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Estimation and Distribution of Some Heavy Metals in Urban Soils at Kufa, Najaf Governorate: An Environmental Geochemistry Research

Ruaa I. Muslim[1]*, Zinah S. Al-Ankaz[1], Mohanad R. A. Al-Owaidi[2]

[1]*Department of Geology, College of Science, Wasit University, Wasit, Iraq*
[2]*Department of Applied Geology, College of Science, University of Babylon, Babylon, Iraq*

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Abstract

Kufa, considered one of the important cities in Iraq, is facing a rapid increase in population proportion and urban development in buildings and industry. Therefore, the concentration of several hazardous heavy metals is the main focus of this study. It presents the distribution and Estimation of heavy metals in urban lands in the Kufa area as an environmental geochemical study. Twenty samples of urban surface soils were collected in many sites to determine concentrations, distribution, and contamination of elements Cu, Zn, Co, Ni, Th, U, Pb, Hf, Nb, and Fe. The mean concentrations of heavy metals were compared with the local studies, UCC guidelines, and the world reference. To distinguish anthropogenic pollution, EF and I_{geo} guides were calculated. The obtained results established that contamination in Kufa soil land was slightly polluted by U (2.83ppm) and Nb (10.81ppm) and moderately polluted by Pb (31.7ppm) and Hf (9.75ppm). The research revealed that the reason for the elevation in the lead in the Kufa soil is that it often suffers from severe vehicle overcrowding during religious occasions.

Keywords: Kufa, Urban land use; Heavy metal; Contamination factor; Enrichment factor; Geoaccumulation index

توزيع وتخمين المعادن الثقيلة في التربة الحضرية في الكوفة في محافظة النجف: بحث في الجيوكيمياء البيئية

رؤى عيسى مسلم[1]*، زينة سليم العنكز[1]، مهند راسم عباس العويدي[2]

[1]قسم علم الارض، كلية العلوم، جامعة واسط، واسط، العراق

[2]قسم علم الارض التطبيقي، كلية العلوم، جامعة بابل، بابل، العراق

الخلاصة

تواجه الكوفة، التي تعتبر من المدن المهمة في العراق، زيادة سريعة في نسبة السكان والتطور العمراني في المباني والصناعة. حيث بينت هذه الدراسة توزيع المعادن الثقيلة وتقديرها في الأراضي الحضرية في منطقة الكوفة كدراسة جيوكيميائية بيئية. جمعت عشرين عينة من تربة سطحية حضرية من عدة مواقع في الكوفة

* Email: ralqurashy@uowasit.edu.iq

لتحديد التراكيز والتوزيع والتلوث لعناصر Cu, Zn, Co, Ni, Th, U, Pb, Hf, Nb, وFe. تمت مقارنة متوسط تراكيز المعادن الثقيلة مع دراسات محلية ومكونات القشرة الارضية العليا كقيمة وكذلك مع مرجعيات عالمية. لتمييز التلوث البشري المنشأ عن أصله الذاتي، تم حساب أدلة EF و Igeo. أثبتت النتائج المتحصل عليها أن الرواسب في تربة الكوفة ملوثة بشكل طفيف بال U (2.83 جزء في المليون) و Nb (10.81 جزء في المليون) ومتوسط التلوث بالرصاص (31.75 جزء في المليون) و Hf (9.75 جزء في المليون). وكشف البحث أن سبب ارتفاع محتوى الرصاص في تربة الكوفة هو أنها تعاني في كثير من الأحيان من الاكتظاظ الشديد في المركبات خلال المناسبات الدينية.

1. Introduction

Over recent decades, pollution assessment of the distribution of heavy metals in soil has been intensively focused on, and it is possible to have adverse effects on health [1]. Heavy metals have a high ecological impact due to their concentration in the soil and then transfer to biota, causing worrying toxic effects because they are non-biodegradable in the ecological cycle [2]. The accumulation of heavy metals in different human body organs, such as kidneys, bones, and liver, causes unwanted side effects [3]. Excessive use of fertilizers, pesticides, lime, and other components used for soil amendment and decomposition or degradation of the atmosphere contribute to increased concentrations of heavy elements [4].

The soil is considered a pool of trace elements, and it plays an important role in the environmental cycling of these elements [5]. Natural and human sources of heavy metals that are concentrated in soil and plants cause major environmental pollution problems. Their impact on food safety and adverse health risks make them one of the most dangerous environmental cases [6]. Environmental pollution of the biosphere with heavy metals due to dense agricultural and other anthropogenic activities demonstrates critical problems for the secure use of agricultural land [7], [8]. Consumption of foods produced on contaminated soil directly affects human health [9], [10].

Elevated levels of heavy metals mark urban soils to extensive anthropogenic activities related to vehicular emissions, fuel combustion, industrial and urban waste, metal industries, wear and tear of tires, building materials, fertilizers use, and agricultural run-off [11].

The concentration of heavy metals depends not only on the anthropogenic and lithogenic sources but also on the textural characteristics, organic matter content, mineralogical composition, and depositional environment of the sediments [12]. Monitoring the distribution of toxins in the environment is vital because it provides data required for planning; helps in the determination of the health and condition of a particular environment; provides a means to record environmental changes and trends over time; and finally, it helps in focusing efforts by relevant authorities towards decision-making [13].

In Kufa, the chemical properties of soils include organic content, sulfate content, and gypsum content. The organic content is low in most localities outside the city. The assemblages of gypsum are concentrated in the west part of the city and decrease towards the east [14]. The main factors controlling heavy metal concentrations in the soils are parent rocks, pH–Eh drainage, climate, time, clay content, and organic matter content [15]. Heavy metal concentrations have been increasing in the environment due to the weathering of rocks or human activities. The heavy metal content of soil depends on the nature of its parent rocks and the amount of sewage sludge, industrial and domestic waste, and fertilizer impurities entering the soil.

This work focuses on measuring the Estimation and distribution of heavy metals in urban surface soils in Kufa District City, Iraq.

2. Geology of the studied area

The study area is located in the Mesopotamia Basin on the Stable Shelf. In the Upper Miocene-Pliocene, a renewed uplift in the whole stable shelf area occurred. This movement directly influences paleogeographic development and is marked by the deposition of terrigenous clastic syn and post-orogenic molasses in the still subsiding and mobile foredeep (Injana Formation). The upper formation of the area is the Dibbdiba Formation (Pliocene–Pleistocene), which consisted of sandstone (fine-coarse grained) with a low percentage of small pebbles. The Quaternary era is characterized by the development of the river systems [16], [17]. The city of Kufa is located above the sediments of the flood plain of the Quaternary age, intertwined with the formation of Dibbdiba sediments (Figure 1).

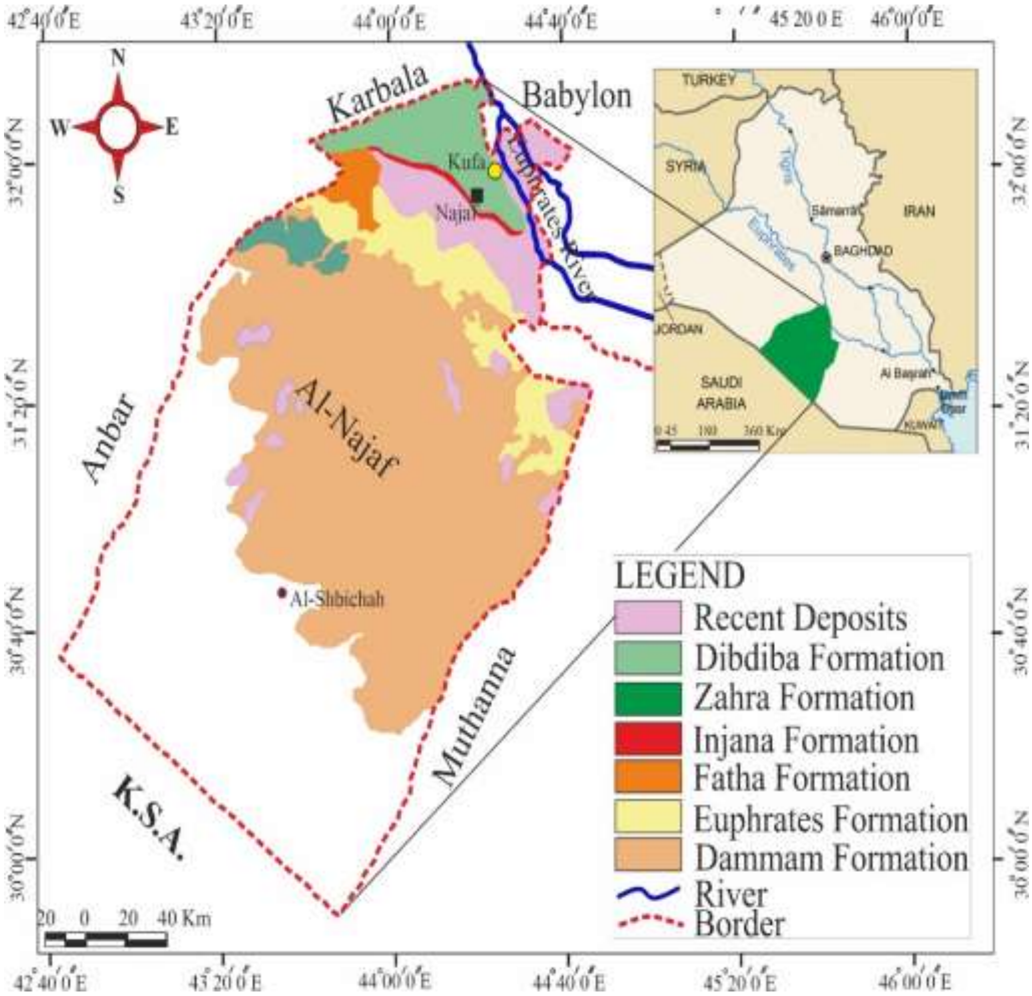

Figure 1: The geological map of the study area [18]

3. Materials and methods

3.1 Study area and Fieldwork

Najaf province, one of the eighteen Iraqi provinces, is located south of Baghdad. Kufa is one of the districts of Najaf Governorate, situated to the northeast of Najaf City, 10 km away. It is located on the right bank of the Euphrates River. The climate in the study area is arid, and the mean annual rainfall is 100–150 mm. It is surrounded by fertile agricultural soils, on which orchards are spread out on most of its sides [14]. The city is considered one of the most important cities in Iraq as it is facing rapid population growth and continuous development in construction, such as residential complexes, hotels, bridges, and shopping malls [19].

The semi-detailed soil survey was carried out in the selected area for study by grade soil system and according to soil texture examination results. Twenty samples of community urban surface soils (depth 0–20 cm [20]) were chosen from sites in Kufa (Figure 2). To provide the best coverage possible, samples were collected at specific locations that encompassed the majority of the urban area. The samples were dried in the sun and the air. Later, the samples were sieved through a 2 mm sieve, and the passing part of them was taken only [21]. The samples were kept in polyethene plastic bags before analysis. Samples were taken during the wet season (April 2021). The study covered an area of 16 km^2 of urban areas in Kufa. The geographical coordinates of the sampling stations are listed in Table 1.

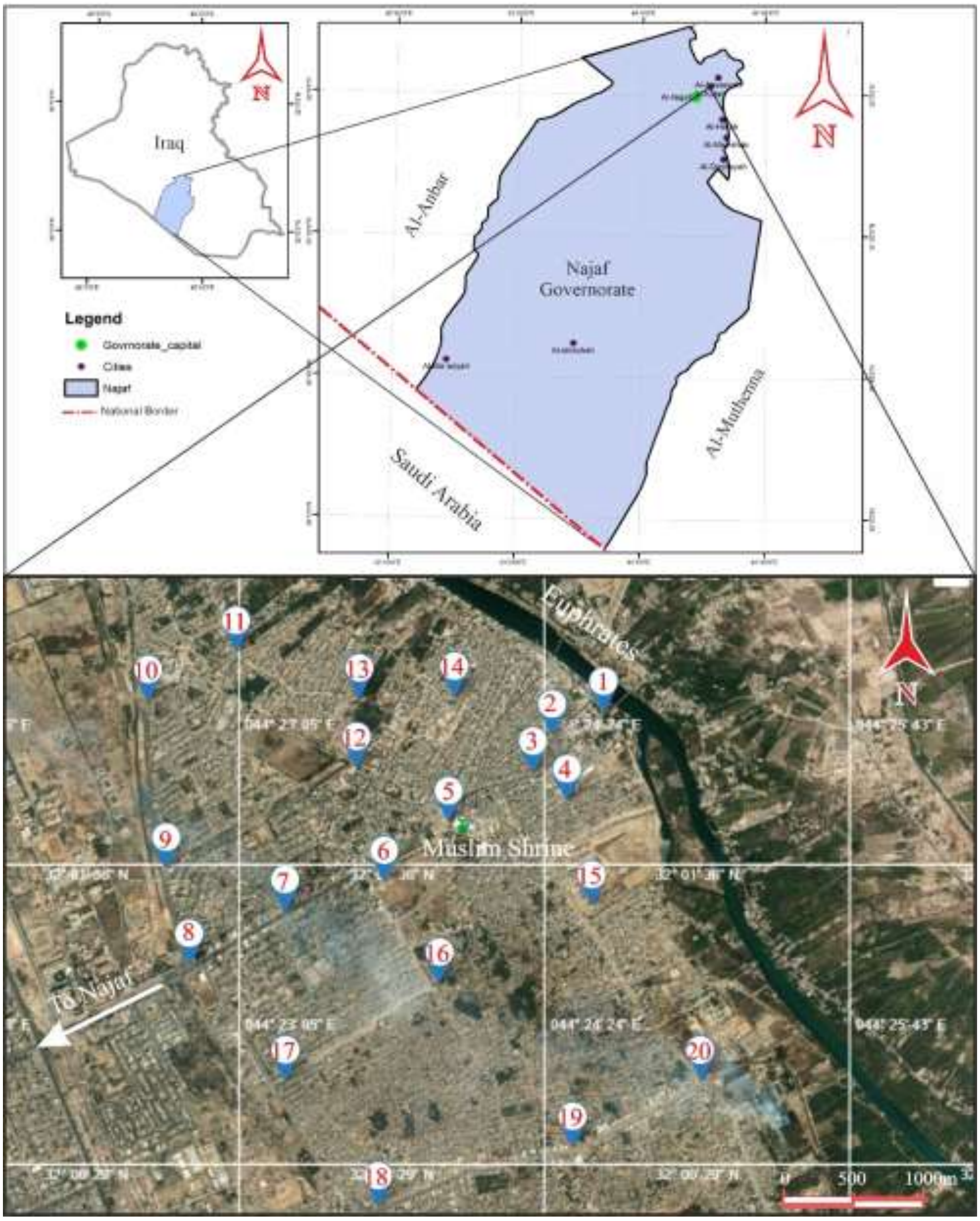

Figure 2: Satellite image for sampling site locations in Kufa District

Table 1: Information on the land soil numbers and site coordinates

Sample No.	Land Use soils	Coordination	
		E	N
1	Urban soils	044° 24′ 39″	32° 02′ 07″
2		044° 24′ 24″	32° 01′ 56″
3		044° 23′ 09″	32° 02′ 21″
4		044° 24′ 28″	32° 00′ 31″
5		044° 24′ 07″	32° 02′ 03″
6		044° 23′ 57″	32° 01′ 42″
7		044° 23′ 49″	32° 01′ 20″
8		044° 24′ 02″	32° 02′ 20″
9		044° 23′ 34″	32° 02′ 00″
10		044° 24′ 27″	32° 01′ 37″
11		044° 23′ 54″	32° 01′ 08″
12		044° 23′ 14″	32° 00′ 47″
13		044° 22′ 55″	32° 01′ 13″
14		044° 23′ 07″	32° 01′ 42″
15		044° 22′ 42″	32° 01′ 57″
16		044° 23′ 38″	32° 00′ 18″
17		044° 25′ 05″	32° 00′ 47″
18		044° 23′ 07″	32° 01′ 31″
19		044° 24′ 23″	32° 02′ 22″
20		044° 24′ 32″	32° 01′ 22″

3.2 Laboratory works

The chemical composition of the soil samples was examined using an X-ray fluorescence spectrometer type SPECTRO XPOS tool (manufactured in Germany) in the XRF laboratory at the Department of Geology, University of Baghdad. From each bulk sample, a representative specimen is chosen. The specimen was prepared by pulverizing and reducing to 50 µ by agate grinder. Then, 10 gm was taken to make pellets in a cylindrical metal mold with a thickness of 3 mm and a 25 mm diameter. The pellet was pressed to 150 N/cm^2 in the mold. Finally, the mold was placed in the X-RF instrument for analysis [22].

3.3 Pollution estimation

The important indices that are employed to assess the presence and density of anthropogenic pollutants in soil are the Enrichment Factor (EF) and Geo-accumulation index (Igeo) [8].

3.1.1 Enrichment Factor

The Enrichment Factor (EF) was employed to assess the pollution of the heavy metals in the soils. The concentration of Fe or Al in the upper continental crust (UCC) [23] was used as a background for the geochemical normalization of heavy metal data in the EF calculation. Iron is used as a conservative element for EF calculation in this study. Several authors have employed iron to normalize heavy metals [24]; [3]. The EF of individual heavy metals in sediments can be calculated with the following equation [25]:

$$EF = [C_{metal}/C_{normalize}]_{soil}/\ [C_{metal}/C_{normalize}]_{control} \quad (1)$$

Where: C_{metal} and $C_{normalize}$ are the concentrations of heavy metal and normalizer in sediment and unpolluted control. EF can be used to differentiate between the metal's origination from anthropogenic activities and those from natural procedures and to assess the degree of anthropogenic influence. EF< 1 indicates no enrichment, EF= 1- >3 is minor enrichment, EF= 3- >5 is moderate enrichment, EF= 5- >10 is moderately severe enrichment, EF= 10- >25 is severe enrichment, EF= 25- >50 is very severe enrichment, and EF< 50 is extremely severe enrichment [25].

3.1.2 Geo-accumulation index

To evaluate the level and quantitative degree of pollution in soil samples, the geo-accumulation index (I_{geo}) is used, which is widely used and calculated by equation (2) [26].

$$I_{geo} = log_2\,(Cn\,/\,1.5\,Bn) \quad (2)$$

Where: *Cn* is the measured concentration of the heavy metal (n) in the sediments, *Bn* is the geochemical background value of each element (n), and 1.5 is the background matrix correction factor due to lithogenic effects [27]. The I_{geo} consists of seven grades (0–6), fluctuating from unpolluted to Very strongly polluted. The highest grade (class six) reflects 100-fold enrichment above the background values [28]. $I_{geo}\leq 0$ (Class 0) unpolluted, I_{geo}< 0-1 (Class 1) Slightly polluted, I_{geo}< 1- 2 (class 2) Moderately polluted, I_{geo}< 2-3 (class 3) Moderately severely polluted, I_{geo}< 3-4 (Class 4) Strongly polluted, I_{geo}< 4-5 (class 5) Strongly to very strongly polluted, I_{geo}> 5 (class 6) Very strongly polluted.

The ARC Map 10.6, 2018 program of maps is used for soil sampling distribution in the study area. Also, Microsoft Excel 2010 was also used to represent, indicate, and assess the concentration of the studied elements in each soil sample.

4. Results and discussion

4.1. Geochemistry of heavy metals

High precipitation of heavy metals and their deposition over time can lead to anomalous enrichment and cause metal contamination of the surface environment. Persistent urban soil contamination and its proximity to the human population can significantly increase the exposure of the urban population to metals via inhalation, ingestion, and dermal contact [29]. Heavy metals are often serious pollutants due to their persistence, toxicity, and non-biodegradable metals accumulated in soil transfer easily to others [30].

The results of the tests can be analyzed to present a database for the locations which cover a wide area of Kufa City. For surface land use, surface land use, surface soil samples were examined for heavy metals such as Cu, Zn, Co, Ni, Th, U, Pb, Hf, and Nb. This was established or represented by geochemical indices to show an understanding of the pollution level in the study area. The concentrations of heavy metals in the studied samples are listed in Table 2.

Regarding the results, Pb and Hf are higher than the guidelines (UCC), whereas the other metals are within limits. The mean concentration of heavy metals is lower than in Iraqi geochemical studies, except for Pb. Lead concentration was higher than in the previous local studies [9]; [31] for Iraqi urban soils.

The increase in Hf concentrations may be attributed to the terrestrial clastic presence in the geological area and to human activity in Kufa City. The mean value of the Hf concentration was 9.75ppm. Concerning the chemical properties of Hf, it may be associated with other minerals because of its terrestrial abundance in sandstones. Also, there was an elevated concentration of Hf in plants grown on soil amended with sewage sludge. This designates its anthropogenic sources [32].

Table 2: Identified heavy metal concentrations in land-use soil samples

Sample No.	Fe	Cu	Zn	Co	Ni	Th	U	Pb	Hf	Nb
	%					ppm				
1	0.48	15	40	4.44	15.3	7.1	3.22	20.63	16.44	8.45
2	0.96	12	46	4.6	16	6.2	3.67	17.25	12.11	12.33
3	0.53	19	56	8.22	27	6	4.11	34.13	8.22	10.77
4	0.46	9	26	7.88	25	8	3.12	34.13	11.36	11.79
5	0.58	15	32	14.8	57	5.11	3.42	32.44	7.18	13.75
6	1.18	13	15	10.2	49	4.21	1.66	27.38	10.34	15.43
7	0.69	34	23	5.1	15	8.62	5.23	52.69	18.55	16.58
8	0.56	10	36	8.3	23	3.1	1.11	52.69	7.44	13.4
9	0.47	5	13	4.5	14	2.22	1.44	42.56	3.76	11.23
10	0.83	5	13	5.9	27	13.3	3.12	32.44	17.79	14.46
11	0.74	13	78	3.4	25	12.4	6.14	37.50	18.69	15.73
12	0.62	5	62	2.11	9	1.56	1.22	22.31	5.88	3.45
13	0.69	8	25	1.22	5	0.96	0.56	22.31	4.55	9.87
14	0.76	22	40	11.56	20	18	6.22	32.44	7.88	17.45
15	0.92	12	46	5.43	5	2.7	1.43	22.31	6.3	7.11
16	0.58	19	56	3.44	15	5.28	3.44	22.31	10.78	9.3
17	0.84	9	26	3.3	5	2.7	1.11	52.69	4.55	5.32
18	1.16	15	33	6.5	7	4.2	2.33	22.31	7.58	10.34
19	0.51	13	45	8	13	3.32	0.98	27.38	6.22	5.18
20	0.97	34	54	4.4	13	6.33	3.11	27.38	9.32	4.33
Min	0.46	5	13	1.22	5	0.96	0.56	17.25	3.76	3.45
Max	1.18	34	78	14.8	57	18	6.22	52.69	18.69	17.45
Mean	0.73	14.35	38.25	6.17	19.27	6.07	2.83	31.76	9.75	10.81
UCC*	3.5	25	71	17	44	10.7	2.8	17	5.8	12
LS**	1.56	17.4	41.6	11.62	75.5	---	---	10.55	---	---
LS***		49.2	73.6	23.17	193.4	----	1.15	13.33	---	----

LS: local study, * [23], ** [31], *** [9]

Lead concentrations is increased in the soil of the region. Some high Pb content has also been identified for calcareous soils and organic matter. Pb reveals a great association with hydroxides, mainly Fe and Mn. It can be concentrated in carbonate or phosphate particles. Lead generally accumulates near the soil surface [33].

In addition to enhancement from parental rocks, which increases lead pollution, urban activities such as severe vehicle overcrowding during religious occasions. The mean value of the Pb concentration was 31.76 ppm.

In Kufa City, the concentration of heavy metals in soils was in descending order of Zn> Pb> Ni> Cu> Nb> Hf> Co> Th> U. Figure 3 shows the distribution patterns chart of Zn, Ni, Cu, Nb, Hf, Pb, Th, Co, and U as means.

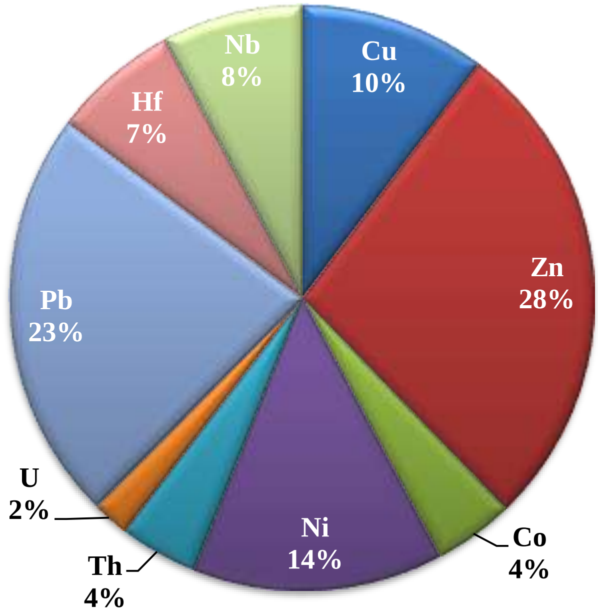

Figure 3: chart distribution patterns of the studied heavy metals as average

4.2 Pollution factors estimation

Soil contamination with heavy metals gets more attention because of its severe threat to the food chain, human health, and soil ecosystems. Soil often behaves as a sink for heavy metals originating from lithogenic and anthropogenic sources [3]. The surface soil samples were investigated with the values of EF and I-Geo.

The result of dividing the ratio of current metal concentrations to background element concentrations in the UCC is represented by the definition of EF (Table 3). It assesses pollution status and evaluates the impact of anthropogenic activities, and can employ environmental indices for pollution, such as EF and I_{geo}. The average enrichment factors for heavy metals in Kufa soil are listed in Table 4 and Figure 4.

Table 3: Mean of EF values in addition to grades of pollution for heavy metals in the studied area

Samples No.	EF values								
	Cu	**Zn**	**Co**	**Ni**	**Th**	**U**	**Pb**	**Hf**	**Nb**
1	4.38	4.11	1.90	2.54	4.84	0.83	8.85	1.12	2.20
2	1.75	2.36	0.99	1.33	2.11	2.17	3.70	1.98	1.82
3	5.02	5.21	3.19	4.05	3.70	1.39	13.26	0.37	8.39
4	2.74	2.79	3.53	4.32	5.69	0.69	15.27	0.45	7.66
5	3.62	2.72	5.25	7.82	2.88	1.48	11.51	0.38	10.66
6	1.54	0.63	1.78	3.30	1.17	1.78	4.78	1.31	3.44
7	6.90	1.64	1.52	1.73	4.09	1.60	15.72	0.71	6.79
8	2.50	3.17	3.05	3.27	1.81	0.77	19.37	0.23	16.86
9	1.49	1.36	1.97	2.37	1.55	1.17	18.64	0.12	26.91
10	0.84	0.77	1.46	2.59	5.24	0.74	8.05	1.33	3.16
11	2.46	5.20	0.95	2.69	5.48	1.40	10.43	1.08	4.24
12	1.13	4.93	0.70	1.15	0.82	1.85	7.41	0.48	2.10
13	1.62	1.79	0.36	0.58	0.46	1.54	6.66	0.41	6.98
14	4.05	2.59	3.13	2.09	7.75	1.00	8.79	0.54	9.41
15	1.83	2.46	1.22	0.43	0.96	1.86	4.99	0.76	2.72
16	4.59	4.76	1.22	2.06	2.98	1.44	7.92	0.82	3.30
17	1.50	1.53	0.81	0.47	1.05	1.32	12.91	0.21	7.30
18	1.81	1.40	1.15	0.48	1.18	2.46	3.96	1.16	2.61
19	3.57	4.35	3.23	2.03	2.13	0.58	11.05	0.34	4.45
20	4.91	2.74	0.93	1.07	2.13	1.82	5.81	0.97	1.30
Max.	6.90	5.21	5.25	7.82	7.75	2.46	19.37	1.98	26.91
Min.	0.84	0.63	0.36	0.43	0.46	0.58	3.70	0.12	1.30
Mean	2.91	2.83	1.92	2.32	2.90	1.39	9.95	0.74	6.62

Table 4: Values of EF for certain heavy metals in the studied subsurface soils

Heavy Metals	Mean	EF Category
Cu	2.912	Moderate enrichment (Mo.E.)
Zn	2.826	Moderate enrichment (Mo.E.)
Co	1.918	Deficiency- minimal enrichment (D-ME)
Ni	2.318	Moderate enrichment (Mo.E.)
Th	2.901	Moderate enrichment (Mo.E.)
U	1.394	Deficiency- minimal enrichment (D-ME)
Pb	9.95	Moderately severe enrichment (Mo.SE)
Hf	3.039	Moderate enrichment (Mo.E.)
Nb	1.435	Deficiency- minimal enrichment (D-ME)

Most of the heavy metals are moderately enriched (Mo.E.) except Co, U, and Ni, which are Deficiency-minimal enrichment (D-ME), and Pb is moderately severe enrichment (Mo.SE). It can be attributed to anthropogenic activities such as the city's widespread domestic and industrial wasteland's failure to raise it for a long time [8]. The intensity of traffic in the city is high because it is a holy city and is visited by many pilgrims. It is also a strategic road linking many provinces to the holy city of Najaf. The output of dust from the

Kufa cement plant, which is eight km away, can cause the city to suffer from pollution [34], especially when the air direction is east. Leaded gasoline, which is used by cars as an antiknock agent, has the potential to emit lead (Pb) into the environment [35]; [36]; [37]; [38]. It may be the main reason for the increase in Pb concentration in the soil of Kufa because it often suffers from severe overcrowding of vehicles during religious occasions.

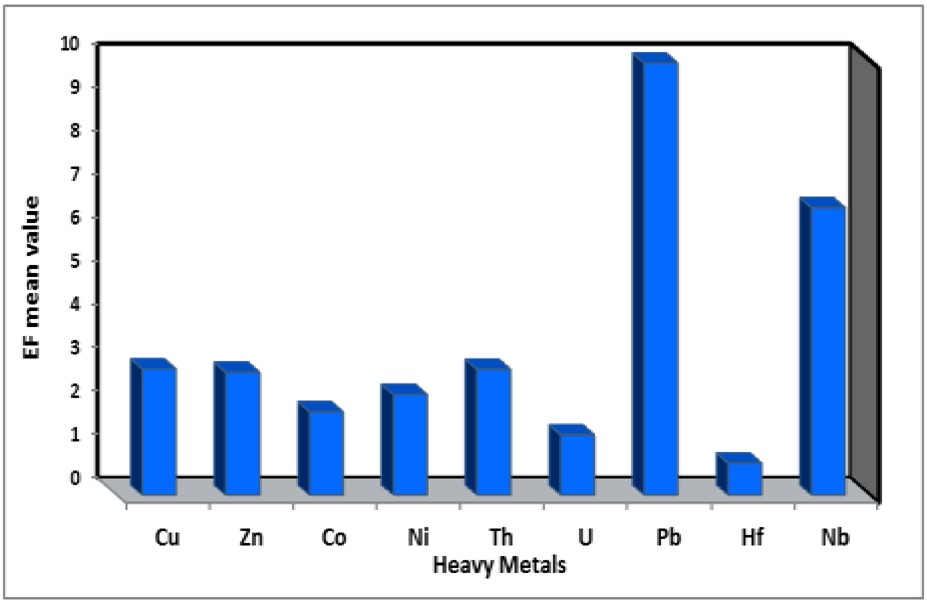

Figure 4: Mean of Enrichment Factor (EF) values of heavy metals in the study area of Kufa City.

As per I_{geo} results, the land use soil is unpolluted by Cu, Zn, Co, Ni, and Th, but slightly polluted by U and Nb and moderately polluted by Pb, and Hf (Table 5 and Figure 5)

Table 5: Geo-accumulation index (I-Geo) values of studied soil samples Najaf Governorate

Sample No.	I_{geo} values								
	Cu	Zn	Co	Ni	Th	U	Pb	Hf	Nb
1	-0.15	-0.24	-1.35	-0.94	-0.01	0.79	0.86	2.09	0.08
2	-0.47	-0.04	-1.30	-0.87	-0.20	0.98	0.61	1.65	0.62
3	0.19	0.24	-0.46	-0.12	-0.25	1.14	1.59	1.09	0.43
4	-0.89	-0.86	-0.52	-0.23	0.17	0.74	1.59	1.55	0.56
5	-0.15	-0.56	0.39	0.96	-0.48	0.87	1.52	0.89	0.78
6	-0.36	-1.66	-0.15	0.74	-0.76	-0.17	1.27	1.42	0.95
7	1.03	-1.04	-1.15	-0.97	0.27	1.49	2.22	2.26	1.05
8	-0.74	-0.39	-0.45	-0.35	-1.20	-0.75	2.22	0.94	0.74
9	-1.74	-1.86	-1.33	-1.07	-1.68	-0.37	1.91	-0.04	0.49
10	-1.74	-1.86	-0.94	-0.12	0.90	0.74	1.52	2.20	0.85
11	-0.36	0.72	-1.74	-0.23	0.80	1.72	1.73	2.27	0.98
12	-1.74	0.39	-2.43	-1.70	-2.19	-0.61	0.98	0.60	-1.21

13	-1.06	-0.92	-3.22	-2.55	-2.89	-1.74	0.98	0.23	0.30
14	0.40	-0.24	0.03	-0.55	1.34	1.74	1.52	1.03	1.13
15	-0.47	-0.04	-1.06	-2.55	-1.40	-0.38	0.98	0.70	-0.17
16	0.19	0.24	-1.72	-0.97	-0.43	0.88	0.98	1.48	0.22
17	-0.89	-0.86	-1.78	-2.55	-1.40	-0.75	2.22	0.23	-0.59
18	-0.15	-0.52	-0.80	-2.07	-0.76	0.32	0.98	0.97	0.37
19	-0.36	-0.07	-0.50	-1.17	-1.10	-0.93	1.27	0.69	-0.63
20	1.03	0.19	-1.36	-1.17	-0.17	0.74	1.27	1.27	-0.89
Max.	-1.74	-1.86	-3.22	-2.55	-2.89	-1.74	0.61	-0.04	-1.21
Min.	1.03	0.72	0.39	0.96	1.34	1.74	2.22	2.27	1.13
Mean	-0.42	-0.47	-1.09	-0.92	-0.57	0.32	1.41	1.18	0.30
Class	Class 0	Class 0	Class 0	Class 0	Class 0	Class 1	Class 2	class 2	Class 1

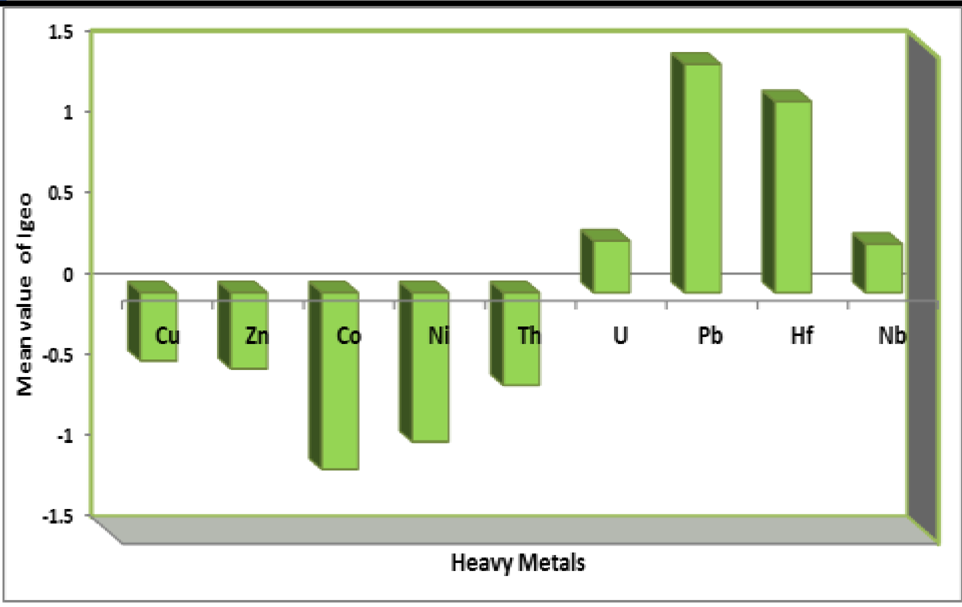

Figure 5: Mean of I-Geo index values of heavy metals in the study area of Kufa City

5. Conclusions

The study calculated the distribution and concentration of heavy metals in urban soil land use in selected sites within the Kufa District in Najaf Governorate. As a general rule, the charts of metal concentrations reveal a variance in heavy metal concentrations attributable to human activities. The requirements for temporary, suitable pollution control methods and consistent quality-control systems analysts have occurred from this research.

The levels, distribution, and evaluation of heavy metals, including Cu, Zn, Co, Ni, Th, U, Pb, Hf, and Nb, have been investigated. The results showed that the mean concentrations of Pb and Hf are higher than the guidelines (UCC), whereas the other metals are within limits. The heavy metals concentration in Kufa urban soils was arranged in descending order Zn> Pb> Ni> Cu> Nb> Hf> Co> Th> U.

The results showed that the mean concentrations of heavy metals are lower than in Iraqi geochemical studies, except for Pb. Lead concentration was higher than the previous local studies in 2016 and 2018 for Iraqi urban soil. This anthropogenic pollution is because Kufa City is characterized by religious tourism, as vehicles are severely overcrowded. At the same time, the increase in Hf concentrations may be attributed to the presence of other minerals due to their terrestrial clastic richness in the geological areas. In addition, Hf has increased due to human and urban activity in Kufa City.

A principal component analysis was applied to the data set to determine correlations in the behavior of analyzed sampling points. The sediment contamination in Kufa soil land-use was slightly polluted by U and Nb and moderately polluted by Pb and Hf.

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