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Chemical Characteristics of the Soil of Al-Hamzah Al-Sharqi District Related to the Formation of Sabakh

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Abstract

In this research, the chemical properties of the soil of the Eastern Hamza District in the Sabakh Formation were identified through the laboratory analysis of soil samples for (12) samples that varied in their distribution within the Eastern Hamza District Center and the Al-Sudair Al-Shanafiyah sub-district. Samples were taken from the study area within the first depth (0-30) cm, and (EC, PH, Mg^{+2}, $CaCO_3$, $CaSO_4$) were analyzed for the selected soil samples, and the outputs of the Arc Gis 10.7 program were adopted in the distribution of samples in the study area.

Keywords: *Al-Hamzah Al-Sharqi, Sabakh Formation, Soil Chemical Characteristics Laboratory Analysis, GIS Mapping*

Introduction

Sabbakh is defined as what is not plowed and not built from the ground for its salinity, and it is a spacious plain formed in dry areas and low on neighboring lands. The surface of the marsh looks somewhat dark in color, and the color takes a change in the edges of the marsh, and here the surface appears to be decorated with bright white salt crusts, and the marsh consists of clay deposits saturated with salts, which is why it is sometimes called, and the marsh salts are a mixture of magnesium, potassium, sodium, and calcium sulfate chlorides.

1- The Research Problem: - The research problem is summarized by the following question (What are the chemical properties of the Sabbakh soil in the eastern Hamza district)?

2- The Research Hypothesis: - The research hypothesis represents an answer to the questions of the problem, which is a preliminary guess for initial solutions, and it is formulated as follows (the characteristics of the Sabbakh soil vary in the Eastern Hamza district, represented by (EC, PH, Mg^{+2}, $CaCO_3$, $CaSO_4$) with high concentrations.

3- The Aim of the Research: - Detecting the Sabbakh land in the eastern district of Hamza and identifying its chemical properties, as well as the study seeks to provide a database for the benefit of specialists in agriculture and water resources in order to reclaim the land and its ministries**.**

4- Search Borders: - Hamza Eastern District is located in the southwestern part of Qadisiyah Governorate, which is located in southern Iraq. It is bordered to the north by Diwaniyah District, to the east by Afak District, to the south by Al Muthanna District, to the south by Rumaitha District, and to the west by Najaf Governorate (Map-1). Thus, it is located between two latitudes (°31 ° 17"0— °31 ° 55"0) north and between two longitudes (°45 ° 13"0- °44 ° 24"0) east, and with an estimated area of (2435) km^2.

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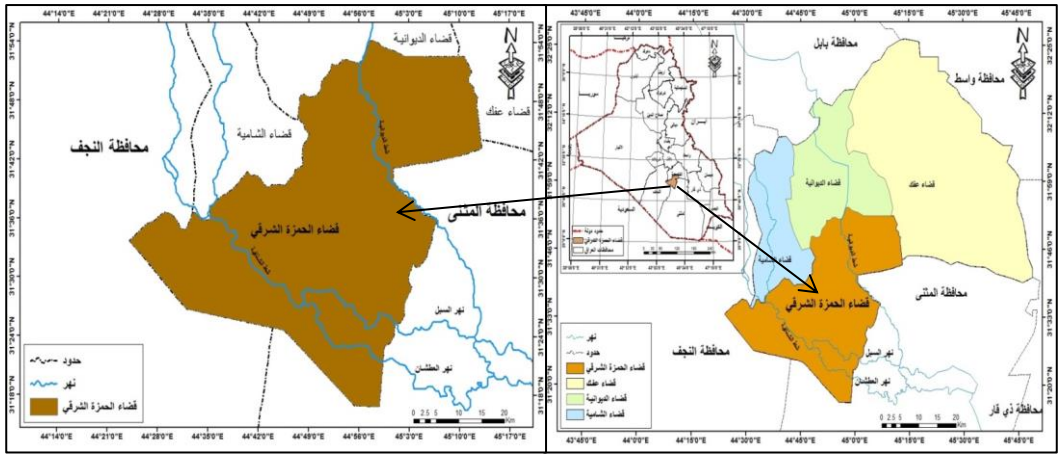
(Map-1): Hamza District Eastern Location of Iraq.



Source: From the Researcher's Work Based on: - 1- Outputs of Arc Gis 10.7.

Work Mechanism

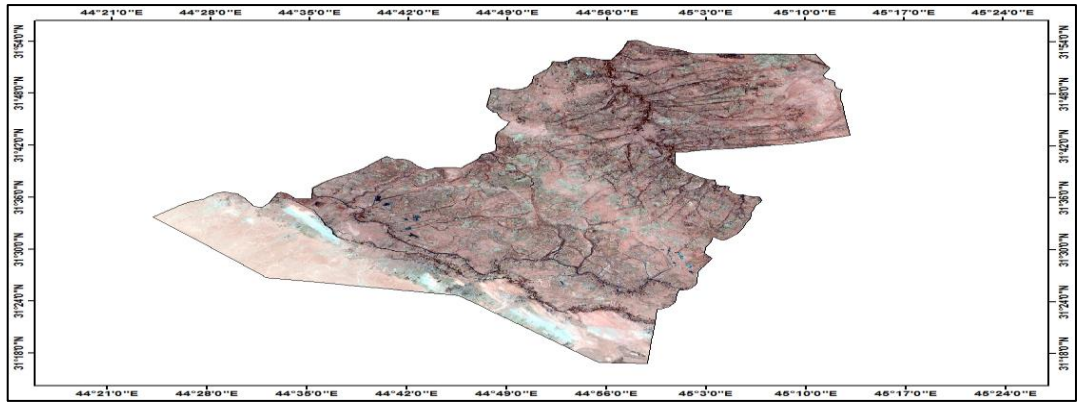
Through the USGS website, the USGS website downloaded the satellite visualization from the site of 8 Land Sat, which contains 11 bands, and based on the Arc Gis 10.7 program, where the bands were integrated through the Windows icon from the toolbar and then the Image Analysis menu. Then, the satellite visualization was deducted through the Clip icon in the Arc Toolbox program and then subjected to geometric and spectral correction. Through the above, the guided classification can be adopted and through the Training Sample Manager from the Classification tape of the satellite visualization and analysis of the spread of the Sabbakh area in the eastern Hamza district. Then, based on the field study and the determination of the coordinates of the Sabbakh areas, samples were collected, where several Sabbakh areas were identified and their own Chipfile work with coordinates, and random locations were selected with coordinates distributed over more than one place distributed as (5samples/ in the eastern Hamza district center) and(3 samples/ in the As-Sudayr sub-district) and (4 samples/ in the Shinafiyah sub-district) (Table-1) ,(Visual- 1) , a map (2- depth of (0-30 cm).

(Table 1): The Locations of the Coordinates of the Samples in the Eastern Hamza District.

Sample number and location	The location of the sample astronomically
1 /Al-Sudair sub-district	E° 45 °8" 27-N° 31 ° 49"52
2 /Al-Sudair sub-district	E° 45°10" 27-N° 31 ° 47"12
3 /Al-Sudair sub-district	E° 45¨11"1 - N° 31¨44"31
4 /Hamza East District Center	E° 44°51 " 41-N° 31°38"40
5 /Hamza Eastern District Center	E° 44°53" 8-N° 31 ° 33"51
6 /Hamza Eastern District Center	E° 44°57" 30-N° 31 ° 30"46
7 /Hamza East District Center	E° 44°57" 29-N° 31 ° 38"4
8 /Hamza Eastern District Center	E°45µ0" 3-N°31µ34 "25
9 /Al-Shanafiyah sub-district	E° 44°48"7-N° 31 ° 30"58
10 /Al-Shanafiyah sub-district	E° 44°40" 27-N° 31 ° 29"54
11 /Al-Shanafiyah sub-district	E° 44°53" 25-N° 31 ° 24"20
12 /Al-Shanafiyah sub-district	E° 44°41"2 - N° 31°33"25

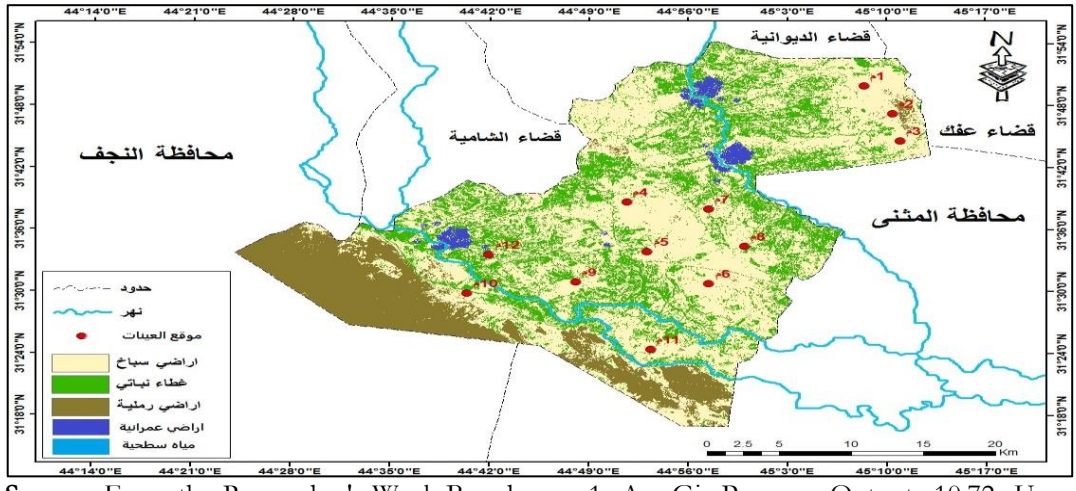
Source: From the Work of the Researcher and Based on the Outputs of Arc Gis 10.7.

Taken on 22/6/2021 (Satellite Visual -1).



Land Sat 8, Usgs Location 2-arc Gis 10.7 Source/from the Researcher's Work Based on: - 1- Outputs.

(Map-2): Distribution of Selected Sample Sites in the Eastern Hamza District.



Source: From the Researcher's Work Based on: - 1- Arc Gis Program Outputs 10.72- Usgs Sample (Satellite Visualization-2).

Ec First/Electrical Voucher

The electrical conductivity is a measure of soil salinity, as the soil whose electrical conductivity value ranges between (0 - 4) decimons/m is non-saline soil, while if the electrical conductivity values have more than (15) decimons/m is a very high-salinity soil (1), **(**Table-2) and is one of the most serious problems facing agricultural production and leads to low levels of quality and quantity, as the amount of excess salts in the soil turns it into saline or alkaline salt soil that limits its agricultural capacity (2), and the high temperatures led to high concentrations of electrical conductivity in the study area , so modern irrigation techniques must be used to reduce water losses (3) , and the salinity of the soil is evidence of the degree of concentration of total dissolved salts in the soil body, which includes chlorides, sulfates, sodium carbonate, magnesium, calcium and potassium(4) constituting sabkh.

(Table-2): US NAC Global Standard for Ec Concentration in Soils.

Salinization	Brackish water	saline water	High Salinity	Very high salinity
Electrical Conductivity Ec Desmans/m	0-4	4-8	8-15	More than 15

Source: U.s.d.defintion and Abbreviation for Oia Description Berkeay,california, 1960, P5.

It is clear from (Table-3) the results of laboratory tests for depth(0-30) cm in the eastern Hamza district for electrical conductivity Ec, that the highest value in (Sample 10) in the Shinafiyah sub-district is 260 ds/m , and the lowest value in (Sample 6)within the eastern Hamza district center is 97.5 ds/m ,and all samples are classified according to (Table 17) It is a soil with very high salinity.|||UNTRANSLATED_CONTENT_START|||-خريطة 3).|||UNTRANSLATED_CONTENT_END|||

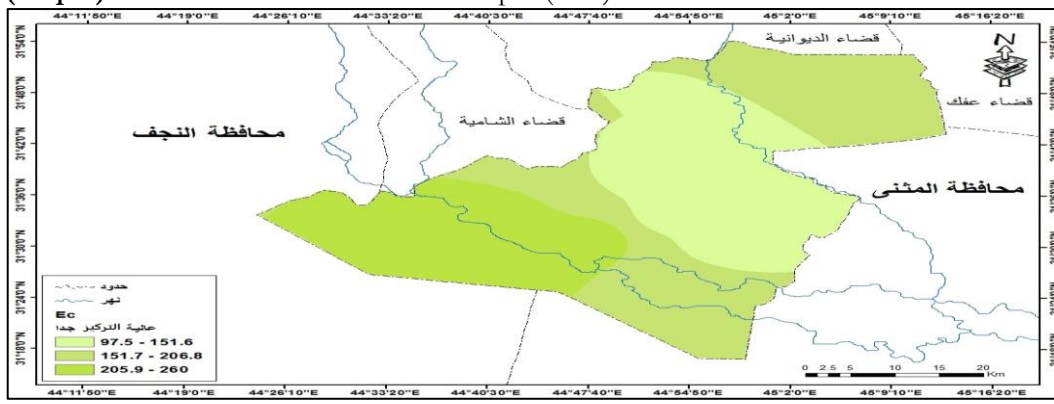
(Table-3): Electrical Conductivity Ec for Depth (0-30) Cm for Soil Samples in the Eastern District of Hamza.

Sample number and location	Electrical Conductivity Ec Desmans/m
1 /Al-Sudair sub-district	140,2
2 /Al-Sudair sub-district	138-2
3 /Al-Sudair sub-district	|||UNTRANSLATED_CONTENT_START|||144,3|||UNTRANSLATED_CONTENT_END|||
4 /Hamza East District Center	99,5
5 /Hamza Eastern District Center	102-3
6 /Hamza Eastern District Center	97,5
7 /Hamza East District Center	98.2
8 /Hamza Eastern District Center	101
9 /Al-Shanafiyah sub-district	212
10 /Al-Shanafiyah sub-district	260
11 /Al-Shanafiyah sub-district	170
12 /Al-Shanafiyah sub-district	182

Source: From the Work of the Researcher Based on the Laboratory of Fadak Farm of the Holy Shrine, Date/22/2/2023ad.

The main reason for the rise of the Ec is due to the clay tissues with very fine pores that prevail in the majority of the study area within the first depth, which retains in the water for the longest possible period. Most of the lands of the eastern district of Hamza were previously depressions in which water collects, whether river flood water or rain. As a result of evaporation, salts accumulated, as well as the high groundwater levels that feed the surface of the earth, and the previous agricultural processes through which salts accumulated for many years, as well as the proximity of some samples to puncture water, in which the concentration of salts is high compared to the rest of the other samples.

(Map-3): Distribution of Ec Values for Depth (0-30) Cm in the Eastern Hamza District.



Arc Gis 10.7 Source: From the Researcher's Work Based on: - 1-Data (Table-3) 2-Program Outputs

PH Second /Degree of Reaction

It expresses the pH of the soil and its base on a scale of (PH), which ranges between (1-14) with an average rate of (7), which indicates equivalence. On the basis of the average limit, the soil can be known whether it is acidic or alkaline. If the amount of (pH) is less than (7), it is considered acidic soil, but if it is more than (7), it is alkaline soil [5], (Table-4).

(Table -4): The Global Standard for (Ph) Soil According to the American Salinity Laboratory Standard.

PH Soil Reaction Limits	Soil Description of PH	PH Soil Reaction Limits	Soil Description of PH
Less than 4.5	Ultra-acid	7	50-50.
4.5-5.00	Very acidic	7-8	Moderate Basal
More than 5-5.5	Extremely acidic	8–8.5	Medium Basal
More than 5.5-6	Medium acidity	8.5-9	Very basic
More than 6- Less than 7	Mildly acidic	More than 9 months	Very basic

Source: Kazem Shenta Saad, Soil Geography, Dar Saq foundation for Publishing and Printing, Maysan University, faculty of Education, 2016, P. 97.

It is clear from (Table -5), the results of laboratory tests within the depth of (0-30) cm within the eastern Hamza district for PH values. It recorded the highest value in (Sample 3) within Al-Sudair sub-district 7.8, and the lowest value in (Sample 5) within the eastern Hamza district center 7.2 (Map -4) and it is according to the standard moderate basal.

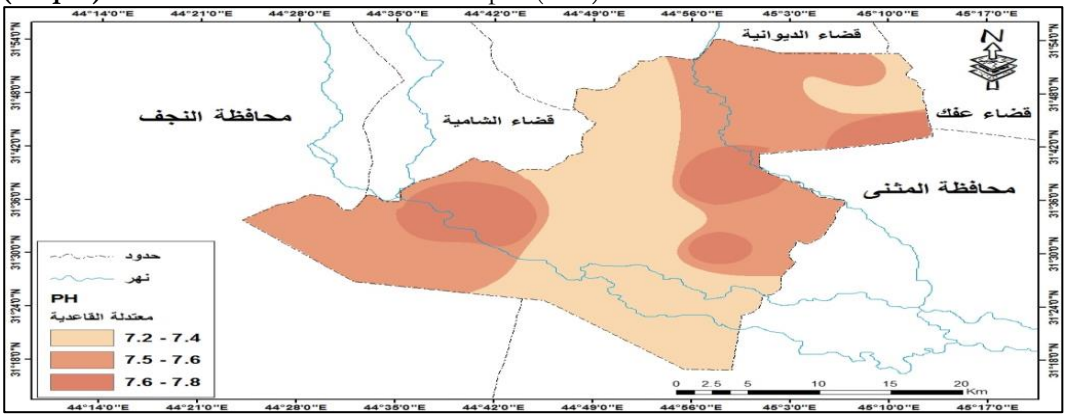
(Table-5): Ph Values for Depth (0-30) Cm for Soil Samples in the Eastern District of Hamza.

Sample number and location	PH
1 /Al-Sudair sub-district	7.5
2 /Al-Sudair sub-district	7.2
3 /Al-Sudair sub-district	7.8
4 /Hamza East District Center	7.3
5 /Hamza Eastern District Center	7.2
6 /Hamza Eastern District Center	7.6
7 /Hamza East District Center	7.7
8 /Hamza Eastern District Center	7.5
9 /Al-Shanafiyah sub-district	7.3
10 /Al-Shanafiyah sub-district	7.5
11 /Al-Shanafiyah sub-district	7.2
12 /Al-Shanafiyah sub-district	7.7

Source/ From the Work of the Researcher Based on the Laboratory of Fadak Farm of the Holy Shrine, Date/22/2/2023ad.

The analyzes indicate that all soil samples are moderately basal, and in general, the degree of soil (PH) varies from year to year. The reason is due to the change in the levels of salts in the soil, as the levels of salts increase when organic and chemical fertilizers are added with nitrogen and potassium, as well as the decomposition of organic materials, and that rainfall affects the degree of acidity of the soil by washing the acid-forming ions. The first depth tends to be basal due to the capillary property and the easily soluble salts contained in the soil, such as chlorides, and that high temperatures, increased evaporation quantities and reduced water quantities. The second depth The accumulation of salts led to moderation in the values of the degree of reaction and some samples tendencies to basal, such as (sample 12) within the Shinafiyah sub-district 7.1 within the first depth, (sample 7) within the center of the eastern Hamza district 7.9 within the second depth.

(Map-4): Distribution of PH values for depth (0-30) cm in the eastern Hamza District.



Arc Gis 10.7 Source: From the Researcher's Work Based on: - 1-data (Table - 5) 2-program Outputs.

III / Magnesium ion Mg^{+2}

It is one of the ions that contribute about (2.1-29) % of the weight and volume of the earth's crust, respectively. The minerals of this element in the soil are in the countries, mite, biotite, hornbill and aluphine, as well as secondary clay minerals such as alite and chlorite. The magnesium ion is released into the soil solution after these minerals are exposed to various weathering processes. This element is found in the form of soluble salts in the saline soil. Sandy soil is less in the presence of magnesium [6]. Magnesium ion is usually found in the form of carbonate and magnesium sulfate and its sources are dolomite and biotite, and it is also a positively charged ion. The soil derived from sandy sedimentary rocks lacks of magnesium, as it increases with the percentage of clay [7], (Table 5) shows the global standard of magnesium ion**.**

(Table-5) Global Standard for Mg^{+2} Ion in Soil for the U.S. Salinity Laboratory (U.S.D.A) /ppm.

classification soil	Low Concentration	Medium Concentration	Highly concentrated
Magnesium Mg^{+2} mg/L	Less than 50%	50-100	More than 100

Source: Soil Survey Division Staff, Soil Survey Manual, United States Department of Agriculture, Handbook No. 18/1993.

It is clear from (Table-6), the results of laboratory tests within the depth (0-30) cm for the values of Mg^{+2}. The highest value in (Sample 11) within the Shinafiyah sub-district was 92mg/L, and the lowest value in (Sample 4) within the eastern Hamza district center was 10mg/L, and it is classified according to the criterion between low and medium concentration, (Map-5).

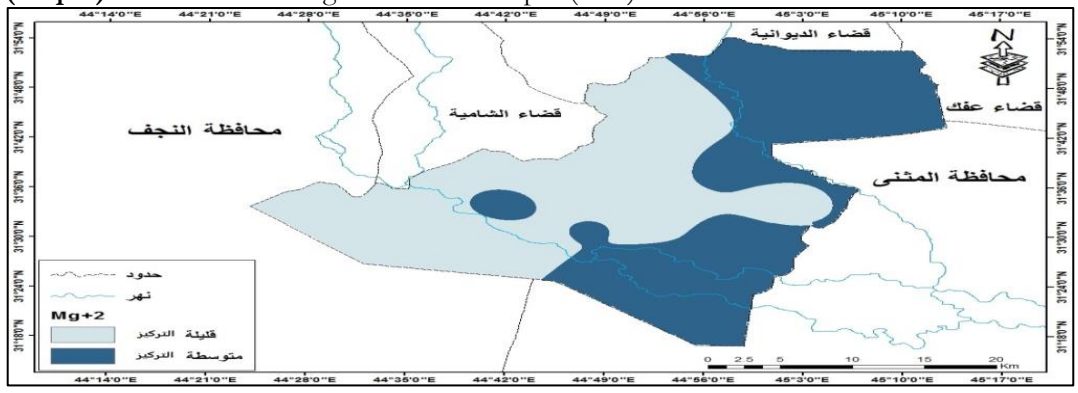
(Table-6): $Mg+_2$ Ion Values for Depth (0-30) Cm for Soil Samples in the Eastern Hamza District.

Sample number and location	Mg^{+2} PPm
1 /Al-Sudair sub-district	85
2 /Al-Sudair sub-district	72
3 /Al-Sudair sub-district	66
4 /Hamza East District Center	10
5 /Hamza Eastern District Center	26
6 /Hamza Eastern District Center	70
7 /Hamza East District Center	83
8 /Hamza Eastern District Center	50
9 /Al-Shanafiyah sub-district	60
10 /Al-Shanafiyah sub-district	45
11 /Al-Shanafiyah sub-district	92
12 /Al-Shanafiyah sub-district	63

Source: From the Work of the Researcher Based on the Laboratory of Fadak Farm of the Holy Shrine, Date/22/2/2023ad.

It turns out that the reason for the high concentrations of the value of magnesium ion in the first depth is due to the silt clay tissue of the soil and because of the medium density that retains water and air for the longest period, and that the area of the eastern district of Hamza was formerly lowlands in which water collects, whether river flood water or rain. As a result of evaporation, salts have accumulated, as well as the high groundwater levels that feed the surface of the earth, and the previous agricultural processes through which salts have accumulated for many years, as well as the geological formation of soil fragments collected in the lowlands of the sedimentary plain. The high temperatures and evaporation allow the opportunity to accumulate salts.

(Map-5): Distribution of Mg^{+2} Values for Depth (0-30) Cm in the Eastern District of Hamza.



Arc Gis 10.7 Source/From the researcher's work based on: - 1-Data (Table - 6) 2-Program Outputs.

IV/$CaCO_3$

Calcium carbonate salts are produced from a light acid (carbonic acid H_2CO_3) and a strong base (2 OH)) **Ca**) that works to raise the degree of soil reactivity when dissolved in water through its control of water decomposition by producing an − (OH) [8]. The Food and Agriculture Organization (FAO) in 1973, that the lime content is higher in soft-tissue soils and that the removal of lime from the soil leads to the tendency of the tissues towards the softest and increase their ability to retain water, by linking the soil particles to each other, and leads to the strength and hardness of the soil surface and becomes harmful when it reaches (20%), especially when combined with high moisture tension (10). Iraqi soils generally contain (20-30%) of calcium carbonate, and this may occur as a result of erosion in the northern region and the transfer of carbonates Calcium along the riverbed to the territory of central and southern Iraq. The presence of calcium carbonate in the soil is of great importance in determining some of the physical and chemical properties of the soil, as it works to reduce the permeability of the soil as well as reduce the value of the cationic reciprocal capacity. Its presence in soft woven soil is more than in sandy soil [11], (Table -7), shows the global standard for calcium carbonate ratio.

(Table-7): Global Standard for $CaCO_3$in Soil for the U.S. Salinity Laboratory (U.S.D.A) %

classification soil	Low concentration	Medium Concentration	High Concentration
Calcium Carbonate CaCO 3%	Less than 15	15-35	More than 35

Source: Soil Survey Division Staff, Soil Survey Manual, United States Department of Agriculture, Handbook No. 18/1993.

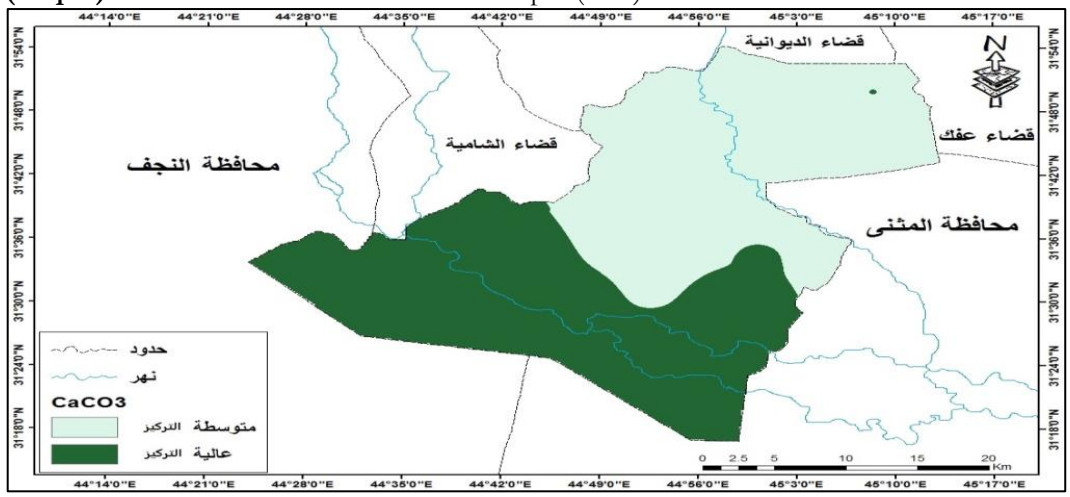
It is clear from (Table-8), the results of laboratory tests within the depth of (0-30) cm in the eastern Hamza district of $CaCO_3$ values. The highest value in (sample 10) within the Shinafiyah sub-district was 37.6%, and the lowest percentage in (sample 2) within the Al-Sudair sub-district was 29.9%, and it is classified between high concentration and medium concentration, (Map-6).

(Table -8): Caco3 Values for Depth (0-30) Cm for Soil Samples in the Eastern District of Hamza.

Sample number and location	$CaCO_3$%
1 /Al-Sudair sub-district	34.8
2 /Al-Sudair sub-district	29.9
3 /Al-Sudair sub-district	30.9
4 /Hamza East District Center	33.7
5 /Hamza Eastern District Center	30.9
6 /Hamza Eastern District Center	36.5
7 /Hamza East District Center	32.3
8 /Hamza Eastern District Center	35.1
9 /Al-Shanafiyah sub-district	35.6
10 /Al-Shanafiyah sub-district	37.6
11 /Al-Shanafiyah sub-district	36.2
12 /Al-Shanafiyah sub-district	37

Source: From the Work of the Researcher Based on the Laboratory of Fadak Farm of the Holy Shrine, Date/22/2/2023ad.

(Map-6): Distribution of Caco3 Values for Depth (0-30) Cm in the Eastern District of Hamza.



Arc Gis 10.7 Source: From the researcher's work based on: - 1-Data (Table - 8) 2-Program Outputs

It turns out that the reason for the high concentrations of the value of calcium carbonate in the first depth is due to the clay tissue of the soil and because of the medium density that retains water and air for the longest period ,and that the area of the eastern district of Hamza was previously a lowland in which water collects, whether river flood water or rain, and as a result of evaporation, the salts accumulated,as well as the high groundwater levels that feed the surface of the earth , and the previous agricultural processes through which the salts accumulated for many years ,as well as the geological formation, most of which is calcite for the soil fragments collected in the depressions of the sedimentary plain , as well as the high salinity is due to the proximity of the sample to the puncture water, in which the concentration of salts is high compared to the rest of the other samples, with the presence of the slit in the last phase with the high temperature and evaporation, which provides the opportunity to accumulate salts.

V/$CaSO_4$

It is the water calcium sulfate ($CaSO_4$ .2H ₂O) It has an impact on the physical and chemical properties of other soil. The increase in gypsum leads to a decrease in the apparent density of the soil due to the low specific weight of the gypsum. Its increase also leads to poor ventilation, low soil tip rate, water conductivity, soil moisture retention, and the micro and macro nutrients necessary for the plant and thus low fertility [12]. It results from the reaction of sulfuric acid (H_2SO_4) with calcium ions (Ca^{+2}) , and it is found in the soil of dry areas in the form of deposits with other salts in different proportions in the surface layer or in the horizon of the calcium carbonate pool [13]**, (Table -9)**, showing the global standard for the ratio of calcium sulfate.

(Table-9): Global Standard for $CaSO_4$ in Soil for the U.S. Salinity Laboratory (U.S.D.A) /ppm.

classification soil	Low concentration	Medium Concentration	High Concentration
Calcium Sulphate % $CaSO_4$	Less than 0.3	0.3-10	More than 10

Source: Soil Survey Division Staff, Soil Survey Manual, United States Department of Agriculture, Handbook No. 18/1993.

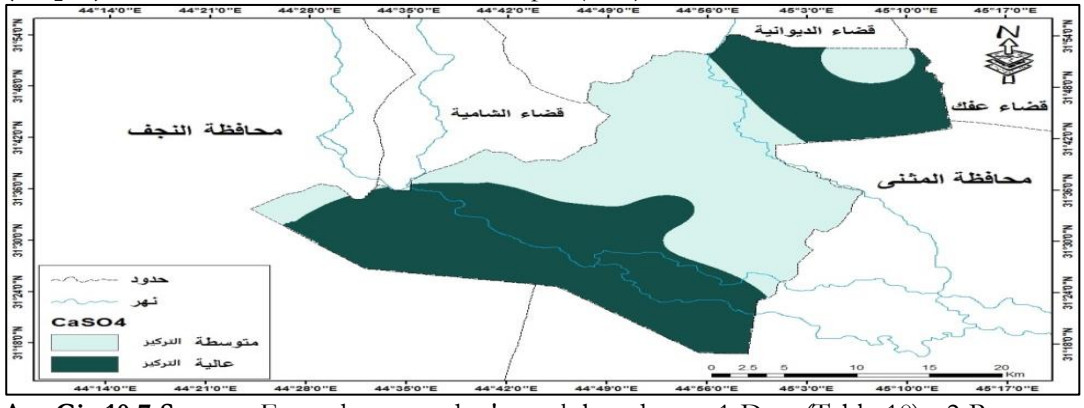
It is clear from (Table-10), the results of laboratory analysis of depth (0-30) cm in the eastern Hamza district of $CaSO_4$, the highest percentage in (sample 2) within the Sudair sub-district is 11%, and the lowest percentage in (sample 4) within the eastern Hamza district center is 8% and classified according to the criterion between high concentration and medium concentration, (Map -7).

(Table -10): Caso Ratio $_4$ for Depth (0-30) Cm for Soil Samples in the Eastern District of Hamza.

Sample number and location	$CaSO_4$%
1 /Al-Sudair sub-district	8.2
2 /Al-Sudair sub-district	11
3 /Al-Sudair sub-district	9
4 /Hamza East District Center	8
5 /Hamza Eastern District Center	9.1
6 /Hamza Eastern District Center	8.6
7 /Hamza East District Center	8.6
8 /Hamza Eastern District Center	8.3
9 /Al-Shanafiyah sub-district	9.1
10 /Al-Shanafiyah sub-district	9.1
11 /Al-Shanafiyah sub-district	9.2
12 /Al-Shanafiyah sub-district	8.9

Source: From the Work of the Researcher Based on the Laboratory of Fadak Farm of the Holy Shrine, Date/22/2/2023ad.

(Map-7): Distribution of Caso4 Values for Depth (0-30) cm in the Eastern District of Hamza.



Arc Gis 10.7 Source: From the researcher's work based on: - 1-Data (Table-10) 2-Program Outputs.

Conclusions

1-The laboratory analysis of the chemical properties shows the high salinity values through the samples that were analyzed for the soil of the eastern Hamza district.

2- It appears through the study that there is a rise in the values of chemical properties in the soil of Hamza district related to the formation of sabbakh by relying on the international standard.

3- Matching the field study of Sabbakh in Hamza district with the satellite visuals.

References

1. Al-Nuaimi, Saadallah Najm Abdullah, Soil Relationship with Water and Plants, Mosul University, Dar Al-Kutub Directorate for Printing and Publishing, Mosul, 1990, p. 142.
2. Al-Jubouri, Salam Salem Abdul Hadi, Spatial Analysis of the Problems of Agricultural Production in Al-Qadisiyah Governorate, Master Thesis, Faculty of Arts, Al-Qadisiyah University, 2002, p. 194.
3. Safaa Majeed A. Al-Muzaffar. Modern irrigation techniques in Najaf Governorate and the available spatial capabilities. Kufa Journal of Arts, [S. l.], v. 1, n. 17, p. 235–278, 2013. DOI: 10.36317/kaj/2013/v1.i17.6447.https://journal.uokufa.edu.iq/index.php/kufa_arts/article/view/6447
4. Tawfiq Shahla Zakir, Spatial Relations of Soil Salinity and Weaving with Agricultural Land Uses in Wasit Governorate, PhD Thesis, Faculty of Education (Ibn Rushd), University of Baghdad ,2006, 104.
5. Al-Shelash Ali Hussein, Soil Geography,1st Edition, Ministry of Higher Education and Scientific Research Press,University of Basra, 1981, p. 52.
6. Saad Kazem Shenta, Soil Geography, Dar SaqFoundation for Publishing and Printing, Maysan University,Faculty of Education, 2016, p. 17 .
7. Abu Raheel Abdul Hassan Madfoon, Kamel Hamza Fleifel Al-Asadi, The Variation of Soil Characteristics of Najaf Governorate Using Geographic Information Systems, Kufa Arts Magazine,Volume 1 ,Issue 18, 2014, p. 161.
8. Karim, T.H. and M.Sulaiman. Changes in some physical properties of some calcareous soil in the north parts of Iraq as affected by decalcification Iraq, J.Agric Sci. "Zanco" Vol.5, No.3, 1998,p.94.
9. Al-Fatlawi, W., & Al-Zamili, A. (2020). Analysis of hydrological characteristics A comparative study (SCS-CN) and correlational relationships between morphometric and hydrological variables in the Abu Khums basin west of Najaf. Kufa Journal of Arts, *1*(42), 191-248.
10. Kifah Saleh Musa Al-Asadi, Estimating the Water Requirements for Tomato Planting in the Eastern Edges of the Western Plateau in Iraq, PhD Dissertation, Faculty of Arts, University of Basra, 1997, p. 104.
11. Radi Kazem Al-Rashdi, Soil Relations with Plants, Ministry of Higher Education and Scientific Research, Basra, 1987, p. 75.
12. Saad Kazem Shenta, Soil Geography, Dar SaqFoundation for Publishing and Printing, Maysan University, Faculty of Education, 2016, p. 104.
13. Abdul Hassan Abu Raheel, & Kamel Fleifel. (2014). Variation of soil properties in the western plateau of Najaf governorate using geographic information systems. Kufa Journal of Arts, 1(18), 147-170.
14. Safaa Majeed A. Al-Muzaffar. The change in housing patterns in the city of Najaf and its impact on the urban environment. Kufa Journal of Arts, [Sl.], v. 1, n. 32, p. 399–448, 2017.DOI:10.36317/kaj/2017/v1i32.6044.https://journal.uokufa.edu.iq/index.php/kufa_arts/article/view/6044
15. Almudhafar, S.M. Spatial Variation of Biological Contamination of Soil from Najaf City. Indian Journal of Environmental Protection this link is disabled, 2020, 40(2), pp. 192–196.

16. Almudhafar, S.M., Alattabi, I.A. Effect of environmental factors on drainage water network in Najaf governorate, Iraq. Indian Journal of Environmental Protection this link is disabled, 2019, 39(11), pp. 1050–1056.
17. Almudhafar, S.M. Environmental assessment of shut alkufa in Iraq. Plant Archives, 2018, 18(2), pp. 1545–1551.
18. Almudhafar, S.M., Abboud, H.A. Spatial variation of surface water contamination by heavy elements in Alhira relative to tourism. African Journal of Hospitality, Tourism and Leisure, 2018, 7(4)
19. KR Kadhim, S Almudhafar, BA Almayahi, 2023. An environmental assessment of the non-living natural resources and the available capabilities and their investment in Al-Najaf Governorate, HIV Nursing 23 (3), 265–273
20. IA Alattabi, SM Almudhafar, BA Almayahi (2023). Natural constituents of the elements affecting soil pollution and health effects and changing their properties by wastewater in Najaf district center, Solid State Technology 63 (6), 5438-5452.