How to Cite:
Hadi, Z. A., Issa, M. J., & Abad, H. J. (2022). Qualitative evaluation of sewage water for Karbala governorate center and study of the possibility of using it for different purposes. *International Journal of Health Sciences*, *6*(S5), 11183–11204. https://doi.org/10.53730/ijhs.v6nS5.10982

Qualitative evaluation of sewage water for Karbala governorate center and study of the possibility of using it for different purposes

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***Abstract*---**The study discussed natural and human factors and their direct and indirect effects on some physical and chemical properties of wastewater in Karbala governorate, for irrigation water quality, it has affected the quality and quantity of water and man has a role that cannot be overlooked its negative impact on those characteristics in its wrong agricultural practices and the irrigation methods used, as well as the use of fertilizers and pesticides in an thoughtful manner. As discussed Physical and chemical properties include temperature, electrical conductivity (EC), and total dissolved solids (TDS).Hydrogen ion concentration (pH) plus laboratory analysis. The hydro chemical study of groundwater includes the main small ionic components (Cl^-), SO_4, NO_3), and trace elements (Fe, Pb, Ni, Cd and Cr). For this study 8 sites for sewage pumping stations were selected in the center of Karbala governorate, and 8 samples were taken from the sites, in order to conduct chemical analyzes on them. The results of the elements varied in the sewage pumping stations. The study also discussed the unified Karbala treatment project and the possibility of this in treating sewage from polluting elements and the possibility of using treated water for irrigation of agricultural crops. The study showed the possibility of investing wastewater according to its validity by clarifying the ionic concentration and comparing it with international standards and water utilization suitable for irrigation, and sewage waste water.

***Keywords*---**Heavy metals, Sewage, Water pollution.

1. Introduction

Increased pollution has resulted from the acceleration of population growth in most nations across the world, as well as the growth of commercial and agricultural technology, as well as the dumping of excreta for various wastes. Sewage is wastewater that contains toxins as a result of sewage interacting with other sources of water. {1}. Sewage is made up of waste water from homes, factories, and streets, as well as ground and surface water, leaching, farm and garden waste, and various sources of liquid waste based on the use of water, and it varies depending on the variety of agricultural, industrial, and commercial production, as well as the use of water in households for washing, personal hygiene, and other consumption patterns. There is a lot of leftover water in vehicles, which contains suspended particles and detergent deposits. Aside from organic compounds, furthermore there are residues of volatile and non-volatile materials from petroleum products, which are a source of risk, are dumped directly into public sewage networks, as well as trash from pharmaceutical enterprises and pesticides {2}. Water from liquefaction systems is used to treat large amounts of sewage, which the Karbala Wastewater Treatment Project (M7) receives and treats on a daily basis. However, the treatment plant's efficiency may be harmed as a result of the difficulties it faces while combining water with industry. Sewage, which increases heavy metal concentrations by impeding the treatment process as the population grows, Construction of contemporary cities, as well as infrastructure and services Basic urban settings, in which the volume of sewage generated by population activity is increasing, and this effluent has been integrated into fixed water policy, and many projects on its use for irrigation and agricultural production have been built in many nations. Working to collect and deliver sanitary ware of wastewater and liquid sludge to treatment plants or final disposal destinations as rapidly as possible is critical, available for processing or transformation into other things that are safe for people, their products, animals, or property {3}. Pollution, defined as a quantitative and qualitative change in the chemical and physical characteristics of environmental elements, can cause significant harm to human life and the environment (humans, animals, and plants), Pollution is a phenomenon that runs counter to the natural order and the construction of machines. Pollution is a serious threat that arises when a clean environment becomes polluted due to improper use. Managing land, water, and air {4}. Heavy metal Untreated wastewater has a number of negative consequences, including interfering with biological wastewater treatment and lowering treatment efficiency. Many times in the sludge, causing an increase in its concentration in the sludge, and hence the use of sludge as a vegetable fertilizer, which will disrupt the food chain. {5}. The many ways in which anaerobic digestion of sludge produces acidic compounds such as formic acid, acetic acid, hydrogen sulfide, and acidic sludge, results in the migration of heavy metals into wastewater, which then finds their way into surface and groundwater, the world's primary freshwater source{6}.

2. Location of the Study Area

Karbala Governorate is located in the center of Iraq in the western part of the alluvial plain, west of the Euphrates, east of the western desert plateau, and al-Qassam the northern part of the Al-Farra region is in the middle, between two

latitudes (32°50′- 32°09′) north of the equator, and longitude (44°18′- 43°10′) east of the Greenwich line It is defined by Anbar Governorate from the north, (Babil) Governorate in the east, and (Anbar) Governorate in the west and (Najaf) Governorate to the south. The area of Karbala Governorate is estimated at 5,034 km, which is equivalent to a percentage (1.15%) of the area of Iraq (435,052 km²), which includes. Governorate (3) districts and (4) areas. The study area (central district) is located in the center of Karbala Governorate, with an area of 2397 km2 and a population of 562965 people during the year 2020.(Ministry of Planning, Central Statistical Organization, Karbala Governorate, unpublished data 2020), The study area is located at latitude (32°38′- 32°18′) in the north and longitude (44°17′- 44°58′) in the east. The spatial boundaries of the study area were represented by the administrative boundaries of Karbala Governorate. The study area is bounded on the north by Al-Husseiniya district, on the east by Al-Hindi district, on the west and northwest by Al-Hur district, and on the south by Al-Najaf governorate. As shown fig (1-1) (Fatlawy,2021).

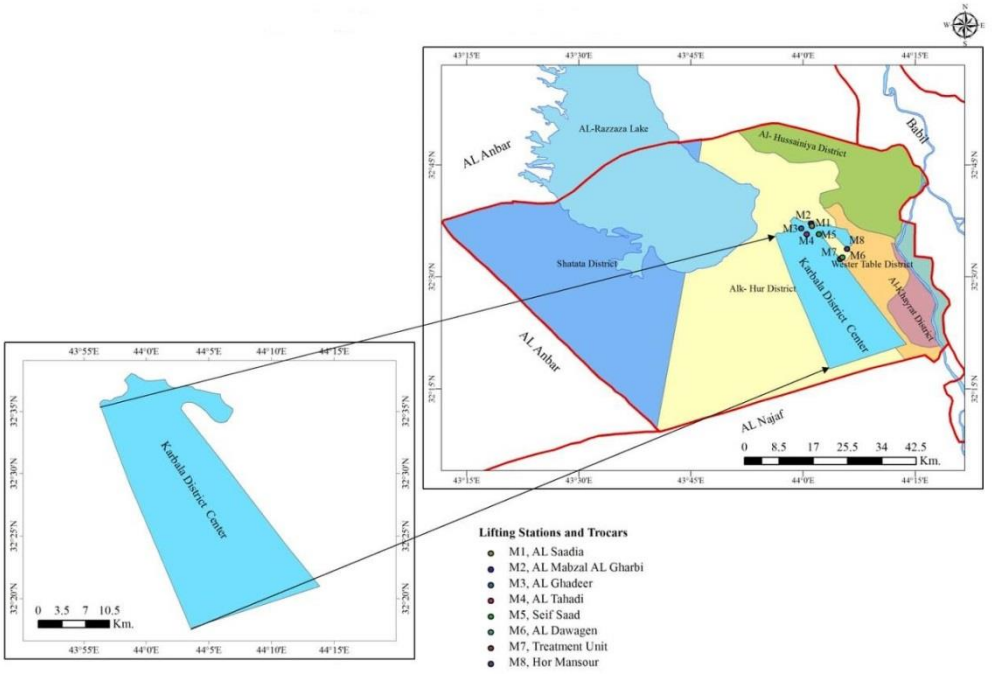

Fig. (1-1) Location map of Karbala city center showing the sewage pumping stations in the city center of Karbala Governorate

3. Materials and Methods

The field work consisted of collecting wastewater samples from the pumping stations located in the governorate center as shown below:

1- A field trip to see the study area and identify sewage pumping stations with the help of specialized engineers from the Directorate of Sewage in Karbala Governorate.

2- One of the engineers of the Karbala Sewer Department (the governorate center) was hired for the purpose of drawing a work plan for the models of field work, because many lifting stations may meet with one main station, and for the purpose of not repeating the models, sites were chosen for modeling in the center of Karbala governorate, (Al saadia (M1),Almabzil AlGharbiu (M2), Al Ghadeer (M3), Rain Altahadiy (M4), Saif Saad (M5), Al Dawagen (M6), Wastewater treatment unit project (M7) Hormansour (M8) show in the fig (1-1).
3- Eight water samples from the study area, from (8) sites were selected according to the distribution of sewage pumping stations locations in January (2022) the rainy period. Sample locations were marked on the map using GIS software in the table (1-1). Each water sample was placed in a (500) mL plastic bottle with a screw cap, in which two samples were collected for each sample point, The first is for the analysis of the main components, the second for the analysis of heavy metals. All water samples are immediately covered with an airtight cap, and they are perfectly marked. No free headspace was left in the plastic bottle and it was ensured that the water sample in each bottle was in contact only with the plastic screw cap and the plastic table of the bottle.

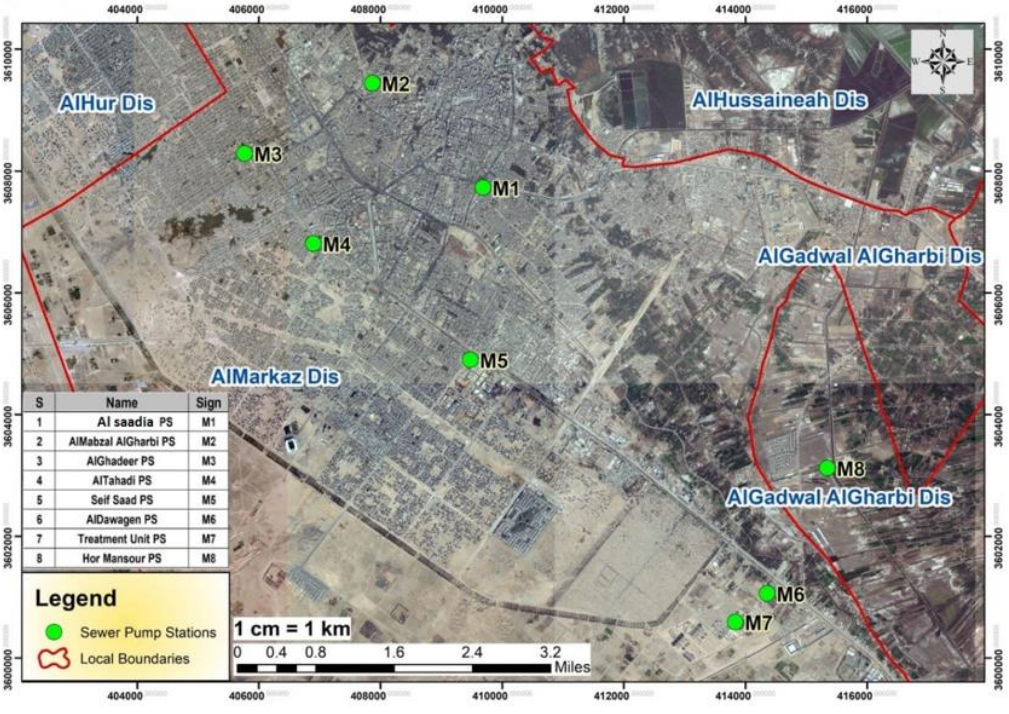

Figure (1-1) the selected sewage lifting stations in the study area from (GIS).

Table(1-1). General information about sewage pumping stations in the study area (Karbala Governorate Sewage Directorate 2020)

station name	Date created	Site	design energy(m^3)	Actual energy (m^3)	Number of served population (people)	final discharge	Sample Name
Al saadia	1980	Karbala governorate center	14,400	22500	90,000	Maytham Al-Tamar station	M1
Almabzil algharbiu	2010	Karbala governorate center	48,000	24500	-	Almabazil station	M2
Al Ghadeer	2014	Karbala governorate center	43,200	-	37,900	Aljahiz station	M3
rain altahadiy	2012	Karbala governorate center	24,000	3000	-	Albahadlia station	M4
Saif Saad	2014	Karbala governorate center	92,160	-	-	Albahadlia station	M5
Aldawagen	2014	Karbala governorate center	259,200	-	final lift station	Hormansour station	M6
Wastewater treatment unit project	2019	Karbala governorate center	400,000	-	2,000,000	Hormansour	M7
Hormansour	2019	Karbala governorate center	-	-	-	Almabzil alrayiysiu	M8

4. Results of analyzes of the main chemical elements

Key physical properties include temperature, electrical conductivity (EC), and total dissolved solids (TDS).Hydrogen ion concentration (pH) plus laboratory analysis. The hydro chemical study of groundwater includes the main small ionic components (Cl-), SO4, NO3), and trace elements (Fe, Pb, Ni, Cd and Cr).

Table2. The value of the analysis of the chemical elements in the sewage pumping stations for the study area

Sit	Longitude	Latitude	T.D.S mg/l	EC µ.S/cm	pH	CL mg/l	SO_4 mg/l	NO_3 mg/l
M1	44.019934	32.614014	+ 2530	+ 3660	7.08	+ 386	+ 875	5.19
M2	44.0179149	32.6187107	+ 3170	+ 4660	7.3	+ 608	+ 1402	5.74
M3	43.9956243	32.6081258	+ 1860	+ 2730	7.10	241	+ 1148	11.72
M4	44.0078442	32.5948562	+ 2060	+ 3100	7.44	+ 251	+ 1233	12.19
M5	44.0355346	32.5948562	+ 2190	+ 3250	7.36	+ 483	+ 1054	10.05
M6	44.0878820	32.5435825	+ 2190	+ 3170	7.23	+ 338	+ 1026	0.62
M7	44.0823623	32.5393251	+ 1749	+ 2690	6.5	237	+ 1270	42.78
M8	44.0982306	32.5622707	+ 1820	+ 2740	7.29	+ 386	+ 1092	37.3
Mean			2196.12	3250	7.16	366.25	1137.5	15.69
Range			1749_3170	2690_4660	6.5_7.44	237_608	875_1402	0.62_42.78
IQS,2012*			1000	1500	6.5-8.5	350	400	50
WHO,2011**			1000	1500	6.5-8.5	250	250	50

*IQS: Iraqi Quality Standards (IQS)
**WHO: World Health Organization (WHO)

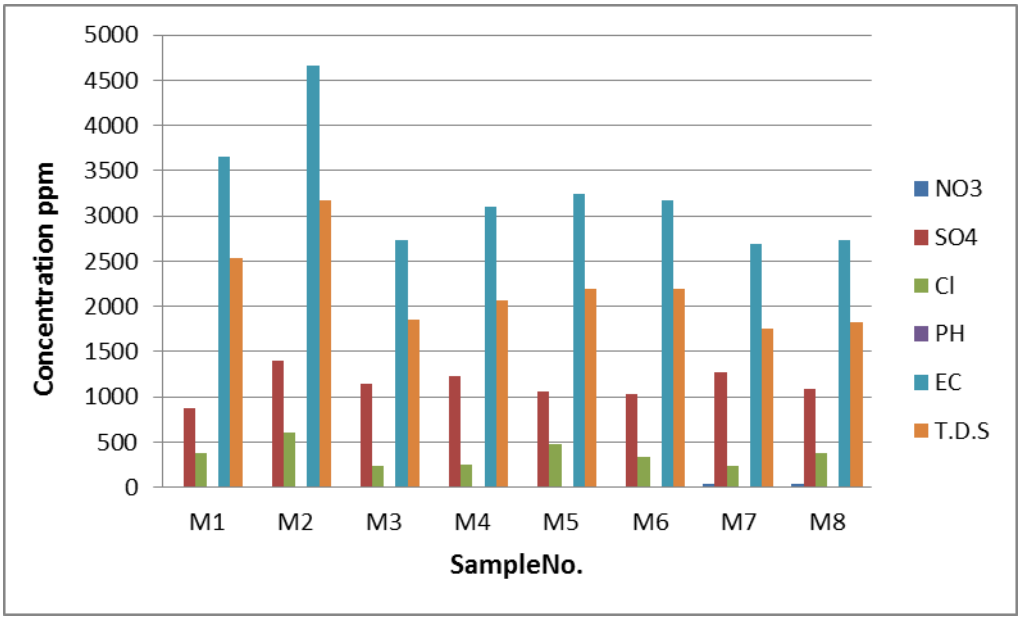

Fig.2. shows the results of the analysis of the chemical elements of the sewage pumping stations for the study area

Heavy metals

These minerals are considered among the most dangerous pollutants because they accumulate in the bodies of aquatic animals such as fish, birds, and plants, and they reach humans by eating fish whose cells contain compounds of these minerals, and they lack the ability to decompose or undergo chemical or bacterial breakdown in the environment when they collect in the bodies of living organisms, heavy metals enter the human body through biological accumulation faster than they are broken down through the processes of metabolism or excreted, resulting in heavy metal poisoning{7}. Qualitative wastewater research is important because it determines the quality of usable water and determines whether or not the water is poisonous to the organisms present and whether or not wastewater treatment systems should be utilized. In recent years, natural solutions for waste water treatment in small towns have gained favor as alternatives to recognized treatment procedures. Water samples were collected from eight sewage sites spread across the study area. On January 2021, 8 sewage samples were collected from lift stations in the city center district.

Table3. The value of the analysis of the Heavy metals in the sewage pumping stations for the study area

Sit	Fe mg/l	Ni mg/l	Cu mg/l	Cr mg/l	Cd mg/l	Pb mg/l
M1	0.047	0	0.014	0	+0.074	+ 0.177
M2	0.029	0	0.083	+ 0.109	+0.056	+ 0.229
M3	0.048	0.023	0.085	+ 0. 12	+0.127	+ 0.184
M4	0.051	0	0.092	0.1	+0.085	+ 0.236
M5	0.023	0.019	0	0	+0.071	+ 0.1 04
M6	0.031	0.02	0	0	+0.068	+ 0.153
M7	0.055	0	0.098	+ 0.104	+0.079	+ 0.242
M8	0.021	0	0	+ 0.112	+0.041	+ 0.215
Mean	0.038125	0.00775	0.0465	0.060714	0.075125	0.1925
Range	0.021_0.055	0_0.023	0_0.098	0-0.112	0.041-0.127	0.104-0.242
IQS,2012*	5	0. 2	0.2	0.1	0.01	0.1
WHO,2011**	0.3	0.07	2	0.05	0.003	0.01
US,EPA2018***	0.3	0.07	2	0.1	0.005	0.015

*IQS: Iraqi Quality Standards (IQS)
**WHO: World Health Organization (WHO)

***USEPA: United State Environmental Protection Agency (U.S EPA)

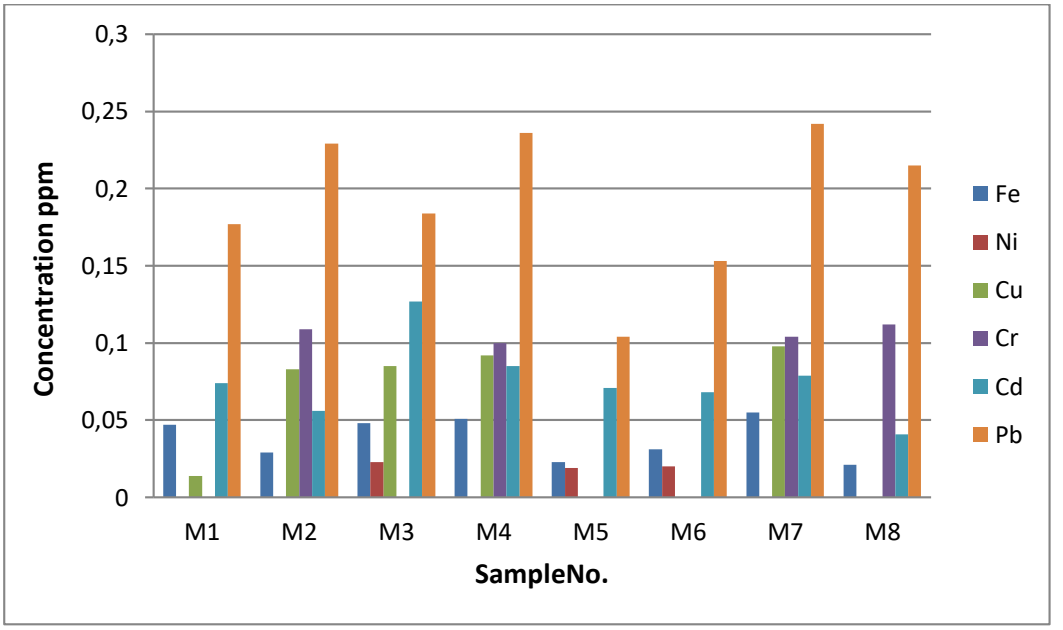

Fig. 3. The results of the analyzes of the chemical elements of the sewage pumping stations for the study area

- Through follow-up with the concerned departments in Karbala governorate and due to the scarcity of analyzes, analyzes were obtained for the year 2020 for the purpose of comparison with the current study for the year 2021-2022 as shown in table (5)

Table.4. Heavy metal analyzes for stations in the study area by the Ministry of Construction, Housing and General Municipalities, General Directorate of Sanitation (2020)

Sit	T.D.S mg/l	pH	CL mg/l	SO_4 mg/l	NO_3 mg/l	Fe mg/l	Ni mg/l	Cu mg/l	Cr mg/l	Cd mg/l	Pb mg/l
M6*	+ 1313	7.3	+ 392	+ 967	38.1	2	+ 5.8	+ 0.64	+ 0.6	+ 0.28	+ 2.8
M7**	+ 1144	7.4	+ 370	293	+56.1	0.74	+ 4.23	0.17	+ 0.4	+ 3.5	+ 2.95
IQS,2012	1000	6.5-8.5	350	400	50	5	0.2	0.2	0.1	0.01	0.1
WHO,2011	1000	6.5-8.5	250	250	50	0.3	0.07	2	0.05	0.003	0.01

*M6: Al Dawagen station

**M7: Wastewater treatment unit project station

5. Discussion and conclusions

1- Iron(Fe)

Iron is a transition metal and, after aluminum, is the second most abundant metallic element in the outer crust for the earth. However, the iron concentration in natural water is generally small, Iron it is part of hemoglobin, the transporter of oxygen and oxygen in red blood cells. Although iron is toxic, it is an undesirable component in drinking water because it has a negative effect on taste, and it may clog the systems distribution It can produce stubborn brown rust spots on fabric and ceramics, So while preparing water drinking is usually removed by ventilation {9}. From the table (3) the results of the analysis of (Fe) samples in sewage pumping stations appeared, which range (0.021-0.055) ppm and are within the acceptable limit (0.3) ppm in the standard specifications.

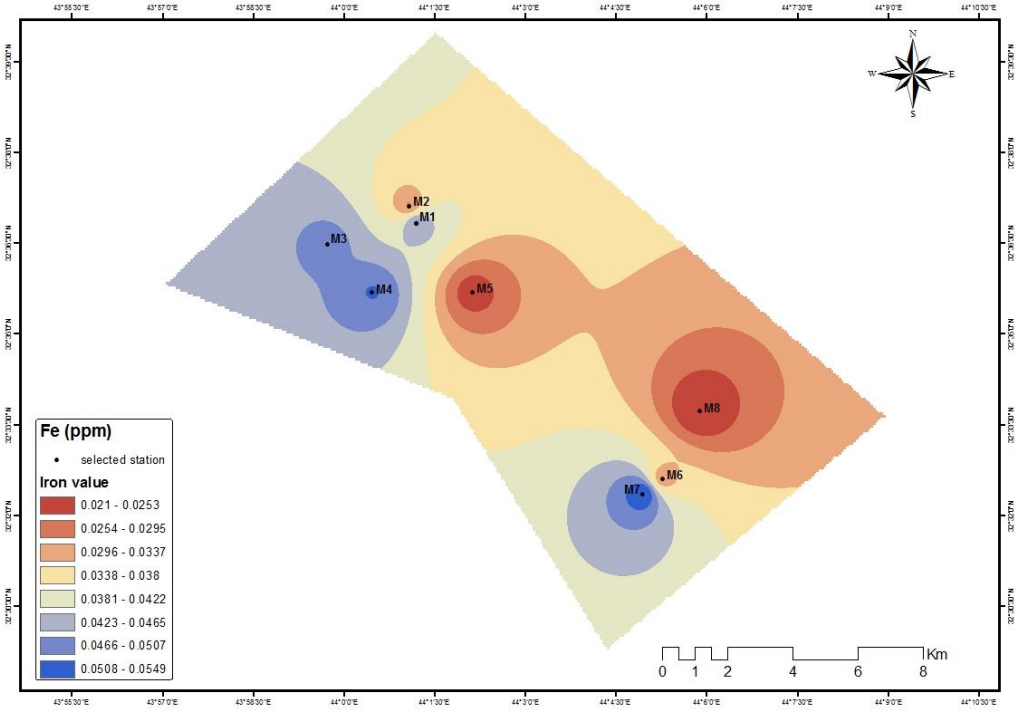

Fig.4.The spatial distribution of the (Fe) element in the study area

2- Nickel(Ni)

Nickel is found in surface and groundwater as a result of erosion and dissolution of rocks and soils, as well as biological cycles, industrial activities and waste disposal. In natural waters with a pH of 5-7, (IPCS, 1991). Nickel leaks from landfills and contributes to contamination of the water layer with nickel, which may be harmful to the environment {10}. The results of examination of nickel samples in sewage pumping stations ranging from (0-0.07) ppm and within the permissible limit of (0.0-0.23) ppm, which is within the standard specifications.

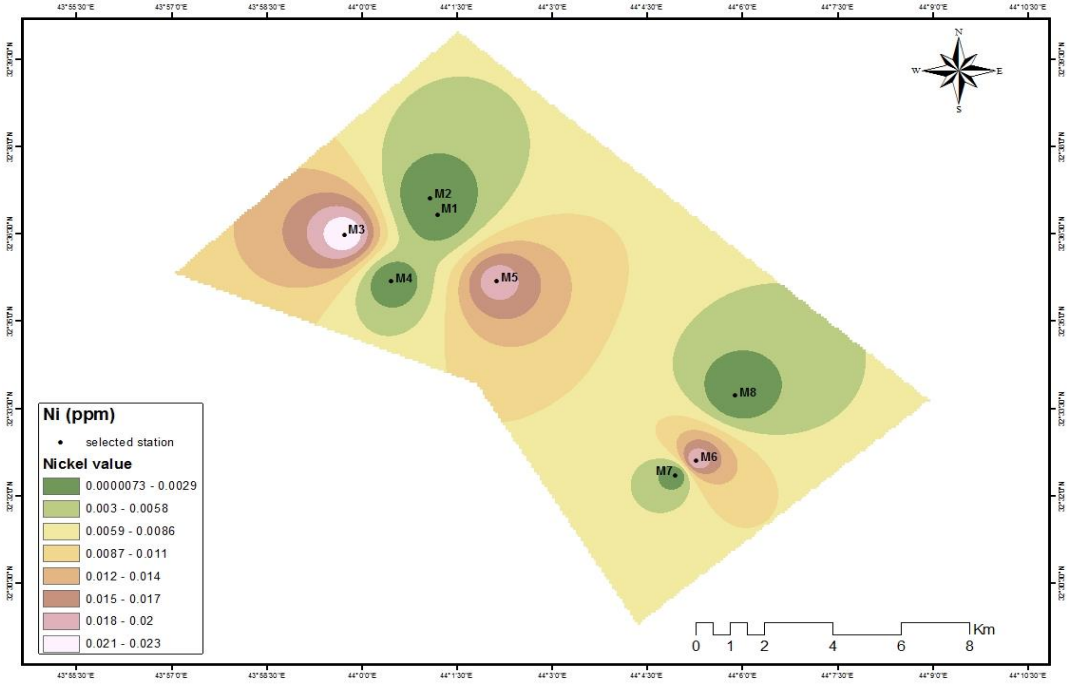

Fig.5.The spatial distribution of the (Ni) element in the study area

3- copper (Cu)

Copper, unlike some other minerals, is beneficial to the body in small levels, but in high doses, it can cause anemia, liver and kidney damage, and gastroenteritis. Copper is used as a metal or metal alloy, as well as an additive designed to reduce algae growth. In addition to casting other metals. for water pipes. Corrosion of these metal goods, scrap disposal, and waste excretion into the environment, either directly or indirectly, after a station treats sewage, sewage sludge, manure, or landfill. Copper Compounds It is widely used in agriculture to treat mother water for water purification, as well as a wood preservative and a fabric preservative {9}. The results of the analysis of (Cu) samples in sewage pumping stations have been revealed, and they vary from (0-0.098) ppm, which is within the permitted limit (0.2-2) ppm in standard specifications.

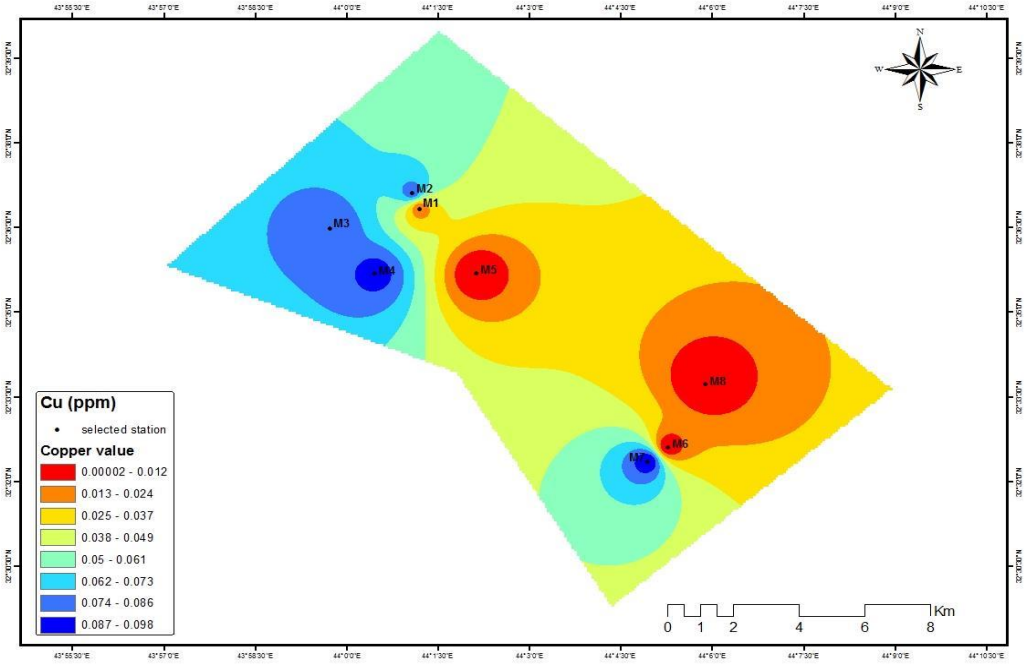

Fig.6.The spatial distribution of the (Cu) element in the study area.

4-Chromium(Cr)

Chromium is a vital human nutrient and is also supplemented by vitamins. It has a relatively low toxicity and can only be a problem with high levels in drinking water, Exposure to hexavalent chromium is considered the most risk on human health {11}. The results of the tests were recorded at stations (M1, M4, M5, M6) ranging from (0.1-0) and were within the allowed limits that ranged from (0-0.1). (0.05-0.1). While the results in stations (M2, M3, M7, M8) showed a considerable increase at a rate ranging from (0.12-0.112), which is outside the applicable specifications. Sedimentation from waste disposal sites and industrial areas located within the sites of the stations that suffer from a rise in the proportion of chromium is the main source of chromium pollution in water.

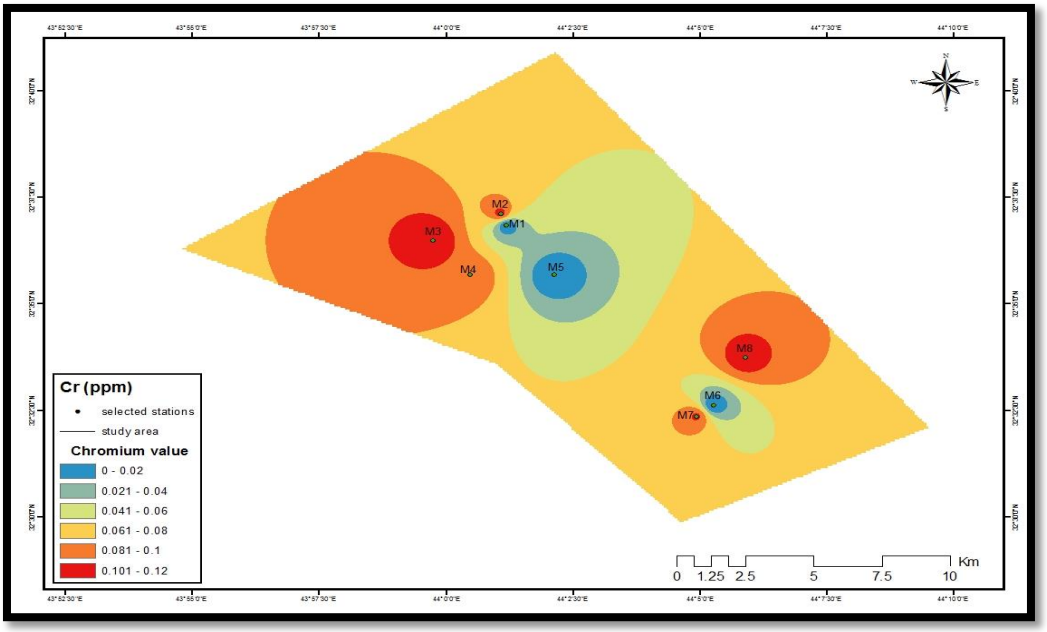

Fig.7.The spatial distribution of the (Cr) element in the study area

5- Cadmium (Cd)

Cadmium considered relatively rare in the geological deposits, occurring mainly in carbonate and hydroxide forms. It released to the environment in waste water and diffuse pollution is caused by contamination from fertilizers and local air pollution {12}.Cadmium represents a highly toxic element and is unnecessary for the human living and animals {13}. It is noted that all the values of the cd element in the study area are outside the limits of the specification and the reason is due to the most important sources of phosphate fertilizer, heavy household water and the products of industrial activities as well as acidic PH, especially in the (M6) station {14}.Fertilizers produced from phosphate constitute a major source of diffuse cadmium pollution. The solubility of cadmium in water is influence to large by its acidity {15}.

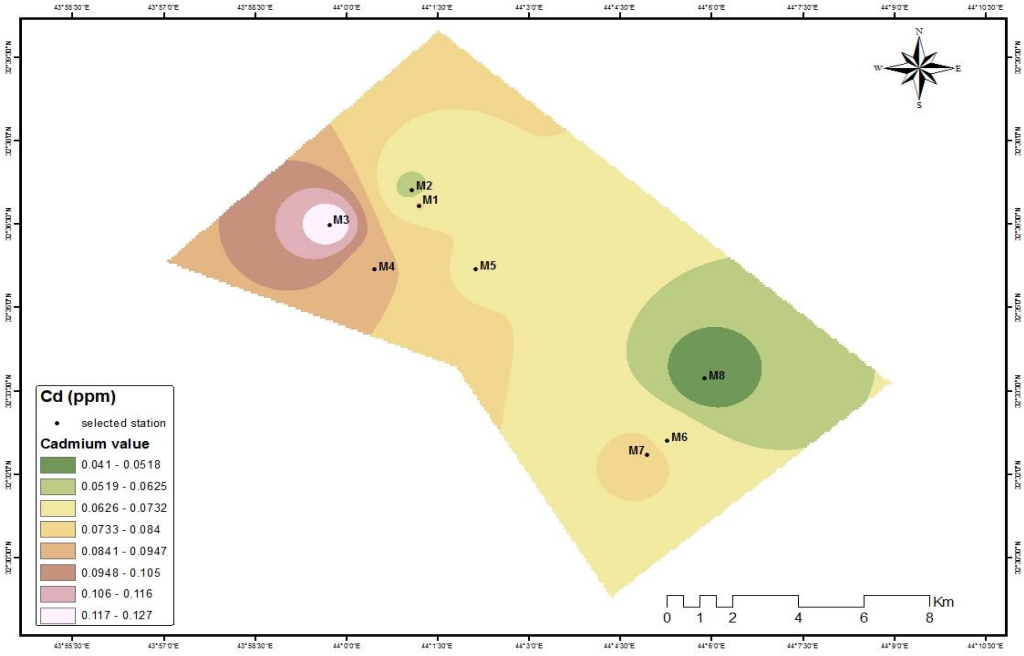

Fig.8.The spatial distribution of the (Cd) element in the study area

6- Lead (Pb)

Lead is a rare metal found in ore along with silver, zinc, and copper, and it is mined with these minerals. Because lead ion-containing minerals have limited water solubility and low natural mobility, the amount of lead in water {16} is lower than that of atmospheric minerals and rocks that release (Pb) into the environment. Other sources of (Pb) include fertilizers, human activities, and industrial processes,the results of the element (lead) showed an increase in its concentrations in sewage pumping stations, which did not meet the Iraqi Quality Standards (IQS) for the year 2012. The causes of lead pollution are due to vehicle emissions and agricultural activities. The lead emitted from the vehicles is then deposited in the soil and may reach sewage water due to continuous washing processes, as well as irrigation and rain {17}.

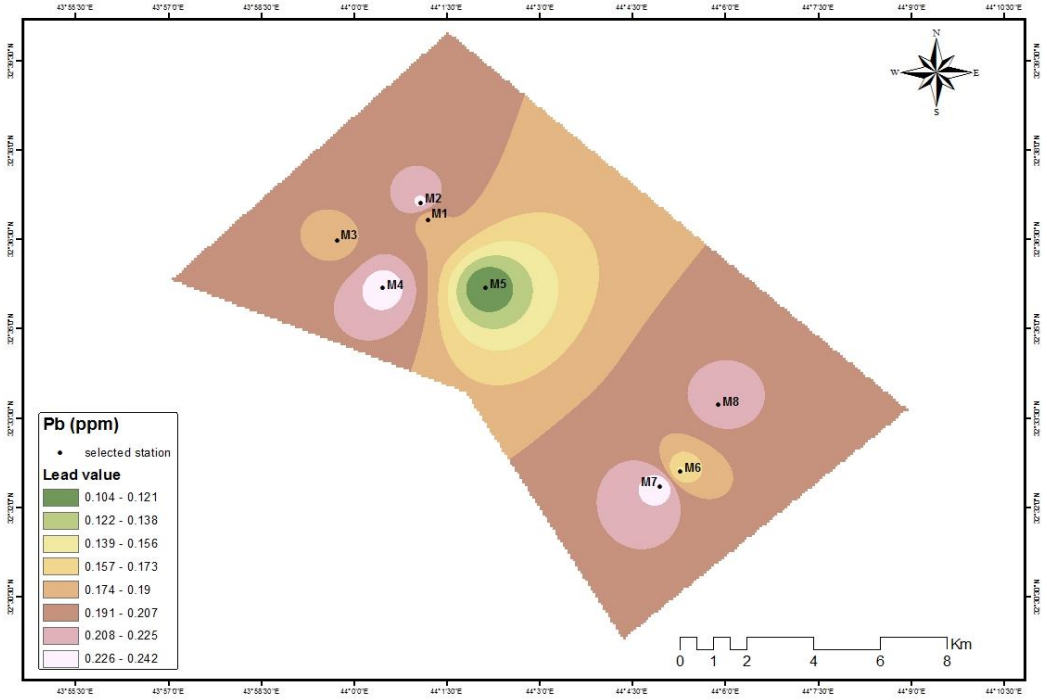

Fig.9.The spatial distribution of the (Pb) element in the study area

7- Total dissolved solids (T.D.S)

The total dissolved solids (TDS) are the total amount of solids remaining when a water sample evaporates to dryness {16}. It represents the total summation of ionic concentration of cations and anions and is measured in (ppm) or (mg/l) units, {18}. An increase in the values of total dissolved salts was observed for all stations in the study area due to rainfall at the time of taking samples in the winter season through washing the soil and dissolving salts.

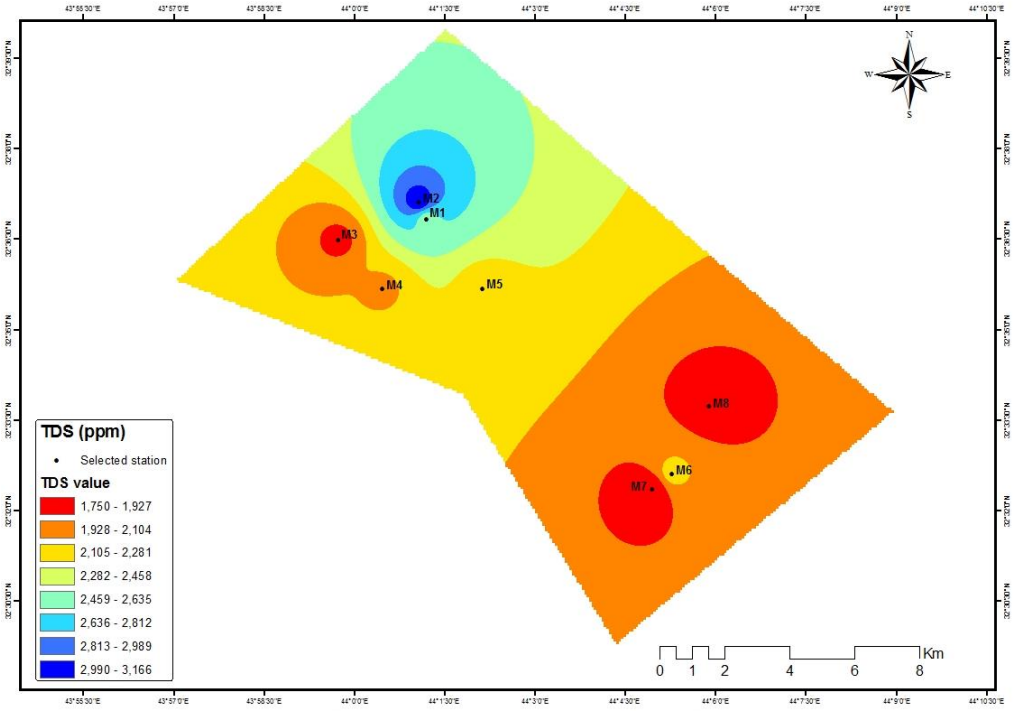

Fig.10.The spatial distribution of the (TDS) element in the study area

8- Electrical Conductivity (EC)

Electrical conductivity is measured in micro Siemens per centimeter (µ.S/cm) and refers to the ability of $1cm^3$ of water to conduct an electric current at a normal temperature of (25C°). It is dependent on the overall amount of soluble salts {19}, as well as water temperature, where a one-degree (C°) increase in water temperature induces a two-percent increase in electrical conductivity{17}. Table (3) shows that all locations are outside the legal limits, requiring treatment before use, with the greatest concentration of EC values recorded in (M2) station (4660).S/cm and the lowest value reported in (M7) station (2740).S/cm, All sites are outside the permissible limits, because the relationship between electrical conductivity and dissolved salts is a direct relationship, The high Ec in the (M2) station of the western drain is due to the presence of many residential areas extending along the drain, whose wastes are dumped in the draining water. It can also be noted that the values of the electrical connection increased due to the increase in agricultural activity and the expansion of the agricultural areas that it drains, and the western drain is considered one of the most important irrigation projects in Karbala Governorate, because it draws groundwater from the area between the Two Holy Mosques, and it is the only outlet for this water, as the drain length is 1300 m, It starts from Siafon under the Hindiya creek and flows into the northern cesspool of Karbala.

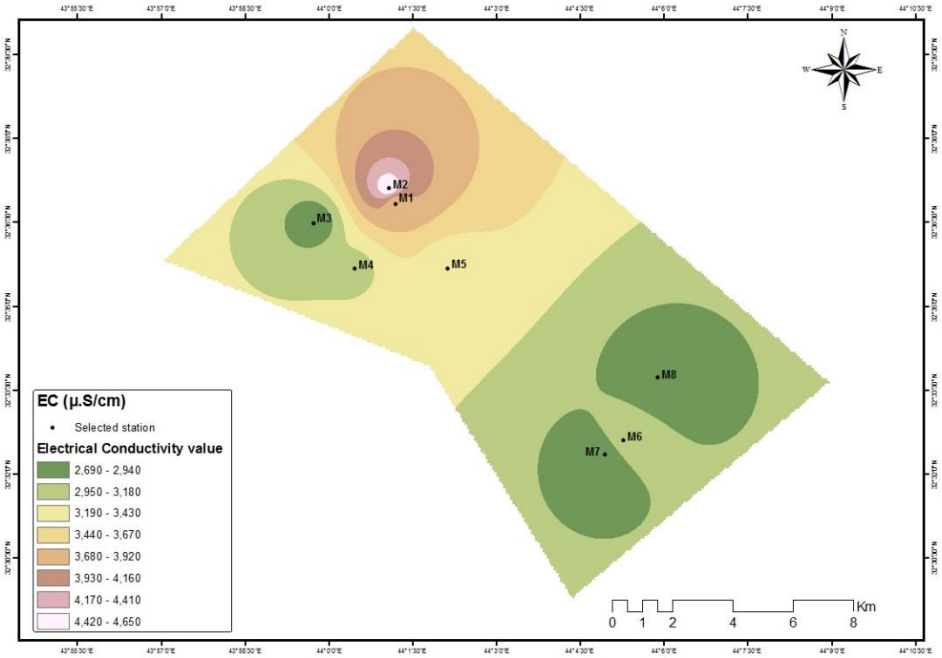

Fig.11.The spatial distribution of the (Ec) element in the study area

9- Hydrogen ion concentration (pH)

The (PH) is a measure of the acidity or alkalinity of solutions and it indicates the activity of the hydrogen ion in water. {20}.As acidic solutions have a pH between (1-7) . It refers to an increase in hydrogen concentration, whereas an increase in hydroxyl ion concentration indicates that the solutions are alkaline and have a pH of (7-14) while neutral solutions in which water is pure have a (pH=7) {21}. The estimation of (PH) is regarded crucial from an agricultural point of view because to its impact on numerous components that affect the validity of water for irrigation, since it leads to a disturbance in the balance between the elements that it absorbs. When the hydrogen ion and the hydroxyl ion compete for uptake by the plant, this effect occurs, and this effect happens when the (PH) is less than (4) or higher than (9) ,high acidity has an effect in dissolving most of the soil components and leads to a decrease in the specific weight of the soil. When the acidity increases, the solubility of calcium, magnesium and potassium increases in water. Food, as it has the ability to move and move over long distances as well as its effect on plants by demolishing the roots of plants, while alkalinity has less effect by increasing the salinity of the soil {22}. Where the PH values ranged from (6.5-7.44), where the acidity value at the (M7) station, which is a treatment plant that changed the concentrations of ions and the general average of all stations in the study area that all water was light alkaline due to the presence of carbonate and bicarbonate ions.

PH<8.2 the hydrogen ion is added to the carbonate and become dissolved bicarbonate

PH>8.2 (Hco3) depletion to (CO3-2) in solution becomes high

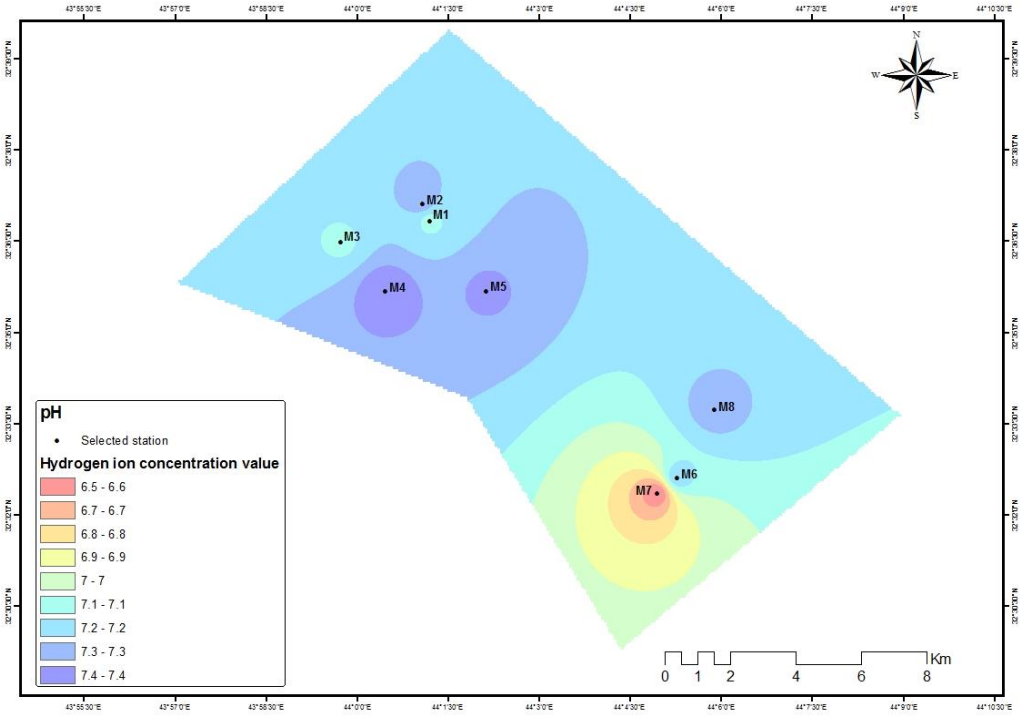

Fig.12. The spatial distribution of the (pH) element in the study area

10- Chloride ion (Cl)

The chloride ion (Cl-) is found in all-natural waters with different concentrations, as its concentration in ocean waters reaches more than (2000) mg / liter, as for rivers and lakes, its concentration ranges between (20-80) mg / liter, which is considered Sedimentary rocks are the main source of chloride ion (Cl-) as well as rainwater and melted snow {23}.the chloride ion in polluted groundwater is organic or industrial waste and irrigation water {24}, also that water treatment with chlorine can lead to an increase in the chloride ion concentration in the water {25}.The largest concentrations of (Cl) values were analysis in stations (M1,M2, M5,M8,) with an average of (386,608,483,336) mg/L, as these values for the listed sites are outside the permissible limits and require treatment before use. The lowest values of (Cl) concentrations were found in the stations (M3, M4, M6, M7) with values of (241,251,237,338,237) mg/L, which indicates that these results are within the permissible limits. Chloride concentrations are increasing with increasing agricultural areas, and this is evident in the (M2) station, where it reached the highest value in the study area (608)mg/l, and its source is from the melting of salty sedimentary rocks, The reason for the high rates of chloride is due to its availability in high quantities in Iraqi waters, whose sources come from the components of the earth's crust and as a result of the exposure of the soil to washing by irrigation water, adding percentages of chloride to the soil, and the chloride salts are exposed to dissolution and decomposition in the water{26}.

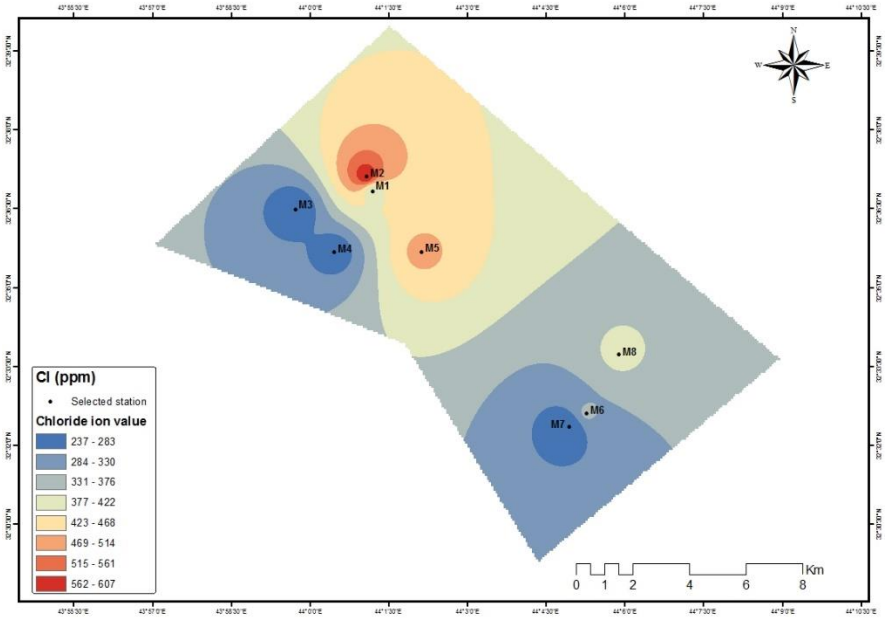

Fig.13.The spatial distribution of the (Cl) element in the study area

11- Sulfate ion (SO_4)

The main source of sulfate (SO_4^{2-}) in water is solutions of sulfate minerals found in rocks Sedimentary materials such as hydrated gypsum ($CaSO_4.2H_2O$), anhydrous gypsum ($CaSO_4$) and anhydrite, as well as from the oxidation of pyrite minerals (or what is known as iron sulfide (FeS2) and in shale and clay rocks{27}.This is in addition to the natural sources of sulfate (SO_4^{2-}) There are human resources such as agricultural activities through the addition of Pesticides as well as industrial activities that increase the emission of sulfur dioxide (SO_2) into the atmosphere{28}. The table (2) where the highest concentration of SO_4 values was recorded in (M2) station and reached (1402) mg/l and the lowest value was recorded in (M1) station and reached (875) mg/l that all sites are outside the permissible limits that require treatment before use. Increasing sulfate concentrations has a negative role on the use of water containing it for irrigation, as increasing its concentration leads to soil salinity, impeding plant growth and the appearance of spots on its leaves. Increasing its concentration works to precipitate calcium sulfate, and this in turn affects the sodium ions dissolved in the water {29}, knowing that The source of most of the sulfates is either naturally as a result of the presence of sedimentary rocks penetrated by the sewage water or from the dissolution of gypsum and hydrodynamic rocks of the sediments of the Quaternary age when water passes over the rock layers containing these rocks, which cover large parts of the study area {30}. Therefore, the concentration of sulfate ions depends on the type of rocks that they pass water. The fact that these rocks contain a high percentage of gypsum leads to the supply of this water with large quantities of sulfate ions {31}. The rain also contains concentrations of sulfate, whose concentration ranges in it (1-3) mg/l, which depends on air pollution rates, as it can be The focus on this limit increases and may be the result of human activities represented by the water discarded from domestic uses,

the water resulting from industrial activities, and the fertilizers used in agriculture{32}.

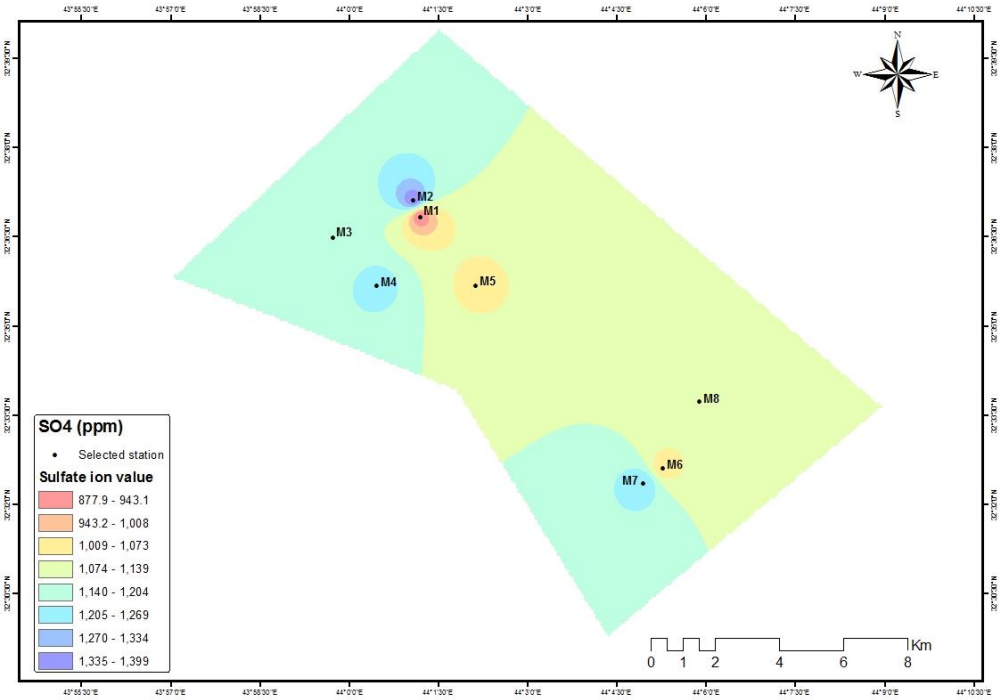

Fig.14 The spatial distribution of the (SO_4) element in the study area

12- Nitrate (NO_3)

Organic, industrial, and agricultural sources of nitrates were found in natural water, but chemical fertilizers were the predominant source of nitrate due to its high solubility in water and poor soil retention. Nitrates are very mobile, flowing through soil at a velocity similar to water. As a result, nitrate is not volatile, and it will most likely persist in water until it is eaten by plants or other organisms {33}. Another source of nitrate is animal waste, plant remnants, industry, and sewage disposal {34}. The (NO3) values in the table (2) varied slightly the maximum concentration of (NO3) values was recorded at the (M7) station (42.78) mg/l the reason for the high nitrate is due to the presence of a treatment plant, while the lowest value was recorded at the (M6) station (0.62) mg/l, indicating that all sites are within allowed limits.

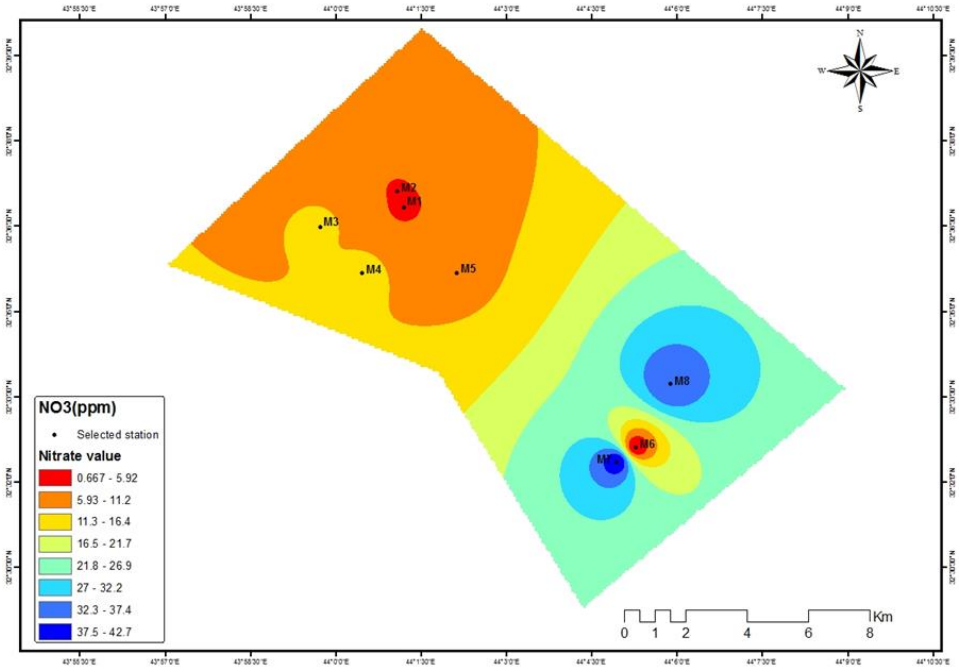

Fig.15.The spatial distribution of the (NO_3) element in the study area

13- Reference

[1] Abou Seeda, M. (1995). Potential benefits and hazards of land application of sludges: A review proc. Seminar production and use of chemical fertilizers and environment 17-21 Dec. 301-323

[2] Abu-Samour and Al-Khatib.,1999: Geography of water resources, Dar Safaa for Publishing and Distribution, Amman, Jordan. .(In Arabic).182p.

[3] AL – Kubaisi, Q.Y. Hydrogeology of Dibdiba Aquafer in safwan – Zubair area, South Iraq, Unpublished Ph.D. Thesis, University of Baghdad, Baghdad. 1996. 43p.

[4] Al Jumaily.M.Fadhil and Ahmed.S.Hadi (2018) .Water and soil pollution, Baghdad,425p.(in Arabic)Berkowitz, B., Dror, I. and Yaron, B., 2008: Contaminant geochemistry, Springer-Verlag Berlin Heidelberg, 412 p.

[5] Al-eisawy, S.A.,2013: Spatial analysis of groundwater characteristics in the Najaf plateau. M.Sc.thesis.Faculty of Arts, University of Kufa. .(Unpublished),(In Arabic).74 p.

[6] Al-Jumaily& Louay,A.H.,2009:Spatial relationships of pollution of the Diyala River water with human activities.M.Sc.thesis,Collage of Education.Ibn Rashid, University of Baghdad.(In Arabic)

[7] Al-Jumaily,M.M.,2005: The effect of industrial water for the nitrogen fertilizer plant in Baiji on the deterioration of some plants. Characteristics of soil and groundwater. M.Sc.thesis,College of Agriculture and Forestry, University of Mosul. .(In Arabic)

[8] Al-Obaidi,S.H.,2010: Ground water in Hawija district and its investments. M.Sc.thesis. Collage of Education, University of Tikrit.(Unpublished),(In Arabic).93 p.
[9] Al-Yasiri,K.H.,2013: Soil pollution and deterioration in Hilla district.M.Sc.thesis. College of Education for Human Sciences, University of Babylon.lraq.(Unpublished),(In Arabic).38 p.
[10] Arief, A. S., Pattiasina, P. J., & Remus, S. P. (2021). Relevance of human resource management on small business objective in digital era: A critical review of research evidence. International Journal of Social Sciences and Humanities, 5(2), 79–91. https://doi.org/10.29332/ijssh.v5n2.1167
[11] Asano, T. and Levine, A.D. (1996). Wastewater reclamation, recycling and reuse: past, present, and future. Water. Sci. Tech. 33 (10-11) 1-16.
[12] BGS, 2003: Water quality fat sheet Nitrate, British Geological Survey,NERC,6 p.
[13] Boyd, C. E., 2000: Water quality an introduction, Kluwer Academic publisher, USA. 330 p.
[14] Daly.D,"Chemical Pollution in Groundwater Over view of the station in Reland Conf, Chemical a cause for concern cork, 1994.p1123-1124.
[15] Drever, J. I., 1997: The Geochemistry of natural water, surface and groundwater environments, 3rd ed., prentice hall, USA, 436 p.
[16] El-den Abd Elsalam, M. S. ., Abd Elbast, M. A., Mohamed, O. E., & El Tayeb, A. (2022). Comparison between Non-obstructive versus obstructive coronary artery disease patients with acute coronary syndrome. International Journal of Health Sciences, 6(S1), 9130–9143. https://doi.org/10.53730/ijhs.v6nS1.7065
[17] Gamila,H.A and Naglaa, F.A (1999). Estimation of the hazard concentration of industrial wastewaters using algal bioassay. Toxicology ,63:3, 407-414.
[18] Hanoon,J. J. M.,2011: Hydrogeomorphology of Karbala Region,Ph.D.Thesis. Collage of Education, Al-Mustansiriya University. (In Arabic).70 p.
[19] Harith,J.F.and Adel.M.R.,2010: Water pollution (sources, risks, treatment), Arab Society Library for Publishing and Distribution. Amman, Jordan. (In Arabic).64 p.
[20] Hem, J.D., 1985: Study and Interpretation of the Chemical characteristics of Natural Water. 3rded .USGS. water supply paper. 263p.
[21] Hudak, P.F.,2000 : Regional Trends in Nitrate Content of Texas Groundwater. Journal of Hydrology, Vol.228: 37-47 p.
[22] Leeming, R. Bate, N.J Hewlett, R. and Nichols, P.D (1998). Discriminating fecal pollution: a case study of storm water entering Port Phillip Bay. Australia, wat. Scie. Technol. 38(10):15-22.
[23] Manahan, S. E., 2001: Fundamentals of Environmental Chemistry Boca Raton: CRC Press LLC, 993 P.
[24] Marian, T, Korolewicz, T and Ciba, J (2005).Removal of heavy metals from sewage sludge used as soil fertilizer. Soil and sediment Contam, 14:143-154
[25] Meback, M." Atomospheric in Pats and River Transport of Dissolved Substance.U.K. LAHS pub1: 1983.p1783-1790.
[26] OEHHA, 2010 :Hexavalent Chromium (Soluble Compounds). Determination of Noncancer Chronic Reference Exposure Levels.
[27] Prasad, M. N. V. 2008: Trace Elements as Contaminants and Nutrients.

[28] Puigagut, J.J. Villasenor, J.J Salas, J.J ,Becares, E. and Garcia, J. (2007). Subsurface-flow constructed wetlands in spain for the sahitation of small communities: a compare ktive/Study Ecol Eng: 30,312-9
[29] Ros JPM, Slooff W, eds. 1987: Integrated criteria document. Cadmium. Bilthoven, National Institute of Public Health and Environmental Protection (Report No. 758476004).
[30] Shural, H.I (1992).Waste water recycling and reuse as a water resource for Mediterranean Countries: hygienic and tech nological Aspects. In proc. Conference Med-Travaux des Experts, Rome, Italy.
[31] Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Get vaccinated when it is your turn and follow the local guidelines. International Journal of Health Sciences, 5(3), x-xv. https://doi.org/10.53730/ijhs.v5n3.2938
[32] Todd, D. K., 2007: Groundwater hydrology third edition, Jhon Wiley and Sons, Third Reprint. Inc. India. 535 p.
[33] Todd, D.K: Groundwater Hydrology, Third edition, Jhon Wiely & Sons, Third reprint, Inc, India, 2005,650p.
[34] Turek, M , Teofil, K and Ciba, J (2005). Removal of heavy metals from sludge used as soil fertilizer. Soil & Sediment Contam.14:143-154.
[35] Twert, A.C & Hoather, R.C.''Water Supply'' .2nd ed. Jhon Wiely and Sons Inc.1974.p285.23-
[36] WHO, World Health Organization, 2006: Guidelines for Drinking- water Quality, 1st Addendum to the 3rd ed., volume 1: Recommendations, World Health Organization, Geneva, 515 p.