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Evaluation of Some Heavy Metals around the Municipal Solid Waste Disposal Area in Halabja City –Kurdistan Region of Iraq

Sherko A. Muhammad[1] and Salar H.Karim[1]*

[1] *Biology Department, College of Science, University of Sulaimani, Kurdistan Regin, Iraq*

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Abstract

Handling and disposal of solid waste can be a major environmental problem in developing countries. In Kurdistan region of Iraq solid waste is not treated and managed properly. It is only collected from the households and disposed on the outskirts of the cities as a pile of garbage nearby the agricultural areas, sometime it is burnt or partially dumped. The samples were collected monthly starting from May to December 2012 including ground and surface water, soil and wheat around the solid waste disposal area. Heavy metal and metalloid concentrations measured for Zn, As, Cd, Fe, Pb and Ni were (0.002 – 0.012) mg.l^{-1}, (0.01 – 0.097) mg.l^{-1}, (0.002 – 0.003) mg.l^{-1}, (0.011- 0.079) mg.l^{-1}, (0.035 – 0.051) mg.l^{-1} and (0.004 -0.015) mg.l^{-1} for ground water respectively, while (0.003 - 0.009) mg.l^{-1}, (0.05 – 0.16) mg.l^{-1}, (0.002 – 0.004) mg.l^{-1}, (0.051 – 0.171) mg.l^{-1}, (0.04 – 0.044) mg.l^{-1}, (0.021 – 0.022) mg.l^{-1} for surface water respectively. However, As and Pb concentration were found to be higher than the permissible values recommended by WHO for drinking water quality while the rest were below the safe limits. The concentrations of heavy metals and metalloids were found in order of Mn> Zn>Cu >Ni> Pb>Cr>As> Cd (987 - 1187 mg.kg^{-1}, 225.03 – 915.3 mg.kg^{-1}, 232.8- 301.1 mg.kg^{-1}, 150.4 – 192.2 mg.kg^{-1}, 76.71 - 193.1 mg.kg^{-1}, 142.2 – 173.1 mg.kg^{-1}, 14.23 – 20.15 mg.kg^{-1} and 2.317 – 5.712 mg.kg^{-1}) which exceed the European union standard for Ni, Zn, Cr, Cd, Mn, Cu, while Pb and As were found to be within the range of all trace elements for agricultural soils. The range for trace elements for wheat samples were 115 mg.kg^{-1} for Zn, 0.0313 mg.kg^{-1} for As, 1.2 mg.kg^{-1} for Cd, 2.1 mg.kg^{-1} for Pb, 1.19 mg.kg^{-1} for Ni and 0.058 mg.kg^{-1} for Cr.

Introduction

Solid waste municipal constitutes a more problem in many third World cities. Most cities do not collect the totality of wastes generated in a proper way, and collecting wastes only as fraction and dumping caused to represent in source of water, land and air pollution, and pose risks to human health and the environment. (Ogbonna *et al*., 2009; Afolayan *et al.*, 2012)

The major environmental problems experienced around the open dump site are the subsequent contamination of surface and groundwater via discharged leachate. When groundwater becomes polluted, the risk of surface water contamination also increases because groundwater recharges surface water more than any other source, including precipitation (LawmaA, 2010; Amuno, 2011). Solid waste disposal in to open dumps is the normal practices by many country. During the rainy days penetrate and formation occurs from the wastes which enters nearby water resources and penetrate deep down in to ground water or the surface water. Leachates compounds composed of high level of organic substances, soluble salts and toxic heavy metals (Obodo, 2001 and Dibakar *et al*., 2012).

Description of the study area:

In general, Kurdistan region of Iraq is a mountainous region. It surrounding by Syria from the west, Iran to the east and Turkey to the north, where fertile plains meet the Zagros Mountains. Kurdistan region boundaries extend from longitude 42° 15 E to 47° 30 E and from latitude 34° 25 N to 37° 50 N. It covers an area of approximately 165000 Km^2.

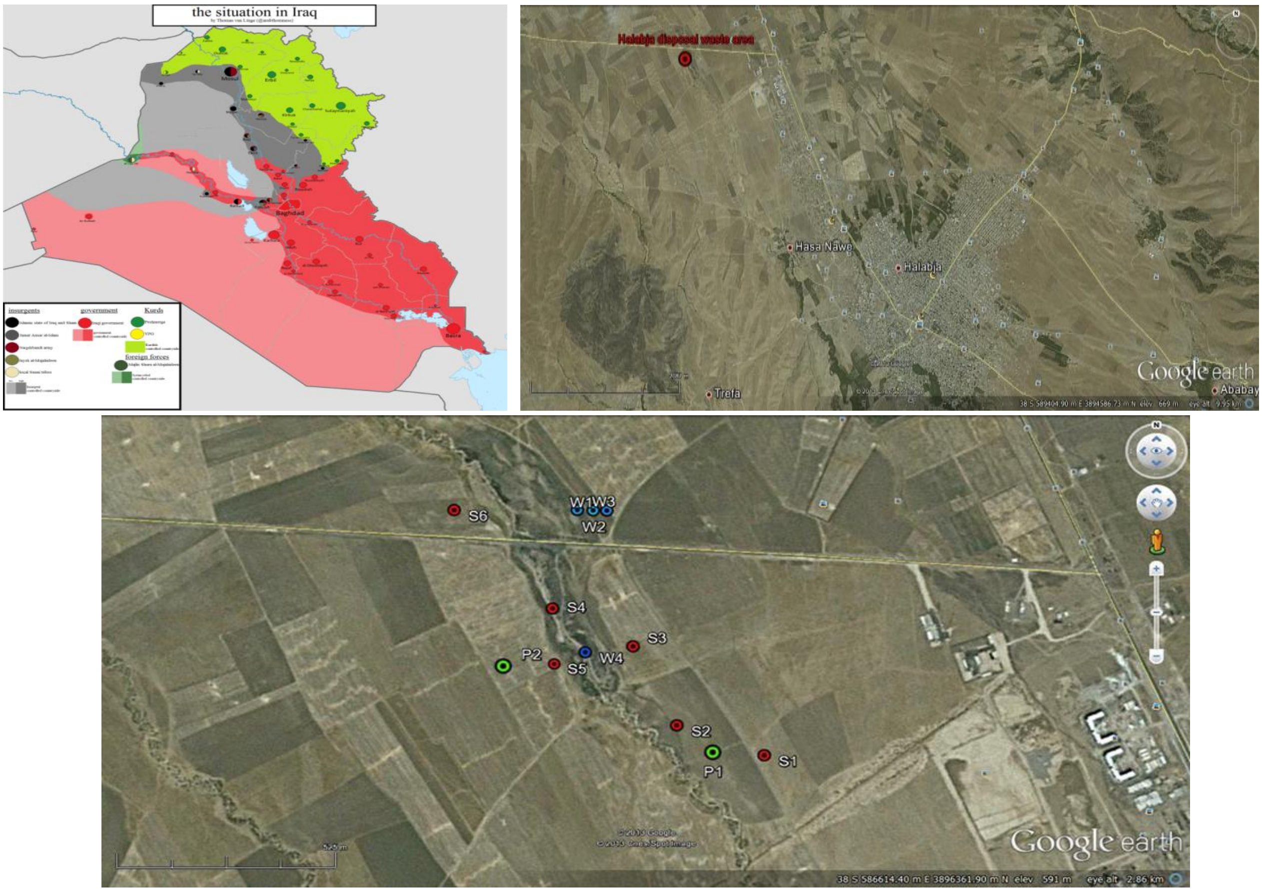

Figure (3.1) Map shows :(Google Earth 2010):

A- Kurdistan Region of Iraq, Halabja District is Blue Coloured.

B- Satellite imager map of Halabja Province showing locations of the studied area

C- Satellite imager showing locations of sample site area

*** S** for soil sample ***W** for water samples ***W4** for surface water ***P** for grain samples

Table (1) Sites, Coordinates and Description of each soil, water and grain sites

Sample	Latitude	Longitude	Elevation	Site description
Soil site 1	35.204703°	45.954147°	606 M	Located 150 m Up ward of dumping site
Soil site 2	35.205099°	45.953325°	598 M	Located 20 m Inside dumping site
Soil site 3	35.205099°	45.953325°	590 M	Located 75 m Up word of dumping site.
Soil site 4	35.206767°	45.953490°	586 M	Located 50 m Down word of dumping site
Soil site 5	35.206388°	45.949843°	591 M	Located 100 Down word of dumping site
Soil site 6	35.206373°	45.949838°	582 M	Located 200 m Down word of dumping site
Site 1 ground water	35.205709°	45.954448°	586 M	Located 150 m at the lateral side on the dumping drilled at 2007 with a depth of 90 m
Site 2 ground water	35.205720°	45.954436°	587 M	Located 155 m on the lateral side of the dumping drilled at 2008 with depth of 100 m
Site 3 ground water	35.205715°	45.954435°	588 M	Located 175 m on the lateral side of the dumping drilled at 2006 with a depth of 85 m
Site 4 surface water	35.206745°	45.953479°	585 M	Located 25 m at the lateral down word of the dumping side
Grain sample site 1	35.205721°	45.954437°	591 M	Located 50 m up word of dumping side
Grain sample site 2	35.206499°	45.949733°	604 M	Located 20 m at the down word of dumping side

Materials and Methods:

In the present study, monthly sampling was carried out around the Halabja municipal solid waste dumping sites; ten sites were selected in order to determine the level of heavy metals in grain plant samples. Water and Soil samples were regularly collected from 10 sites and 2 grain sample sites around and within the solid waste dumping area within Halabja city Kurdistan region. for heavy metals detection to minimize the precipitation and adsorption to the container wall were acidified with concentration HNO_3 to bring pH < 2, and stored in refrigerators for later determination (APHA, 2005).

Soil and water sample collection:

Soil and water samples were collected from May to December 2012 , monthly soil collected from (0 to 20) cm depth from surface for detecting some chemical, and physical properties, Soil samples were collected using a clean stainless steel trowel or auger and were sealed in plastic bags for transport. The samples were air dried in aluminium trays, gently disaggregated using a pestle and sieved to obtain a <2 mm fraction. A portion of each sample was finely grained using an agate ball mill

Water analysis for trace heavy metals concentrations: Water trace elemental analysis was undertaken by ICP-OES (Inductively Coupled Plasma-Optical Emission Spectroscopy) model 2100 Perkin Elmer in ‘collision cell mode’(7% hydrogen in helium) to reduce polyatomic interferences. Samples were brought from an autosampler (Cetac ASX-520 with 4 x 60-place sample racks) through a concentric glass venturi nebuliser (Thermo-FisherScientific; 1 ml.min^{-1}). Internal standards were introduced to the sample stream via a T-piece and included Sc (100 ng mL-1), Rh (20 ng mL^{-1}) and Ir (10 ng mL^{-1}) in 2% TEG HNO3. External multi-element calibration standards (Claritas-PPT grade CLMS-2, Certiprep/Fisher) included Al, As, Ca, Cd, Co, Cr, Cs, Cu, Fe, Mn, Mo, Ni, Pb and Zn, all in the preferred range of 0-100 µg. l^{-1}. Samples processing were undertaken using Plasma lab software (version 2.5.4; Thermo-Fisher Scientific) set to employ separate calibration blocks and internal cross-calibration where required (Nabulo *et al*., 2012).

Results

From the onset results that shown in the tables below calculated for the studied sites over the studied period were as the following:

Table (2): Zinc (Zn) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja city from May to December 2012.

Studied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.004	0.01	0.012	0.009	0.004	0.003	0.0022	0.004	0.006b	0.0008
Well 2	0.003	0.004	0.004	0.004	0.0025	0.0022	0.0025	0.003	0.003a	0.0037
Well 3	0.004	0.004	0.003	0.002	0.002	0.002	0.0022	0.004	0.003a	0.0008
Mean	0.004b	0.006c	0.006c	0.005bc	0.003ab	0.0024a	0.002a	0.003ab	0.004	0.0026
±SD	0.0003	0.0031	0.0042	0.0031	0.0009	0.0005	0.0005	0.001	0.0026	0.0026
Surface										
Stations 1	0.003	0.004	-	-	-	-	0.006	0.009	0.005	0.0023
Mean	0.003	0.004	-	-	-	-	0.006	0.009	0.005	0.0023
±SD	0.0001	0.0001	-	-	-	-	0	0.0001	0.0023	0.0023

Table (3): Arsenic (As) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja city from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.01	0.011	0.016	0.045	0.052	0.093	0.013	0.014	0.032a	0.028
Well 2	0.016	0.014	0.02	0.016	0.061	0.073	0.096	0.013	0.039c	0.032
Well 3	0.014	0.013	0.019	0.015	0.059	0.068	0.097	0.014	0.037b	0.032
Mean	0.014b	0.013a	0.019c	0.026d	0.057e	0.078f	0.069g	0.0135	0.036	0.03
±SD	0.003	0.002	0.002	0.015	0.004	0.012	0.042	0.002	0.03	0.03
Surface water										
Stations 1	0.05	0.06	-	-	-	-	0.13	0.16	0.1	0.05
Mean	0.05	0.06	-	-	-	-	0.13	0.16	0.1	0.05
±SD	0.001	0.001	-	-	-	-	0.002	0.001	0.05	0.05

Table (4): Cadmium (Cd) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja city from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.003	0.0026	0.0023	0.0022	0.003	0.003	0.0025	0.003	0.003b	0.0005
Well 2	0.0027	0.0022	0.0022	0.0021	0.0025	0.0023	0.0022	0.0025	0.002a	0.0005
Well 3	0.0029	0.002	0.002	0.0025	0.0029	0.0029	0.0025	0.0028	0.003b	0.0004
Mean	0.003b	0.0022	0.002a	0.0022	0.003b	0.003b	0.003b	0.003b	0.003	0.0005
±SD	0.0004	0.0002	0.0003	0.0005	0.0004	0.0005	0.0002	0.0003	0.0005	0.0005
Surface water										
Stations 1	0.003	0.002	-	-	-	-	0.0025	0.004	0.0025	0.0003
Mean	0.003	0.002	-	-	-	-	0.0025	0.0035	0.003	0.0003
±SD	0.0005	0.0001	-	-	-	-	0.0001	0.0001	0.0003	0.0003

Table (5): Iron (Fe) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid Waste disposal Area in Halabja city from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.032	0.013	0.023	0.069	0.078	0.052	0.049	0.052	0.046b	0.021
Well 2	0.012	0.016	0.011	0.067	0.079	0.036	0.036	0.027	0.036ab	0.021
Well 3	0.013	0.015	0.012	0.064	0.076	0.038	0.038	0.028	0.035a	0.023
Mean	0.019b	0.014a	0.015a	0.067f	0.078e	0.042d	0.041d	0.036c	0.039	0.023
±SD	0.01	0.001	0.006	0.002	0.001	0.008	0.006	0.012	0.023	0.023
Surface water										
Stations 1	0.051	0.076	-	-	-	-	0.096	0.171	0.099	0.0468
Mean	0.051	0.076	-	-	-	-	0.096	0.171	0.099	0.0468
±SD	0.0006	0.0006	-	-	-	-	0.0006	0.0006	0.0468	0.0468

Table (6): Lead (Pb) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid waste Disposal area in Halabja city from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.051	0.037	0.036	0.035	0.038	0.039	0.038	0.039	0.039a	0.005
Well 2	0.046	0.043	0.042	0.04	0.039	0.037	0.039	0.039	0.041b	0.003
Well 3	0.045	0.043	0.041	0.042	0.039	0.038	0.039	0.038	0.041b	0.003
Mean	0.048c	0.041b	0.040b	0.039a	0.039a	0.038a	0.039ab	0.039a	0.04	0.004
±SD	0.003	0.004	0.003	0.003	0.001	0.001	0.001	0.001	0.004	0.004
Surface water										
Stations 1	0.042	0.04	-	-	-	-	0.041	0.044	0.04	0.0016
Mean	0.042	0.04	-	-	-	-	0.041	0.044	0.042	0.0016
±SD	0.0005	0.0003	-	-	-	-	0.0013	0.0012	0.0016	0.0016

Table (7): Nickel (Ni) Concentration in Water (mg.l^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja city from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Well water										
Well 1	0.006	0.015	0.008	0.007	0.007	0.007	0.008	0.009	0.008ab	0.003
Well 2	0.008	0.015	0.013	0.005	0.0068	0.008	0.006	0.007	0.009b	0.004
Well 3	0.008	0.009	0.008	0.004	0.007	0.006	0.007	0.006	0.007a	0.002
Mean	0.007b	0.013c	0.010b	0.005a	0.007b	0.007b	0.007b	0.007b	0.008	0.003
±SD	0.001	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.003	0.003
Surface water										
Stations 1	0.021	0.022	-	-	-	-	0.021	0.022	0.021	0.0023
Mean	0.021	0.022	-	-	-	-	0.021	0.022	0.021	0.0023
±SD	0.0032	0.0006	-	-	-	-	0.0006	0.0025	0.0023	0.0023

Table (8): Zinc (Zn) Concentration in Soil (mg.kg^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Station 1	527.34	432.01	356.61	356.61	411.15	418.52	413.01	444.79	420.00c	51.7
Station 2	397.57	379.24	363.58	360.74	371.79	426.05	370.97	371.95	380.24b	20.99
Station 3	370.99	607.51	661.31	862.12	616.43	628.45	915.34	686.39	668.57f	160.28
Station 4	425.27	527.86	397.11	357.75	524.78	628.45	915.2	627.57	550.52d	173.2
Station 5	403.43	356.61	415.59	421.27	403.11	366.07	370	355.84	386.49b	27.23
Station 6	299.21	260.32	277.69	283.76	275.77	282.73	225	241.29	268.22a	23.61
Mean	403.97	427.26b	411.98a	440.38c	433.84bc	458.38d	534.95e	454.64d	445.7	162.95
±SD	70.1	121.81	123.73	198.39	113.01	132.81	283.72	160.44	162.95	51.7

Table (9): Arsenic (As) Concentration in Soil (mg.kg^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	
Station 1	14.25	17.72	16.32	17.04	17.4	17.26	14.75	15.82	16.32c	1.27
Station 2	15.94	17.52	17.27	18.73	18.09	17.26	16.67	16.82	17.29d	1.15
Station 3	16.61	16.68	18.1	18.81	19.32	20.15	16.09	16.25	17.75e	1.54
Station 4	15.8	17.71	17.54	17.02	16.66	16.69	15.33	16.03	16.60c	0.9
Station 5	16.63	14.23	16.04	16.99	16.63	15.65	15.96	15.54	15.96b	1
Station 6	14.8	15.16	14.43	14.43	14.93	15.09	14.74	14.58	14.77a	0.34
Mean	15.67a	16.50b	16.62b	17.17c	17.17c	17.02c	15.59a	15.84a	16.45	1.45
±SD	0.95	1.47	1.28	1.57	1.42	1.72	1.2	0.81	1.45	1.45

Table (10): Nickle (Ni) Concentration in Soil (mg.kg^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Station 1	158.9	186.85	171.03	171.16	174.17	174.53	184.73	162.56	172.99ab	9.44
Station 2	160.47	190.27	180.39	179.4	169.83	168.54	181.73	172.93	175.45b	10.67
Station 3	175.38	180.97	183.35	190.71	185.14	185.7	184.74	185.16	183.89c	5.49
Station 4	171.17	192.2	172.53	172.06	171.94	175.21	172.67	176.23	175.50b	7.81
Station 5	179.62	166.14	173.84	175.29	181.68	173.85	174.86	179.94	173.68b	10.92
Station 6	167.24	150.4	172.13	170.25	175.65	172.18	168.13	172.18	170.49a	4.1
Mean	168.80a	177.81b	175.55b	176.48b	176.40b	175.00b	177.82b	174.83b	175.3	9.32
±SD	158.9	186.85	171.03	171.16	174.17	174.53	184.73	162.56	172.99	91.2

Table (11): Chrome (Cr) Concentration in Soil (mg.kg^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Station 1	146.22	166.49	153.69	151.44	161.48	165.88	167.3	161.17	159.20bc	7.96
Station 2	142.88	170.06	165.14	163.53	163.65	157.79	170.28	164.89	162.27d	9.81
Station 3	157.57	162.38	167.66	173.1	170.56	171.48	167.3	168.62	167.33e	6.05
Station 4	155.79	169.6	160.8	157.95	157.95	160.64	161.82	161.21	160.72cd	5.88
Station 5	155.79	148.5	155.5	162.71	160.46	160.54	163	161.38	157.70b	8.56
Station 6	153.52	142.2	152.39	155.28	154.46	157.16	154.2	157.61	154.14a	3.68
Mean	151.96a	159.88b	159.20b	160.6bc	161.43bc	162.25bc	163.98c	162.48bc	160.2	3.43
±SD	6.06	11.6	6.4	8.4	5.51	6.78	9.8	3.87	7.3	5.37

Table (12): Manganese (Mn) Concentration in Soil (mg.kg^{-1}) with Mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Station 1	1108	1109	1095	1092	1074	1066	1027	1074	1080a	35
Station 2	1121	1110	1098	1180	1098	1098	1021	1047	1098a	68
Station 3	1135	1070	1092	1187	1133	1152	1027	1075	1107a	58
Station 4	1141	1110	1109	1094	1015	1118	1061	1033	1084a	208
Station 5	1139	1063	1034	1113	1088	1106	1054	1091	1084a	64
Station 6	1107	987	1070	1115	1105	1071	1014	1082	1078a	35
Mean	1125c	1074abc	1083abc	1131bc	1050a	1101c	1033a	1067ab	1085	78
±SD	40	63	38	50	237	43	35	44	68	73

Table (13): Copper (Cu) Concentration in Soil ($mg.kg^{-1}$) with mean and (±SD) at Solid Waste Disposal area in Halabja City from May to December 2012.

Studied sites	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	±SD
Station 1	298.53	297.14	293.19	291.41	286.99	291.89	232.8	248.21	280.02a	24.37
Station 2	290.65	299.14	290.39	292.89	287.97	293.38	293.94	250.91	287.40c	14.84
Station 3	293.6	294.46	295.11	301.1	292.26	295.83	238.81	260.22	284.17ab	23.72
Station 4	293.37	297.72	292.49	295.39	290.52	291.94	235.81	276.91	283.89b	21.1
Station 5	299.1	301.01	294.22	297.09	292.56	293.41	292.42	284.84	294.33d	6.85
Station 6	290.53	293.26	289.47	290.31	289.63	290.88	287.49	285.32	289.61c	3.21
Mean	294.29de	297.12e	292.4cd	294.7de	289.99c	292.89cd	262.04a	267.73b	286.4	15.68
±SD	4.42	5.07	3.97	6.57	3.75	3.8	31.04	16.66	9.41	12.55

Table (14): Trace heavy metals concentration ($mg.kg^{-1}$) in wheat grain with mean and (±SD) at agricultural site in solid waste disposal area in Halabja city.

Studied site	Ni	Zn	As	Cd	Cr	Pb
Station 1	1.255	111	0.0345	1.45	0.085	2.93
Station 2	1.125	119	0.028	0.95	0.03	1.27
Mean	1.19^{b}	115^{e}	0.0313^{a}	1.2^{d}	0.058^{c}	2.1^{bc}
±SD	0.21	6.69	0.115	1.40	0.665	0.98

Discussion

Heavy Metal Concentration in Water and Soil:

The contaminations of soil, water and air with heavy metals even at low concentrations are known to have potential impact on environmental quality and human health; these metals also pose a long-term risk to groundwater and ecosystems in general (Cecilia and Christian, 2008). Many elements listed as environmental hazards (arsenic, cadmium, lead, mercury, etc.) which is required for normal growth and development of plants, animals and human beings. The lines of demarcation between essential and toxic levels are rather arbitrary:

(a) Essential at trace levels for sustenance of life processes

(b) Deficient at lower levels than (a) causing malnutrition;

(c) Toxic at levels higher than (a) causing system disorder and on occasions, fatal effects.

Environmental impact of open dump of solid waste can usually result from the run-off of the toxic compounds into surface water and groundwater, which affect water pollution.(Beaven and Walker, 1997). The occurrence of various heavy metals such as Mn, As, Cr, Cd, Ni, Zn, Co, Cu, pb and Fe in solid waste dumpsites were reported by many researchers (Ogundiran and Osibanjo, 2008, Tripathi and Misra, 2012). Municipal solid waste has been found to contain appreciable quantity of heavy metals such as Cd, Zn, Pb, and Cu, all of which may eventually end - up in the soil and are leached down the profile (Oyedele *et al.*, 2008).

The contaminations of soil and water with heavy metals even at low levels are known to have major impact on environmental quality and human health; these metals also pose a long-term risk to groundwater and ecosystems in general (Beyene and Banerjee, 2011). A study by Esakku *et al.* (2003) on heavy metals in a municipal solid waste dumpsite in India revealed that the concentrations of Cr and Pb more than the normal range set by Government of India. Another study by Mehreteab and Silke (2009) . Another study in Nigeria indicated that heavy metals (Pb, Cu, Fe and Zn) increased by between 214% and 2040% in the soils of the dump sites via a soils from non-dump sites (Anikwe and Nwobodo, 2002). A distribution of heavy metals in groundwater and at solid waste disposal sites in Malaysia revealed that the heavy metals like Pb, Mn, Zn, Fe and Cd were found in significantly high levels exceeding the maximum permissible concentration as specified by the WHO standards for drinking water (Kamarudin *et al.*, 2009). These may lead to increased uptake of metals by some test crops although their transfer ratios differ from crop to crop.

Trace Element Concentrations in Water Samples:

The impacts of a solid waste disposal site on environmental pollution were investigated; pollution was found to occur mostly through migration of leachate (Kassenga and Mbuligwe, 2009).

Arsenic is one of the less abundant metal in the earth's crust. In addition to its natural occurrence, more than 80 % of all the (As) are produced by the human, man-made pollution have many hazards on all the biota and on the environment because it has been used in an environmentally dissipative manner – as herbicides, insecticides, feed additives, wood preservative, chemical warfare agent, constituents of organic and inorganic pigments and drugs, as well as an alloying element (Lubin *et al*., 2007). WHO (2006) considers that lead is toxic for both central and peripheral nervous system, including subencephalopathic neurological and behavioral effects. In other hand Cadmium (Cd) is a widespread pollutant and one of the most toxic heavy metals in the environment due to its high mobility and toxicity at low concentration (Moustakas *et al*., 2011). In addition, the using of chemical fertilizer may increase heavy metals pollution in the farmland. It was reported that there was 2-3 mg.kg^{-1} (Cd) in the phosphorous fertilizer (He and Hu 1991).Among them heavy metals, also Cd, Pb and Ni are often forming a part of the active compound of pesticide (Cheng, 2003). Pollution of groundwater in the studied area may result from leakage of pollutants towards groundwater. In particular, some cadmium compounds are able to leach through soil to ground water (EPA, 2004).

As shown in the table(2) the average concentrations of zinc in well waters ranged between 0.002 to 0.012 mg.l^{-1} and 0.004 mg.l^{-1} as mean, while surface water value ranged between 0.003 to 0.009 mg.l^{-1} with the mean value 0.005 mg.l^{-1}. The mean average concentrations of zinc in well waters were below those that are recommended by WHO (2006), and EPA (2004) level of 3 mg.l^{-1} for portable use. The mean average concentrations of arsenic in well waters ranged between 0.010 -0.097 mg.l^{-1} and 0.036 mg.l^{-1} as mean, while surface water value ranged between 0.05-0.16 mg.l^{-1} with the mean value of 0.10 mg.l^{-1}. The mean average concentrations of arsenic in well waters exceeded those that are recommended by WHO (2006), and EPA (2004) level of 0.01 mgL^{-1} for portable use. This may be due contribute to either natural process such as ,Weathering of rocks and sediment, wind-blown dust, and gaseous forms through water and air, or to human activity such as agricultural application of pesticides and fertilizer, High traffic rate, disposal and incineration of solid waste and Atmospheric deposition (Nriagu and Pacyna,1988).

While for well waters, Cadmium concentration values ranged from 0.002 to 0.0034 mg.l^{-1} and 0.0025 mg.l^{-1} as mean value, while for surface water values it ranged from 0.002 to 0.0035 and 0.0028 mg.l^{-1} as mean. Cadmium concentration values for well water was below the permissible level 0.003 and 0.005 mg.l^{-1} according to WHO (2006), EPA (2004).

The mean average concentrations of iron in well waters ranged between 0.011 to 0.079 mg.l^{-1}, with the mean value 0.039 mg.l^{-1}. while surface water value ranged between 0.051 to 0.171 mg.l^{-1} with the mean value 0.099 mg.l^{-1}. The mean average concentrations of iron in well waters were below the detection limit recommended by WHO (2006), and EPA (2004) level of 0.3 mg.l-1 for portable uses. According to Diagomanlin et al. (2004), and Berry et al. (1980) may be the source of heavy metal (iron) in groundwater include raw household wastewater which may contain metals such as pharmaceutical, paint, battery and also vegetable matter and human excreta.

On the other hand, the Lead concentration value for well waters ranged from 0.035 mg.l^{-1} as minimum, 0.051 mg.l^{-1} as maximum with the mean value of 0.04 mg.l^{-1}, while for surface water ranged from 0.04 to 0.044 mg.l^{-1} with the mean value of 0.04 mg.l^{-1}. Lead concentration values in all well water samples exceeded those that are recommended by WHO (2006), EU (2006), which is equal to 0.01 mg.l^{-1}, while for surface water, its 0.003 mg.l^{-1} from different references (WHO 2006, EU 2004) .This very high concentration level of lead in well waters illustrates the impact of solid waste landfill leachate which penetrates soil profile towards groundwater (Rashid, 2010).

Nickle concentration values for well waters ranged from 0.004 mg.l^{-1} as minimum, 0.015 mg.l^{-1} as maximum with the mean value of 0.008 mg.l^{-1}, while for surface water it ranged from 0.021 to 0.022 mg.l^{-1} with the mean value of 0.021 mg.l^{-1}. Nickle concentration values in all well water samples were below or in surface water equal to those that are recommended by WHO (2006), all studied water samples show high pollution by nickel, which exceed permissible level 0.02 mg.l^{-1}. Surface water pollution by nickel is greater than ground water pollution, this may be related to the fact that surface water is more exposed to anthropogenic pollution than ground water, such as effluent of leachate water, atmospheric deposition and disposal municipal waste around the water sources then runoff during rainy season into the water body (Yin. *et al*. 2009).

Trace Element Concentrations in Soil Samples:

Migration of contaminants from the place of dumping to other pleases or to biota by biogeochemical reaction process due to bioconcentration of trace heavy metals. These metals can bio-magnify in plants and animals eventually making their way to humans through the food chain (Abrahams, 2002). Iron (Fe), manganese(Mn) and lead(Pb) have less to very low mobility at $pH < 7$ and thus would be enriched in soil. Nickel, copper and zinc have high mobility under acidic conditions $pH > 7$.

Disposal of municipal solid wastes and household hazardous wastes including batteries, paint residue, ash, treated woods and electronic wastes increase heavy metals in soil (Macki Aleagha *et al*, 2009). Cr, Pb, Ni, Cd and As are the chief heavy metals of MSW (Williams, 2005).

Martin (2009) reported that Cd and Ni encountered in industries dealing with pigment, metal plating, some plastic and batteries. Heavy metals release naturally by erosion of rocks, volcanic activity, forest fire and artificially by many industries, paper mills, vehicles and human activities and it can release in large quantities directly affecting the flora, fauna as well as human population.

Behavior of all heavy metals in soil all depends on the soil pH, properties of metals, humidity, ring structure of the chemical substance, clay texture, cation and anion (redox) exchange capacity and soluble ligands in the surrounding fluid. Heavy metals are generally more mobile in the soil in the acidic pH range (Alloway,1997). The potential hazards associated with the heavy-metal contamination of soils tend to increase with time. This may be caused by a decrease in soil pH, especially when the nitrogen and Sulphur contents of the waste products are high and the lime content low (Roghanian et al., 2012). Soil pH affects the speciation and adsorption of heavy metals in soil, determining the mobility, bioavailability and toxicity of the metal (Yin *et al*., 2009).

Similar observations have been reported by Beyene and Banerjee (2011) who revealed that the maximum concentration of Cr in the dumpsites was (561 ppm) and (513 ppm) respectively. The mean concentration of Cr (243 ppm) was found to be in an elevated concentration than the typical concentration of MSW compost in the United States (Flavia *et al*., 2008). Though of low phytotoxicity, lead may become mobile at lower pH and enter the food chain from the numerous agricultural activities that use the stream water poising health risks to consumers of the agricultural products (Nabulo *et al*., 2010). Similar studies in Egypt by Rashad and Shalaby (2007) and Kenya by Njoroge (2007) indicated that land surfaces surrounding dumpsites have been contaminated with high levels of metals. Trace element accumulation in soil of the dump site may lead to increased uptake by plants.

Cadmium metal is used as an anticorrosive, electroplated on steel, also commonly used as pigments in plastics, batteries and in various electronic components by throwing into the dump as waste, during decomposition, the Cd component is leached into the surrounding soil and over time gets accumulated in the soil (Che *et al*., 2003; Amadi and Nwankwoala, 2013). Copper is widely used in electrical wiring, roofing, various alloys, pigments, cooking utensils, piping and in the chemical industries (Aboud and Nandini, 2009). Cr It is used in alloys, electroplating, pigments, paints manufacture, fungicides, photography, glass and leather tanning industries. Chromium is carcinogenic by inhalation and corrosive to tissue (Yin *et al*., 2001).Nickel is used mainly as alloys, stainless steels, non-ferrous alloys and super alloys, nickel-cadmium batteries, welding and electronic products (Amadi, 2011).

Zinc is used in making alloys of brass and bronze, batteries, fungicides, pigments, pesticides, galvanizing steel and iron products. Excessive concentration of Zn in soil leads to phyto-toxicity as it is a weed killer (Aboud & Nandini, 2009). These heavy metals are leacheing away and accumulate at the top surface of the soil where they are adsorbed because of affinity for metals by organic matter (Amadi, 2011).

Trace element concentrations in dumping sites soils collected from six locations showed a wide range of trace element concentrations across the studied area found in order of Mn> Zn >Cu> Ni> Pb>Cr>As> Cd (1187-987 $mg.kg^{-1}$, 915.3-225.03 $mg.kg^{-1}$, 301.1-232.8 $mg.kg^{-1}$, 192.24-150.41 $mg.kg^{-1}$,193.1-76.71 $mg.kg^{-1}$, 173.1-142.2 $mg.kg^{-1}$, 20.15-14.23 $mg.kg^{-1}$ and 5.712-2.317 $mg.kg^{-1}$). The mean concentration of Ni, Zn, Cd, Cr , Mn and Cu were exceeding European union standards (EU, 2006), while the mean value of As and Pb were below .Ni, Zn, Cd, Cr and Cu were available in very high levels as it is very close to the municipal waste disposal and dumping place of the city. It overlooks the fields and, during rainy seasons, runoff is washed into farming fields and flying ash generated by waste incineration precipitates on the surrounding waste disposal fields. Higher concentrations of toxic elements were found, this is probably due to the irregular dumping site, irrigation of the farms by water discharges and may be due to the precipitation of strong industrial dust and fly ashes generated by incineration of solid waste into nearby the agricultural fields. It's known that the bioavailability of metals in soil depend on pH, organic matter and total metal content (Adjia *et al*., 2008).

Heavy metals concentration at Halabja disposal waste area at many sampling points were considerably high; this is because those sampling sites were relatively close to the solid waste pile therefore this high concentration may referred to the effect of the waste pile. In general, Cu and Zn contamination of soil is derived from the application of agricultural materials particularly fungicides, such as, Bordeaux mixture and the atmospheric deposition from industrial activities (Maas *et al*., 2010). It can be noted that, the concentration of Cu and Zn were relatively higher at solid disposal area compared to other areas. In most developing countries including Iraq, leaded gasoline is still widely used, for example in Kurdistan region more than 82% of the gasoline consumption is leaded (Rashid, 2010).

The result is supported by values obtained by other researcher such as (Awokunmil *et al*., 2010; Amuno, 2011, and Chinyere *et al.*., 2013).

Accumulation of Trace Elements in the Wheat Grain

However, predicting exposure to potentially toxic metals from consumption of food crops is more complicated because uptake of metals by plants depends on soil properties and plant physiologic factors (Chinese Department of Preventive Medicine, 1995). Heavy metals contained in bio solids are easily immobilisable by plants, because of their strong association with organic matter in the bio solids (Silveira *et al*, 2003). Many factors affect the uptake and bioaccumulation of heavy metals in plants is influenced by more the one factors such as atmospheric conditions, climate changes, the concentrations of heavy metals in soils, the texture of the soil, humidity, and the degree of maturity of the plants at the time of the harvest (Olufunmilayo, et al., 2014).

The range for trace elements for wheat samples were 115 $mg.kg^{-1}$ for Zn, 0.0313 $mg.kg^{-1}$ for As,1.2 $mg.kg^{-1}$ for Cd, 2.1 $mg.kg^{-1}$ for Pb, 1.19 $mg.kg^{-1}$ for Ni and 0.058 $mg.kg^{-1}$ for Cr. The concentrations of all metals except Zn and Cr in wheat crops around the open dump waste disposal area were constantly higher than the recommended value set by (UK food standard agency, 2009)standard limits. They variation were found in the order of Zn>Pb>Ni>Cd>Cr>As .

Wheat contamination with high levels of Ni, Cd, and Cu content at all sites might refer to the presence of Ni and Cu rich rocks in the areas, and increasing heavy metals in soil due to the dumping site. The concentration of As in the wheat, at solid waste dumping area because they are being influenced by the municipal waste dump near the sampling sites. By contrast, higher pb concentration was found at the open dump solid waste area, this was due to anthropogenic source of contaminations in the area such as soil waste disposal and industrial outcomes, rather than using waste/industrial water for irrigation purposes. On the other hand the comparatively high level of lead in grain at study area station could be as a result of physical contact with air-borne materials from vehicular emissions (Ideriah *et al*., 2010) .

Similar study by Yin *et al.* (2009) revealed that accumulation of Zn, Pb, Cd and Ni increased in the dump site cassava tuber relative to non- dumpsite. Also same study by Magji (2012) was revealed that the concentrations of heavy metals in all the samples cultivated around the dumpsite are higher than those from the control site.

This finding was in agreement with the studies conducted in different countries (Barazani *et al*., 2004; Rashad and Shalaby, 2007; and Olanipekun, 2010).

Conclusions:

1. Open dump area are considered a serious threat to their surrounding urban environments and great source of pollution. Pollutants discharged from the open dumping leachate are responsible for alterations of water and soil physico-chemical properties and the majority of water.
2. Soil and wheat samples are polluted by heavy metals. The effect of open dump pollution causes an increase in organic matter in soils around the area.
3. Results show that the waste dump have significant effects on the water quality, although the mean values of many parameters analyzed fell below WHO and EU standards for drinking water.
4. The results of the study revealed that soils around the dumpsite are considerably contaminated by metals with their concentrations beyond threshold values according to EU.
5. The long term result of open waste disposal is a considerable amount of heavy metals and metalloid accumulated in the agricultural fields and consequently in plants grown on these fields such as wheat.
6. The health risk assessments like Hazard indices for heavy metals indicated that the drinking water no health risk for human consumption.
7. The application of WQI suggests that the groundwater around the open dumpsite is good water in quality, while surface water is poor water in quality.

Recommendations:

1. Solid waste should be carefully reduce, reuse, recycle, reuse and sorted out to recyclable organic and hazardous substances,. The toxic substances must be removed and landfilled hence ensuring the safety of the agricultural fields around the disposal areas.
2. Refrain from disposing waste in and around agricultural fields because it may pose potential health risk to the local consumers, as well as burning waste near the city will result in toxic emissions that are liberated directly in to the atmosphere consequently leading to possible health hazards to the residence.
3. Systematic investigation on the local environmental pollution, particularly agricultural soil contamination, is strongly recommended because it may decrease the level of contamination and improve human health in the area.
4. Conducting more studies for more other characteristics in water and soil in details and time interval are necessary. especially focus on future studies about arsenic and lead .

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