alshawy district	0.06957	7.58E-06	0	6.96E-02	0	0	8.52E-05	8.52E-05
Algameia district	0.05821	6.34E-06	0	5.82E-02	0	0	7.13E-05	7.13E-05
Eskan district	0.04631	5.04E-06	0	4.63E-02	0	0	5.67E-05	5.67E-05
Alzahraa district	0.01293	1.41E-06	0	1.29E-02	0	0	1.58E-05	1.58E-05
Agiculture area	0.00071	7.78E-08	0	7.10E-04	0	0	8.74E-07	8.74E-07
Home at algamea district	0.09267	1.01E-05	0	9.27E-02	0	0	0.000113	0.000113
Home at alkarama district	0.09381	1.02E-05	0	9.38E-02	0	0	0.000115	0.000115
Home at aldhobat district	0.08871	9.66E-06	0	8.87E-02	0	0	0.000109	0.000109
Home at al-easkan district	0.09488	1.03E-05	0	9.49E-02	0	0	0.000116	0.000116
Home at alaskary district	0.08671	9.44E-06	0	8.67E-02	0	0	0.000106	0.000106
Home without generator	0.00202	2.2E-07	0	2.02E-03	0	0	2.48E-06	2.48E-06
Beginning of al emam ali street	0.08748	9.53E-06	0	8.75E-02	0	0	0.000107	0.000107
Middle of alemam ali street	0.09486	1.03E-05	0	9.49E-02	0	0	0.000116	0.000116
Near alwelada hospital	0.08243	8.98E-06	0	8.24E-02	0	0	0.000101	0.000101
Alom sahat	0.06552	7.14E-06	0	6.55E-02	0	0	8.02E-05	8.02E-05
Court with one generator	0.09452	1.03E-05	0	9.45E-02	0	0	0.000116	0.000116
Court with two generator	0.10531	1.15E-05	0	1.05E-01	0	0	0.000129	0.000129
Court with three generator	0.115	1.25E-05	0	1.15E-01	0	0	0.000141	0.000141
Court without generator	0.0045	4.9E-07	0	4.50E-03	0	0	5.51E-06	5.51E-06
Beginning of an generator repair street	0.09676	1.05E-05	0	9.68E-02	0	0	0.000118	0.000118
Middle of an generator repair street	0.10412	1.13E-05	0	1.04E-01	0	0	0.000127	0.000127
Middle of an generator repair street	0.10605	1.15E-05	0	1.06E-01	0	0	0.00013	0.00013
End of an generator repair street	0.08698	9.47E-06	0	8.70E-02	0	0	0.000106	0.000106

Table (26): Noncarcinogen Hazard Index and Carcinogen Risk for selected sites for child.

Station name.	**HI(child)(noncarcinogen)**				**R(child)(carcinogen)**			
	HI_{ing}	**HI_{der}**	**HI_{inh}**	**$\sum(HI_{ing+} HI_{der+} HI_{inh})$**	**R_{inh}**	**R_{der}**	**R_{inh}**	**$\sum(R_{ing+} R_{der+} R_{inh})$**
Third nader industrial district	0.11263	3.23E-05	0	1.13E-01	0	0	0.000138	0.000138
Bab almashhad industrial distict	0.11263	3.23E-05	0	1.04E-01	0	0	0.000138	0.000138
Althawra industrial district	0.10378	2.97E-05	0	7.88E-02	0	0	0.000127	0.000127
Alsafafer soq region	0.07875	2.26E-05	0	1.13E-01	0	0	9.64E-05	9.64E-05
Benzene station at bab almashhad	0.11313	3.24E-05	0	1.23E-01	0	0	0.000138	0.000138
Benzene station at althawra	0.12305	3.53E-05	0	1.31E-01	0	0	0.000151	0.000151
Benzene station near merjan hospital	0.13125	3.76E-05	0	1.27E-01	0	0	0.000161	0.000161
Al moahad garage at sixty street	0.12693	3.64E-05	0	3.45E-02	0	0	0.000155	0.000155
Galaj region	0.03448	9.88E-06	0	3.43E-02	0	0	4.22E-05	4.22E-05
Sahat al boreg region	0.0343	9.83E-06	0	1.06E-01	0	0	4.2E-05	4.2E-05
Al ma'aredh region forty street	0.10552	3.02E-05	0	9.79E-02	0	0	0.000129	0.000129
Babylon university region	0.09792	2.81E-05	0	1.02E-01	0	0	0.00012	0.00012
Steel bridge station (front doctors	0.10224	2.93E-05	0	8.04E-02	0	0	0.000125	0.000125
Althawra intersection station	0.08036	2.30E-05	0	7.52E-02	0	0	4.22E-05	4.22E-05
Abo alqasim street	0.07513	2.15E-05	0	1.14E-01	0	0	3.94E-05	3.94E-05
Altohmazia intersection at sixty street	0.11362	3.26E-05	0	7.24E-02	0	0	5.96E-05	5.96E-05
Al akrad region station	0.0724	2.07E-05	0	8.96E-02	0	0	3.8E-05	3.8E-05
Alshawy distict station	0.08956	2.57E-05	0	1.33E-03	0	0	4.7E-05	4.7E-05
Agriculture region near albosultan	0.00133	3.81E-07	0	7.60E-04	0	0	6.97E-07	6.97E-07
Agriculture region near al nikhala	0.00076	2.16E-07	0	7.61E-02	0	0	3.96E-07	3.96E-07
Alshawy district	0.07609	2.18E-05	0	6.37E-02	0	0	3.99E-05	3.99E-05
Algameia district	0.06367	1.82E-05	0	5.07E-02	0	0	3.34E-05	3.34E-05
Eskan district	0.05065	1.45E-05	0	1.41E-02	0	0	2.66E-05	2.66E-05
Alzahraa district	0.01414	4.05E-06	0	7.80E-04	0	0	7.42E-06	7.42E-06
Agiculture area	0.00078	2.24E-07	0	1.01E-01	0	0	4.1E-07	4.1E-07
Home at algamea district	0.10135	2.90E-05	0	1.03E-01	0	0	5.32E-05	5.32E-05
Home at alkarama district	0.1026	2.94E-05	0	9.71E-02	0	0	5.38E-05	5.38E-05
Home at aldhobat district	0.09703	2.78E-05	0	1.04E-01	0	0	5.09E-05	5.09E-05
Home at al-easkan district	0.10378	2.97E-05	0	9.49E-02	0	0	5.44E-05	5.44E-05
Home at alaskary district	0.09484	2.72E-05	0	2.21E-03	0	0	4.98E-05	4.98E-05
Home without generator	0.00221	6.34E-07	0	9.57E-02	0	0	1.16E-06	1.16E-06
Beginning of al emam ali street	0.09568	2.74E-05	0	1.04E-01	0	0	5.02E-05	5.02E-05
Middle of alemam ali street	0.10375	2.97E-05	0	9.02E-02	0	0	5.44E-05	5.44E-05
Near alwelada hospital	0.09016	2.58E-05	0	7.17E-02	0	0	4.73E-05	4.73E-05
Alom sahat	0.07167	2.05E-05	0	1.03E-01	0	0	3.76E-05	3.76E-05
Court with one generator	0.10339	2.96E-05	0	1.15E-01	0	0	5.42E-05	5.42E-05
Court with two generator	0.11518	3.30E-05	0	1.26E-01	0	0	6.04E-05	6.04E-05
Court with three generator	0.12578	3.60E-05	0	4.92E-03	0	0	6.6E-05	6.6E-05
Court without generator	0.00492	1.41E-06	0	1.06E-01	0	0	2.58E-06	2.58E-06
Beginning of an generator repair street	0.10583	3.03E-05	0	1.14E-01	0	0	5.55E-05	5.55E-05
Middle of an generator repair street	0.11388	3.26E-05	0	1.16E-01	0	0	5.97E-05	5.97E-05
Middle of an generator repair street	0.11599	3.32E-05	0	9.52E-02	0	0	6.08E-05	6.08E-05
End of an generator repair street	0.09513	2.73E-05	0	0.00E+00	0	0	4.99E-05	4.99E-05

Conclusion:

From this study the following conclusions are obtained :

1- Air media in Hilla city was high polluted by lead, especially at industrial, traffic, generator repair street, doctors courts with three generators and benzene station. This attributed to the addition of lead to benzene and emission of lead after fuel incineration, therefore inhalation intake and risk were very high which may cause cancer or other diseases related to lead poisoning.

2- For soil media, noncarcinogen HI resulted from ingestion of soil was insignificant but the cumulative non-carcinogenic risk resulted from dermal contact tends to become significant , mainly for children , since it approaches unacceptable values and there was no particularly dangerous single heavy metal , but their cumulative effect, , is for concern. Carcinogen risk was resulted mainly from ingestion of soil also, mainly for children especially location near oil station.

3- For water, the high mercury levels caused by seepage of mercury to river from polluted areas which are located near the sources of pollution and lie near the banks of Shatt Al-Hilla river and attributed to the presence of many companies and factories that discharge waste directly into river or due to natural sources coming from the erosion of sediment or from solid contained devices that used mercury such fluorescent lamp. The other reason for exceeding other heavy metals such cadmium, lead may be attributed to different reasons such as chemical compounds which are used in agricultural purposes such as commercial fertilizers and pesticides, phosphate fertilizers contain different concentration of cadmium. Lead in river resulted from the burning process of lead tetraethyl (used as anti-knock) in the internal combustion machines**.** This phenomenon has a significant effect on lead levels in river water especially after the great increase in the number of cars in the country after 2003.

4- For industrial waste water media, the exceeding of mercury at general company for chemical industries resulted from the using of mercury cells in brine purification unit in caustic soda plat and chloride drying process plant.

In Hilla Textile Factory max value of ∑HI was 33.2386 (child) attributed to dermal contact of chromium which was 13.128 and this exceeding attributed to the using of metlic dyes trough dyeing and printing process.[13] For Hilla Educational Hospital max value of ∑HI was 45.5625 attributed to using of heavy metal in different way such X-ray room , Dental care center (dental fillings) , Renal dialysis and/or mechanical department.

الخلاصة:

الدراسة الحالية قدمت عملية تقييم المخاطر البيئية والتي تعتمد على أربع خطوات مقرة من قبل الأكاديمية الوطنية للعلوم، و وكالة حماية البيئة. الخطوات الأربعة هي: تعريف الخطر، تقييم التعرض، تقييم السمية وأخيرا تحديد مقدار الخطورة. أخذت هذه الدراسة بنظر الاعتبار أربع أوساط بيئية تتمثل ب(المياه ، مياه الفضلات الصناعية ، التربة أخيرا الهواء).

بداية تم قياس تركيز بعض المعادن الثقيلة(الزئبق ، الرصاص، الخارصين ، النيكل والكادميوم) في المياه عند (حلة/قرب مأخذ النسيج ، مدينة الهاشمية) وتركيز كل من (الزئبق ، الرصاص، الخارصين، الكروم والكادميوم)في مياه الفضلات الصناعية المطروحة من (معمل نسيج الحلة، مجزرة الحلة، مستشفى الحلة التعليمي و الشركة العامة للصناعات الكيمياوية/ معمل حرير السدة) بالإضافة إلى تركيز كل من (الزئبق ، الرصاص، الخارصين ، النيكل،الكادميوم، البنزين والتلوين) في التربة عند المواقع (حلة/قرب محطة نفط البكرلي ، مدينة الهاشمية). تم جمع العينات وتحليلها خلال فترة الدراسة ابتداء من (تشرين الثاني 2009 ولغاية مايس 2010) أما بالنسبة لبيئة الهواء فان تركيز الرصاص أخذت من دراستين سابقتين أجريت في مدينة الحلة.

بالاعتماد على النتائج السابقة تم حساب جرع (الهضم والجلد) في بيئة المياه ومياه الفضلات الصناعية والتربة بالإضافة إلى جرع (الهضم، الجلد والاستنشاق) في الهواء ، أيضا تم حساب الخطر الغير مسرطن متمثلا بمؤشر الخطر والخطر المسرطن عند مسارات التعرض والأوساط البيئية المذكورة.

أظهرت النتائج انه مؤشر الخطر الكلي للمياه والمياه الصناعية كان أعلى من الحدود المسموحة المقرة من قبل وكالة حماية البيئة وان أعلى قيمة له في المياه كان 35.5929 للأطفال والذي يعود نتيجة للتلامس الجلدي للزئبق في المياه البالغ 13.433أما أعلى قيمة لمؤشر الخطر كانت 14.03 في مدينة الحلة للسبب نفسه.

أما بالنسبة للمياه الصناعية فان أعلى قيمة لمؤشر الخطر الكلي كان 310.5485للأطفال عند الشركة العامة للصناعات الكيماوية ناتج عن السبب المذكور .أما بالنسبة لمصنع نسيج الحلة ومستشفى الحلة التعليمي فان قيمة مؤشر الخطر الكلي كانت 33.2386 ، 45.5625 للأطفال بالترتيب ناتج عن التلامس الجلدي مع الكروم البالغ 13.128، 24.877 للأطفال بالترتيب.

أما بالنسبة للتربة كان هناك خطر غير مسرطن والأخر مسرطن الأول ضمن الحدود المسموحة ماعدا مدينة الهاشمية كان مؤشر الخطر الكلي 1.18 للأطفال وهو لايرجع لملوث واحد بل ناتج عن مجموع المؤشرات للملوثات الغير المسرطنة ككل أما الثاني فان أعلى قيمة له $6.38*10^{-6}$ للأطفال يعود للبنزين في التربة . أما بالنسبة للهواء فان قيم الخطر الغير مسرطن كانت ضمن الحدود المسموحة أما المسرطن فان أعلى قيمه له كانت $161*10^{-6}$ للأطفال عند محطة تعبئة البنزين قرب مستشفى مرجان.

References :

1. Ortolano. L., (1997)**, "Environmental Regulation and Impact Assessment"**, John Wiley &Sonc,Inc.
2. **"Physical Planning Directorate in Babylon Governorate "**(2006).
3. Sonnemann, G, (2004)**, "Integrated Life-Cycle and Risk AssessmentFor Industrial Processes",** Lewis Publishers.
4. Richard J.Watts**,** (1997), **"Hazardous Wastes",** department of Civil and Environmental engineering**,** Washington state university, copy by John Wiley & Sons
5. Susan J . M., (2004), "**Principles of Environmental Engineering and Science",** McGraw Hill, New York.
6. USEPA, (1997), **"Exposure Factor Handbook"**,
7. USEPA (1992), "**Dermal Exposure Assessment: Principal and Applications**", EPA/600/8-91/011B.
8. Rodriguez R. · Grant R. L. (2005)**, "Handbook of Environmental Chemistry Vol. 5, Part F**,**"** Springer-Verlag Berlin Heidelberg.
9. Mark G. R., (2007), **"Risk Assessment for Environmental Health",** John Wiley & sons.
10. USEPA, (1989), **"Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)",** (EPA/540/1-89/002).
11. Dakhil N., Alaa K. Israa S**., (**2005**), ''First Scientific Conference for Environmental Searches'',** Babylon University, Iraq.
12. Dakhil N., Alaa K. Israa S**., (**2005**), "Effect of home generation on concentration of lead in air**"**'',** Babylon University magazine.
13. Nemerow, N., L., (1978), **"Industrial Water Pollution Origins, Characteristics, and Treatment"**, Addison Wesley Publishing company USA.