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Distribution of Total Petroleum Hydrocarbons (TPHs) in Sediments of Southern Iraqi Rivers

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Abstract

Although the Tigris, Euphrates, and Shatt Al-Arab rivers are important parts of Iraq, pollution has a series effect on these rivers. The aim of this study is to determine the origins and sources of Total Petroleum hydrocarbons in sediment samples collected from 15 stations in 2022. The concentration of the total petroleum hydrocarbons was determined using a spectrofluorometer. The study found that Station 12, located at Shatt Al-Arab rivers, had the highest concentration at 28.76 µg/g dry weight, while Station 1 had the lowest concentration at 3.41 µg/g dry weight. There are several facilities that may contribute to the rise in total petroleum hydrocarbons, which may be attributed to the emissions of power stations and oil fields, such as West Qurna, Majnoon, Siba, and Rumaila. In addition to the pollution of fishing boats, which use oil as fuel, sewage pipes also dump their waste.

Keywords: Total petroleum hydrocarbons, sediments, Tigris, Euphrates, Shatt Al-Arab, Southern Iraq.

Introduction

Petroleum is an intricate blend of hydrocarbons that exhibit distinct chemical compositions and unique physical traits. These attributes are contingent upon the geographical and geological sources of crude oil as well as the method of cracking applied during the refining process. The issue surrounding petroleum hydrocarbons in the environment stems from their potential to inflict severe health repercussions on both humans and animals (Nuhad *et al.*, 2014).

Total Petroleum Hydrocarbons (TPH) are complex chemical compounds originating from crude oil, encompassing a vast array of substances primarily composed of carbon and hydrogen. These include but are not limited to alkanes, cycloalkanes, alkenes, and aromatic hydrocarbons such as arenes (Todd *et al.*, 1999). Various processes can release hydrocarbons into the environment, such as burning solid waste, seepage, and accidental spillage during transportation of petroleum products. Oil spills in aquatic environments, whether in seas or rivers, can lead to widespread contamination (Liu *et al.* 2009). Additionally, these compounds can be transported to sediments through adsorption onto particles or suspended

materials in the water column, eventually precipitating to the bottom (Jazza 2015).

In recent decades, there has been a notable increase in the presence of hydrocarbons in aquatic environments. This escalation is often attributed to human activities and can have detrimental effects on biota (Li *et al.*, 2020). Recognizing potential hazards, legal limits for petroleum distillates have been established in various contexts, such as a limit of 500 ppm in the workplace by the Occupational Safety and Health Administration (OSHA) (Todd *et al,*1999). Moreover, the diffusion of pollutants, including pesticides, petroleum oils, trace elements, and other contaminants, into aquatic environments, particularly rivers, can cause long-term harmful effects on biota, with harm sometimes manifesting only after a prolonged period (Sharma and Cyril, 2007). These hazardous pollutants are hazardous because of their mutagenic, carcinogenic, immunotoxic, and teratogenic effects. These components threaten all life forms, ranging from microorganisms to humans, when they are released into the environment, especially via human activities (Muharrem and Olcay, 2019).

The primary aim of this study was to investigate the variations in the concentrations and sources of Total Petroleum Hydrocarbons (TPH) in sediment samples collected from the Tigers, Euphrates, and Shatt al Arab rivers. This study contributes to a broader understanding of environmental pollution and offers insights that may guide future monitoring and mitigation strategies.

Materials and Methods

Description of the study area

The Shatt Al-Arab River area is in the lower Mesopotamian delta in the southern part of Iraq and extends from the confluence of the Euphrates and Tigris rivers in Al-Qurna City, north of the Al-Basra Governorate (31°00’17″’ N and 47° 26’29″″ E), to the Arabian Gulf. The Shatt Al-Arab River spans approximately 200 km in length, with its width varying from 250 m to more than 2 km in the estuary. Its depth ranges from 8 to 17 m, accounting for tidal influences (Hamdan *et al.*, 2018).

Sampling Location

Sediment samples were collected from 15 stations, with stations 1–4 representing the Tigers River, stations 5–8 representing the Euphrates River, and stations 9–15 representing the Shatt Al-Arab River (Figure 1).

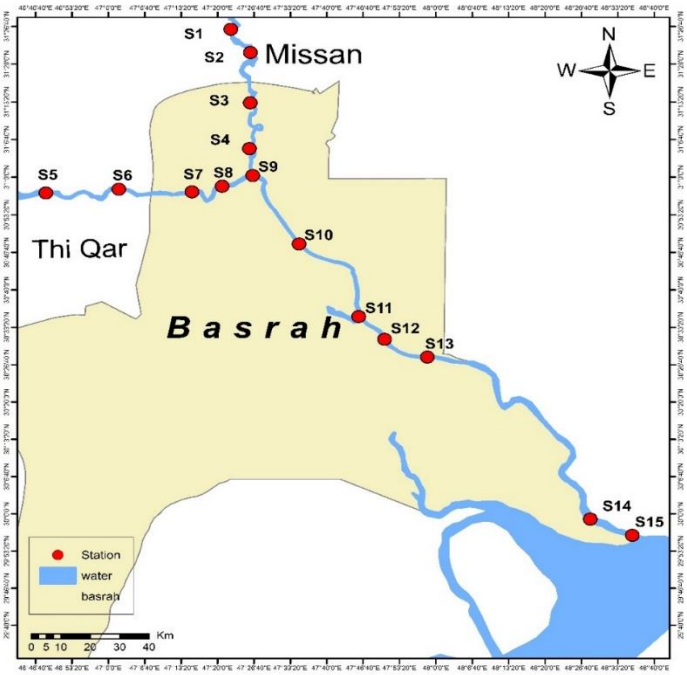

Fig (1) The Studied Stations, Southern Iraq

Extraction

The samples were dried, finely ground, and sieved with a mesh pore size of 0.64 before being Soxhlet extracted for 24 h with 250 ml of a Methanol: Benzene (1:1) mixture, following the method described in a previous study (UNEP, 1992). The combined extracts were saponified for 2 h by adding 15 ml of 4M MeOH(KOH), maintained at a constant temperature, and subsequently cooled to room temperature. After extracting the unsaponified matter with hexane and drying it over anhydrous sodium sulfate, the extract was concentrated using a stream of N2 for UVF analysis. The concentration of Total Petroleum Hydrocarbons (TPH) was determined using a spectrofluorometer following established procedures.

Statistical analysis

Data values were analyzed using range means and standard deviations (mean collectively influence the distribution of hydrocarbons in these rivers (Al-Saad et al ,2017) . The Tigris and Euphrates Rivers showed lower TPH concentrations because of the absence of oil tanker traffic and oil spills and the effect of microbial degradation or volatilization. However, industrial and sewage discharge from cities and factories along river paths may still contribute to contamination (Jazza, 2015 and Al-Khatib, 2008). Considering Iraq's status as a major oil-producing country in the Arabian Gulf, these patterns reflect broader regional dynamics. The observed TPH levels were consistent with the values reported for the comparable regions (Table 2).

±SD) and were analyzed using MS Excel 2013. ArcMap software was used to map the data.

Results and Discussion

Table 1 and Figure 2 showed different concentrations at various rivers, the findings were as follows: In Tigris River, the lowest concentrations (3.41 μg/g dry weight) were found at Station 1, while the highest concentrations (5.86 μg/g dry weight) were found at Station 4. In the Euphrates River, concentrations ranged from a low of 6.50 μg/g dry weight at Station 5 to a high of 8.73 μg/g dry weight at Station 8. Similarly, in the Shatt Al-Arab River, the lowest and highest concentrations were recorded at 11.75 μg/g and 28.76 μg/g dry weight, respectively, at Stations 9 and 12. The TPH range varied between 3.41 μg/g dry weight at Station 1 and 28.76 μg/g dry weight at Station 12.

The Shatt Al-Arab River exhibited the highest concentrations of Total Petroleum Hydrocarbons (TPHs), possibly due to factors such as oil spills and engine exhaust from numerous small fishing boats, particularly at stations 12, 13, and 14. These elevated levels may also be linked to pollution from boat engines, military remnants in Ashar, and sewage discharges. In contrast, the sources of TPHs in the Shatt Al-Arab estuary and the Northwest Arabian Gulf are pyrogenic and petrogenic, with biogenic sources being rare (Al-Saad et al, 1997). Several factors, including volatilization, mixing, flushing, adsorption, chemical oxidation, photodecomposition, sedimentation, and biodegradation

Table (1) Total petroleum hydrocarbon (TPHs) concentrations (µg/g dry weight) in the sediments at the studied stations in Southern Iraq.

	Station	TPHs (µg/g)	range	mean	±SD
Tigris	1	3.26	3.26-3.52	3.41	0.13
		3.52			
		3.46			
	2	4.50	4.50-4.64	4.57	0.07
		4.64			
		4.58			
	3	4.68	4.68-4.96	4.84	0.14
		4.96			
		4.88			
	4	5.73	5.73-6.01	5.86	0.14
		5.85			
		6.01			
Euphrates	5	6.22	6.22-6.83	6.50	0.30
		6.83			
		6.46			
	6	7.18	7.18-7.83	7.42	0.35
		7.26			
		7.83			
	7	8.52	8.52-8.84	8.66	0.16
		8.63			
		8.84			
	8	8.33	8.33-8.96	8.73	0.35
		8.92			
		8.96			
Shatt Al-Arab River	9	11.28	11.28-12.06	11.75	0.41
		12.06			
		11.93			
	10	20.63	20.03-20.92	20.52	0.45
		20.03			
		20.92			
	11	22.68	22.41-23.06	22.71	0.32
		22.41			
		23.06			
	12	28.64	28.64-28.92	28.76	0.14
		28.73			
		28.92			
	13	29.31	27.54-29.31	28.49	0.89
		28.63			
		27.54			
	14	26.42	26.42-27.31	26.75	0.48
		26.54			
		27.31			
	15	13.23	13.23-15.47	14.70	1.27
		15.42			
		15.47			

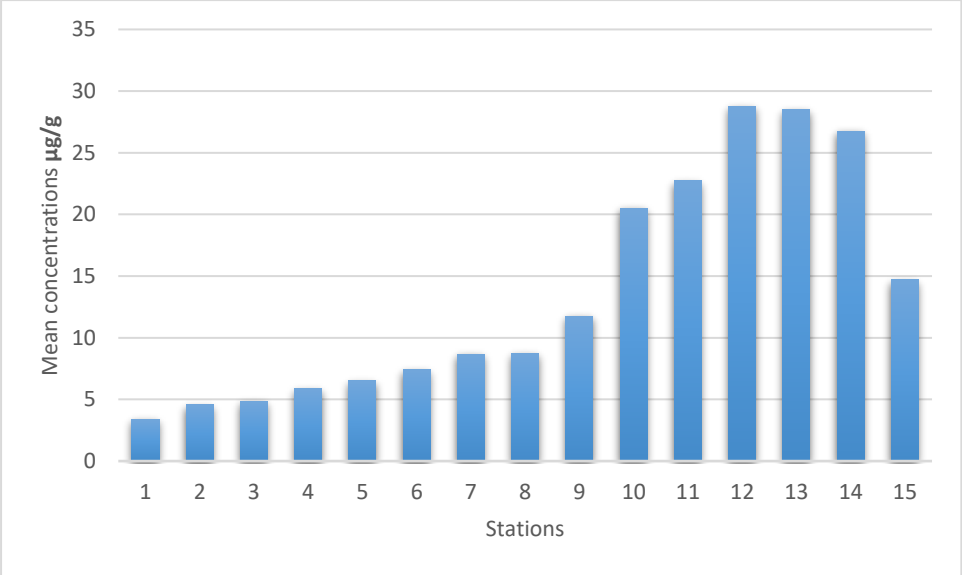

Fig (2) Mean concentrations of Total Petroleum Hydrocarbons in sediments at the studied stations.

Table (2): Comparison between the levels of total hydrocarbons (µg/g dry weight) in sediments for the present study and those of previous studies.

Studied Areas	Total Hydrocarbons(µg/g)	References
Shatt Al-Arab River &NW Arabian Gulf	2.46 -38.33	Al-Saad,1995
Shatt Al-Arab River &NW Arabian Gulf	0.108 – 37.02	Al-Khatib,1998
Shat Al-Arab estuary and northwest Persian Gulf	2.55-26	Hantoush,2006
Shatt Al-Arab River ,Northern	7.37-24.41	Al-Imarah *et al* , 2010
Iraqi Coast Region	2.39- 30.88	Al-Khion,2012
Euphrates River /Nasiriya city	4.74-12.32	Abed, 2013
Shatt Al-Arab River	4.76 – 45.24	Al-Hejuje,2014
Al-Kahlaa River /Missan province	3.16 -135.18	Jazza,2015
Shatt Al-Arab River	0.94-26.27	Al-Mahana,2015
Tigris river	2.83-12.3	Al-Nakeeb& Neran, 2015
Umm Qasser	26.27	Al-Saad *et al* ,2017
Shatt Al-Arab River	6.52-7.01	Al-Gizzi *et al* ,2021
Shatt Al-Basrah	3.87-57.5	Glou *et al*, 2022
Tigris river **Euphrates River** **Shatt Al-Arab River**	3.20-3.53 2.95- 4.85 8.89- 10.83	Salem *et al* ,2022
The Study Area	**3.41-28.76**	**The present work**

Conclusion

According to the results of the present study, the sediments from the southern Iraqi rivers were unpolluted with Total Petroleum Hydrocarbons (TPHs), aligned with the standards established by the Occupational Safety and Health Administration (OSHA). These findings provide valuable insights into the environmental quality of the region and may guide future monitoring and conservation efforts.

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توزيع الهيدروكاربونات الكلية في رواسب انهار جنوب العراق

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المستخلص:

بالرغم من أهمية أنهار دجلة والفرات وشط العرب كجزء من العراق، فإن التلوث يتسبب في آثار سلبية على هذه الأنهار. تهدف هذه الدراسة لتحديد مصادر ومنشأ الهيدروكربونات البترولية الكلية في عينات الرواسب المأخوذة من 15 محطة في عام 2022. تم تحديد تركيز الهيدروكربونات البترولية الكلية باستخدام جهاز السبكتروفلورومیتر. أظهرت الدراسة أن المحطة 12 الموجودة عند شط العرب كانت لديها أعلى تركيز بلغ 28.76 ميكروغرام/جم وزن جاف، بينما كان لدى المحطة 1 أقل تركيز بلغ 3.41 ميكروغرام/جم وزن جاف. هناك العديد من المنشآت التي قد تسهم في زيادة هيدروكربونات البترول الكلية، والتي يمكن أن تعزى إلى انبعاثات محطات الطاقة وحقول النفط، مثل حقول غرب القرنة، مجنون، السيبة والرميلة. بالإضافة إلى التلوث من قوارب الصيد التي تستخدم النفط كوقود، كما تفرغ أنابيب الصرف فضلاتها في الأنهار ايضاً.

الكلمات المفتاحية: الهيدروكاربونات الكلية، رسوبيات، دجلة، الفرات، شط العرب، جنوب العراق.