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Contaminating Soil in the North and South Rumaila Oil Fields, Basrah, Southern Iraq

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Abstract

For the assessment of hydrocarbon contamination, six samples were collected at a depth of 0 to 30 cm from the Rumaila oil fields in Basrah city. Individual n-alkanes and PAHs quantification was done by gas chromatography and a flame ionization detector. The values of CPI vary from 0.27 at station 5 to 0.98 at station 4. It supports the fact that the distribution of alkanes is mainly influenced by human activities. In North Rumaila, the lowest n-alkane content was represented by St6 (7.640µg/g), but the highest value should be at St1 (76.400µg/g dry weight). The C17/Pr and C18/Ph ratios also varied between the different stations, suggesting that there is a combination of both biogenic and petrogenic sources. The total concentration ranged from 7.64 to 76.40 µg/g, with phenanthrene being the most abundant PAH. Soil texture analysis revealed a strong correlation between PAH levels and silt and clay fractions, while sand content had minimal explanatory value. When converted to total organic carbon (TOC) using the van Bemmelen factor (0.58), the levels of organic matter (OM) varied from 0.33% to 1.37%, further demonstrating the role of organic fractions in hydrocarbon retention. The PCA and correlation analyses consistently reveal that hydrocarbon-related parameters are the main drivers of spatial variability across the study area. The integration of both figures highlights the strong coupling between TPH and PAHs, emphasising the predominance of petroleum inputs over natural sediment characteristics in determining contamination levels.

Keyword: PAHs, N-alkanes, TOC, pollution.

INTRODUCTION

The oil field is located in southeastern Iraq, approximately 45 km northwest of Basrah city, near the bounder with Kuwait. Rumaila is recognized as largest oil fild in the Basrah region and one of the most significant hydrocarbon reservoirs in Middle East Structurally, the field is divided into North and South Rumaila, associated with N-S and NW-SE fold axes. The field contributes nearly one –third of Iraq's total oil production. With a daily output capacity of 1.5 million barrels, Rumaila ranks as the third largest producing oil field worldwide. Development of the field has resulted in approximately 700 wells, including 550 producing and 150 injectoe wells. The majority of production is derived from the Zubair Formation, which represents the principal reservoir unit (Khwedim, 2016).

Oil and gas development has significantly increased crude oil production while simultaneously contributing to environmental degradation (AL-Salman and Abadalsamad, 2023).

These substances include polycyclic aromatic hydrocarbons (PAHs), also known as polycyclic organic matter (POM), which are made up of two or more fused rings and include naphthalene, anthracene, benzo(a) pyrene, and phenanthrene, as well as monocyclic aromatic compounds like benzene, tulane, and xylene.

Of these hydrocarbons, alkanes and aromatics are key to the environmental fate and industrial value of crude oil. Oil exploration and production processes, transportation accidents, refining activities, drainage stations, and tank leaks release these pollutants into the environment where they become harmful to living organisms (Bahar *et al*. 2014). Alkanes are commonly employed as tracers to monitor oil released during spills or accidents. Structural variations among alkanes with identical carbon number provide abasis for this identifications. Hydrocarbon contaminants are considered critical environmental pollutants, particularly in oil –producing regions. Soil hydrocarbon contamination represent a major environmental challenge in many oil-producing countries (Al-Saad *et al*.2015). Human activities are the predominant source hydrocarbons detected in soil.

In Basrah Province, oil extraction fields, intensified drilling and exploration, extraction and refining processes, associated pollutions, and oil spills have resulted in severe soil contamination by hydrocarbons, including n-alkanes and PAHs (Saleem, 2022, Kareem *et al*. 2025). While air and water are essential for soil systems, they can also act as pathways of contamination through precipitation and leaching.

Additionally, PAH have been employed to evaluate sediments contamination from pyrogenic and petrogenic sources (Abreu-Mota *et al.* 2014). These compounds include monocyclic aromatic such as benzene, tulane, and xylene, as well as PAHs referred to as polycyclic organic matter which consist of two or more fused rings, including naphthalene, anthracene, benzo(a) pyrene, and phenanthrene (ATSDR, 2012).

PAH receive particular attention in environmental studies due to their carcinogenic potential and their ability to trans farm in to carercinoges through microbial metabolism (Uddin & Xu, 2024). Consequently, the US Environmental Protection Agency (US EPA) has designated PAH as priority pollutants (Readman *et al.* 2002). In addition to oil field activities, other anthropogenic sources such as industrial emissions, vehicular exhaust, and biomass burning contribute significantly to PAH contamination in soils and sediments.

Basrah is annually exposed to hazardous fuel residues from vehicles, as locally refined gasoline and diesel fail to meet international standards. This has led to severe hydrocarbon contamination, affecting both the environment and human health. Human exposure to PAHs occurs mainly through dermal contact, including benzo(a)anthracene, chrysene, and benzo(a)pyrene, are recognized carcinogens (Mallah *et al.*2022), while nine others such as pyrene, anthracene, and naphthalene are generally classified as non-carcinogenic.

Aromatic hydrocarbons are classified into two types on molecular structure. These include low molecular weights (LMW) and high molecular weights (HMW) compounds. Conventional wet chemistry techniques to assessing TPH involve extracting contaminants from soil samples. TPH concentrations in the extract are determined using GC-MS and gravimetry calibrated with EPA standards. This study examines the distribution and source of N-alkanes and PAHs in soil from the South and North Rumaila oil fields, Basrah Governorate, Iraq, aregion with extensive oil reserves.

Materials and Methods

A total of six soil samples were collected from Basrah Governorate, three of them from the South and three from North Rumaila oil fields in during the period December 2022. (Figure 1).

Sampling sites were located at distances of approximately 800 m, 700 m and 600 m from the the oil facilities. Surface soil samples (0-30 cm depth) were collected in polyethylene bags and transferred to the Marine Science Center laboratory. they were ari-dried at room temperature. Dried samples were crushed into fine powder using mechanical mortar and sieved with a 63 μm mesh.

Hydrocarbon analysis followed the methods described by Al-Hejuje (2014) and Goutx & Saliot (1980). Hydrocarbon extraction was performed following the procedures Wang *et al* (2011) and Grimalt and Olive (1993). A 50 g of sieved soil (<63 μm) were extracted for 24 h by Soxhlet extraction using 100 mL of a methanol–benzene (1:1) mixture Extracts were fractionated on on a column packed with silica gel (10 g, 100–200 mesh) and alumina (10 g, 100–200 mesh), with 1 g sodium sulfate layered above. eluted aliphatic hydrocarbons (n-alkanes) with hexane and quantified by gas chromatography (GC) using internal standards and aromatic hydrocarbons with benzene, respectively.

Gas chromatography–mass spectrometry (GC/MS) with a capillary column (30 m × 0.25 mm, 0.25 μm film thickness), an oven temperature programmed from 60 °C to 300 °C at 4 °C/min, and external standards for identification and quantification were used to analyze aromatic hydrocarbons (PAHs) that were eluted with benzene.

Soil Texture (Grain size analysis %):

The pipette method described by Folk (1974), was employed to determine the mean grain size. Approximately 20 g of oven-dried soil were dispersed in distilled water to facilitate the sepration of sand, silt, and clay fractions. The suspension was passed through a 63 µm sieve to isolate the sand fraction. The sand fraction was subsequently dried at 105°C for 24 hours in an oven and weighed. The silt and clay suspension was transferred into a 1L cylinder and repeatedly washed with distilled water to remove soluble salts.To ensure complete dispersion 20 ml of 20% hexametaphosphate solution was added, and the mixture was left stand for four hours. A 20 ml aliquot was than withdrawn from depth of 5 cm, dried, and weighed to determine the clay fraction.

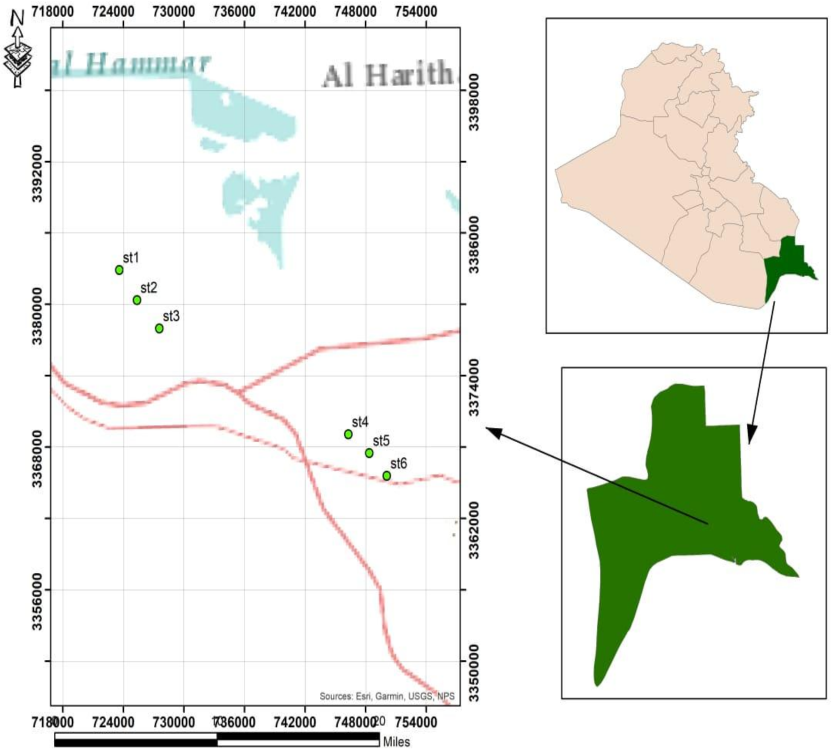

Figure 1: Map of the station of soil samples

Organic Matter (LOI Method):

The loss on ignition (LOI) method originally described by Ball (1964) was employed to estimate the soil organic matter content of soil samples. Approximately two grams of the sieved soil were weighed in pre dried crucibles. The samples were ignited at 550 °C for two hours, cooled in desiccators to room temperature, and reweighed until a constant mass was achieved. Organic matter percentage was calculated as the weight loss relative to the initial dry mass at 105 °C.

$$\mathrm{OM\%} = \frac{(\mathrm{W105°C} - \mathrm{W500°C})}{\mathrm{W105°C}} \times 100$$

And the

- W105°C: Initial dry weight of the soil sample after oven-drying at 105°C.
- W500°C: Final weight of the soil sample after ignition at 500°C in a muffle furnace
- OM%: Organic Matter Percentage.

Total Organic Carbon (TOC%):

The Loss-on-Ignition (LOI) values were multiplied by 0.58 the conversion factor to determined the total organic carbon (TOC) content. This factor assumes that OM contains about 58% carbon, a convention originally proposed by van Bemmelen and widely applied in soil science, while its accuracy may depend on soil type and composition (Heaton *et al.*2016).

Statistical analyses:

The statistical analyses conducted using Python (Google Colab Environment). Packages used in data processing included Pandas and NumPy. For Principal Component Analysis (PCA), Scikit-learn was used. Seaborn and Matplotlib libraries for generating the heatmap of the Spearman Correlation Matrix.

RESULTS AND DISCUSSION

The carbon chain lengths of n-alkanes in the soil samples were determined and found to range from C7 to C39. Including pristane and phytane, were also detected within the aliphatic fraction. Table 1 presents the concentrations of n-alkanes in the soils collected from the six sampling stations. The total n-alkane concentrations varied considerably among the sites, with values of 76.40 µg/g at St1, 31.16 µg/g at St2, 10.84 µg/g at St3,

Table 1: the concentration of n-alkane compounds in the research area (µg g-1 DW).

Carbon number	St1	St2	St3	St4	St5	St6
N-C7	1.690	1.330	1.340	1.440	1.370	0.170
N-C8	0.000	0.000	0.000	0.000	0.000	0.000
N-C9	0.000	0.000	0.000	0.000	0.000	0.000
N-C10	0.000	0.000	0.000	0.000	0.000	0.000
N-C11	0.000	0.000	0.000	0.000	0.000	0.000
N-C12	0.000	0.000	0.000	0.000	0.000	0.000
N-C13	0.000	0.000	0.000	0.000	0.000	0.000
N-C14	0.610	0.290	0.000	0.000	0.400	0.060
N-C15	0.570	0.300	0.000	0.000	0.350	0.060
N-C16	5.830	2.650	0.000	0.700	4.330	0.580
N-C17	0.440	0.170	0.000	0.210	0.160	0.040
pr	0.290	0.140	0.000	0.150	0.000	0.030
N-C18	0.560	1.950	0.780	0.850	2.520	0.060
Ph	0.210	0.390	0.180	0.330	0.000	0.020
N-C19	0.910	0.180	0.210	0.310	0.170	0.090
N-C20	3.030	1.350	1.050	0.930	1.580	0.300
N-C21	1.350	0.190	0.230	1.850	0.190	0.140

N- C22	0.540	1.210	1.070	2.310	1.060	0.050
N-C23	0.970	0.500	0.440	0.960	0.310	0.100
N-C24	1.550	0.300	0.680	1.600	0.670	0.160
N-C25	3.900	0.290	0.430	5.030	0.350	0.390
N-C26	5.520	1.590	0.560	6.150	0.650	0.550
N-C27	7.110	1.950	0.540	7.970	0.770	0.710
N-C28	5.160	1.750	0.580	5.900	0.630	0.520
N-C29	5.380	2.100	0.570	5.750	0.540	0.540
N-C30	5.550	2.760	0.880	5.360	0.250	0.560
N-C31	3.620	4.200	1.110	3.150	0.260	0.360
N-C32	4.890	2.090	1.010	1.210	0.390	0.490
N-C33	3.900	2.730	0.400	3.330	0.220	0.390
N-C34	0.650	0.930	0.000	4.090	0.000	0.060
N-C35	3.370	0.990	0.310	2.420	0.000	0.340
N-C36	5.510	0.710	0.000	2.280	0.000	0.550
N-C37	3.070	0.000	0.000	0.280	0.000	0.310
N-C38	1.880	0.000	0.000	0.370	0.000	0.190
N-C39	0.520	0.000	0.000	0.000	0.000	0.050
Total	76.400	31.160	10.840	63.020	15.770	7.640

63.02µg/g at St4, 15.77µg/g at St5, and 7.64 µg/g at St6. The highest concentration was recorded at St1 (76.40 µg/g dry weight), whereas the lowest was observed at St6 (7.64 µg/g). The n-alkane distribution exhibited a bimodal pattern, with C21, C22, C23, C24, and C7 comprising the majority of the low-molecular-weight fraction (C7–C25).

The phytane/pristane ratios ranged from 1.44 at St1 and 6 to 0.00 at St3 and 5. St1 and 6 exhibited pristane/phytane ratios greater than one, which, due to elevated pristane levels, suggest an abiogenic origin of the detected n-alkanes. In contrast, St2, 3, 4, and 5 displayed pristane/phytane ratios below one, indicating an anthropogenic origin of these hydrocarbons. The C17/pristane ratio was 1.517 at St1 and 1.333 at St6. According to Table 2, the C18/phytane ratio ranged from 2.576 at St4 to 5.00 at St2.

The ratio analysis indicates that both biogenic and anthropogenic sources influence alkane concentrations in soil. C18/ phytan and C17 /pristine ratios less than 1 suggest anthropogenic contributions to hydrocarbon inputs. Isoprenoid hydrocarbons, including pristane and phytane, were detected in most soil samples. These compounds are widely employed as diagnostic of markers of petroleum-related. According to (Wang *et al.*2011), variations in the pristine- to-phytane ratio amongst oil are considered indicative of the depositional environment of the source rocks. Table 2 summarizes the CPI values, average odd-

Table 2: n-alkane compound indicators across all locations during the study period. Anthropogenic(A) and Natural (N)

CPI	0.860	0.790	0.640	0.980	0.270	0.860
Source type	A	A	A	A	A	A
Pri/Phy	1.410	0.370	0.000	0.470	0.000	1.410
Source type	N	A	A	A	A	N
C17/Pri	1.517	1.214	-	1.400	-	1.333
C18/Phy	2.667	5.000	4.333	2.576	-	3.000
Σodd	35.120	13.580	4.230	31.270	3.300	3.510
Σeven	41.280	17.580	6.600	31.750	12.470	4.130

even carbon numbers distributions of alkanes, and the calculated ratios (Pristine/Phytane, Pristine/C17, and Phytane/C18).

Human activities represent the primary source of hydrocarbons at oil sites. The carbon preference index (CPI) is used to qualified contribution of anthropogenic n-alkane inputs.N-alkanes derived from bacteria, higher plants, and marine organisms are typically observed when the CPI values across sampling sites under 1. According to Douabul *et al.* (2011), CPI values greater than one often suggest inputs of fresh oil, whereas values approaching to one indicate that n-alkanes predominantly originate from petroleum and plankton sources. Table 3 compares selected stations with findings from previous pollution studies.

Table 3: Comparing the Current Study's Soil N-alkane (µg g-1dw) with Previous Research

Researcher name	Study area	N- alkane (µg g-1dw)
Douabul et al. (2012)	Basrah city	9.2 - 42.9
(AL-Saad et al. 2015)	Basrah city	3.575 - 21.266
Kadhim (2019	West Qurna-1 Oil Field	5.868 - 17.788
Al-Halfy et al. 2021	Rumaila Oil Field	99.99 – 100
Saleem (2022).	Basrah city	10.317 – 410.812
Resen, (2024)	Oil Field	112.169-651.333
Current study	selected station	7.64 – 76.4

The present investigation identified 18 polycyclic aromatic hydrocarbons (PAHs) in soil samples (Stations 1-6).

Based on molecular weight, the PAHs were classified into two major groups. The first group consisted of nine compounds, including acenaphthylene, naphthalene, phenanthrene, anthracene, fluorene, and acenaphthene. These compounds contain two to three fused aromatic rings and are categorized as low molecular weight PAHs. The second group included nine compounds, such as benzo(g,h,i)perylene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, and benzo(a)anthracene. These complexes feature four or more fused aromatic rings and are classified as high molecular weight.

The PAHs levels ranged from non-detectable values at several sites up to 32 ng/g, with Station 4 recording the highest concentration (Table 4). Light PAHs such as acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene were most abundant.

Table 4: Concentrations (ng/g DW) of petroleum hydrocarbons as Aromatic in soil samples around

Rumailla oil fields.

PAHs compounds	ST1	ST2	ST3	ST4	ST5	ST6
Naphthalene	0.100	0.190	0.320	0.090	0.150	0.060
Naphthalene, 2-methyl	0.380	0.000	0.080	0.000	0.000	0.000
000090-12-0 Naphthalen...	0.530	0.000	0.170	0.800	0.000	0.000
000208-96-8 Acenaphthy...	0.000	0.000	0.050	0.210	0.000	0.000
Acenaphthene	0.350	0.000	0.760	0.000	0.000	0.270
Fluorene	0.000	0.090	1.100	0.000	0.000	0.290
Phenanthrene	0.000	4.500	4.900	32.000	0.560	9.000
Anthracene	0.070	0.000	0.090	0.000	0.000	0.250
Fluoranthene	0.000	0.100	0.000	3.000	0.310	3.100
Pyrene	0.000	0.210	0.000	0.000	0.000	0.000
000056-55-3 Benz[a]ant...	0.140	0.000	0.030	0.000	0.000	0.000
000218-01-9 Chrysene	0.000	0.240	0.000	0.000	0.000	0.240
000205-99-2 Benzo[b]fl...	0.830	0.000	0.490	1.200	0.000	0.040
Benzo [k] fluoranthene	0.070	0.170	0.250	0.000	0.000	0. 25

000050-32-8 Benzo[a]py...	0.900	0.150	0.220	0.590	0.760	0.100
000193-39-5 Indeno[1,2...	5.800	0.310	0.150	0.110	0.450	0.000
000053-70-3 Dibenz[a,h...	0.000	0.350	0.230	0.510	0.000	0.000
Benzo[ghi]perylene	0.000	0.190	0.150	0.210	1.700	2.700
ΣPAHs (ng·g–1)	9.170	6.500	8.990	38.720	3.930	16.300

Evidence from Patel *et al.* (2015) and Saleem *et al.* (2022) suggests that benzo(a)pyrene degradation relies on bacteria mineralization phases. High molecular weight PAHs such as pyrene, fluoranthene, benzo(a)pyrene, and benzo(a)anthracene are comparatively more recalcitrant than lighter PAHs like naphthalene and phenanthrene (Bakhtiari et al., 2009; Obayori & Salam, 2010).

Low molecular weight PAH (e.g., naphthalene) possess higher vapor pressure; consequently, volatilization is a principal environment removal pathway (USEPA, 1982). In St4 had the highest conce. of PAHs (32 ng/g DW), with phenanthrene, being notably maybe abundant.

As shown in Table 5, the origin of PAHs was attributed to both pyrogenic and petrogenic inputs. At St3, the phenanthrene to anthracene ratio was 1.37, while at St1 was 0.0ng/g DW.

Table 5: lists the values of the PAH contamination indices and descriptions of their sources in soil samples

Locations	Ant/(Ant+ Phen)	Description	BaA/(BaA+ Chry)	Description
St1	1	Pyrogenic	1	Pyrogenic
St2	0	Petrogenic	0	Petrogenic
St3	0.018	Petrogenic	1	Pyrogenic
St4	0	Petrogenic	-	-
St5	0	Petrogenic	-	-
St6	0.27	Pyrogenic	0	Petrogenic

According to the ratio data, pyrogenic and petrogenic processes were the sources of PAHs in sediment (Table 6).

Table 6 lists the anathor index values of PAHs and descriptions of their sources in soil samples.

Locations	Fl / Py	Description	Phen/ Ant	Description	LMW /HMW	Description
St1	-	-	0	pyrogenic	0.185	pyrogenic

St2	0.476	pyrogenic	-	-	3.012	petrogenic
St3	-	-	54.444	petrogenic	4.914	petrogenic
St4	-	-	-	-	3.779	petrogenic
St5	-	-	-	-	0.351	pyrogenic
St6	-	-	36	petrogenic	3.895	petrogenic

Comparison with previous investigations in Iraqi revealed that PAH levels showed intermediate values depending on sampling location (Table7). These contamination patterns have implications for regional land, water, and air quality, with potential downstream effects on biota (Locke, 2024).

Table 7: compares the PAH in surface soil (ng g-1 dw) with those found in earlier research conducted in Iraq.

Researcher name	Study area	PAHs compounds (ng g-1dw)
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
Resen, (2024)	Oil field	18.4-4515
Current study	selected station	3.93 - 38.72

According to the study of soil samples, the total organic carbon (TOC) and the Organic matter (OM) varied significantly among the six locations. TOC values varied between 0.33% and 1.37%, which were determined using the van Bemmelen conversion factor (0.58), The OM values ranged from 0.57% to 2.40% (Table 8). According to Ukalska-Jaruga & Smreczak (2020) research, organic matter plays an important role for the sorption and stabilization of PAHs in contaminated soils. These results suggest that soils with higher organic fractions represent greater potential for hydrocarbon retention (Kareem *et al.*2025).

Table 8: Grain size at six Locations and TOC% in soil samples.

Stations	Sand	Silt	clay	OM%	TOC %
St1	71.60	10.00	18.00	0.81	0.4698
St2	59.42	12.00	28.00	1.81	1.0498
St3	72.84	6.00	20.00	0.91	0.5278
St4	81.08	6.00	16.00	0.57	0.3306
St5	71.92	20.00	8.00	1.24	0.7192
St6	81.71	6.00	12.00	1.50	0.87

Sand percentage represented almost all of samples (59–82%) in regard to soil texture, while silt and clay fractions varied significantly, ranging from 6–20% and 8–28%, respectively.

The principal component analysis (PCA) (Figure 2) effectively differentiated the studied stations based on their hydrocarbon and sediment characteristics. The first principal component (PC1) explained 53.9% of the total variance, while the second component (PC2) accounted for 24.0%, together describing nearly 77.9% of the total data variability. Stations located on opposite sides of the PC1 axis exhibited contrasting hydrocarbon accumulation behaviours, whereas those clustered near the origin shared comparable sedimentary and geochemical properties. This pattern clearly indicates that hydrocarbon-related parameters—particularly TPH, PAH, and TOC—constitute the dominant factors shaping spatial variability across the studied sediments (Heaton *et al.* 2016).

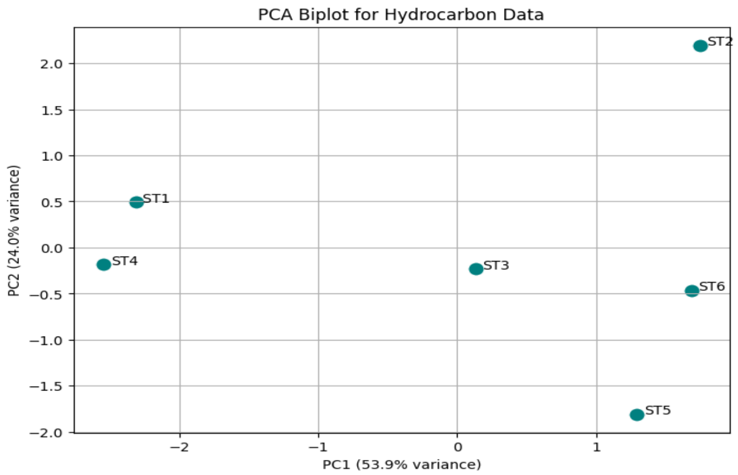

Figure2: The principal component analysis (PCA)

The Spearman correlation heatmap (Figure 3) revealed a strong positive association between total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), with a correlation coefficient of approximately 0.91. Most aliphatic and aromatic compounds displayed high positive inter-correlations, suggesting that their accumulation occurs under similar environmental controls, while weaker or negative relationships were detected with textural parameters such as sand and silt. These findings confirm that hydrocarbon concentrations are primarily governed by organic-matter content and fine-particle fractions rather than by sediment texture alone (Łyszczarz *et al*.2021).

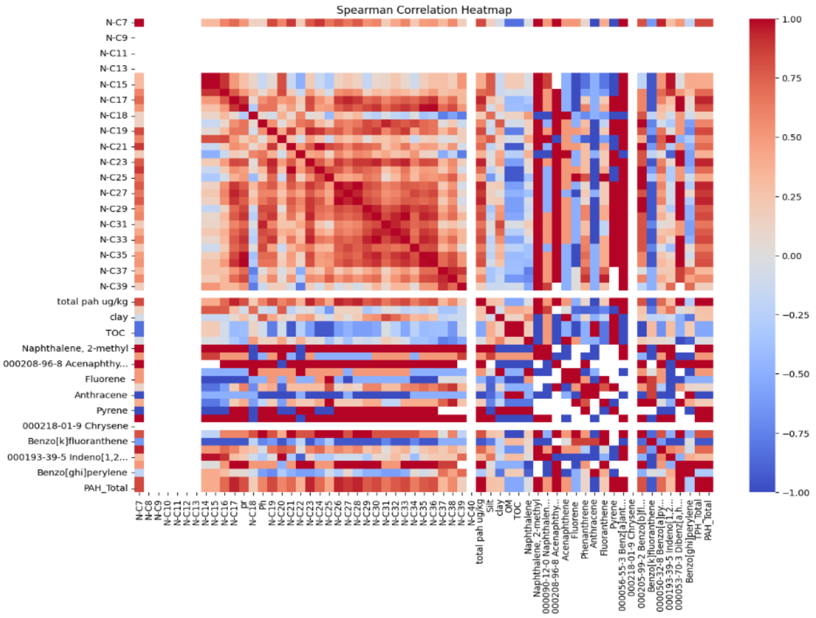

Figure 3: The Spearman correlation heatmap.

Conclusion

This study established the baseline distribution and concentration aliphatic hydrocarbons in soil samples from the northern and southern Rumaila regions of Basrah Governorate.

Analyses revealed that total aliphatic hydrocarbon concentration in soil ranged from 7.64 and 76.4 µg/g-1 of dry weight. Dissemination forms and diagnostic indices indicated that most n-alkanes in North Rumaila soils were of anthropogenic origin. Furthermore, the study established a baseline for the PAH contamination in the Basra oil field environment, primarily resulting for crude oil spills and associated gas flaring.

Based on molecular weight, PAH were classified in two principal groups. The first category nine compounds, including naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. The low molecular weight PAHs contain two to three fused aromatic rings. The second category included nine high molecular weight PAHs such as indeno(1,2,3-cd) pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, benzo(a)anthracene, and pyrene or more. both the PCA configuration and the correlation structure consistently demonstrate that hydrocarbon-related variables are the principal drivers of spatial heterogeneity within the study area. The integration of the two analyses emphasizes the strong coupling between TPH and PAH, reinforcing the notion that petroleum inputs dominate over natural sediment characteristics in determining the overall contamination pattern.

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تلويث التربة في حقول الرميلة الشمالية والجنوبية، البصرة، جنوب العراق

حلا علي شبر وصال فخري حسن ماجدولين عزيز رسن حامد طالب السعد فارس جاسم الامارة

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لأغراض تقييم التلوث بالهيدروكربونات، تم جمع ست عينات من عمق 0 إلى 30 سم من حقول الرميلة النفطية في مدينة البصرة. تم تحليل الكميات الفردية للألكانات المستقيمة (n-alkanes) والهيدروكربونات العطرية متعددة الحلقات (PAHs) باستخدام جهاز الكروماتوغرافيا الغازية. تتراوح قيم مؤشر الكربون المفضل (CPI) من 0.27 في المحطة 5 إلى 0.98 في المحطة 4، مما يدعم حقيقة أن توزيع الألكانات يتأثر بشكل رئيسي بالأنشطة البشرية. في الرميلة الشمالية، سجلت المحطة 6 أقل محتوى من الألكانات المستقيمة (7.640 ميكروغرام/غرام)، بينما كانت أعلى قيمة في المحطة 1 (76.400 ميكروغرام/غرام وزن جاف). كما تباينت نسب C17/Pr C18/Ph بين المحطات المختلفة، مما يشير إلى وجود مزيج من المصادر البيولوجية (البيوجينية) والنفطية (البتروجينية). تراوح التركيز الكلي بين 7.64 إلى 76.40 ميكروغرام/غرام، وكان مركب الفينانثرين هو الأكثر وفرة بين مركبات PAHs. كشف تحليل التربة نسجة عن وجود علاقة قوية بين مستويات PAHs ومحتوى السلت والطين، في حين كان لمحتوى الرمل قيمة تفسيرية ضئيلة. وعند التحويل إلى الكربون العضوي الكلي (TOC) باستخدام معامل فان بيميلين (0.58)، تراوحت مستويات المادة العضوية (OM) من 0.33% إلى 1.37%، مما يبرز دور الكسور العضوية في احتجاز الهيدروكربونات.