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Total Petroleum Hydrocarbons in the Soil of West Qurna-2 Oil Field Southern Iraq

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Abstract This study focused on the determinate the concentrations of Total hydrocarbon by using spectroflurometer, for soil in ten stations at West Qurna-2 oil field. The regional distribution of TPHs at the present study showed a highest concentration of TPHs during spring at station 10 (41.86 µg/g dry weigh) while a lowest concentration observed during spring at station 1 (14.82 µg/g dry weigh). The seasonal distribution of TPHs show highest level in all stations during winter (30.350 µg/g) and the lowest levels observed during summer (24.167 µg/g). With respect to spatial variably of studied parameters, the parameters concentrations in studied stations gradually increased from station 1 to station 5, and then significantly decreased at station 6 and finally increased to station 10. The fluctuation in concentrations of concentrations in stations is due to distance from the flame of the flare which near to the stations 8, 9, 10 and far to the stations 1, 2, 3, 4, 5, 6, 7, while the seasonal concentration arrange as following: winter >spring >autumn>summer. There were non-significant correlation between the TPH in soil and each of the soil texture compounds (sand, silt and clay), while there is significant correlation between the TPH in soil and TOC%. By comprising the result concentration of this study with literature reviews, the concentration levels lies within it and in other cases exceed it.
Keywords TPH; Soil; Pollution; West Qurna-2 oil field; Southern Iraq

Introduction

Petroleum is a complex mixture of components, including organic and inorganic chemicals. Organic hydrocarbon contains 4–26, or more carbon atoms with different arrangements that include straight and branched aliphatic hydrocarbons, or cyclic rings. The total petroleum hydrocarbons (TPHs) refer to any mixture of hydrocarbons found in crude oil (Douben, 2003).Total petroleum hydrocarbons (TPHs), defined as a mixture of aromatic and aliphatic hydrocarbons coming from crude oil products used in industry and transportation, can be both toxic for soil microorganisms as well as beneficial as a carbon source (Sutton et al., 2013).

Petroleum hydrocarbons come into the environment through accidents, spills or leaks, from industrial discharges, or by items from business or residential employments (Ines et al., 2013).

Low amounts of hydrocarbons from natural sources “biogenic” such as higher plants can kept by soil (Zhang et al., 2012), several processes such as volatilization, photo-oxidation, chemical reactions, leaching and biodegradation may be removed the hydrocarbons from soil (Grimalt and Olive, 1993). Some of these processes may take very long time and part of these compounds will remain in soil and become more resistant that depending on environmental conditions (Barakat et al., 2001). Increasing hydrocarbons levels in the environment can cause pollution to the natural resources (Buddhadasa et al., 2002; Douabul et al., 2012).

The objective of the present study is to determine the spatial and seasonal variations in concentrations of Total Petroleum hydrocarbons in West Qurna-2 oil field Southern Iraq and to analyze with reference to its adverse health effects.

1 Materials and Methods

West Qurna oil field is located in Basrah city southern Iraq, around 65 km NW of the city of Basrah. Soil samples were collected seasonally during the period from September 2015 to March 2016 at ten stations in West Qurna-2 oil field at Basrah city (Figure 1). Samples were warped with aluminum foil then transferred to the laboratory for analysis.

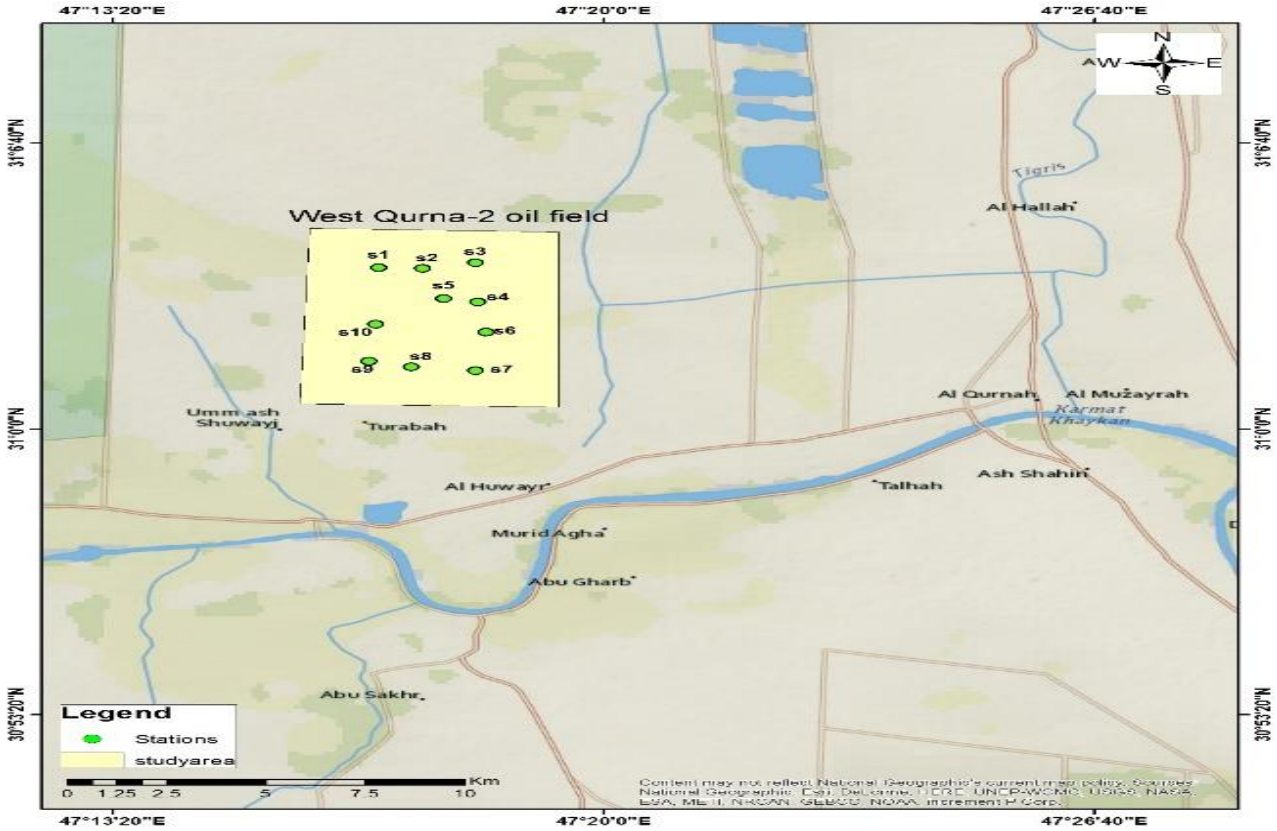

Figure 1 The study area and sampling stations

Before analysis, soil samples were freeze-dried, ground finely in an agate mortar and sieved through a 62 um metal (stainless- steel) sieve.

The extraction and cleanup procedure for the determination of petroleum hydrocarbons in the soil was based on that of Al-Saad (1995). Soil was placed in a pre-extracted cellulose thimble and soxhlet extracted with 150ml methanol: benzene (1: 1) mixture for 24 hours. At the end of this period, the extract was transferred to a storage flask and the samples were further extracted with a fresh solvent. The combined extracts were reduced in volume to 10ml in a rotary evaporator. It was then saponified for 2 hours with a solution of 4N KOH in 1: 1 methanol: benzene. After extracting the unsaponified matter with hexane, the extract was dried over anhydrous sodium sulfate, concentrated by a stream of N2 for UVF analysis.

2 Results and Discussion

The concentrations of TPHs in soil samples at ten stations were range as following: Station 1 (14.75-20.19 µg/g), station 2 (16.91-20.59 µg/g), station 3 (17.75-22.46 µg/g), station 4 (22.39-26.82 µg/g), station 5 (24.85-32.29 µg/g), station 6 (22.75-28.45 µg/g), station 7 (27.05-35.69 µg/g), station 8 (29.56-38.5 µg/g), station 9 (29.57-39.17 µg/g) and station 10 (33.37-41.94 µg/g) dry weight (Table 1).

The mean concentration during different season range in station 1 from 14.82 µg/g during spring to 20.1 µg/g during winter, while station 2 ranged from 16.99 µg/g during spring to 20.53 µg/g during winter, whereas station3 ranged from17.77 µg/g during summer to 22.42 µg/g during winter, station4 ranged from 22.43 µg/g during spring to 26.76 µg/g during winter, station5 ranged from 24.87 µg/g during summer to 32.23 µg/g during winter, station 6 ranged

from 22.77 µg/g during spring to 28.28 µg/g during winter, station 7 ranged from 27.07 µg/g during summer to 35.63 µg/g during winter, station 8 ranged from 29.59 µg/g during summer to 38.45 µg/g during winter, station 9 ranged from 29.59 µg/g during summer to 39.07 µg/g during spring and at station 10 ranged from 33.39 µg/g during summer to 41.86 µg/g during spring (Table 2; Figure 2).

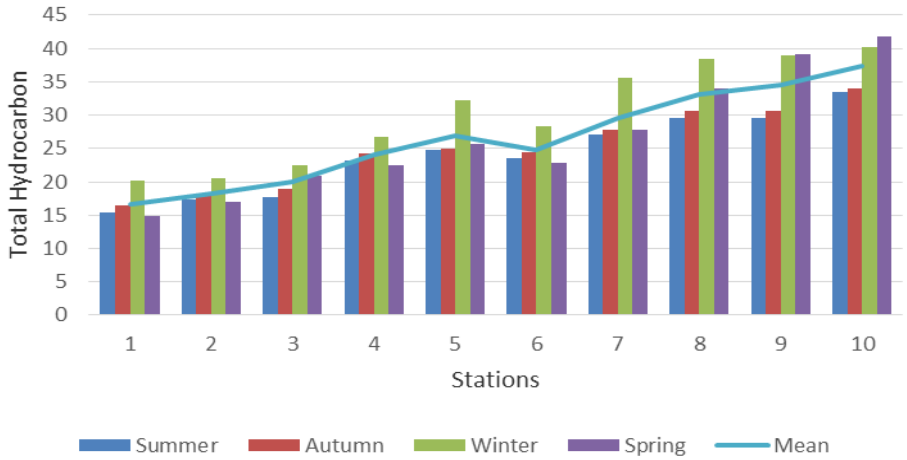

Figure 2 Seasonal and Mean concentrations of Total Petroleum Hydrocarbons of West Qurna-2 oil field

Seasonal variations of Total petroleum Hydrocarbons were observed during this study. The highest concentrations were noticed during winter season while lower concentration observed during summer season (Figure 3).

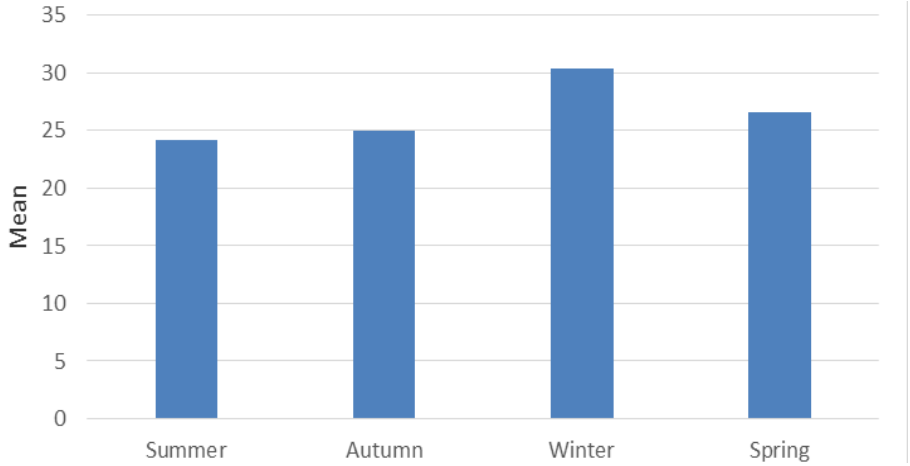

Figure 3 Seasonal Variations of Total Petroleum Hydrocarbons of West Qurna-2 oil field

Based on our data, the GIS maps represented the concentrations of TPHs measured during different seasons (Figure 4).

The results of the present study showed a highest mean concentration (37.372µg/g dry weigh) of TPHs in station 10, while a lowest concentration (16.657 µg/g dry weigh) observed at station 1 (Table 2).

Variations in the recorded concentrations of the Total Petroleum Hydrocarbons was observer during the study, they gradually increased starting from station 1 until station 5, and then significantly decreased at station 6 and then increased to station 10. The fluctuation in concentrations of TPH in stations is due to distance from the flame of the flare which near to the stations 8,9,10 and far to the stations 1, 2, 3, 4, 5, 6, 7 (Figure 4).

The results regional distributions of TPHs at the present study showed a highest concentration of TPHs during spring at station 10 (41.86 µg/g dry weigh) while a lowest concentration also observed during spring at station 1 (14.82 µg/g dry weigh) (Table 2).

The refined oils and gas creation plants, electrical producing stations, oil wastes discharges, transportation, internal combustion in industrial and vehicle motors, Natural gas flares and explosions, breathing air at Gasoline

stations and local exercises could be the possible sources of anthropogenic hydrocarbons in the sampled stations (Al-Saad et al., 2016), also crude oil extraction and production (oilfields), Neighboring oilfields (West Qurna-1, Majnoon and Nahr Umr). All of these was contribution to increase the concentration of TPH (Al-Saad et al., 2015).

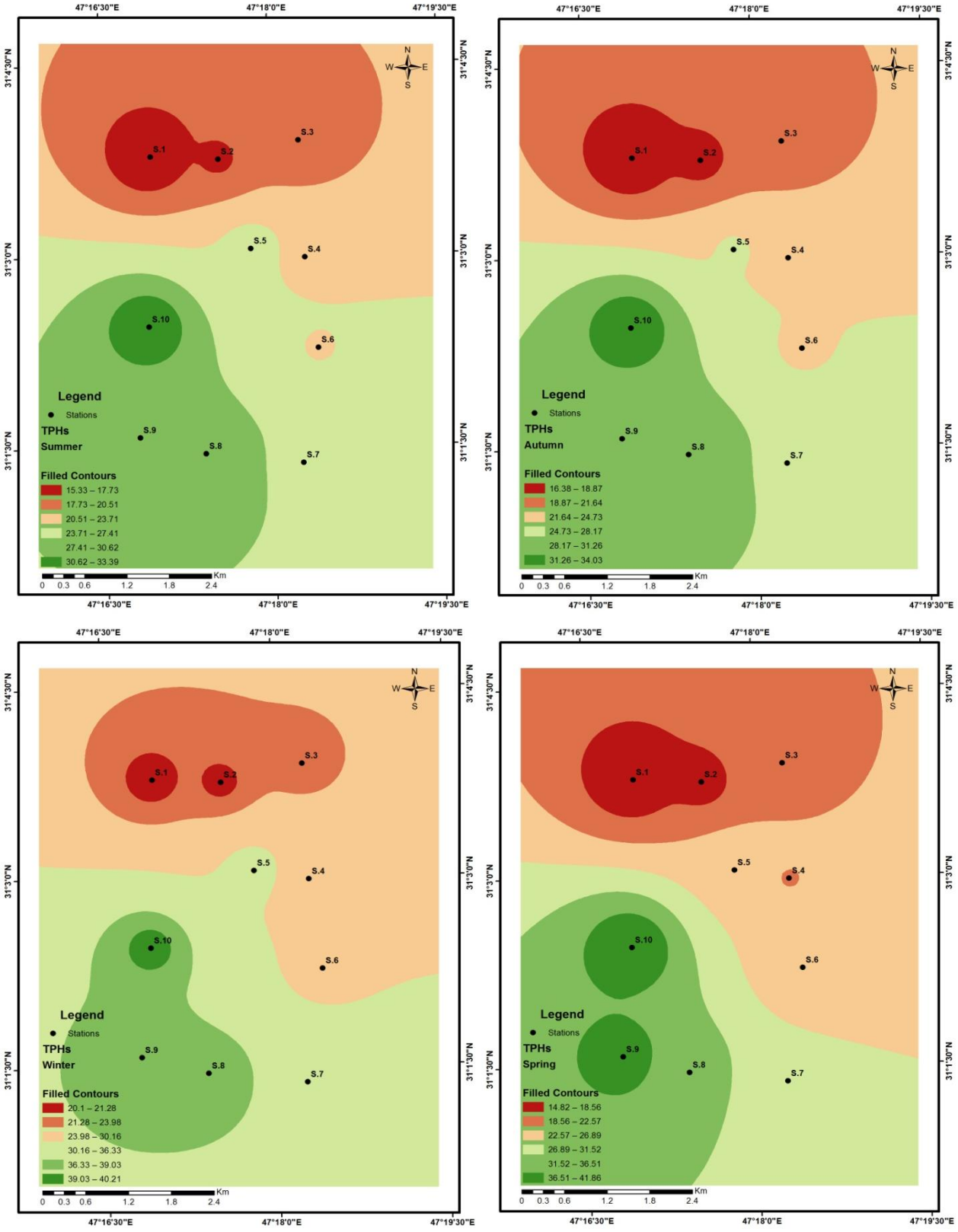

Figure 4 GIS map showing Total petroleum Hydrocarbon distributions in soil of West Qurna-2 oil field for different seasons

Table 1 Regional Concentration of Total Petroleum Hydrocarbon (μg/g) in ten stations during different season

Stations	Summer 2015				Autumn 2015				Winter 2015				Spring2016			
	TPHs	Range	Mean	±SD	TPHs	Range	Mean	±SD	TPHs	Range	Mean	±SD	TPHs	Range	Mean	±SD
1	15.31	15.31-15.35	15.33	0.02	16.32	16.32-16.46	16.38	0.072	20.03	20.03-20.19	20.1	0.081	14.75	14.75-14.9	14.82	0.075
	15.33				16.36				20.08				14.81			
	15.35				16.46				20.19				14.9			
2	17.31	17.31-17.37	17.34	0.03	18.02	18.02-18.06	18.04	0.02	20.45	20.45-20.59	20.53	0.072	16.91	16.91-17.08	16.99	0.085
	17.34				18.04				20.55				16.98			
	17.37				18.06				20.59				17.08			
3	17.75	17.75-17.79	17.77	0.02	18.8	18.8-18.97	18.88	0.085	22.39	22.39-22.46	22.42	0.036	20.76	20.76-20.85	20.81	0.045
	17.77				18.87				22.41				20.82			
	17.79				18.97				22.46				20.85			
4	23.11	23.11-23.17	23.14	0.03	24.18	24.18-24.26	24.22	0.04	26.71	26.71-26.82	26.76	0.055	22.39	22.39-22.49	22.43	0.052
	23.14				24.22				26.75				22.41			
	23.17				24.26				26.82				22.49			
5	24.85	24.85-24.89	24.87	0.02	24.93	24.93-25.07	24.99	0.072	32.18	32.18-32.29	32.23	0.055	25.61	25.61-25.7	25.66	0.045
	24.87				24.97				32.22				25.67			
	24.89				25.07				32.29				25.7			
6	23.56	23.56-23.6	23.58	0.02	24.33	24.33-24.4	24.36	0.036	28.18	28.18-28.45	28.28	0.147	22.75	22.75-22.8	22.77	0.026
	23.58				24.35				28.21				22.76			
	23.6				24.4				28.45				22.8			
7	27.05	27.05-27.09	27.07	0.02	27.83	27.83-27.9	27.86	0.036	35.55	35.55-35.69	35.63	0.072	27.78	27.78-27.87	27.82	0.045
	27.07				27.85				35.65				27.81			
	27.09				27.9				35.69				27.87			
8	29.56	29.56-29.61	29.59	0.026	30.61	30.61-30.65	30.63	0.02	38.41	38.41-38.5	38.45	0.045	33.97	33.97-34.07	34.01	0.052
	29.6				30.63				38.44				33.99			
	29.61				30.65				38.5				34.07			
9	29.57	29.57-29.61	29.59	0.02	30.64	30.64-30.69	30.67	0.026	38.94	38.94-39.03	38.98	0.0458	39.01	39.01-39.17	39.07	0.087
	29.59				30.68				38.97				39.03			
	29.61				30.69				39.03				39.17			
10	33.37	33.37-33.41	33.39	0.02	34.01	34.01-34.04	34.03	0.017	40.18	40.18-40.24	40.21	0.03	41.79	41.79-41.94	41.86	0.075
	33.39				34.04				40.21				41.85			
	33.41				34.04				40.24				41.94			

Table 2 Seasonal variations of Total Petroleum Hydrocarbons (μg/g) dry weigh with mean in soil samples of West Qurna-2 oil field

Station	Summer	Autumn	Winter	Spring	R. Mean	SD±
1	15.33	16.38	20.10	14.82	16.657	2.385
2	17.34	18.04	20.53	16.99	18.225	1.597
3	17.77	18.88	22.42	20.81	19.97	2.060
4	23.14	24.22	26.76	22.43	24.137	1.896
5	24.87	24.99	32.23	25.66	26.937	3.545
6	23.58	24.36	28.28	22.77	24.747	2.442
7	27.07	27.86	35.63	27.82	29.595	4.039
8	29.59	30.63	38.45	34.01	33.170	3.993
9	29.59	30.67	38.98	39.07	34.577	5.154
10	33.39	34.03	40.21	41.86	37.372	4.290
S. Mean	24.167	25.006	30.359	26.624	-	-

Note: R. Mean= regional mean, S. Mean= seasonal mean

The seasonal distribution of TPHs show that the highest level in all stations was recorded during winter (30.350 μg/g) and the lowest levels was during summer (24.167 μg/g), while spring was (26.624 μg/g) and autumn (25.006 μg/g) (Figure 3; Table 2), the seasonal concentration arrange as following: winter > spring> autumn> summer. This result was in agreement with (Douabul et al., 2012) and (Al-Hassen, 2011) who found that the concentrations of total hydrocarbons were higher in winter than summer, this can point largely to role of which played the climatic conditions. During winter, soil temperature declined due to the declining of air temperatures, this acts as slow down the evaporation process of fluids from the soil surface and ground. Since increase in soil moisture during this season (as a result of rainfall, groundwater table rise, seepage, low rate of evaporation, etc.) also acts as rise to absorption ability between soil particles and fluid molecules, then hydrocarbons will extend during the winter more than summer. It is during the summer season, violate organic compounds expose to a further urgent evaporation as a consequence of elevated air temperatures (Al-Hassen, 2011).

Al–Saad (1995) reported that the concentrations of total hydrocarbons during winter was greater than in summer because of the more extensive event of combustion processes with large amount of fossil fuel utilized as a part of family warming during the cold season as well as the higher association of these hydrocarbons with atmospheric particles at lower ambient temperature.

The most important factor governing the removal of hydrocarbons in the environment by evaporation was temperature (Wang et al., 2005). Also the favors microbial degradation process was increase by temperature (Coulon et al., 2007). The components of oil was degraded by photo-oxidation (Garrett et al., 1998). The intense solar radiations combined with relatively high temperature were the characteristic features of the climate of the subtropical regions of Iraq. Temperature and photo–oxidation could account for rather low levels of hydrocarbons encountered in the area, especially during summer (Farid et al., 2014).

Grain size of collected soil from the studied station can be classified as silty sand and sandy silt texture. There were non-significant correlation between the TPHs in soil and all of the soil texture compounds (sand, silt and clay). This result was in agreement with (Al-Hejuje, 2014).

Total organic carbon (TOC), concentration of various classes of hydrocarbons and diagnostic parameters at each soil sampling site are outlined in (Table 3). A significant correlation was observed ($p \geq 0.01$) between the percent of Total Organic Carbon and total petroleum Hydrocarbons ($r=0.814$). This result was in agreement with (Al-Mahana, 2015).

If we compared our data with other study, we find that the data are within the range as shown in Table 4.

Table 3 Seasonal variation of TOC% and Grain size in West Qurna-2 oil field

Station	TOC%				Grain size			
	Summer	Autumn	Winter	Spring	Clay%	Silt%	Sand%	Clay%
1	0.256	0.558	1.116	1.118	2	70	28	2
2	0.358	0.651	1.162	1.162	1	41	58	1
3	0.461	1.023	1.441	1.213	3	68	29	3
4	0.666	1.038	1.581	1.415	1	47	52	1
5	0.923	1.829	1.813	1.668	1	76	23	1
6	0.82	1.162	1.674	1.649	2	32	66	2
7	0.974	1.953	1.891	1.668	1	42	57	1
8	1.025	2.046	2.000	1.800	1	56	43	1
9	1.179	2.093	2.418	1.876	1	39	60	1
10	1.282	2.511	2.511	2.445	2	73	25	2

Table 4 Comparison between the levels of total hydrocarbons (μg/g dry weight) in soil for the present study with the other previously 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)
Al-Howaiza Marsh	4.057- 47.335	Al-Khatib (2008)
Al-Hammar Marsh	0.458-1.250	Talal (2008)
Shatt Al-Arab River ,Northern	7.37-24.41	Al-Imarah *et al.* (2010)
Iraqi Coast Region	2.39- 30.88	Al-Khion (2012)
Shatt Al-Arab River	4.76 – 45.24	Al-Hejuje (2014)
Shatt Al-Arab River	0.94-26.27	Al–Mahana (2015)
West Qurna-2 Oil field	14.82- 41.86	The present work

3 Conclusions

The highest concentrations of TPHs were recorded at Location 10, while the lowest at Location 1.The highest seasonal mean concentrations of TPHs were recorded during Winter season, while the lowest during Summer season except some locations.

Authors' contributions

Conceived and designed the experiments: AL-Saad H.T., Karem D.S., and Kadhim H.A. Analysed the data: Karem D.S. Wrote the first draft of the manuscript: AL-Saad H.T., Karem D.S. Contributed to the writing of the manuscript: Kadhim H.A. Agree with manuscript results and conclusions: AL-Saad H.T., Karem D.S., and Kadhim H.A. Jointly developed the structure and arguments for the paper: AL-Saad H.T., and Karem D.S. Made critical revisions and approved final version: AL-Saad H.T., Karem D.S., and Kadhim H.A. All authors reviewed and approved of the final manuscript.

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