Spatial and temporal distribution of heavy elements in the roadsides of Basrah Government

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Abstract

Since heavy element pollution of soil has become a global issue   for human health and food security concerns, the purpose of this study is to determine the levels of heavy element pollution by examining the effects of vehicle traffic on the roads and the toxic waste it generates in the streets of Basrah Government in southern Iraq. The core samples were collected randomly from October 2022 to April 2023 for the purpose of measuring the concentrations of heavy elements (manganese - lead - cadmium - chromium - zinc - iron - nickel) in exchangeable and residual phases in roadsid soil, using the flame atomic absorption spectrometer (AAS). Pollution indicators: geoaccumulation index (I-geo) , Contamination factor (CF) and Enrichment factor (EF) , were also measured .

  The results of the highest concentrations of heavy elements (Ni, Fe, Zn, Cr, Cd, Pb, Mn) in the Exchangeable phase of soil were (113.45,2462.16,69.24,204.87,3.49,842.05,1407.00 μg/g dry weight respectively. While the lowest concentration was 14.82,598.58,8.96,72.88,0.84,5.14,45.11) μg/g dry weight respectively. Whereas the highest concentration in residual phase of soil was 94.45 ,3340.87 ,58.35 ,318.59 ,2.74, 681.12 ,222.44 μg/g dry weight respectively. While the lowest concentration was (18.30,902.32,12.04,40.69,0.54,14.72,6.53 (μg/g dry weight respectively. Assessment of heavy elements pollution, using pollution indexes registered that the annual average of study station with (I-geo) factor ranged from moderately polluted to polluted, especially with Pb, Ni and Cr. Also, contamination factor indicated CF considerable contamination to very high contamination especially with Pb and Ni . Enrichment factor(EF) indicated very severe enrichment to   extremely severe enrichment especially with, Pb, Ni and Cr . pollution of the study area by heavy elements depended of indexes factors in the order of Pb > Ni > Cr > Cd > Mn > Zn > Fe .

Keywords: pollution, soil, accumulation, heavy elements, cadmium.

I.   Introduction:

  Soil pollution is one of the most important environmental problems, which has taken a serious economic, social and environmental dimension, especially after the great and rapid industrial development and because of modern technologies and the production of new materials dangerous to the environment, as pollutants of all kinds are not stopped by regional or political borders and pollution may appear in a country that does not practice any industrial activity as rivers, winds and clouds contribute to the transfer of pollutants to it (Al-Tai, 2012).

Weapons residues deployed in different areas, inappropriate waste disposal in residential areas and leakage of effluents, pesticides and fertilizers used in agriculture, excessive use of chemicals in agriculture, aromatic hydrocarbons and persistent organic pollutants, surplus nutrients and agricultural chemicals that are leaked into the soil, floods, soil erosion, atmospheric sedimentation, where the atmosphere contributes to the transfer of pollutants to certain areas and their deposition in other areas in increasing the quantities of elements in the upper layers of soil (Mishra *et al.*, 2016 ; Maliszewska - Kordybach,2003).

Heavy elements contribute significantly to environmental pollution as a result of human activities such as mining, smelting, electroplating, energy and fuel production, energy transmission, intensive agriculture and sludge dumping , which represents one of the most serious threats to water and soil resources as well as human health. Heavy elements bio accumulates during the food chain and are not degraded by degradable organisms (Alam *et al* ,2014). Some heavy elements have a crucial role in the functioning of enzyme systems but become toxic at high concentrations. Others, such as lead , mercury and cadmium, have no known biological function yet and may be toxic even at low levels (Savci, 2012).

Elevated concentrations of heavy elements were observed in the soil on the roadside, which was found to represent the third most important factor affecting the accumulation of heavy elements in the soil after its proximity to the city or waste disposal area (Karacocuk *et al.,* 2022).   The relocation of industrial areas from cities to locations with low population density, led to vehicle emissions from the main source of heavy elements in the urban environment. Lead was the oldest and most widely studied heavy element in roadside soil due to its role as a gasoline additive (Wang, 2018).

The reason for the pollution of the roadside soil with heavy elements has been determined in that it is due to traffic emissions for a long time. However, the decisive factors affecting the accumulation of heavy elements in urban soils on the side of the road due to frequent disturbances such as repairing damaged roads are rarely identified.

Current study aims to evaluate the level of some heavy elements concentration in addition to calculate the enrichment factor (EF) , geographical accumulation index(I-geo) , and contamination factor (CF) of the districts of Basrah Governorate vertically at three depths: 0-10 cm, 11-20 cm and 21-30 cm and estimation of the total rate of the two exchangeable and residual phase of seven heavy elements :Iron, Lead , Manganese , Nickel, Chromium, Cadmium and Zinc .

II.   Materials and methods:

Core samples were collected seasonally during the period from July 2022 to April 2023 at five stations in roadsides of Basrah Government (Qurna ,Basrah center,Jaziirah , Abu Al- kahseep and Al-Zubair stations) as shown in table (1) . Core samples were put it in the polyethylene bags then transferred to the laboratory for analysis.

Table 1.Streets in Basrah Government GPS Locations

Longititude	Latitude	Location
47.9488215	30.4617713	Abu AL-Khasep
47.7754229	30.5785626	Jazeera
47.8543228	30.5055046	Basrah center
47.4396159	31.0107734	Qurna
47.6865336	30.4382994	Zubair

Heavy elements extraction:

The exchangeable phase:

The exchangeable heavy elements ions were extracted from core sample were divided according to depth to 0-10 , 11-20 and 21-30 cm then dried in room temperature then sieved (63µm) the method of Chester and Voutsinou (1981) . (1 gm) of the dried soil sample was put in (50ml) polyethylene test tube having a tight cover. Then add 30 ml of Hydrochloric acid (0.5N) and shaking for (16 hours).After that the sample was separated by centrifuge at 3000rpm for 20 minute , then the solution was filtered using (filter paper No. 1the filter was put in plastic vial till measuring by Flame Atomic Absorption Spectrophotometer (FAAS).

Extraction the residual phase:

The residual heavy elements were extracted according to sturgeon *et al*.(1982)   added HNO_3 (5ml) for each sample and evaporation using Teflon (PTFE) beakers to near dryness on a hotplate at 70°C, then 5 ml of a mixture of concentration $HCIO_4$ and HF (1:1) were added , (30ml) of HCL(0.5 N) and leave the sample on hot plate until the sample volume is less than (25ml) . The extraction was filtered and decanted and completed into (30 ml) using deionized D.W . Samples were stored in tight stopper polyethylene vials to be ready for analyses by (FAAS).

Heavy Elements pollution Indices:

Determination of Geo- accumulation index (I- geo) :

To determine the extent of soil pollution with heavy elements, Muller (1969) suggested using the coefficient (I geo) based on the following equation:
I-geo = Log2 (Cn / 1.5 Bn)
   Where Cn is the concentration of the heavy elements in the samples of the current study, *Bn* is the concentration of the heavy elements in the earth's crust (the average crust) according to CBSQG , 2003 and 1.5 is a fixed value that is used to reduce the differences and potential changes of the heavy elements that are exposed to natural and human influences (Muller, 1969; Kowalska *et al*., 2018) classified as shown in Table (2)

 Table (2) classification of igeo accumulation index (Igeo).

I-geo value	Soil pollution case
<1	practically unpolluted – Background sample
1-2	unpolluted to moderately polluted
2-3	moderately polluted to polluted
3-4	strongly polluted
4-5	strongly to extremely polluted
>5	extremely polluted

Contamination Factor (CF)

Contamination Factor (CF)was used to determine contamination status of soil in the current study . CF was calculated according to the equation described below: CF=Mc/Bc

Where Mc: measured concentration of the element and Bc : is the background concentration of the same element .Four contamination categories a documented on the basis of contamination factor (Hakanson, 1980) table (3)

Table (3) classification of contamination factor .

CF value	Contamination status
CF < 1	Low contamination
1≤ CF≤ 3	Moderate contamination
3< CF ≤ 6	Considerable contamination
CF > 6	Very high contamination

Enrichment factor (EF) :

To evaluate magnitude of source material found in the earths crust (Huheey, 1983) the following equation was used to calculate the EF a contaminant in the environment , the enrichment factors (EF) which computed relative to the abundance of species as proposed by Atgin *et al* ;(2000).

EF= (CM / CFe) sample / (CM / CFe)Earths crust

Where ,(CM/ CFe) sample is the ratio of concentration of trace element , (CM) to that of (CFe) in the soil sample : (CM/ CFe)Earths crust is the same reference ratio in the Earths crust , table(4)

Table (4) classification of enrichment factor.

EF value	Enrichment factor Indicates
EF<1	No enrichment
1-3	Minor enrichment
3-5	Moderate enrichment
5-10	Moderate to severe enrichment
10-25	severe enrichment
25 -50	very severe enrichment
EF>50	extremely severe enrichment

III.   **Results**:

Ni: The mean concentration of nickel in the **exchangeable phase** showed significant   differences ($p<0.05$)among seasons . In exchangeable phase the highest seasonal mean concentrations (113.45 µg/g dry weight) were detected during Autumn season in 0-10 cm depth , while lowest mean concentration (14.82 µg/g dry weight) noticed during Winter in 0-10 cm depth . In the station the highest mean concentrations (48.57 µg/g dry weight) detected in the Bsrah center station while lowest mean concentrations noticed in (28.33 µg/g dry weight) noticed in Abu AL-Khaseb station .

  The mean concentration of nickel in the exchangeable phase showed non- significant differences ($p>0.05$) among station or among depths.

In **residual phase** the highest seasonal mean concentrations(94.45 µg/g dry weight) were detected Autumn season at 0-10 cm depth, while lowest mean concentrations (18.30 µg/g dry weight) noticed during Winter at 0- 10 cm depth . showed significant differences ,($p<0.05$) between seasons.

The highest mean concentration in the station was (59.69 µg/g dry weight)detected in Qurna station while lowest mean concentrations (32.88 µg/g dry weight)recorded in Zubair station . The result Showed non- significant differences ,($p>0.05$) among station .

Also, showed non- significant differences ,($p>0.05$) among depths Table(5)

Table: (5) concentration of nickel (µg/g dry wight) in core samples from the roads .

depth cm		Mean of season		Qurna		Basrah center		Jazeera		Zubair		Abu Al-khaseeb	
0-10 CM	**Season**	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re
	Summer	56.08	54.96	71.35	28.46	62.83	37.38	3.45	18.97	70.24	41.24	72.52	148.77
	Autumn	113.45	94.45	216.47	153.45	69.97	97.53	100.58	119.45	159.62	59.06	20.62	42.78
	Winter	14.82	18.30	5.80	6.44	37.70	43.82	7.41	19.97	13.21	7.73	9.99	13.53
	Spring	22.59	51.84	30.71	52.90	13.99	33.08	51.58	100.18	6.83	23.89	9.83	49.14
11-20CM	Summer	42.32	39.96	16.39	49.52	52.20	10.96	51.98	7.76	29.00	35.12	62.05	96.44
	Autumn	56.65	61.55	39.70	96.19	61.22	70.24	56.85	36.69	98.39	57.27	27.08	47.40
	Winter	38.86	29.00	39.31	24.17	82.49	18.69	67.34	28.68	2.90	41.24	2.26	32.22
	Spring	25.71	39.28	36.40	50.62	14.37	17.96	48.59	85.97	21.61	18.20	7.56	23.63
21-30 CM	Summer	56.21	52.79	34.52	50.88	80.87	13.21	42.71	64.67	58.64	12.57	64.29	122.61
	Autumn	44.16	61.63	24.62	94.40	67.78	72.48	43.73	65.77	65.60	49.66	19.08	25.85
	Winter	20.75	24.94	11.60	54.13	23.20	30.61	21.28	3.22	8.70	14.50	38.99	22.23
	Spring	26.28	46.13	35.26	55.17	16.26	23.63	48.59	101.67	25.60	34.13	5.67	16.07
Mean				46.84	59.69	48.57	39.13	45.34	54.42	46.69	32.88	28.33	53.39

Fe: In **exchangeable phase** the highest seasonal mean concentrations (2462.16 µg/g dry weight) were detected during spring season in depth 21-30cm , while lowest mean concentration (598.58 µg/g dry weight) noticed during winter in depth 0-10 cm . In the stations highest mean concentrations (2210.20 µg/g dry weight) detected in the Qurna station while lowest mean concentrations (975.72 µg/g dry weight) noticed in Basrah center station .

the mean concentration of Iron in the **exchangeable phase** showed significant differences ,($p<0.05$) among seasons and stations ,whereas showed non- significant differences ($p>o.o5$) among depths.

In **residual phase** the highest seasonal mean concentrations(3340.87 µg/g dry weight) were detected Summer season in depth 0-10 cm , while lowest mean concentrations (902.32 µg/g dry weight) noticed in Winter season in depth 11-20 cm . The mean concentration of Iron in the residual phase showed significant differences ($p<0.05$) among seasons .

In the stations highest mean concentration (2551.64 µg/g dry weight)detected in Zubair station while lowest mean concentrations (1683.30 µg/g dry weight)noticed in Jazeera. The result showed non-significant differences ,($p>0.05$)among stations ,whereas showed non -significant differences ,($p>0.05$) among depths Table (6) .

Table: (6) concentration **of Iron** (µg/g dry weight) in core samples from the roads

depth cm		Mean of season		Qurna		Basrah center		Jazeera		Zubair		u Al-
0-10 CM	Season	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex
	Summer	1543.12	**3340.87**	2738.34	3326.23	391.25	4409.19	2761.55	3349.44	452.22	4169.39	
	Autumn	1415.59	**1547.75**	1248.28	1599.04	1507.92	1580.67	1554.95	1529.23	1566.71	1576.26	
	Winter	598.58	**1323.39**	881.07	634.13	432.01	920.70	439.01	437.06	754.04	324.18	
	Spring	2403.04	**2538.39**	3885.75	4412.25	1442.84	1616.57	1460.05	1434.85	3784.50	4423.50	
11-20CM	**Summer**	1498.85	**3041.86**	2676.46	3457.74	419.70	3109.64	2707.40	3233.41	374.99	4030.16	
	Autumn	1391.30	**1541.13**	1234.14	1591.69	1529.97	1593.16	1527.76	1466.77	1505.72	1588.02	
	Winter	608.92	**902.32**	935.94	683.92	530.47	905.46	327.23	594.49	874.97	525.39	
	Spring	2453.81	**2441.96**	4077.00	4200.75	1437.38	1486.47	1358.48	1437.90	3890.25	4369.50	
21-30 CM	**Summer**	1484.94	**3104.56**	2452.13	3349.44	392.26	4099.78	2877.58	3101.91	355.68	3550.56	
	Autumn	1392.29	**1527.91**	1188.50	1579.20	1550.54	1561.56	1576.26	1520.41	1450.60	1567.44	
	Winter	623.56	**1393.73**	1004.03	663.60	566.04	999.97	370.92	667.66	746.93	359.74	
	Spring	2462.16	**2410.57**	4200.75	4410.00	1508.28	1494.26	1349.32	1426.45	3780.00	4135.50	
Mean				**2210.20**	**2492.33**	**975.72**	**1981.45**	**1525.88**	**1683.30**	**1628.05**	**2551.64**	

Zn: The mean concentration of Zink in the **exchangeable phase** showed non- significant differences ,(p>0.05) among seasons and stations . In exchangeable phase the highest seasonal mean concentrations (69.24 µg/g dry weight) were detected during Spring season in depth 11-20 cm , while lowest mean concentration (8.96 µg/g dry weight) noticed during Autumn in depth 21-30 cm. Highest mean concentrations of stations (70.39 µg/g dry weight) was detected in the Qurna station while lowest mean concentrations (16.55 µg/g dry weight)   noticed in Jaziirah station .The result showed non- significant differences (p>o.o5) among depths.

In **residual phase** the highest seasonal mean concentrations(58.35 µg/g dry weight) were detected Autumn season in depth 0-10 cm , while lowest mean concentrations (12.04 µg/g dry weight)noticed in Winter season in depth 21-30 cm . The mean concentration of Zinc in the residual phase showed significant differences ,(p<0.05) among seasons and among depth .

In the stations highest mean concentration (41.50 µg/g dry weight)detected in Qurna while lowest mean concentrations (23.27 µg/g dry weight)noticed in Zubair. Showed non- significant differences ,(p>0.05) among stations .Table 7

Table: (7) concentration of **Zinc** (µg/g dry wight) in core samples from the roads .

depth cm		Mean of season		Qurna		Basrah center		Jazeera		Zubair		Abu Al-khaseeb	
0-10 CM	Season	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re
	Summer	61.04	32.19	246.93	73.53	1.80	25.66	27.88	25.66	8.88	23.17	19.70	12.93
	Autumn	11.24	58.35	17.64	85.00	22.47	74.74	3.42	56.61	4.28	45.67	8.41	29.74
	Winter	13.41	13.82	15.37	8.81	13.43	11.05	18.57	10.64	15.85	7.85	3.84	30.74
	Spring	51.38	31.82	78.37	28.62	63.22	44.24	4.31	19.70	69.15	14.42	41.83	52.13

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11-20CM	Summer	48.10	32.30	164.39	58.13	26.50	32.60	38.57	26.64	1.80	34.40	9.23	9.73
	Autumn	34.88	42.63	36.22	45.28	41.73	64.86	3.64	26.38	7.06	46.82	85.76	29.81
	Winter	18.96	16.14	30.90	10.41	29.14	10.89	3.20	36.34	19.85	8.65	11.69	14.41
	Spring	69.24	26.66	133.32	24.39	71.51	39.83	3.69	14.90	52.57	13.01	85.14	41.17
21-30 CM	Summer	28.24	20.29	24.23	39.95	22.20	13.60	74.22	21.50	4.44	18.03	16.13	8.37
	Autumn	8.96	57.49	18.29	74.64	11.98	63.90	3.00	81.07	3.42	40.87	8.09	26.96
	Winter	22.83	12.04	48.83	14.25	28.18	8.97	16.33	20.01	17.45	7.36	3.36	9.61
	Spring	49.04	28.54	30.24	35.01	109.73	43.71	1.72	14.16	73.81	18.97	29.67	30.87
Mean					70.39	41.50	36.82	36.17	16.55	29.47	23.21	23.27	26.90	24.70

Cr:The mean concentration of chromium in the **exchangeable phase** showed significant differences ,($p<0.05$) among seasons . In exchangeable phase the highest seasonal mean concentrations (204.87 µg/g dry weight) were detected during Summer season at the depth 0-10cm , while lowest mean concentration (72.88 µg/g dry weight) noticed during Autumn at depth 11-20 cm. In the stations highest mean concentrations (141.9 µg/g dry weight) detected in the Basrah center station while lowest mean concentrations (87.37 µg/g dry weight) noticed in Ab-alkaseeb station. in the exchangeable phase showed non- significant differences ,($p>0.05$) among stations. The mean concentration of chromium in the exchangeable phase showed non- significant differences ($p>0.05$) between depths.

In **residual phase** the highest seasonal mean concentrations (318.59 µg/g dry weight) were detected Summer season at depth 21-30 cm , while lowest mean concentrations (40.69 µg/g dry weight) noticed during Autumn at the depth0-10 cm . showed significant differences ,($p<0.05$) between seasons..

In the stations highest mean concentration (258.14 µg/g dry weight)detected in Qurnah while lowest mean concentrations (115.29 µg/g dry weight)noticed in Zubair station. showed significant differences ,($p<0.05$) between stations ,table 8.

Table: (8) concentration of **chromium** (µg/g dry weight) in core samples from the roads

depth cm		Mean of season		Qurna		Basrah center		Jazeera		Zubair		Abu Al-khaseeb	
0-10 CM	Season	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re
	Summer	204.87	**216.53**	330.60	381.90	336.83	25.79	41.80	330.60	184.35	81.17	130.78	263.20
	Autumn	111.19	**40.69**	84.31	73.36	16.19	24.94	89.07	12.23	275.30	32.28	91.09	60.65
	Winter	122.52	**81.97**	196.11	136.55	128.74	99.38	22.31	21.43	175.15	9.10	90.28	143.38
	Spring	83.92	**245.40**	72.45	342.92	124.25	334.68	86.08	258.24	38.64	132.82	98.20	158.32
11-20 CM	**Summer**	174.53	**276.05**	216.60	355.30	279.17	132.76	41.65	423.70	290.55	226.83	44.70	241.68

	Autumn	72.88	**43.72**	76.92	79.72	54.66	26.90	149.80	31.30	42.57	32.77	40.49	47.93
	Winter	80.29	**132.91**	16.47	100.14	154.94	25.79	101.66	45.52	98.05	308.00	30.35	185.10
	Spring	77.48	**208.70**	48.30	318.77	132.27	298.61	74.49	221.82	12.08	164.22	120.24	40.08
21-30 CM	Summer	204.81	**318.59**	201.40	704.90	166.90	185.86	332.50	418.00	131.24	6.07	192.02	278.10
	Autumn	118.00	**59.67**	115.38	142.32	114.28	33.75	133.60	30.81	155.87	53.80	70.85	37.66
	Winter	88.40	**114.10**	12.72	109.24	66.62	94.07	124.41	11.38	223.05	160.07	15.17	195.72
	Spring	91.81	**283.52**	108.67	352.58	118.24	410.83	59.59	243.34	48.30	176.29	124.25	234.54
Mean				123.33	258.14	141.09	141.11	104.75	170.70	139.60	115.29	87.37	157.20

Cd: The mean concentration of Cadmium in the **exchangeable phase** showed non- significant differences ,(p>0.05) in the seasons . In exchangeable phase the highest seasonal mean concentrations 3.49 µg/g dry weight) were detected during Summer season at the depth 0-10 cm , while lowest mean concentration (0.84 µg/g dry weight) noticed during Winter at the depth 0-10 cm , and highest mean concentrations of stations (1.80 µg/g dry weight) detected in the in Basrah center while lowest mean concentrations (0.86 µg/g dry weight) noticed in Jaziirah station. The mean concentration of Cadmium in the exchangeable phase showed signification differences (p<o.o5) between stations.

In **residual phase** the highest seasonal mean concentrations (2.74 µg/g dry weight) were detected Summer season in the depth 11-20 cm , while lowest mean concentrations (0.54 µg/g dry weight) noticed during Winter in the depth 11-20 cm . The results showed significant differences ,(p<0.05) between seasons.

In the stations highest mean concentration (2.04 µg/g dry weight)detected in Qurnah while lowest mean concentrations (0.82 µg/g dry weight)noticed in Abu ALchaseb station . The results showed significant differences ,(p<0.05) among locations ,table 9.

Table: (9) concentration **of cadmium** (µg/g dry weight) in core samples from   the roads.

depth cm		Mean of season		Qurna		Basrah center		Jazeera		Zubair		Abu Al-khaseeb	
0-10 CM	Season	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re	Ex	Re
	Summer	3.49	**2.58**	2.32	1.34	3.42	1.34	3.21	5.95	5.06	3.13	3.41	1.16
	Autumn	1.33	**1.50**	3.24	4.70	0.19	1.18	0.10	0.24	0.48	1.18	2.61	0.19
	Winter	0.84	**1.00**	1.04	1.64	1.16	0.74	0.22	0.22	1.34	2.08	0.45	0.30
	Spring	1.80	**1.44**	0.95	1.33	2.57	2.31	0.62	1.23	1.09	2.12	3.76	0.20

depth cm	Season	Mean of season Ex	Re	Qurna Ex	Re	Basrah center Ex	Re	Jazeera Ex	Re	Zubair Ex	Re	Abu Al-khaseeb Ex	Re
11-20CM	Summer	2.16	**2.74**	1.34	4.91	3.13	2.53	1.47	1.49	3.42	2.38	1.44	2.38
	Autumn	1.21	**1.41**	2.95	3.88	0.10	1.65	0.19	0.12	0.19	0.71	2.61	0.71
	Winter	1.16	**0.54**	1.49	0.15	0.45	0.45	0.74	1.19	2.68	0.45	0.45	0.45
	Spring	1.10	**1.20**	0.27	0.81	0.99	2.37	1.56	1.18	1.49	0.81	1.19	0.81
21-30 CM	Summer	1.82	**1.77**	0.45	3.72	3.87	2.83	0.10	0.45	3.87	1.34	0.82	0.51
	Autumn	1.15	**0.59**	2.57	0.43	0.48	0.24	0.10	1.29	0.39	0.82	2.23	0.15
	Winter	1.09	**0.88**	1.64	0.32	2.23	0.43	1.23	2.23	0.18	0.74	0.17	0.65
	Spring	1.13	**1.03**	0.41	1.23	2.97	0.15	0.72	1.28	0.16	0.14	1.38	2.37
Mean				**1.56**	**2.04**	**1.80**	**1.35**	**0.86**	**1.41**	**1.70**	**1.32**	**1.71**	**0.82**

Pb: The mean concentration of Lead in the **exchangeable phase** showed significant differences ,($p<0.05$) among seasons . In exchangeable phase the highest seasonal mean concentrations (842.05 µg/g dry weight) were detected during Autumn season in the depth 21-30 cm , while lowest mean concentration (5.14 µg/g dry weight) noticed during Winter in the depth 21-30 cm , and highest mean concentrations in the station (477.50 µg/g dry weight) detected in the Basrah center while lowest mean concentrations (14.70 µg/g dry weight) noticed in Abo -alkaseb station .

The mean concentration of lead in the exchangeable phase showed signification differences (p<o.o5) between station. In **residual phase** the highest seasonal mean concentrations (681.12 µg/g dry weight) were detected Summer season in the depth 21-30 cm , while lowest mean concentrations (14.72 µg/g dry weight) noticed during Winter 11-20 cm depth. showed significant differences ,($p<0.05$) among seasons.

In the stations highest mean concentration (225.42 µg/g dry weight)detected in Basrah center while lowest mean concentrations (48.58 µg/g dry weight)noticed in Abo - alkasep. showed significant differences ,($p<0.05$) among stations table 10 .

Table: (10) concentration of Lead (µg/g dry weight) in core samples from the roads.

depth cm	Season	Mean of season Ex	Re	Qurna Ex	Re	Basrah center Ex	Re	Jazeera Ex	Re	Zubair Ex	Re	Abu Al-khaseeb Ex	Re
0-10 CM	Summer	434.86	381.09	181.14	93.59	901.81	805.03	220.39	83.02	858.80	772.76	12.16	151.03
	Autumn	493.35	38.97	25.33	55.24	1330.81	61.55	342.21	22.10	760.47	28.41	7.91	27.57

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depth cm	Season	mean of season Ex	Re	Qurna Ex	Re	Basrah center Ex	Re	Jazeera Ex	Re	Zubair Ex	Re	Abu Al-khaseeb Ex	Re
	Winter	5.26	20.81	4.32	9.82	6.32	45.31	5.85	16.28	7.55	17.37	2.27	15.28
	Spring	39.72	41.78	35.76	20.49	36.82	20.60	57.78	131.77	34.54	18.56	33.70	17.48
11-20 CM	Summer	411.46	416.62	66.42	203.79	832.68	811.17	351.72	202.58	797.34	780.45	9.12	85.14
	Autumn	236.06	23.52	26.12	15.78	456.28	44.19	494.30	23.67	190.12	29.99	13.46	3.95
	Winter	15.49	14.72	14.35	17.37	22.66	18.88	9.06	16.28	18.13	8.31	13.24	12.75
	Spring	29.45	41.58	21.54	21.64	25.59	22.47	54.73	119.61	1.70	22.36	43.69	21.85
21-30 CM	Summer	426.62	681.12	113.21	817.63	920.25	798.88	282.37	788.79	811.17	818.85	6.08	181.43
	Autumn	842.05	37.65	19.00	23.67	1140.70	53.66	1330.81	48.92	1711.05	31.56	8.71	30.45
	Winter	5.14	18.37	3.78	17.37	10.57	12.08	3.02	16.65	5.29	30.96	3.02	14.77
	Spring	25.77	37.20	4.21	13.43	45.56	11.24	51.69	125.69	4.32	14.45	23.09	21.22
Mean				42.93	109.15	477.50	225.42	266.99	132.95	433.37	214.50	14.70	48.58

Mn: The mean concentration of manganese in the **exchangeable phase** showed significant differences ,($p<0.05$) in the seasons . In exchangeable phase the highest seasonal mean concentrations (1407.00 µg/g dry weight) were detected during Autumn season in the depth 21-30 c m, while lowest mean concentration (45.11 µg/g dry weight) noticed during Winter in the depth 11-20 cm , and highest mean concentrations in station (890.83 µg/g dry weight) detected in the Zubair station while lowest mean concentrations (230.65 µg/g dry weight) noticed in Abo- alkaseb station . The results showed significant differences ($p<o.o5$) between stations.

In **residual phase** the highest seasonal mean concentrations(222.44 µg/g dry weight) were detected Autumn season in the depth 0-10 cm , while lowest mean concentrations (6.53 µg/g dry weight) noticed during Winter in the depth 0-10 cm . the results were   Showed significant differences ,($p<0.05$) between seasons.

In the stations highest mean concentration (147.17 µg/g dry weight)detected in Qurna station while lowest mean concentrations (94.26 µg/g dry weight)noticed in Zubair station. The results were showed significant differences ,($p<0.05$) among stations ,table11.

Table: (11) concentration **of manganese** (µg/g dry weight) in core samples from the roads

depth cm	Season	mean of season Ex	Re	Qurna Ex	Re	Basrah center Ex	Re	Jazeera Ex	Re	Zubair Ex	Re	Abu Al-khaseeb Ex	Re
0-10 CM	Summer	239.65	105.14	351.69	158.15	49.43	19.08	404.90	124.74	29.40	33.16	362.82	190.57
	Autumn	1312.42	222.44	335.44	201.41	1987.16	292.98	747.34	239.58	3226.99	219.67	265.15	158.55
	Winter	71.20	6.53	15.33	4.07	35.66	0.94	124.19	5.77	3.44	6.88	177.37	15.02

Depth	Season												
	Spring	306.33	148.02	382.54	169.63	266.93	133.05	432.12	171.76	222.45	143.80	227.63	121.86
11-20 CM	Summer	216.45	96.40	357.62	170.03	30.34	19.08	343.02	112.86	6.26	41.92	345.00	138.10
	Autumn	1371.21	186.51	351.78	269.32	2069.82	215.69	829.99	108.43	3309.65	177.52	294.82	161.59
	Winter	45.11	55.12	10.95	7.51	10.95	10.32	105.11	101.67	11.57	1.56	86.96	154.53
	Spring	255.37	134.13	368.81	181.27	174.52	119.48	382.37	143.55	149.39	144.27	201.76	82.11
21-30 CM	Summer	200.69	90.19	375.20	134.88	25.65	39.73	283.38	107.16	2.19	23.15	317.04	146.02
	Autumn	1407.00	204.03	338.61	263.23	2152.47	189.46	912.65	276.12	3392.30	163.00	238.96	128.34
	Winter	66.82	37.98	12.51	12.51	15.33	7.20	137.33	81.33	11.26	2.19	157.66	86.65
	Spring	279.74	132.99	396.97	194.06	216.54	119.72	367.52	125.73	325.07	174.05	92.61	51.41
Mean				274.79	147.17	586.23	97.23	422.49	133.22	890.83	94.26	230.65	119.56

Table (12):Annual Geoaccumulation Index (I- geo) of Heavy elements in core sample of Streets of Basrh Government .

Note: value <

Depths	station	Mn igeo	Pb igeo	Cd igeo	Cr igeo	Zn igeo	Fe igeo	Ni igeo
0-10cm	Qurnah	-1.57	0.13	0.62	0.96	-0.91	-2.97	0.73
	Basrah center	-1.66	2.38	0.34	0.41	-2.09	-3.56	1.38
	jazeera	-0.63	1.47	0.06	-0.21	-2.38	-3.76	0.49
	Zubair	-2.03	1.93	0.84	0.59	-2.09	-3.16	0.87
	Abu - Alkaseeb	-0.96	-1.46	0.48	0.71	-2.01	-3.32	0.95
11-20cm	Qurnah	-1.52	0.25	0.90	0.73	-0.79	-2.94	0.78
	Basrah center	-2.08	1.90	0.65	0.59	-1.31	-3.52	1.07
	jazeera	-0.57	1.27	-0.33	0.68	-2.38	-3.53	0.68
	Zubair	-2.11	0.22	0.74	0.32	-2.04	-3.08	0.91
	Abu - Alkaseeb	-0.98	-0.41	0.08	0.20	-1.80	-3.63	0.79
21-30cm	Qurnah	-1.41	-0.14	0.14	1.17	-1.36	-2.94	1.17
	Basrah center	-1.90	2.07	0.68	0.25	-1.52	-3.40	1.08
	jazeera	-0.54	1.78	-0.57	0.83	-1.96	-3.47	0.35
	Zubair	-2.14	1.43	-0.73	0.57	-2.21	-3.23	0.75
	Abu - Alkaseeb	-1.31	-1.32	0.16	0.35	-2.65	-3.37	0.74

i- geo 1

practically unpolluted , 1-2 unpolluted to moderately polluted , 2-3 moderately polluted to polluted

The highest value of annual average in (I-geo) of total Lead (Pb) in core sample was(2.38) in Basra center station at depth 0-10 cm. While the lowest value of total Iron (Fe) was (-3.76) in Jazeera station at depth 0-10 cm .

Contamination Factor (CF)of Heavy elements in core sample   :

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Annual average table of study stations evidence table 13.

Table (13):Annual contamination Index (CF) of Heavy elements in core sample of streets of Basrh Government **.**

Depths	station	Mn CF	Pb CF	Cd CF	Cr CF	Zn CF	Fe CF	Ni CF
0-10cm	Qurnah	0.88	2.93	3.26	3.83	1.15	0.23	5.37
	Basrah center	1.51	22.24	2.39	2.73	0.51	0.15	4.31
	jazeera	1.22	6.12	2.45	2.10	0.33	0.16	4.37
	Zubair	2.11	17.37	3.62	2.32	0.39	0.21	4.15
	Abu - Alkaseeb	0.83	1.56	2.46	2.59	0.42	0.16	3.99
11-20cm	Qurnah	0.93	2.71	3.65	3.03	1.05	0.24	3.29
	Basrah center	1.44	15.51	2.94	2.76	0.66	0.14	3.57
	jazeera	1.16	7.31	1.50	2.62	0.32	0.16	3.61
	Zubair	2.09	12.68	3.06	2.83	0.38	0.21	3.30
	Abu - Alkaseeb	0.80	1.41	2.03	1.88	0.60	0.12	3.25
21-30cm	Qurnah	0.94	1.62	2.22	4.37	0.59	0.24	3.54
	Basrah center	1.50	20.78	3.19	2.69	0.63	0.15	3.57
	jazeera	1.25	22.07	1.21	3.38	0.48	0.16	3.62
	Zubair	2.22	23.70	1.84	2.39	0.38	0.20	2.93
	Abu - Alkaseeb	0.66	1.69	2.05	2.44	0.28	0.15	3.42

Note: CF< 1 low contamination , 1≤ CF ≤ 3 moderate contamination 3< CF ≤ 6 considerable contamination CF > 6 very high contamination.

The highest value of annual average in (CF) of total **Lead(Pb**) in core sample was(23.70) in Zubair station at depth 21-30 cm. While the lowest value of total **Iron (Fe**)was (0.15) Abu-ALaseeb station at depth 21-30 cm table14.

 Enrichment Factor (EF) of heavy elements in core samples :

Table (14): Annual Enrechment factor Index (EF) of Heavy elements in core sample of Streets of Basrah Government .

Depths	station	Mn EF	Pb EF	Cd EF	Cr EF	Zn EF	Ni EF
0-10cm	Qurnah	3.83	12.06	3.26	20.64	4.91	33.21
	Basrah center	10.03	121.44	2.39	24.33	3.51	38.92
	jazeera	9.76	39.93	2.45	13.14	3.28	31.37
	Zubair	12.66	88.04	3.62	17.35	2.29	25.41
	Abu - Alkaseeb	5.99	11.67	2.46	17.99	3.12	29.01
11-20cm	Qurnah	4.17	11.69	3.65	13.25	4.57	21.84
	Basrah center	9.36	93.25	2.94	20.80	4.87	30.76
	jazeera	8.72	42.27	1.50	19.87	2.94	40.18

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	Zubair	12.86	62.28	3.06	21.97	2.25	22.00	
	Abu - Alkaseeb	6.43	11.49	2.03	15.55	5.00	25.45	
21-30cm	Qurnah	4.23	7.51	2.22	18.80	3.75	22.11	
	Basrah center	9.71	111.09	3.19	18.41	4.47	24.71	
	jazeera	9.10	108.75	1.21	20.92	3.49	22.69	EF< 1
	Zubair	13.69	142.78	1.84	23.96	2.27	18.46	
	Abu - Alkaseeb	4.67	12.95	2.05	15.83	2.27	23.55	

Note: no enrichment , 1-3 minor enrichment , 3-5 moderate inrechment , 5-10 moderate to severe enrichment , 10-25 severe enrichment , 25-50 very severe enrichment , EF >50 extremely severe enrichment.

The highest value of annual average in (EF) of total **Lead(Pb)** in core sample was(142.78) in Zubair station at depth 21-30 cm. While the lowest value of total **Cadmium (Cd)**was (1.21) in Jazeera station at depth 21-30 cm .

IV.   Discussion:

Heavy metals concentrations in road dust are significantly affected by vehicle operation and road abrasion. It should be noted that more tire abrasion occurs when a vehicle drives on a concrete motorway compared with an asphalt surface (Duong and Lee , 2011). Driving on concrete surfaces also requires higher energy use, which results in higher fuel consumption. Higher hydrocarbon concentrations and lower heavy metal concentrations were reported from driving on asphalt. Heavy metal concentrations in road dust strongly depend on vehicle speed. As such, the highest concentrations have been recorded on motorways. Higher speeds also result in greater tire wear and increased fuel combustion. Duong and Lee (2011) compared dust from roads, where the average speed ranged from 80 to 90 km/h with roads where the average speed ranged from 70 to 80 km/h. They have found that higher concentrations of heavy metals occurred in dust from roads that had higher average driving speeds.

  According to Duong and Lee (2011), the concentrations of heavy metals in road dust vary significantly depending on traffic and road features such as roundabouts, motorway roads, and traffic lights. The concentrations of metals in road dust from motorways are approximately twice those found near roundabouts and downtown areas (Duong and Lee 2011). The influence of different pavement surfaces on environmental heavy metal pollution has recently been investigated by Murphy *et al.* (2015)

Through this study, an increase in the rate of concentrations of heavy elements in hot seasons such as summer and autumn and a decrease in the rate of these concentrations in the winter season was observed. High temperatures increase the solubility, mobility and readiness of the elements in the soil and their association with some other elements. In winter, the concentrations of heavy elements decrease due to the frequent rainfall, which in turn facilitates the leaching of these elements to streets soil. High concentration of lead and chromium in Basrah station because very much vehicle move in the city , tiers waste and existing emission from cars

 Assessment of heavy elements pollution, using pollution indexes registered that the annual average of study station with (I-geo) factor ranged from moderately polluted to polluted, especially with Pb ,Ni and Cr in the core sample , also, contamination factor indicated CF considerable contamination to very high contamination especially with Pb and Ni . Enrichment factor EF indicated very severe enrichment to   extremely severe enrichment especially with , Pb ,Ni and Cr . This high results of Pb ,Cr, and Ni in street soil are often to the human activities and environmental factors , lead used as an additive in gasoline. Residues remain in the environment , especially in areas with heavy traffic. Chromium and nickel these elements are components of vehicle parts like brake pads, tires, and engine components. Wear and tear release metal particles into the soil .Industrial pollution like Factors , Workshop and metal industries near streets can release Lead , chromium and nickel through emission waste disposal   .

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the mean concentration value for Pb, Cd, and Cr was several times higher than that of the background concentrations, indicating possible anthropogenic input of toxic metals from the wear of motor vehicle parts, the combustion of fossil fuels, and metal processing. The findings of the literature align with the mean concentrations of HMs reported in UStD (Zheng et al. 2020; Chen et al. 2022)

V.   Conclusion:

The present study in Basrah streets environmental manner including the spatial distribution, contamination status, ecological risk assessment, and the identification of the main sources of Cr, Cd, Ni, Pb,Mn,Fe and Zn in the of Basrah streets stations. We observed hotspots of toxic metal concentration and reported results. We also compared them with those already reported from other stations. According to the conclusions, the studied area is markedly enriched by large-scale circulation. Together, the high EF for Pb,Ni and Cr in street dust represents the important levels of environmental pollution caused by these elements, which primarily come from anthropogenic sources. Pb was determined as a priority pollutant according to the assessment tool for potential eco-risks in the studied sit.More studies are also needed to characterize potential hazards in Basrah City that have not been described in the contaminated stations. Management strategies should be applied to reduce the discharge of potentially toxic metals from the industrial area.

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