Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

Sources and Distribution of Polycyclic Aromatic Hydrocarbons (PAHs) in Sediment Core of Khor Al-Zubair

Fatima Fakhir Abo-Turab [1], Abbas Hameed Mohammed [2], Hamid Talib Al-Saad [3]
[1,2] University of Basrah – collage of science
[3] University of Basrah – collage of marine science

Email: Fatimafakhir98@gmail.com[1], Doctorabbas71@yahoo.co.in[2], htalsaad@yahoo.com[3]

Abstract. Hydrocarbon pollution is related to the pollution of the environment by hydrocarbons, organic compounds that include hydrogen and carbon, which occur naturally in various forms. Crude oil and natural gas are significant hydrocarbon sources utilized for energy,which is one of the most important causes of pollution. The source and distribution of PAHs has been studied in core sample in Khor Al-Zubair, Basrah southern Iraq. Sediment samples were taken from 5 station. The sediment was extracted and the PAHs were determined by Gas chromatography mass (GC-Mass). The average of total PAHs concentrations ranged frome 31.31 to 157.901 ng/g. The study contributed to revealing the pollution levels in the study area, as the result indicated that most components originate from a petrogenic source. This study gave a baseline on the source and distribution of these components in the Khor Al-Zubair area of Basra Governorate and can be used as a baseline for future studies

Highlights:

1. Hydrocarbon pollution: Environmental contamination from crude oil and natural gas.
2. Study area: PAHs analyzed in Khor Al-Zubair sediments using GC-Mass.
3. Findings: PAHs (31.31–157.901 ng/g) mainly from petrogenic sources.

Keywords: polycyclic aromatic hydrocarbons, PAHs, sediment pollution, Khor Al-Zubair, Basrah governorate.

Introduction

PAHs compounds (Polycyclic Aromatic Hydrocarbons) are long-lasting environmental pollutants that pose serious toxic and carcinogenic risks. [1, 2]. These compounds are mutagenic, carcinogenic and cytotoxic. They can accumulate in the living organisms and in the environment, leading to a variety of health issues. [3].

Information regarding the presence, sources, behaviors, and effects of PAHs in coastal aquatic areas and marine environments is limited, especially in southern Basrah. [4].

Many sources of pollution affect this area, such as contaminated rivers,petrochemical operations,direct oil spills, houseboats, oil refineries, and the

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

disposal of household waste. This study's goal is to track the vertical accumulation of PAHs in Khor Al-Zubair's five sediment cores, examine the area's sedimentary PAHs' sources, origins, and distribution; investigating the important environmental effects, changes in hydrocarbon sources, and trends in the introduction of contaminants; Determine the amounts and chemical characteristics of PAH pollution, and advise local environmental authorities on management techniques to reduce PAH concentrations.[5]. Polycyclic Aromatic Hydrocarbons (PAHs) are a class of chemicals that can be produced by natural events and industrial processes, particularly the burning of fossil fuels.[6]. Industrial combustion methods related to coal, syngas, heavy oil, oil-sandy mixtures, crude oil, and gas combustion are frequently connected to them. The sources of chemical pollutants can also be traced using PAHs. [7].

1.1. Characteristics of PAHs

"Polycyclic aromatic hydrocarbons" refers to a class of organic compounds that have two or more fused benzene rings. They are often emitted when combustion processes are not complete. The number of aromatic rings determines the grouping of polycyclic aromatic hydrocarbons: Low molecular weight (LMW) has two or three rings, while high molecular weight (HMW) has four or more rings. [8]. Molecular wight affects the PAHs instability such as the LMW PAHs can be found in gas phase, and it has poor solubility in water, so it sticks to existing sediments. [9]

1.2. Sources of PAHs Hydrocarbons

Natural sources of PAHs are possible, human activity is typically thought to be the primary source of it. [10]. The two main sources of anthropogenic PAHs in the environment are thermal and petrochemical processes. When organic materials like wood, fossil fuels, asphalt, and industrial waste are not completely burned, trace pollutants known as PAHs are created. PAHs from petroleum activity are commonly found in crude and refined petroleum. [11].

2. Study Area

Khor al-Zubair is an important area in southern Iraq near the Arabian Gulf. Nearby latitudes are 30°11'N and longitudes are 47°53'E. Approximately 15 kilometers to the south of Basra, it is situated near Umm Qasr. The existence of tidal inlets and intertidal mud flats, which serve as crucial habitat for a variety of aquatic species, is another feature that sets Khor Al-Zubair apart. Significant environmental problems, particularly

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

oil pollution, plagued the area, destroying vegetation and harming the ecosystem's general health. Fig (1).

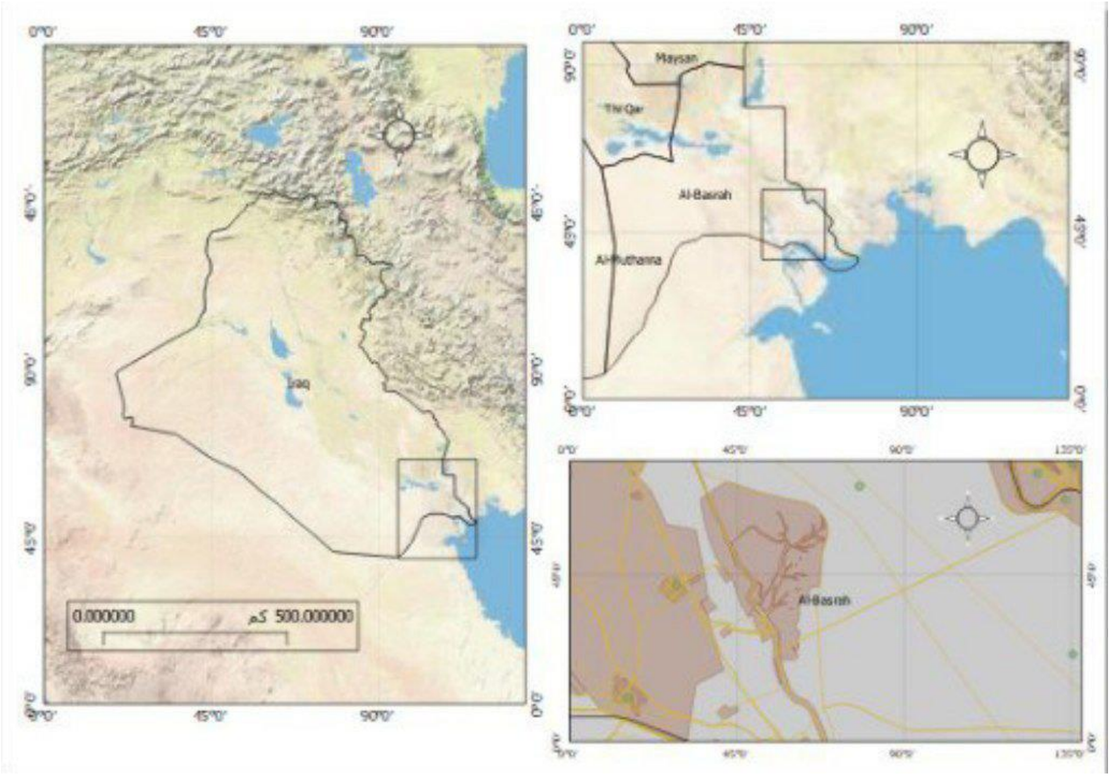

Fig 1: Study area in Basrah Southern Iraq.

Methods

Sediment cores were collected from five areas A hollow cylindrical tube was used to collect samples (50 cm) and cores, which were hammered into the sediments of the shallow water zone (Fig. 2). The date of sample collecting, the name of the station, and the practical intentions were written down after sampling in order to generalize it. Up and down . The sample was preserved by using plastic bags. The core was then transferred to the laboratory. The samples were powdered using a mechanical grinder and sieved with a metal sieve with 63 μm diameter holes and placed in glass conical flasks to make them ready for Extraction of hydrocarbon compounds. The weight of 50 grams of dried, powdered and sieved sediment was taken, then 150 mL of a 3:1 methylene chloride:methanol mixture was added to the sample and a small amount of copper was added to desulfurize the extracts in order to prevent sulfur interferences in GC-MS . The sample was passed through a Separation column with glass wool at the bottom, 5 g of silica gel, 1 g of alumina to remove the residual fatty acids, and 1 g of

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

anhydrous sodium sulfate to absorb water If there is, then 25 ml of n-hexane was used to separation the aliphatic component and 25 ml of benzene was used to separation the aromatic component, then the sample was completely dried and transferred for analysis in a GC-MS. [12].

Fig 2: Stations of Sampling (Google Earth)

Result and Discussion

In samples, eighteen polycyclic aromatic compounds were identified in the sediment for the current study. They have been divided into two main groups based on their molecular weight. The first group of high molecular weight compounds consisting of four or more aromatic rings linked together, which includes ten compounds are (Fluoranthene, Pyrene, Benz[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno[1,2,3-cd] pyrene ,Dibenz[a,h]anthracene , Benzo[ghi]perylene) . The second include low molecular weight compounds includes compounds with two to three aromatic rings fused and contains eight componentsa are (Naphthalene, Naphthalene, 2-methyl-, Naphthalene, 1-methyl-, Acenaphthylene ,Acenaphthene ,Fluorene ,Phenanthrene ,Anthracen).

The following PAHs concentrations were found in the sediment samples from the five station cores. The highest concentration, approximately 148.57 ng/g, was recorded at the first station core, while the lowest, 14.98 ng/g, was recorded there. 35.1 ng/g

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

was the lowest concentration and 105.62 ng/g was the highest at the second station core. At the third core, the lowest concentration was 17.67 ng/g, and the highest was 111.35 ng/g. The concentration at the fourth station core ranged from 19.13 ng/g at the lowest to 49.75 ng/g at the highest. Finally, at the fifth core, the lowest concentration was 63.64 ng/g, and the highest concentration was 257.48 ng/g (as shown in Tables 1 to 5 and their GC-MS chromatograms shown in Fig. 3).

Table 1: Concentrations of PAH compounds (ng/g) dry weight in First core.

	Componenet	core 1									
		0-5	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
1	Naphthalene	5.56	9.6	17.07	18.75	10.65	5.95	4.25	4.52	4.59	3.58
2	Naphthalene, 2-methyl-	3.09	3.59	10.69	13.64	5.24	0.73	0.75	2.93	0.75	0
3	Naphthalene, 1-methyl-	2.05	3.77	7.15	9.57	3.56	1.18	0	2.13	0.73	0
4	Acenaphthylene	4.02	0.66	1.2	2.4	0.51	0.3	0	0.33	0	0
5	Acenaphthene	2.38	2.57	1.24	2.8	1.34	1.2	0.74	1.01	0.7	0.53
6	Fluorene	11.73	7.74	9.1	9.91	4.84	1.48	4.13	2.29	2.12	3.48
7	Phenanthrene	14.16	13.87	9.96	16.61	8.95	10.9	8.28	8.3	4.95	4.46
8	Anthracene	0.48	0.41	0.65	4.87	0.76	0.12	0.29	0.51	1.4	1.62
9	Fluoranthene	2.43	0.45	2.81	0.17	1.01	0.93	0.28	0.86	0.28	0
10	Pyrene	3.34	2.34	5.02	6.39	3.14	1.92	0.47	1.24	0.41	0.13
11	Benz[a]anthracene	2.64	0.96	4.76	5.15	3.39	1.5	0	0	0	0
12	Chrysene	7.38	7.03	27.44	30.37	25.54	7.35	3	1.76	0	0
13	Benzo[b]fluoranthene	3.16	2.39	5.85	4.35	4.5	1.38	0.55	0.41	0.71	0.42
14	Benzo[k]fluoranthene	2.01	1.86	1.63	1.12	2.42	0.003	0.33	0.4	0.27	0.61
15	Benzo[a]pyrene	0.65	0.4	12.92	11.76	8.004	0.73	0.33	1.74	0.2	0.15
16	Indeno[1,2,3-cd]pyrene	2.39	0.52	0.8	0.58	8.33	0.92	0.97	0.14	0	0
17	Dibenz[a,h]anthracene	3.61	4.67	2.92	1.68	2.39	2.4	2.29	0.23	0	0
18	Benzo[ghi]perylene	4.01	1.91	2.76	8.45	3.65	0.87	0.62	1.02	0.17	0
	Total PAHs	75.09	64.74	123.97	148.57	98.22	39.863	27.27	29.85	16.58	14.98

Table 2: Concentrations of PAH compounds (ng/g) dry weight in Second core.

	component	core 2								
		0-5	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45
1	Naphthalene	4.45	3.8	4	2.99	4.21	5.65	4.89	6.24	4.65
2	Naphthalene, 2-methyl-	1.08	1.49	4.74	0.72	0	1.29	3.61	5.02	3.93
3	Naphthalene, 1-methyl-	0	0.24	4.93	1.13	0	1.76	3.55	3.43	2.88
4	Acenaphthylene	0.83	0.74	1.68	0.47	0.65	0.58	1.41	1.17	1.17
5	Acenaphthene	0.72	3.57	4.39	0.96	1.82	4.51	4.37	4.009	3.87
6	Fluorene	14.4	32.6	41.42	8.84	22.64	20.05	28.81	22.81	24.6
7	Phenanthrene	17.94	23.23	34.32	14.6	18.24	30.92	26.57	28.1	24.3
8	Anthracene	1.25	0.21	0.95	0.42	0.69	1.15	1.42	1.78	0.99
9	Fluoranthene	2.08	0.48	1.39	0.49	0.88	2.45	1.67	2.13	1.97
10	Pyrene	2.71	1.2	1.93	0.75	1.41	2.57	3.13	3.34	3.03
11	Benz[a]anthracene	0.79	0	0	0	0	0.85	0.15	1.52	0.32
12	Chrysene	4.6	0.33	2.73	1.6	1.55	3.89	2.62	4.91	3.86
13	Benzo[b]fluoranthene	3.33	0.77	1.21	0.97	1.53	2.97	1.79	2.9	1.98
14	Benzo[k]fluoranthene	1.26	0.85	0.11	0.18	1.23	1.01	0.54	0.95	0.81
15	Benzo[a]pyrene	0.26	1.01	0.17	0.16	1.65	0.36	0.13	0.22	0.7
16	Indeno[1,2,3-cd]pyrene	0.76	0	0	0	0	0.64	0.52	0.28	0.31
17	Dibenz[a,h]anthracene	0	0	0	0	0	0	0.46	0	0.75
18	Benzo[ghi]perylene	2.25	0.36	1.65	0.82	0.36	1.51	0.3	2.94	2.48
	Total PAHs	58.71	70.88	105.62	35.1	56.86	82.16	85.94	91.74	82.6

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

Table 3: Concentrations of PAH compounds (ng/g) dry weight in the third core.

	componenet	core 3									
		0-5	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
1	Naphthalene	5	4.56	4.39	4.1	2.77	6.66	4.47	7.47	6.99	7.04
2	Naphthalene, 2-methyl-	1.64	1.04	0.53	0	0	1.09	0.45	1.68	3.71	1.64
3	Naphthalene, 1-methyl-	1.79	1.22	0	0.5	0	0.85	0	0.87	2.67	1.24
4	Acenaphthylene	0	0	0	0	0	0	0	0	1.54	0.62
5	Acenaphthene	0.71	0	0.23	0.46	0	0.45	0	0.22	4.47	2.78
6	Fluorene	5.03	1.59	3.64	8.25	17.56	9.34	3.95	28.78	1.8	17.78
7	Phenanthrene	8.76	5.79	7.17	10.65	22.36	17.24	12.34	54.74	23.7	23.16
8	Anthracene	0.64	1.26	0.2	0.25	1.14	0.43	1.13	1.49	1.92	1.34
9	Fluoranthene	1.01	0.29	0	0	0.46	1.34	0.98	2.16	1.45	1.39
10	Pyrene	0.13	0.67	0.76	0.58	0.7	1.46	0.61	3.19	2.43	2.03
11	Benz[a]anthracene	0	0	0	0	0	0.3	0	0.44	0	0
12	Chrysene	0	0	0	0	0	1.66	0.36	6.65	2.62	1.06
13	Benzo[b]fluoranthene	0.98	1.17	0.13	0.6	0	2.12	0	1.46	2.46	1.42
14	Benzo[k]fluoranthene	0.72	1.16	0.13	0.45	0.6	2.09	1.02	1.44	2.42	1.4
15	Benzo[a]pyrene	1.08	1	0.49	0.5	0.48	2.5	0.52	0.59	0.68	1.97
16	Indeno[1,2,3-cd]pyrene	0	0	0	0	0	0	0	0	0	0
17	Dibenz[a,h]anthracene	0	0	0	0	0	0	0	0	0	0
18	Benzo[ghi]perylene	0	0	0	0	0	0	0.17	0.17	0	0
	Total PAHs	27.49	19.75	17.67	26.34	46.07	47.53	26	111.35	58.86	64.87

Table 4: Concentrations of PAH compounds (ng/g) dry weight in the fourth core.

	componenet	core 4									
		0-5	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
1	Naphthalene	6.76	5.3	4.15	5	4.31	5.52	4.29	4.81	4.33	3.4
2	Naphthalene, 2-methyl-	1.06	0.23	0	0.22	0.22	1.13	0	0.51	0.25	0
3	Naphthalene, 1-methyl-	0.84	0.24	0	0	0	0.58	0	0	0.5	0
4	Acenaphthylene	0	0.47	0	0	0	0.51	0	0	0	0
5	Acenaphthene	0	0	0	0	0.44	0.22	0	0	0	0
6	Fluorene	2.92	1.85	6.23	0.81	8.01	8.81	0.63	3.52	1.69	3.69
7	Phenanthrene	14.16	6.17	8.76	7.37	13.38	18.15	7.96	11	11.54	9.91
8	Anthracene	0.51	0.78	1.3	1.61	0.64	0.36	0.69	0.79	0.43	0.31
9	Fluoranthene	2.75	2.76	1.1	0.69	1.5	1.93	1.03	1.48	1.2	1.15
10	Pyrene	3.74	2.93	2.78	0.96	3.09	0.13	1.74	0.41	2.47	2.04
11	Benz[a]anthracene	1.97	1.33	0	0	0	0.63	0	0	0	0
12	Chrysene	4.58	0.16	1.45	0.33	1.08	3.33	2.51	2.02	1.74	0.71
13	Benzo[b]fluoranthene	5.31	1.95	0.79	0.73	1.12	1.93	2	1.47	2.57	1.58
14	Benzo[k]fluoranthene	2.9	1.93	0.71	0.83	1.06	1.01	0.29	0.35	2.71	0.57
15	Benzo[a]pyrene	0.46	0.52	0.6	0.41	1.58	0.29	0.22	0.21	0.15	1.57
16	Indeno[1,2,3-cd]pyrene	0.29	0.5	0	0	0	0.14	0	0.45	0	0
17	Dibenz[a,h]anthracene	0	0	0	0	0	0	0	0	0	0
18	Benzo[ghi]perylene	1.5	2	0.35	0.17	0.35	0.73	0.17	0.76	0.72	0.18
	Total PAHs	49.75	29.12	28.22	19.13	36.78	45.4	21.53	27.78	30.3	25.11

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

Table 5: Concentrations of PAH compounds (ng/g) dry weight in the fifth core.

	Componenet	Core 5									
		0-5	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
1	Naphthalene	11.82	6.88	12.23	10.42	9.58	21.82	9.28	8.67	10.43	15.1
2	Naphthalene, 2-methyl-	2.19	0.73	1.61	2	5.09	7.03	4.6	1.67	1.26	7.09
3	Naphthalene, 1-methyl-	1.42	1.09	0.55	1.78	3.89	5.45	4.08	1.1	1.28	6.34
4	Acenaphthylene	10.44	1.82	3.03	3.11	3.95	9.7	7	3.81	6.8	15.45
5	Acenaphthene	1.63	0	2.51	2.3	2.61	1.02	1.92	0.49	2.18	5.99
6	Fluorene	14.9	5.46	10.26	7.5	11.88	11.98	10.32	7.02	9.73	12.5
7	Phenanthrene	24.77	11.88	19.83	17.77	20	25.08	25.3	16.74	10.85	20.76
8	Anthracene	7.65	0.65	0.19	3.59	2.85	0.45	2.59	0.72	0.3	3.07
9	Fluoranthene	8.67	2.41	3.65	3.58	3.41	5.21	8.47	5.84	7.82	12.32
10	Pyrene	8.78	5.54	9.3	13.63	13.76	29.59	16.85	14.7	28.05	38.11
11	Benz[a]anthracene	9.63	4.97	4.64	4.03	6.6	16.28	9.44	13.95	26.05	24.78
12	Chrysene	14.97	0.5	4.56	4.01	9.1	0.78	7.45	29.19	16.19	16.94
13	Benzo[b]fluoranthene	11.95	5.65	5.46	4.72	9.21	19.08	10.36	20.36	22.06	19.26
14	Benzo[k]fluoranthene	2.11	2.16	4.94	0.76	1.61	0.16	1.28	23	2.62	0.35
15	Benzo[a]pyrene	8	4.2	2.88	4.79	9.96	17.95	9.98	16.04	16.69	19.93
16	Indeno[1,2,3-cd]pyrene	4.72	1.65	2.88	1.29	5.42	9.28	7.27	19.68	10.09	10.47
17	Dibenz[a,h]anthracene	0.75	1.01	1.08	2.37	1.15	4.42	2.35	35.11	5.24	3.13
18	Benzo[ghi]perylene	8.47	7.04	3.02	4.88	9.08	15.64	11.29	39.39	16.09	14.65
	Total PAHs	152.87	63.64	92.62	92.53	129.15	200.92	149.83	257.48	193.73	246.24

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

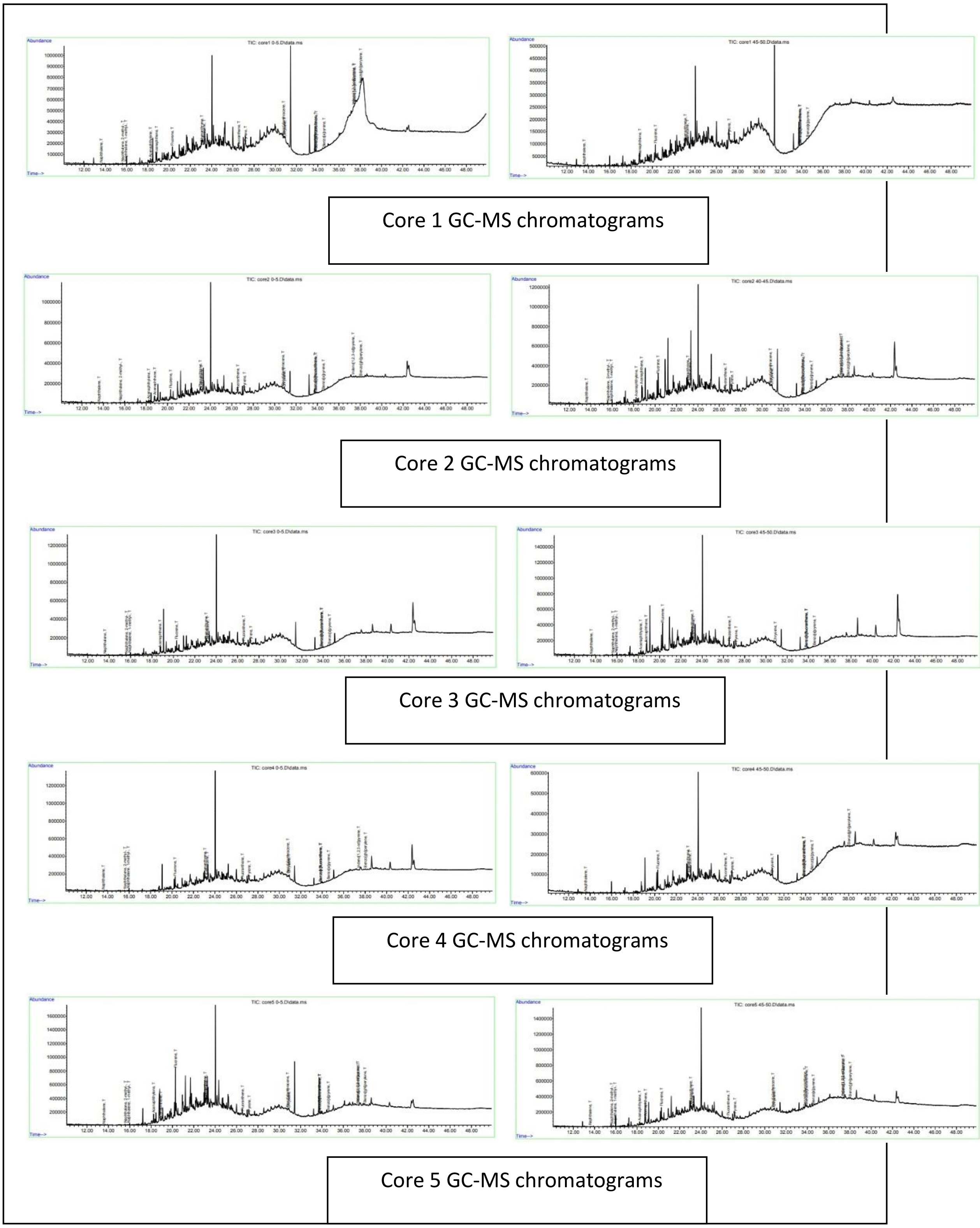

Fig 3: GC-MS Chromatograms of core stations.

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

The origin of the aromatic hydrocarbons present in the area has been determined using a distinct set of ratios (explained in Tables 6 and 7):

1- Ratio of low molecular weight (LMW-PAHs) to high molecular weight PAHs (HMW-PAHs): The ratios of low-molecular-weight (LMW) to high-molecular-weight (HMW) polycyclic aromatic hydrocarbons (PAHs), with values lower than one, are indicative of pyrogenic sources. Conversely, values exceeding one suggest petrogenic origins from crude oil and its derivatives [13].

2- The ratio of benzo(a)anthracene/benzo(a)anthracene + chrysene (BaA/(BaA+Chr)): A ratio of BaA to (BaA + Chr) less than 0.2 suggests a petrogenic source of PAHs. The source of PAHs can be either petrogenic or pyrogenic if the ratio falls between 0.2 and 0.35. However, a . pyrogenic source of PAHs is suggested when the ratio is greater than 0.35. [14].

3- Fluoranthene to pyrene ratio: A source of PAHs is generally considered petrogenic if the Fla/Pyr ratio is less than one, and pyrogenic if it is greater than one. [3,12,15].

4- Phenanthrene/anthracene ratio: PAHs originating from pyrogenic sources are those whose ratio is less than ten, whereas those originating from petrogenic sources have a ratio greater than ten. [16].

5- The ratio of anthracene/anthracene + phenanthrene: If the anthracene to anthracene + phenanthrene ratio is less than 0.1, it indicates a petrogenic source of PAHs; if it is greater than 0.1, a pyrolytic source is recommended. [17].

The levels of PAH pollution indicators in the study stations' core samples, along with an explanation of their sources, are displayed in Tables 6 and 7.

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

Table 6: levels of PAHs pollution indicators in core samples from the study stations and description of their source.

ND: Not Detected

Station	Depth	Fl/Py	Discription	LMW/HMW	Discription	BaA/(BaA+Chr)	Discription
core 1	0-5	0.72	Petrogenic	1.37	Petrogenic	0.24	Petrogenic + pyrgenic
	5--10	0.19	Petrogenic	1.87	Petrogenic	0.11	Petrogenic
	10--15	0.55	Petrogenic	0.85	Pyrogenic	0.14	Petrogenic
	15-20	0.02	Petrogenic	1.12	Petrogenic	0.14	Petrogenic
	20-25	0.32	Petrogenic	0.6	Pyrogenic	0.11	Petrogenic
	25-30	0.48	Petrogenic	1.21	Petrogenic	0.16	petrogenic
	30-35	0.59	Petrogenic	2.08	Petrogenic	0	petrogenic
	35-40	0.69	Petrogenic	2.81	Petrogenic	0	Petrogenic
	40-45	0.68	Petrogenic	7.47	Petrogenic	ND	
	45-50	0	Petrogenic	10.43	Petrogenic	ND	
core 2	0-5	0.76	Petrogenic	2.25	Petrogenic	0.14	Petrogenic
	5--10	0.4	Petrogenic	13.17	Petrogenic	0	Petrogenic
	10--15	0.72	Petrogenic	10.49	Petrogenic	0	Petrogenic
	15-20	0.65	Petrogenic	6.06	Petrogenic	0	Petrogenic
	20-25	0.62	Petrogenic	5.6	Petrogenic	0	Petrogenic
	25-30	0.95	Petrogenic	4.05	Petrogenic	0.17	Petrogenic
	30-35	0.53	Petrogenic	6.59	Petrogenic	0.05	Petrogenic
	35-40	0.63	Petrogenic	3.78	Petrogenic	0.23	Petrogenic + pyrgenic
	40-45	0.65	Petrogenic	4.09	Petrogenic	0.07	Petrogenic
core 3	0-5	7.76	Pyrogenic	6.01	Petrogenic	ND	
	5--10	0.43	Petrogenic	3.6	Petrogenic	ND	
	10--15	0	Petrogenic	10.7	Petrogenic	ND	
	15-20	0	Petrogenic	11.36	Petrogenic	ND	
	20-25	0.65	Petrogenic	19.56	Petrogenic	ND	
	25-30	0.91	Petrogenic	3.14	Petrogenic	0.15	Petrogenic
	30-35	1.606	Pyrogenic	6.1	Petrogenic	0	Petrogenic
	35-40	0.67	Petrogenic	5.91	Petrogenic	0.06	Petrogenic
	40-45	0.59	Petrogenic	3.88	Petrogenic	0	Petrogenic
	45-50	0.68	Petrogenic	5.99	Petrogenic	0	Petrogenic
core 4	0-5	0.73	Petrogenic	1.11	Petrogenic	0.3	Pyrogenic
	5--10	0.94	Petrogenic	1.06	Petrogenic	0.89	Pyrogenic
	10--15	0.39	Petrogenic	2.62	Petrogenic	0	Petrogenic
	15-20	0.71	Petrogenic	3.64	Petrogenic	0	Petrogenic
	20-25	0.48	Petrogenic	2.76	Petrogenic	0	Petrogenic
	25-30	14.84	Pyrogenic	3.48	Petrogenic	0.15	Petrogenic
	30-35	0.59	Petrogenic	1.7	Petrogenic	0	Petrogenic
	35-40	3.6	Pyrogenic	2.88	Petrogenic	0	Petrogenic
	40-45	0.48	Petrogenic	1.62	Petrogenic	0	Petrogenic
	45-50	0.56	Petrogenic	2.21	Petrogenic	0	Petrogenic
core 5	0-5	0.98	Petrogenic	0.95	Pyrogenic	0.39	Pyrogenic
	5--10	0.43	Petrogenic	0.81	Pyrogenic	0.9	Pyrogenic
	10--15	0.39	Petrogenic	1.18	Petrogenic	0.5	Pyrogenic
	15-20	0.26	Petrogenic	1.1	Petrogenic	0.5	Pyrogenic
	20-25	0.24	Petrogenic	0.86	Pyrogenic	0.42	Pyrogenic
	25-30	0.17	Petrogenic	0.69	Pyrogenic	0.95	Pyrogenic
	30-35	0.5	Petrogenic	0.76	Pyrogenic	0.55	Pyrogenic
	35-40	0.39	Petrogenic	0.18	Pyrogenic	0.55	Pyrogenic
	40-45	0.27	Petrogenic	0.28	Pyrogenic	0.32	Pyrogenic
	45-50	0.32	Petrogenic	0.53	Pyrogenic	0.59	Pyrogenic

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): January
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

Table 7: levels of PAHs pollution indicators in core samples from the study stations and description of their source.

Station	Depth	Phen/Ant	Discription	Ant/(Ant+Phen)	Discription
Core 1	0-5	29.16	Petrogenic	0.032	Petrogenic
	5--10	33.82	Petrogenic	0.028	Petrogenic
	10--15	15.32	Petrogenic	0.061	Petrogenic
	15-20	3.41	Pyrogenic	0.226	Pyrolytic
	20-25	11.77	Petrogenic	0.078	Petrogenic
	25-30	90.83	Petrogenic	0.0108	Petrogenic
	30-35	28.55	Petrogenic	0.033	Petrogenic
	35-40	16.27	Petrogenic	0.057	Petrogenic
	40-45	3.53	Pyrogenic	0.2204	Pyrolytic
	45-50	2.75	Pyrogenic	0.226	Pyrolytic
core 2	0-5	14.35	Petrogenic	0.065	Petrogenic
	5--10	110.61	Petrogenic	0.0089	Petrogenic
	10--15	36.12	Petrogenic	0.026	Petrogenic
	15-20	34.76	Petrogenic	0.027	Petrogenic
	20-25	26.43	Petrogenic	0.036	Petrogenic
	25-30	26.88	Petrogenic	0.035	Petrogenic
	30-35	18.71	Petrogenic	0.0507	Petrogenic
	35-40	15.78	Petrogenic	0.059	Petrogenic
	40-45	24.54	Petrogenic	0.039	Petrogenic
Core 3	0-5	13.68	Petrogenic	0.068	Petrogenic
	5--10	4.59	Pyrogenic	0.178	Pyrolytic
	10--15	35.85	Petrogenic	0.027	Petrogenic
	15-20	42.6	Petrogenic	0.022	Petrogenic
	20-25	19.61	Petrogenic	0.048	Petrogenic
	25-30	40.09	Petrogenic	0.024	Petrogenic
	30-35	10.92	Petrogenic	0.083	Petrogenic
	35-40	36.73	Petrogenic	0.026	Petrogenic
	40-45	12.34	Petrogenic	0.074	Petrogenic
	45-50	17.28	Petrogenic	0.54	Petrogenic
Core 4	0-5	27.76	Petrogenic	0.034	Petrogenic
	5--10	7.91	Pyrogenic	0.11	Pyrolytic
	10--15	6.73	Pyrogenic	0.12	Pyrolytic
	15-20	4.57	Pyrogenic	0.17	Pyrolytic
	20-25	20.9	Petrogenic	0.045	Petrogenic
	25-30	50.41	Petrogenic	0.019	Petrogenic
	30-35	11.53	Petrogenic	0.079	Petrogenic
	35-40	13.92	Petrogenic	0.067	Petrogenic
	40-45	26.83	Petrogenic	0.035	Petrogenic
	45-50	31.96	Petrogenic	0.0303	Petrogenic
Core 5	0-5	3.23	Pyrogenic	0.235	Pyrolytic
	5--10	18.27	Petrogenic	0.051	Petrogenic
	10--15	104.36	Petrogenic	0.0094	Petrogenic
	15-20	4.94	Pyrogenic	0.016	Petrogenic
	20-25	7.01	Pyrogenic	0.012	Petrogenic
	25-30	55.73	Petrogenic	0.017	Petrogenic
	30-35	9.76	Pyrogenic	0.092	Petrogenic
	35-40	23.25	Petrogenic	0.041	Petrogenic
	40-45	36.16	Petrogenic	0.026	Petrogenic
	45-50	6.76	Pyrogenic	0.128	Pyrolytic

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

The petroleum industry is one of the many sources from which polycyclic aromatic hydrocarbons (PAHs) can leak into the environment. The oil industry presents significant environmental hazards and could affect the air, water, soil, and eventually all biological life in our area. The pollution that comes from every action at every step of the production of oil and gas. [18]

The results of the Flo/Py indices indicate that the most common origin of PAHs is petrogenic, and the predominant origin of the LMW/HMW and BaA/(BaA+Chr) ratios seems to be petrogenic from the first to the fourth station. However, the results of the fifth station show that the most common origin is pyrogenic. The results of Phen/Ant and Ant/(Ant+Phen) show that petrogenic origins predominate.

Table 8: The Comparison of The Current Concentrations of Sediment PAHs Compounds (ng·g–1 dry weight) With Previous Studies at Basrah province.

Researcher name	Study area	PAHs compounds (ng g 1dw)
Ali (2013)	Kirkuk oil refinery	10.92-26.92
Abed et al., (2015)	industrial district Baiji - Kirkuk	94.9 - 416.3
Alawi and Azeez (2016)	Al-Ahdab oil field, Waset	19 - 855
Essa and Mohsin (2016)	Nasiriyah oil field	0.003 - 73.462
Jasim (2017)	Agriculture fields in Baghdad	0.21 - 30.2
Kadhim and Salman (2018)	Agriculture fields in Baghdad	99.1 – 322.6
Al-Rudaini and Almousawi (2018)	AL-nahrawan bricks factory, Baghdad	64910 – 245005
Al-Rudaini et al., (2019)	AL - zubaidiya Thermal Power Plant, Baghdad	22790 - 45550
Al-Manmi et al., (2019)	Oil refinery and petrol stations in Sulaymaniyah	55300
Aoeed et al., (2021)	Kirkuk province	26.4 – 42.79
Saleem, (2022)	Basrah city	531.21 - 5737.23
Majdalena Azeez et al., (2023)	Selected station in Basrah oil fields	18.4-4515
current study	Khor Al-Zubair , Basrah	31.31-157.901

Conclusion

This study concluded by providing a basic baseline of the contamination caused by aromatic hydrocarbons from oil spills and other sources. Eight low molecular weight compounds with only two or three aromatic rings made up the first group. The ten compounds in the second group had a high molecular weight and four or more aromatic rings. Since the results showed that the majority of the components come from a petrogenic source, the study helped to uncover the pollution levels in the study area. As a result, this result can serve as baseline information for future research in the area. Additionally, the area's pollution levels must be regularly monitored, and the primary causes must be addressed

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

References

[1] R. A. Grmasha, et al., "Ecological and Human Health Risk Assessment of Polycyclic Aromatic Hydrocarbons (PAH) in Tigris River Near the Oil Refineries in Iraq," Environmental Research, vol. 227, pp. 11-91, 2023. Available: sciencedirect.com.

[2] R. A. Grmasha, et al., "Polycyclic Aromatic Hydrocarbons in the Surface Water and Sediment Along Euphrates River System: Occurrence, Sources, Ecological and Health Risk Assessment," Marine Pollution Bulletin, vol. 187, pp. 11-68, 2023. Available: sciencedirect.com.

[3] M. M. Al-Khuzaie, et al., "Assessment of Untreated Wastewater Pollution and Heavy Metal Contamination in the Euphrates River," Environmental Pollutants and Bioavailability, vol. 36, no. 1, pp. 22-110, 2024.

[4] M. Fadel, et al., "A Comprehensive Review of PM-Related Studies in Industrial Proximity: Insights from the East Mediterranean Middle East Region," Sustainability, 2024. Available: mdpi.com.

[5] D. S. Kareem, et al., "Distribution of Total Petroleum Hydrocarbons (TPHs) in Sediments of Southern Iraqi Rivers," Marsh Bulletin, 2023. Available: iasj.net.

[6] H. H. Sultan, M. A. Sultan, and A. M. Jawad, "Environmental Risk Assessment of Petroleum Pollutants in Water and Sediments of Al-Mushab and Al-Salal Marshes," AIP Conference Proceedings, 2023.

[7] M. Al Hello, et al., "Source Apportionment of Polycyclic Aromatic Hydrocarbons in New York/New Jersey Harbor Sediment," Water and Environment Journal, vol. 37, no. 3, pp. 527-537, 2023. Available: wiley.com.

[8] B. Vrana, A. Pasch, and P. Popp, "Polycyclic Aromatic Hydrocarbon Concentration and Patterns in Sediments and Surface Water of Mansfeld Region, Saxony-Anhalt, Germany," Environmental Pollution, 2001.

[9] J. N. Anyahara, "International Journal of Advanced Academic Research," vol. 7, no. 3, 2021.

[10] P. Baumard, H. Budzinski, and P. Garrigues, "Polycyclic Aromatic Hydrocarbons in Sediments and Mussels of the Western Mediterranean Sea," Environmental Toxicology and Chemistry, vol. 17, no. 5, pp. 765-776, 1998.

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

[11] Y. Liu, et al., "Source Apportionment of Polycyclic Aromatic Hydrocarbons (PAHs) in Surface Sediments of the Huangpu River, Shanghai, China," Science of the Total Environment, vol. 407, pp. 2931–2938, 2009.

[12] M. M. Al-Hejueje, "Application of Water Quality and Pollution Indices to Evaluate the Water and Sediments Status in the Middle Part of Shatt Al Arab River," Ph.D. dissertation, Dept. of Biology, College of Science, Univ. of Basrah, 2014.

[13] D. Yan, et al., "Characteristics, Sources, and Health Risk Assessment of Airborne Particulate PAHs in Chinese Cities," Environmental Pollution, vol. 248, p. 804, 2019.

[14] X. Gao, et al., "Non-Aromatic Hydrocarbons in Surface Sediments Near the Pearl River Estuary in the South China Sea," Environmental Pollution, vol. 148, pp. 40-47, 2007.

[15] D. D. Al-Khion, "Distribution of Polycyclic Nuclear Compounds in Iraqi Coast Regions," Ph.D. dissertation, College of Agriculture, Univ. of Basrah, 2012.

[16] F. Kafilzadeh, A. H. Shiva, and R. Malekpour, "Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Water and Sediments of the Kor River, Iran," Middle-East Journal of Scientific Research, vol. 10, no. 1, pp. 1-7, 2011.

[17] M. B. Yunker, et al., "PAHs in the Fraser River Basin: A Critical Appraisal of PAH Ratios as Indicators of PAH Source and Composition," Organic Geochemistry, vol. 33, no. 4, pp. 489-515, 2002.

[18] H. T. Al-Saad, et al., "Polycyclic Aromatic Hydrocarbons (PAHs) in Sediment Samples from Euphrates River, Iraq," International Journal of Marine Science, vol. 6, no. 2, pp. 1-6, 2016.

[19] L. A. Ali, "Environmental Impact Assessment of Kirkuk Oil Refinery," Ph.D. dissertation, College of Science, Univ. of Baghdad, 2013.

[20] M. F. Abed, S. M. Ali, and B. S. Altawash, "Health Risk Assessment of Polycyclic Aromatic Hydrocarbons in Surface Soils at North Baiji City, Iraq," Iraqi Journal of Science, vol. 56, no. 4A, pp. 2927–2938, 2015.

[21] M. A. Alawi and A. L. Azeez, "Study of Polycyclic Aromatic Hydrocarbons (PAHs) in Soil Samples from Al-Ahdab Oil Field in Waset Region, Iraq," Toxicology Reviews, vol. 35, no. 3–4, pp. 69–76, 2016. doi:10.1080/15569543.2016.1198379.

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.100

[22] H. N. Essa and E. A. Mohsin, "Study of Crude Oil Spills and Gas Burning of Accompanied Natural Gas on the Environment of Nasiriyah Oil Field, Southern Iraq," Diqar Science Journal, vol. 6, no. 1, pp. 52-59, 2016.

[23] A. J. Jasim, "Evaluation and Monitoring the Impact of Environmental Pollution in Water and Soil South of Baghdad," Research Journal of Pharmacy, Biology, and Chemical Sciences, vol. 8, no. 4, pp. 659-663, 2017.

[24] A. J. Kadhim and J. M. Salman, "Evaluation of PAHs in Agricultural Soil Samples—Al-Khacheya Site, South of Baghdad, Iraq," Plant Archives, vol. 18, no. 1, pp. 1005-1008, 2018.

[25] T. K. M. Al-Rudaini and I. M. H. Almousawi, "Determination of Polycyclic Aromatic Hydrocarbon in Soil at Al-Nahrawan Bricks Factory," Pakistan Journal of Biotechnology, vol. 15, no. 2, pp. 445-450, 2018.

[26] T. K. M. Al-Rudaini, et al., "Environmental Assessment of Polycyclic Aromatic Hydrocarbon Concentrations in Soil at Al-Zubaidiya Thermal Power Plant," Journal of Physics: Conference Series, vol. 1294, 2019.

[27] D. A. M. A. Al-Manmi, et al., "Soil and Groundwater Pollution Assessment and Delineation of Intensity Risk Map in Sulaymaniyah City, NE Iraq," Water, vol. 11, no. 10, p. 2158, 2019. doi:10.3390/w11102158.

[28] Y. H. Aoeed, et al., "Concentration of Some Polycyclic Aromatic Hydrocarbons in Soil Samples of Kirkuk Province, Iraq," in IOP Conference Series: Earth and Environmental Science, vol. 877, p. 012023, 2021. doi:10.1088/1755-1315/877/1/012023.

[29] F. M. Saleem, H. T. Al-Saad, and M. M. Al-Hejuje, "Using Toxic Equivalent Quotients (TEQs) to Evaluate the Risk of Polycyclic Aromatic Hydrocarbons Compounds in Soil at Basrah Governorate, Iraq," Basrah Journal of Agricultural Sciences, vol. 35, no. 2, pp. 160-172, 2022.

[30] M. A. Resen, H. K. Abdulhassan, and H. T. Al-Saad, "Determining the Sources and Distribution of Polycyclic Aromatic Hydrocarbons in the Soil of Different Oil Fields at Basrah, Iraq," Ecology and Environmental Technology, pp. 24-26, 2023. doi:10.15587/2706-5448.2023.293837.