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وحماية المستهلك

STUDY THE IMPACT OF INDUSTRIAL POLLUTION ON AGRICULTURAL SOILS IN SOUTHERN IRAQ

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ABSTRACT

This study was conducted to determine the effect of pollution with hydrocarbons and total heavy metals in soil sites near oil fields in southern Iraq over several distances (center of the field, after 250 meters, after 500 meters) and its relationship with the physical and chemical properties of the soil. The values of petroleum hydrocarbons were higher than the critical limit of 10 mg kg^{-1}, especially in soils close to the source of pollution, and it decreases as we move away from the pollution, up to a distance of 500 meters, and it becomes less polluted. As for the values of heavy metals, especially lead, cadmium, and nickel, they were higher than the critical limit for all distances. The results of the study showed the effect of hydrocarbon pollutants and heavy metals in The oil fields were based on the values of electrical conductivity, where the results ranged between (16.9 - 98) ds m^{-1}, where the highest value of conductivity was in the North Rumaila field and the lowest value in the Nasiriyah field, while the values of the calcium element ranged between (13.75-37.5) mmol L^{-1}.The highest value was in the North Rumaila field and the lowest value was in the Nasiriyah oil field. As for the magnesium element, the results ranged between (16.25-87.5) mmol L^{-1}, where the highest value was in the Nahran Bin Omar field and the lowest value was in the Nasiriyah oil field. As for the sodium element, the results ranged between (105-750) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value was in the Nasiriyah oil field. As for the potassium element, the results ranged between (0.46-3.46) mmol L^{-1}, where it was The highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field.

Keywords: chemical properties, hydrocarbons, toxicity, soil pollution

[*]**This article is taken from the doctoral dissertation of the first researcher.**

دراسة التلوث الصناعي وتأثيره على الترب الزراعية في جنوب العراق

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الخلاصة

أجريت هذه الدراسة لمعرفة تاثير التلوث بالهيدروكاربونات والعناصر الثقيلة الكلية في مواقع الترب القريبة من الحقول النفطية في جنوب العراق ولعدة مسافات (مركز الحقل ، بعد 250 متر ، بعد 500 متر) وعلاقتها مع الخصائص الفيزيائية والكيميائية للتربة، كانت قيم الهيدروكاربونات النفطية اعلى من الحد الحرج 10 ملغم كغم$^{-1}$ خصوصا عند الترب القريبة من مصدر التلوث وتقل كلما ابتعدنا عن التلوث وصولا الى مسافة 500 متر تصبح قليلة التلوث ، اما قيم العناصر الثقيلة وخصوصا الرصاص والكادميوم والنيكل كانت اعلى من الحد الحرج ولجميع المسافات ، اظهرت نتائج الدراسة تاثير الملوثات الهيدروكاربونية والعناصر الثقيلة في الحقول النفطية على قيم الايصالية الكهربائية حيث كانت النتائج تتراوح بين (16.9 - 98) ديسي سيمنز م$^{-1}$ حيث كانت اعلى قيمة للايصالية في حقل الرميلة الشمالي واقل قيمة في حقل الناصرية ، اما قيم عنصر الكالسيوم كانت تتراوح بين (37.5-13.75) مليمول لتر$^{-1}$ حيث كانت اعلى قيمة في حقل الرميلة الشمالية واقل قيمة في حقل الناصرية النفطي ، اما بالنسبة لعنصر المغنيسيوم كانت النتائج تتراوح بين (87.5-16.25) مليمول لتر$^{-1}$ حيث كانت اعلى قيمة في حقل نهران بن عمر واقل قيمة في حقل الناصرية النفطي ، اما بالنسبة لعنصر الصوديوم كانت تتراوح بين (105-750) مليمول لتر$^{-1}$ حيث كانت اعلى قيمة في حقل الرميلة الشمالية واقل قيمة في حقل الناصرية النفطي، اما بالنسبة لعنصر البوتاسيوم كانت النتائج تتراوح بين (3.46-0.46) مليمول لتر$^{-1}$ حيث كانت اعلى قيمة في حقل الرميلة الشمالية واقل قيمة في حقل الناصرية النفطي

الكلمات المفتاحية: الخصائص الكيميائية ، الهيدروكاربونات ، السمية ، تلوث التربة.

INTRODUCTION

The effect of hydrocarbon compounds comes as a result of adding foreign materials to the soil that do not decompose or disintegrate chemically easily. Some of these compounds are transported in the food chain and accumulate in the tissues of living organisms, while others are not transported that easily and are characterized by low toxicity, but their presence causes the formation of a solid insulating layer that hinders the chemical reactions of the soil. Hydrocarbon compounds are characterized by being neutral, non-polarized liquids that surround soil particles and thus reduce the electrical double layer surrounding them (**Edokpayi, 2016; Odthar, 2021**).

Total petroleum hydrocarbons (TPHs) are used to describe the mixture of organic compounds present or derived from crude oil, which consists of hydrogen and carbon. It may also contain sulfur and nitrogen compounds, heavy metals, and oxygen. They can burn easily. Some are clear or light-colored liquids that evaporate easily, and others are liquids. Dark or semi-solid that does not evaporate, including oily odors. Modern industries currently use many products based on petroleum hydrocarbons, such as gasoline, kerosene, fuel oil, mineral oils, and asphalt, and they are considered pollutants if they reach the environment, and they are widespread pollutants in the environment (**Shirdam *et al*., 2008; Sylvia, 2019; Qasim, 2019; Al-Niemi and Al-Kshab, 2023**).

Heavy elements are mineral elements whose density is five times greater than the density of water, 5 mg/cm. These metals are characterized as being stable, meaning they are not consumed in the human body during the food chain. They are toxic substances, even in low concentrations. Some heavy metals such as iron, copper, zinc, and manganese. They have an important role in the vital system, while others are harmful to health, such as mercury, lead, arsenic, and cadmium. Also, essential metals become toxic when their concentration exceeds the maximum permissible limit (**Hamil *et al*. 2016; Abbas & Al-Jubouri, 2018; Abdullatif, 2020**).

MATERIALS AND METHODS

Four polluted areas close to the oil fields were chosen, represented by (Amara, Nasiriyah, Rumaila, and Nahran Bin Omar fields). Surface (0-30)cm samples were taken from the sites surrounding the field at a distance of up to 500 meters and in 4 different directions (north, south, east, west) to study the effect of these pollutants on the properties of Agricultural soil, The samples were air dried, crushed, and sieved through the sieve of 2 mm openings and transported to the laboratory to conduct analyses on them. Also, 3 profiles were dug for each site, the first being 250 meters away, the second being 500 meters away, and the third being a control for the same site. For comparison's sake.

All chemical and physical characteristics of contaminated soil samples (pH, salinity, positive and negative ions, texture, and organic matter) were estimated, and all positive and negative ions were estimated according to what was stated in (**Black, 1965**).

Total heavy elements from the soil were estimated according to **Jones *et al.* (2001**) method by acid digestion, and all solutions were measured with an atomic absorption spectrometer.

RESULT AND DISCUSSION

Chemical and physical properties were measured, and hydrocarbon pollutants and heavy metals in the soil were measured.

Table (1): Physical and chemical characteristics of the Amara field.

measuring unit	Control			Second profile			First profile			Zero distanc	Adjective
	150-85	85-35	35-0	150-65	65-30	30-0	90-55	55-27	27-0		
	7.82	7.61	7.6	7.53	7.5	7.5	7.44	7.3	7.3	7.3	**pH**
ds m^{-1}	2.1	3.2	5.65	18.2	21.6	27.1	43.5	53.2	65.3	88	**EC**
Mmol L^{-1}	4	7	12.5	11.25	30	22.5	41.25	56.3	37.5	21	Ca^{+2}
Mmol L^{-1}	3.75	6	7.75	27.25	20	32	51.25	85	62.5	50.5	Mg^{+2}
Mmol L^{-1}	4.1	6.4	15.4	95.3	115	164	242.2	255.2	390	720	Na^{+}
Mmol L^{-1}	0.23	0.45	1.62	0.46	0.47	0.56	0.44	0.32	0.45	0.99	K^{+}
Mmol L^{-1}	0.5	0.6	0.5	2.5	2	1.8	2	1.78	2.5	2.0	HCO_3^{-}
Mmol L^{-1}	2.1	3.4	15.2	19.5	7.75	4.25	18.05	35	17.3	18.2	SO_4^{-2}

Mmol L^{-1}	16	25	25.3	130	192.5	267	389	463.2	550	846	**CL^-**
mg kg^{-1}	20	38	42	10	34	35	38	42	38	56	**N**
mg kg^{-1}	7.6	8.5	10	6.5	10	7.8	8.2	10	5.54	4	**P**
gm kg^{-1}	4.5	12.3	21.2	10.2	27.4	20.9	4.32	4.4	36.4	62.1	**O.M**
gm kg^{-1}	270	282	212	239	115	300	288	280	240	190	**$CaCO_3$**
$Cmol_+$ kg-^{1}	4.5	9.4	10.5	16.6	14	14.8	14	16.5	16	15.9	**CEC**
gm kg^{-1}	607	543	618	564	604	691	565	585	645	704	**Sand**
gm kg^{-1}	158	185	180	140	120	108	141	131	161	120	**Silt**
gm kg^{-1}	235	272	202	296	276	201	296	284	194	176	**Clay**
	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	ndy Clay Lo	andy Clay L	Sandy Clay Loam	andy Clay L	Sandy Loam	Sandy Loam	**Soil texture**
mg kg^{-1}	0.00	0.01	0.00	0.01	0.11	2.20	0.06	5.74	36.37	73.53	**TPHs**
mg kg^{-1}	0.5	0.9	1.1	4.3	4.9	5.9	3.1	5.3	6.3	6.43	**Cd**
mg kg^{-1}	25	38	42	104	125	173	120	154	180	275	**Pb**
mg kg^{-1}	18	23	26	90	87	89	60	70	95	120	**Ni**
mg kg^{-1}	18.5	22.3	27.17	88.5	94.4	90.2	88.3	116.74	90.4	134	**Zn**
mg kg^{-1}	9944	9783	9993	11030	10754	10501	11020	10230	10504	11359	**Fe**

Table (2): Physical and chemical characteristics of the Nasiriyah field.

measuring unit	**Control**			**Second profile**			**First profile**			**Zero distanc**	**Adjective**
	150-85	85-30	30-0	140-65	65-30	30-0	150-85	85-30	30-0		
	7.83	7.81	7.66	7.89	7.78	7.8	7.83	7.65	7.69	7.7	**$_P$H**
ds m^{-1}	1.6	4.18	5.7	3.1	5.5	6.2	8.5	12.2	16.71	16.92	**EC**
Mmol L^{-1}	4.5	7.75	12.5	8.4	12	13	8.25	9.65	11.25	13.75	**Ca^{+2}**
Mmol L^{-1}	1.6	5	5.25	6.6	7.15	8.25	5	7	9.25	16.25	**Mg^{+2}**
Mmol L^{-1}	3	15.08	24.5	12.5	15.2	17.4	65	85	120.9	105.4	**Na^+**
Mmol L^{-1}	0.23	0.38	0.47	0.34	0.46	0.32	0.44	0.62	0.45	0.46	**K^+**
Mmol L^{-1}	1.5	2	1.5	0.6	0.5	1.2	1.1	1.5	2.5	1	**HCO_3^-**
Mmol L^{-1}	2.1	5.79	9.25	3.9	4.1	5.15	3.9	4.15	5.1	11.45	**SO_4^{-2}**
Mmol L^{-1}	8.7	27	32	25	45	50	75	115	150	141.5	**CL^-**
mg kg^{-1}	30	46	52	22	45	48	42	44	52.2	42	**N**
mg kg^{-1}	1.1	1	1.2	1.4	1.8	4	2	2.2	1	2	**P**
gm kg^{-1}	3.4	3.9	4.4	2.2	3.8	5.7	3.4	3.9	40.2	59.9	**O.M**
gm kg^{-1}	280	275	250	240	205	155	280	275	250	240	**$CaCO_3$**
$Cmol_+$ kg-^{1}	9.5	11.6	12.3	3.8	9.7	10.8	5.8	9	11.7	15.7	**CEC**
gm kg^{-1}	860	800	880	824	860	800	880	812	860	772	**Sand**
gm kg^{-1}	76	110	40	96	76	136	36	80	76	141	**Silt**
gm kg^{-1}	64	90	80	80	64	64	84	108	64	87	**Clay**
	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy san	Loamy sand	Loamy san	Loamy sand	Loamy sand	Loamy sand	**Soil texture**
mg kg^{-1}	0.00	0.04	0.12	0.01	0.07	1.00	0.10	6.43	20.26	46.47	**TPHs**
mg kg^{-1}	0.51	0.75	0.9	3.3	3.1	3.2	3.7	3.9	4.4	5.2	**Cd**
mg kg^{-1}	19	28	33	118	121	127	129	132	136	225	**Pb**
mg kg^{-1}	21	25	29	68	72	74	92	90	97	154	**Ni**
mg kg^{-1}	2	19	25	78	81	71	102.3	126.8	140	112.12	**Zn**
mg kg^{-1}	10867	10558	10501	11359	11028	10967	11831	11671	11191	11455	**Fe**

Table (3): Physical and chemical characteristics of the North Rumaila field.

measuring unit	Control			Second profile			First profile			Zero distan	Adjective
	150-85	85-30	30-0	140-75	75-30	30-0	150-90	90-30	30-0		
	7.59	7.62	7.51	7.51	7.55	7.6	7.6	7.6	7.5	7.3	**$_P$H**
ds m^{-1}	3.8	4.1	4.6	35.1	39.2	42.6	30.9	47	62.9	98	**EC**
Mmol L^{-1}	5.5	6.35	8.51	35	26.2	25	22.5	23.5	39.4	37.5	**Ca^{+2}**
Mmol L^{-1}	4.2	3.95	6.1	40	36.5	47.5	31.25	43	60	75	**Mg^{+2}**
Mmol L^{-1}	12.8	13.2	15.33	210	261.9	277.6	201.9	331.5	422.8	750	**Na^{+}**
Mmol L^{-1}	0.9	1.08	1.45	3.25	3.2	2.48	2.8	2.44	3.48	3.46	**K^{+}**
Mmol L^{-1}	1.2	1.28	1.8	2	2	3	2	3.1	3.5	3	**HCO_3^{-}**
Mmol L^{-1}	9.2	10.5	13.26	29	20	13.05	29.95	9.2	5.65	11	**SO_4^{-2}**
Mmol L^{-1}	14.9	14.4	18.45	300.5	330	393.5	247.5	440	605	950	**CL^{-}**
mg kg^{-1}	22	34	55	33	40	42	28	42	49	75	**N**
mg kg^{-1}	5.6	3.4	7.96	4.15	3.4	5.42	3.8	4.3	5.57	4.78	**P**
gm kg^{-1}	6.6	17.6	21.2	6.3	7	34.9	6.3	40.9	38.7	63.1	**O.M**
gm kg^{-1}	290	230	212	235	205	215	295	279	240	225	**$CaCO_3$**
$Cmol_{+}$ kg^{-1}	13	19	14	12.8	18.8	13.4	19.5	14.4	15	17	**CEC**
gm kg^{-1}	779	580	595	718	581	734	664	690	720	708	**Sand**
gm kg^{-1}	135	286	290	261	285	232	332	292	200	194	**Silt**
gm kg^{-1}	86	134	113	21	134	34	24	18	80	98	**Clay**
	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	**Soil texture**
mg kg^{-1}	0.02	0.00	0.00	0.01	0.24	9.12	0.01	3.10	21.50	58.98	**TPHs**
mg kg^{-1}	0.55	0.61	0.85	2.5	2.7	2.98	2.3	4.0	4.9	5.5	**Cd**
mg kg^{-1}	18	19.5	23	85	101	112	93	118	122	180	**Pb**
mg kg^{-1}	20	22	28	66	112	127	90	125	137	144	**Ni**
mg kg^{-1}	22.3	25.2	28.86	52.71	64	78	92.37	85.2	70.41	126	**Zn**
mg kg^{-1}	9310	9110	9210	9816	9230	9701	9860	9211	9430	10501	**Fe**

Table (4): Physical and chemical characteristics of Nahran Bin Omar field.

measuring ur	Control			Second profile			First profile			Zero distan	Adjective
	150-75	75-30	30-0	150-95	95-30	30-0	150-85	85-35	35-0		
	7.78	7.89	7.92	7.6	7.8	7.65	7.79	7.41	7.43	7.37	**$_P$H**
ds m^{-1}	3.2	5.3	5.75	5.5	7.8	21.6	18.08	35.5	43.6	71.5	**EC**
Mmol L^{-1}	7	10.5	9	7.3	9.25	14.5	11.25	12.5	27.5	37.4	**Ca^{+2}**
Mmol L^{-1}	6	6.5	8.75	9,2	12.35	10.5	27.25	25	37.5	87.5	**Mg^{+2}**
Mmol L^{-1}	6.4	17.4	22.3	25.3	35.2	115	95.3	277	305	588	**Na^{+}**
Mmol L^{-1}	0.9	1.9	3.09	0.7	0.73	2.4	1.07	1.96	3.30	2.03	**K^{+}**
Mmol L^{-1}	1.1	1	3.5	3	3.2	2	2.5	2.5	1.5	3.5	**HCO_3^{-}**
Mmol L^{-1}	6.8	4.2	8.65	3.4	4.1	7.9	19.9	10.25	5.5	7.75	**SO_4^{-2}**
Mmol L^{-1}	25	42	37	48	69.3	192	130	329	430	694	**CL^{-}**
mg kg^{-1}	22	32	35	23	44	45	21	35	38	70	**N**
mg kg^{-1}	6.5	7.9	7.82	6.7	4.9	4.5	3.76	7.64	6.5	7.8	**P**
gm kg^{-1}	3.8	7.6	13	3.8	5.7	20.9	3.4	3.8	16.8	62.5	**O.M**
gm kg^{-1}	310	280	245	290	275	235	380	320	275	240	**$CaCO_3$**
$Cmol_{+}$ kg^{-1}	9.8	17.2	11.7	10.5	6.9	12.8	5.3	12.3	14.4	14.6	**CEC**
gm kg^{-1}	779	700	708	700	779	758	604	660	644	662	**Sand**
gm kg^{-1}	135	240	204	240	135	220	372	252	332	252	**Silt**
gm kg^{-1}	86	60	88	60	86	22	24	88	24	86	**Clay**

	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	**Soil texture**
mg kg^{-1}	0.00	0.01	0.03	0.01	0.03	2.50	0.13	2.23	41.28	97.97	**TPHs**
mg kg^{-1}	0.40	0.45	0.77	3.1	3.3	3.6	3.4	3.5	3.7	4.7	**Cd**
mg kg^{-1}	18	32	38	112	119	122	127	130	167	240	**Pb**
mg kg^{-1}	11	25	35	92	98	105	110	118	127	148	**Ni**
mg kg^{-1}	12.5	18.2	22.2	63.8	92.3	85.5	51.8	78.91	128.5	97.5	**Zn**
mg kg^{-1}	9993	9895	9949	10501	10203	10230	10754	9993	10502	10867	**Fe**

The results of analyses of contaminated soil, as shown in Tables (1, 2, 3, 4), showed a significant change in many agricultural soil properties, the most important of which are salinity and the percentage of organic matter. The results were as follows:

electrical conductivity (ec)

The results of the study showed the effect of hydrocarbon pollutants and heavy metals in oil fields on electrical conductivity values, where the results ranged between (16.9 - 98) dsm-^{1} for the zero distance from the field, that is, inside the oil field, where the highest value in the North Rumaila field, and the lowest value in the Nasiriyah field, at a distance of 250 meters from the source of pollution, the values ranged between (16.7 - 65) dsm^{-1}, where the highest value was in the Amara oil field and the lowest value in the Nasiriyah field, and at a distance of 500 meters from the source of pollution, the conductivity value ranged. Between (6.2-42)dsm^{-1}, where the highest value was in the Rumaila field and the lowest value was in the Nasiriyah field. The study showed that the electrical conductivity values decrease as we move away from the source of pollution. In general, the study samples were classified as being within saline soils because most of the samples were higher than the critical limit (**Salem &Ali, 2017**). The correlation coefficient showed that there is a highly significant positive relationship(**0.722) between the TPHs values in the study samples and the EC values, as reached, as the higher the values of hydrocarbon pollutants in the soil, the more it leads to the deterioration of the soil and the increase in salinity in it, and this consistent with the findings of (**Ahmed, 2019 & Al-Aboudi,2020**). The reason for the high conductivity values is the high temperatures in the summer and the semi-arid climate of the region. This is consistent with the findings of **Nimah (2010)**, where indicated that the amount of salts increases in the arid and semi-arid areas due to the increased rate of evaporation and accumulation. Salts on surfaces. Salinity values in the soil and water increase as we get closer to the sources of oil pollution. This is consistent with the findings of **Al-Zaidi (2017),** who showed that the waste, pollutants, and toxic gases resulting from the process of extracting oil from the ground, refining it, and transporting it lead to increased soil and water pollution and increasing the conductivity values in these lands, and thus these lands became outside the agricultural scope due to the increase in salinity in them and their influence by the products of combustion and pollutants resulting from oil fields.

ph

Results of Table (1,2,3,4) showed that the soil reaction degree values ranged between (7.3-7.7) for the zero distance from the pollution source, where the value was 7.7 in the Nasiriyah oil field and 7.3 in the Amara oil field, and at a distance of 250 meters the values were (7.3-7.69) for the same two fields in a row, and at a distance of 500 meters from the source of pollution, the values were (7.5-7.8) for the same two fields. We note that most of the values were classified as neutral soils, and this is consistent with what Al-Kawaz (2015) found, as he showed that Iraqi soils contain a high percentage of calcium carbonate. Which works to increase the soil buffering capacity, especially in arid and semi-arid areas. The study showed that there was a highly significant inverse relationship between electrical conductivity and the degree of soil interaction, as the correlation coefficient reached (** -0.916). The study also showed that there is an inverse relationship between hydrocarbons (the level of petroleum content in the soil) and the degree of soil reaction reached (-0.692). This is consistent with what **Qasim (2019)** stated, as he explained that the decrease in the degree of soil reaction was the result of increased salinity in the study samples and increased contamination, as with increased salinity, especially in the study samples close to the source Pollution: pH values decreased and vice versa, and this is consistent with what **Al-Mamouri (2004)** reached, as he showed that the quantity and quality of salts present in the soil could affect the degree of soil reaction and lead to its decrease.

POSITIVE IONS

Results of Table (1,2,3,4) showed that the values of calcium at a zero distance from the source of pollution ranged between (13.75-37.5) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field, and at a distance of 250 meters it was ranged between (11.25-39.4) mmol L^{-1} for the same two fields, and at a distance of 500 meters it was (13-25) mmol L^{-1} for the same two fields. Also, the high calcium values in the study soil areas are due to the highly soil content of $CaCO_3$, in addition to the fact that the Iraqi soil contains It contains a high percentage of calcium carbonate, and the high electrical conductivity values for most of the study soil sites led to high calcium values, as the correlation coefficient between conductivity and calcium (**0.778) was a highly significant correlation, and there is also a positive direct correlation between petroleum hydrocarbons and calcium values in the study soils. It reached (0.488), and this is consistent with what was found by **(Al-Salman, 2015**).

As for the magnesium element the results at zero distance from the source of pollution ranged between (16.25-87.5) mmol L^{-1}, where the highest value was in the Nahran Bin Omar field and the lowest value in the Nasiriyah oil field, and at a distance of 250 meters it ranged between (9.25-62.5) mmol L^{-1} where the highest value was in the Amara oil field and the lowest value in the Nasiriyah field, and at a distance of 500 meters it was (8.25-47) mmol L^{-1}. The highest value was in the Rumaila field and the lowest value was in the Nasiriyah field. Also, the high magnesium values in the study areas are due to the source. The original result of weathering of rocks in addition to the high soil contents of magnesium salts, and the high electrical conductivity values of most of the study soil sites led to high magnesium values, as the correlation coefficient between conductivity and magnesium (** 0.883) was a highly significant correlation. A significant correlation was also found. In the study of soil samples between calcium and magnesium, as a result of increasing conductivity values, the values of calcium and magnesium elements increased, and the correlation coefficient between them was (**0.925), a high moral correlation. There is also a positive direct correlation between hydrocarbon pollutants and magnesium values, as it reached (0.702), as with increasing pollution, it increases. It brings with it salinity and thus an increase in the elements calcium and magnesium, and this is consistent with what was found by (**Al-Aboudi, 2020**).

As for the sodium element, the results of Table (1,2,3,4) show that the sodium values at zero distance from the source of pollution ranged between (105-750) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field, and at a distance of 250 meters it was It ranged between (120-422) mmol L^{-1} for the same two fields, and at a distance of 500 meters, it was (17.4-277) mmol L^{-1} for the same two fields. Also, the increase in sodium values in the study sites is a result of the increase in the salt conductivity values of the samples, as they have a high moral correlation (** 0.987). The reason for the increase in sodium values in polluted soils, is the departure of these soils from their productive capacity, such that these lands are left without cultivation and without treatment. As a result of the high temperatures in the summer, the lack of rainfall, the dry and semi-arid climate of Iraq, especially in the regions of southern Iraq, and the high level of groundwater and its participation in the salinization process, all of these things have led to increase the percentage of sodium in the soil, and thus the physical properties of these soils deteriorate, their particles are dispersed, and their solutions become with high osmotic pressure, which is fatal to plants, and thus these soils become unsuitable for agriculture. This is consistent with what **Al-Saadi (2007**) reached. We note that the most common salt in the soils of the study was, NaCl, where the values of sodium and chlorine were very high and directly related to the value of electrical conductivity and began to decrease as we moved away from the source of pollution. It was noted through the study that there was a significant direct relationship between the hydrocarbon petroleum pollutants and the sodium values as a result of the high salinity in these fields, where the correlation coefficient was a Highly significant correlation between hydrocarbons and heavy material with sodium (**0.771), and this is consistent with findings of (**Abdullatif & Naser, 2019; Al-Aboudi *et al*., 2022**).

As for the potassium element, the results were, as shown that the values of the potassium element at zero distance from the source of pollution ranged between (0.46-3.46) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field and at a distance 250 meters ranged between (0.45-3.48) mmol L^{-1} for the same two fields, and at a distance of 500 meters it was (0.32-2.48) mmol L^{-1} for the same two fields as well, and when comparing the critical limit (0.5) mmol L^{-1} proposed by IPI (2016), most of the soils of the study samples are of Good content of soluble potassium, except for the Nasiriyah field, where most of the study samples had a low content of soluble potassium. Likewise, the Amara field was part of the study samples with a low content of soluble potassium. This is due to the variation in the minerals present in the soil, such as mica minerals, where this element is fixed inside. Layers of minerals. This was confirmed by **Jarallah & Essa (2016); Alawsy & Nafawa (2022)** who showed that the presence of potassium depends on the type of parent material, the type of mineral, and the surrounding conditions.

Negative ions

The results of Table (1,2,3,4) showed, that the values of the chlorine element at a zero distance from the source of pollution ranged between (141.5-950) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field, and at a distance of 250 meters it was It ranged between (150-605) mmol L^{-1} for the same two fields, and at a distance of 500 meters it was (50-393.5) mmol L^{-1} for the same two fields. It was also noted that there was an increase in chlorine values as a result of high salinity in soil samples contaminated with hydrocarbons, as the correlation coefficient showed that there is a direct correlation between pollutants and the percentage of chlorine in the samples reached (**0.714), and this is consistent with (**Jabr 2021**). The chlorine ion carries a negative charge, so it is not adsorbed on the clay particles. Rather, it is largely present in the soil solution in a solubleform, and its value decreases as the pollution decreases and the electrical conductivity decreases, especially when moving away from Pollution sources: This is consistent with (**Ayoub & Albayati, 2010; Voral *et al*., 2011; Hassoon, 2018**).

As for sulfates, the results of the study show the values of the sulfur element at zero distance from the source of pollution ranged between (11-18.2) mmol L^{-1}, where the highest value was in the Amara oil field and the lowest value in the Rumaila oil field at a distance of 250. meters, it ranged between (5.1-17.3) mmol L^{-1}, where the highest value was in the Al-Amara field and the lowest value in the Nasiriyah field, and at a distance of 500 meters it was (4.25-13.05) mmol L^{-1}, where the highest value was in the Rumaila field and the lowest value in the Al-Amara field. The variation in sulfate values in the fields four oil pollutants are due to the samples' content of hydrocarbon pollutants, products of combustion of oil burners, and the content of organic matter. The direct correlation coefficient between organic matter and sulfates was (*0.681), and between sulfates and petroleum hydrocarbons was (0.451), which is the result of the difference in the distribution of hydrocarbons and the effect of distances from the oil fields. The values of organic matter and the values of sulfates, and this is consistent with **Qasim (2019),** who showed in his study that the rise in temperatures, especially in oil-polluted areas, and the increase in the content of organic matter in them leads to an increase in sulfate values within the soil.

As for carbonate (CO_3), the results of the study showed the absence of this ion because it reacts directly with calcium, a component of calcium carbonate, which Iraqi soils are characterized by containing a high percentage of this compound. Likewise, the degree of soil reaction is required to reach more than 10.5 for us to see this ion in the soil. and because most Iraqi soils have a neutral pH, we do not see carbons in a free form, and this is consistent with what was found (**Al-Kawaz, 2015 & Odthar, 2021**).

As for bicarbonate, the results of the study, show the bicarbonate values at a distance of zero from the source of pollution ranged between (1-3.5) mmol L^{-1}, where the highest value was in the Nahran Bin Omar field and the lowest value in the Nasiriyah oil field and at a distance of 250. meters, it ranged between (1.5-3.5) mmol L^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nahran bin Omar field. At a distance of 500 meters, it was (1.2-3) mmol L^{-1}, where the highest value was in the Rumaila field and the lowest value was in the Nasiriyah field. We notice a decrease in the values. Bicarbonate is a result of the low presence of carbonate in Iraqi soil, and this is consistent with what was found by (**Odthar, 2021**).

We notice in general from what was mentioned that the increased concentrations of positive ions such as sodium, magnesium, and calcium and negative ions such as chloride and sulfate in the soils of the study represented by the soils of the oil field areas, which indicates the transformation of these lands into saline that are not suitable for agriculture, especially in the areas very close to the oil field. Due to the nature of the effect of hydrocarbon pollutants and heavy elements, caused these soils to turn into barren soils that do not contain any plants, and the plants present in them are not even suitable for grazing animals due to the increased concentration of pollutants in them, and this effect decreases the further we move away from the source of pollution, and this is what was confirmed by (**Essa & Al-Jubouri, 2017; Al-Haddad, 2017; Al-Aboudi, 2020 & Jabr, 2021**).

Organic matter

The results of the study showed, that the values of organic matter at a zero distance from the source of pollution ranged between (59.9-63.1) g kg-1, where the highest value was in the North Rumaila field and the lowest value in the Nasiriyah oil field, and at a distance of 250 meters it was It ranged between (16.8-40.2) g kg-1 for the same two fields, and at a distance of 500 meters it was (5.7-34.9) g kg-1 for the same two fields. We note that the samples close to the area of contamination with hydrocarbons had the highest content of organic matter as a result of the hydrocarbons containing carbon, which increases the organic matter in the soil and the farther away we are. Regarding the source of pollution, if we go down to the depths of the soil, the organic matter decreases as a result of the lack of effectiveness of organisms under the surface of the soil, where the direct positive correlation coefficient was highly significant between the organic matter and the hydrocarbon values, as it reached (*0.805), and this is consistent with (**Shirdam *et al*., 2008; Ismail, 2010**). They pointed out that the values of organic matter in soils contaminated with hydrocarbons are higher than in uncontaminated soils (**Al-Mahana, 2015**).

Available Nitrogen

Nitrogen values in field soils show at a zero distance between (42-75) mg kg^{-1}, where the highest value was in the Rumaila field, and the lowest value in the Nasiriyah field, and at a distance of 250 meters, it ranged between (38-52.2) mg kg^{-1}, where the highest value was in Nasiriyah field and the lowest value in Al-Amarah field, at a distance of 500 meters, was (48-35) mg kg^{-1}. Also, the highest value was in the Al-Nasiriyah field and the lowest value was in the Al-Amarah field. When classifying the values of ready nitrogen in oil field soils, they ranged from adequate to high (**Ali & Al-Qaisi, 2017**).

Cation Exchange Capacity

The results of the study showed that the values of the cation exchange capacity at zero distance from the source of pollution ranged between (14.6-17) Cmol kg^{-1}, where the highest value was in the North Rumaila field and the lowest value in the Nahran bin Omar oil field and at a distance of 250 meters, it ranged between (11.7-16) Cmol kg^{-1}, where the highest reading was in the Amara oil field and the lowest reading in the Nasiriyah field, and at a distance of 500 meters, it was (10.8-14.8) Cmol kg^{-1}, for the same two fields mentioned. The value of the cation exchange capacity is directly related to what is present at the top. For the clay fractions in the study samples, as well as for the organic matter values, the results showed that most of the values were medium cation exchange capacity due to the low values of the clay fractions in all the soils of the study. This is consistent with what **Mahmoud (2018); Al-Tamimi, (2017); Al-Salmani & Ibrahim (2021)** reached when they studied the soils of central and southern Iraq, where they noticed a decrease in the cation exchange capacity values. In sandy soils and higher values in soils with high clay content, the correlation coefficient for the study values showed that there is a positive direct correlation between the values of exchange capacity and the values of clay fractions, reaching (0.544). The study showed that hydrocarbon pollutants increase the CEC value, especially soil samples close to the source. Pollution, as the correlation coefficient reached (*0.608) and the reason is due to the high percentage of organic matter in these samples, which increases the value of the cation exchange capacity, and this is consistent with what was found by (**Jabr, 2021**).

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