Strategic management of groundwater according to the water quality assessment in terms of the standard score in Al-Qadisiyah Governorate

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Abstract:

This descriptive study tackles illocutionary speech acts in two short Surahs of the holy Quran, specifically, Surah Al-Tariq and Surah Al-Ma'un. The aims of this study are to find out the types of the illocutionary speech acts and the pragmatic functions in addition to whether they were implicitly or explicitly performed in the said Surahs. The significance of this study is to reveal the classes of the illocutionary speech acts and the pragmatic functions employed in these Surahs and to highlight the high eloquence of the selected Surahs in conveying messages to the recipients. Only sixteen samples have been analyzed, and the approach followed to analyze the data is qualitative. Furthermore, some books of exegesis have been consulted and depended on to analyze the data. The results of the present study are that the illocutionary speech acts of representatives, directives and commissives were used in the two Surahs mentioned above. Different pragmatic functions like describing, ordering, threatening, asserting, warning and promising were employed in these Surahs. Moreover, explicit speech acts were used with a high frequency of occurrence whereas implicit speech acts were used with a low frequency of occurrence. In addition, some verses perform more than one speech act at the same time to convey more than one message, and they have been analyzed under more than one type of speech acts. This indicates the high eloquence of the selected Surahs in conveying the messages to people.

Keywords: Quran, Surahs, Speech Acts, Pragmatic Functions, Al-Tariq, Al-Ma'un

الإدارة الاستراتيجية للمياه الجوفية
وفقا لتقييم جودة المياه بدلالة معدل الدرجة المعيارية في محافظة القادسية

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الملخص:

يسلط البحث الضوء على تقييم جودة المياه الجوفية في محافظة القادسية على أعتبار ان المياه الجوفية مورد مهم من موارد المياه في المحافظة لسد النقص الحاصل في المياه السطحية ، والتي يتعذر وصولها لمساحات واسعة ضمن الاطار الاداري للمحافظة بفعل الجفاف الملازم لتغير المناخ نحو الدفء،فمن خلال تقييم جودة المياه الجوفية في المحافظة،والذي يمكن قياس مدى ملاءمة المياه الجوفية للاغراض المتعددة،كما ان للتقييم ضرورة التباين المكاني لمستوى التدهور في خصائصها النوعية.

لقد اعتمد الباحث في بناء القاعدة البيانية على الدراسات السابقة،وقد تم معالجة البيانات بأستخدام الدرجة المعيارية بهدف تصنيفها وفقا للمؤشرات الفيزيائية و الكيميائية للمقارنة المكانية بين الوحدات الادارية للمحافظة،كما واعتمد البحث على احدث الدراسات الاجنبية في طرح الدائل للنهوض بمستوى ادارة المياه الجوفية في المحافظة ،لذا طرح البحث العديد من البدائل للنهوض بواقع الادارة الاستراتيجية للمياه الجوفية ،للحد من تدهور نوعية وكمية المياه الجوفية في محافظة القادسية ،والتي يمكن تصنيف البدائل الى الاصناف الرئيسة على النحو الاتي:

١- بدائل للحد من التأثير السلبي للتركيب الجيولوجي في كمية و نوعية المياه الجوفية.

٢- بدائل للحد من التأثير السلبي للمياه السطحية الملوثة في نوعية المياه الجوفية.

٣- بدائل للحد من التأثير السلبي للتربة الملوثة و ذات التراكيز العالية نسبيا في الاملاح في تدهور المياه الجوفية.

وقد توصل البحث الى مجموعة نتائج ،ويمكن ايجازها على النحو الاتي:

١- تمخض البحث عن نتيجة مفادها-ان تراكيز الاملاح الكلية الذائبة (T.D.S) في جميع مواقع الآبار للمياه الجوفية ضمن محافظة القادسية هي اعلى من الحد المسموح به لغرض الري وفقا لمعيار المنظمة الإسلامية لجوده المياه (ISEC1).

٢- كما كشف البحث ان جميع مواقع الآبار الارتوازية للمياه الجوفية في محافظة القادسية هي اعلى من الحد المسموح وفقا لمؤشر التوصيلية الكهربائية (EC) كدالة لتركز الاملاح، اذ بلغ المعدل العام للمؤشر (٤,١١ مليموز/سم) ،وهو مؤشر خارج الحد المسموح به لغرض الري والشرب وفقا لمعيار تصنيف مختبر الملوحة الامريكي.

٣- كشفت عملية تصنيف جودة المياه الجوفية باعتماد المعالجة الإحصائية لقاعدة بيانات تمثل الخصائص الكيميائية و الفيزيائية للمياه الجوفية بدلالة معدل الدرجة المعيارية كأداة لتصنيف نوعية المياه الجوفية بحسب مواقع الآبار ضمن اقضية ونواحي محافظه القادسية ،فقد اظهرت نتائج التصنيف - ان اقل مستوى لتدهور المياه الجوفية ظهرفي ناحية آل بدير ،واعلى مستوى للتدهور في قضاء الديوانية ،على الرغم من ان جميع الوحدات الادارية ضمن المحافظة وهي خارج الحد المسموح به وفقا للمعايير المعتمدة عالميا و محليا.

الكلمات المفتاحية: المياه الجوفية،ادارة المياه ، تقييم جودة المياه، نوعية المياه الجوفية

Introduction :

There is no doubt that assessing the quality of groundwater has an important role in the success of water resources management strategies, especially in Al-Qadisiyah Governorate, noting that economic activities within the governorate depend on groundwater as an important resource in most months of the year to fill the shortage of surface water and rain.

The importance of periodically evaluating the quality of groundwater is highlighted, as it is the indicator that can be adopted to benefit from groundwater for various purposes. By evaluating the quality of groundwater periodically, it is possible to measure the suitability of groundwater to international standards on the one hand, and to determine the places with the least and highest deterioration in the quality of groundwater within the area. The administrative administration of Al-Qadisiyah Governorate on the other hand, thus forming a basis for water resources management now and in the future.

The research problem revolves around the following questions:

1- Is the quality of groundwater in Al-Qadisiyah Governorate within the internationally permissible standards?

2- Is there a spatial variation in the level of groundwater quality in Al-Qadisiyah Governorate?

3- Is it possible to benefit from global strategic alternatives as global experiences to improve the groundwater situation in terms of quantity and quality?

The research hypotheses were presented as follows:

1- The quality of groundwater in Al-Qadisiyah Governorate is outside international standards.

2- There is spatial variation in groundwater quality in Al-Qadisiyah Governorate.

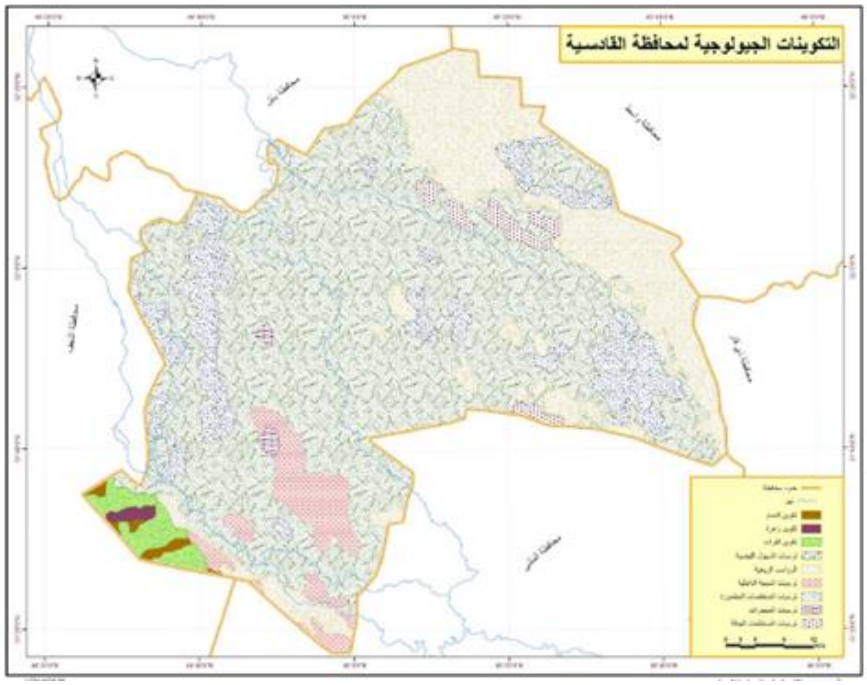
3- Global experiences in reducing the deterioration of groundwater quality can be used as strategies for optimal management of groundwater resources.

The first section: factors affecting the quality of groundwater

1- Geological structure

Geological survey is a crucial factor when searching for suitable places to drill wells in the hot desert climate. By conducting a geological survey, you can collect basic information about rock formations and the structure of subterranean layers, so understanding the geological structure and hydrogeological dynamics of the area is crucial to drilling successful wells. It helps determine the appropriate depth for drilling and evaluate the potential yield and sustainability of the water source [(1).]

Al-Qadisiyah Governorate is located within the formations of the alluvial plain, which represents the newest section of Iraq's surface in formation because it contains sedimentary materials. The origin of the sedimentary plain in Al-Qadisiyah Governorate goes back to the Pleistocene era (2), see map (1)



Map (1) Geological formations of Al-Qadisiyah Governorate

Source: Ministry of Industry and Minerals, General Authority of Geological Survey, scale maps (1: 25,000), 1997.

The geological structure in Al-Qadisiyah Governorate can be summarized as follows:

First: Tertiary sediments of the Dammam Formation: (lower Eocene to middle Eocene)

This formation is located in the southwestern side of the governorate (Al-Shafiya district) and has an area of (49,286 km2). This formation consists of limestone or dolomite rocks, and its thickness reaches about (250 - 290)(3) meters.

Studies have proven that limestone and dolomite rocks significantly affect the physical and chemical properties of groundwater due to their solubility. These rocks consist of calcium carbonate CaCO_3 in the case of limestone and a compound of calcium carbonate and magnesium CaMg(CO_3)_2 in the case of dolomite. Limestone and dolomite formations often act as a water basin, which are porous underground layers that allow the storage and transport of groundwater [(4).] .

The increased permeability in these rocks can allow contaminants to move more easily through the groundwater system [(5).]

When water interacts with limestone and dolomite, carbon dioxide (Co2) can be exchanged between the water and the rock. This process plays a role in carbon cycling and may affect the overall carbon balance in the groundwater system [6].
Hence, the effect of limestone and sand rocks on the physical and chemical properties of groundwater is evident in various ways that depend on factors such as the composition of the rocks, their porosity and permeability, and specific geochemical interactions between water and rock. Therefore, limestone rocks are often an important water basin, as they provide an important medium for storing and transporting groundwater thanks to its porosity and permeability [7].

Second: Quaternary time deposits:

Internal sabkha sediments:

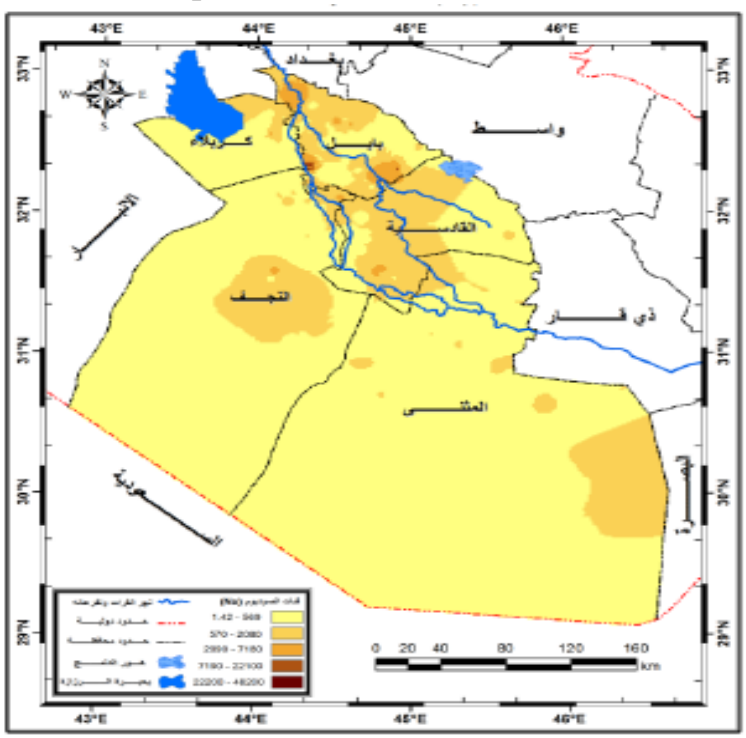
Salt flats occupy multiple areas of the lower part of the alluvial plain, and the study area is one of them. These deposits are formed as a result of the evaporation of surface water that is highly salinity, in addition to groundwater near the surface by capillary action, which leaves a dense salt cover [8]. Therefore, the presence of salt deposits In aquifers it can significantly affect the physical and chemical properties of groundwater. As salt deposits can contribute to increased salinity in groundwater, high levels of salinity may lead to an increase in the total amount of dissolved steel, which may make the water unsuitable for some uses such as drinking and irrigation[9].

This affects the level of electrical conductivity: salty groundwater has a higher electrical conductivity due to the presence of dissolved salt in it. Electrical conductivity is a basic indicator for evaluating the general quality of groundwater [10], and the reason for the increase in the electrical conductivity index of groundwater in the study area is due to the presence of this The deposits are in the southwestern side of the governorate. The area of these deposits is about (382,341) km2, representing (4.69)% of the area of the governorate [11].

The main source of sodium ions is the dissolution of minerals that make up salt rocks in places where evaporites spread, especially the mineral halite (NaCl). Sodium salts are characterized by a high solubility, and their precipitation does not occur except when their concentrations exceed the saturation limit [12].

This explains the increasing deterioration of groundwater quality within the western regions of Al-Qadisiyah Governorate in terms of sodium (Na) concentration, see map (2). It is also clear that the highest level of potassium concentration is located in the southwestern parts of the governorate.

Map (2) Spatial variation of sodium concentration in groundwater within the governorates of the Middle Euphrates



المصدر: محمد خضير كلف الحويس، تقييم الملائم المكانية بين العوامل الطبيعية واستعمالات الارض بمحاصيل الحبوب في محافظات الفرات الاوسط باستخدام (GIS)، اطروحة دكتوراه، كلية الآداب، جامعة القادسية، ٢٠٢٢، ص١٩٨.

What explains the concentration of chemical elements in the groundwater of Al-Qadisiyah Governorate is that the slow movement of groundwater in these parts of the governorate increases the contact between rocks and water, which results in an increase in the concentration of dissolved materials in the water [13]. See Table (1), as it is noted that the relative decrease in water movement in Al-Nouriya and Ghams.

Table (1) Variation in the rate of moving groundwater levels in Al-Qadisiyah Governorate

عدد الابار الكلي	مكان الآبار التي تم تحليل مياهها	عدد الآبار المحللة	معدل اعماق الابار (م)	معدل منسوب الماء المستقر(م)	معدل منسوب الماء المتحرك(م)	معدل الماء المتدفق لترا/ثا
1271	الديوانية	14	22.07	3.96	10.68	4.07
	عفك	10	11.8	3	7.7	2.4
	الحمزة	7	32	5.71	14.43	5.57
	الشامية	1	12	4	8	2
	النورية	1	12	3	9	3
	غماس	1	12	3	8	2
	ال بدير	1	12	3	8	3
المعدل العام		35	16.98	3.61	9.63	3.34

المصدر: محمد خضير كلف الحويس، تقييم الملائم المكانية بين العوامل الطبيعية واستعمالات الارض بمحاصيل الحبوب في محافظات الفرات الاوسط باستخدام (GIS) ، اطروحة دكتوراه، كلية الآداب، جامعة القادسية، ٢٠٢٢، ص١٤٠.

The first section: factors affecting the quality of groundwater

2- The effect of surface water pollution on the characteristics of groundwater

The origin of groundwater is due to the water of rivers and reservoirs, whose paths are determined by the topography of the earth and the nature of the water-bearing rocks [14].

Buringh (1960) also showed that the deep groundwater in central and southern Iraq is likely to be in contact with seawater [15], and since the drainage projects that drain their water into the main rivers in Iraq have led to an increasing contribution to raising the salt values in these rivers because Such salty water pollutes river water [16]. Studies have shown a relative increase in the concentration of salts in Al-Shinafiyah to (2630 parts per million) and in Samawah, ranging between (2070 - 2759 parts per million). This indicates the high content of the water of harmful ions [17], as these rivers receive groundwater during periods of humidity and lose water. By seeping into the canal bottom during periods of drought [18]. See figure (1)

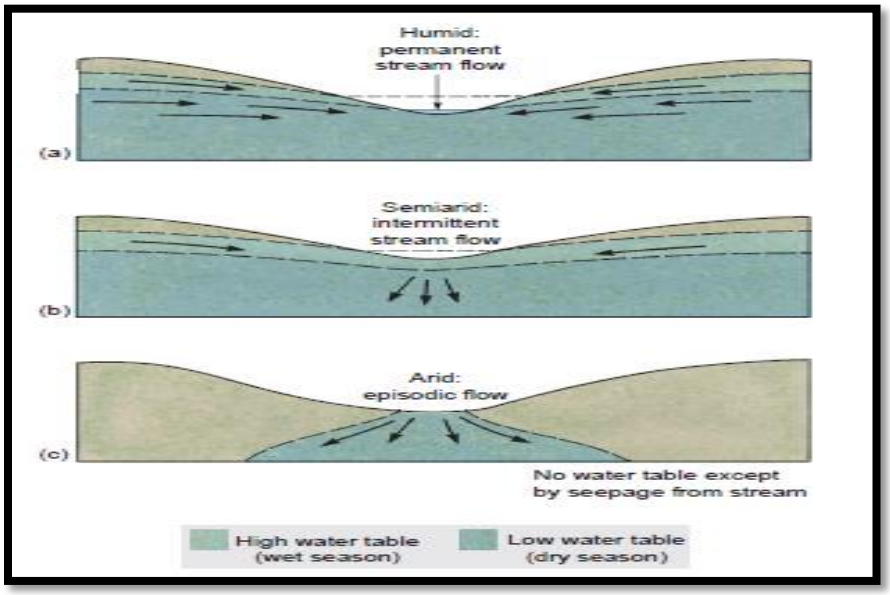
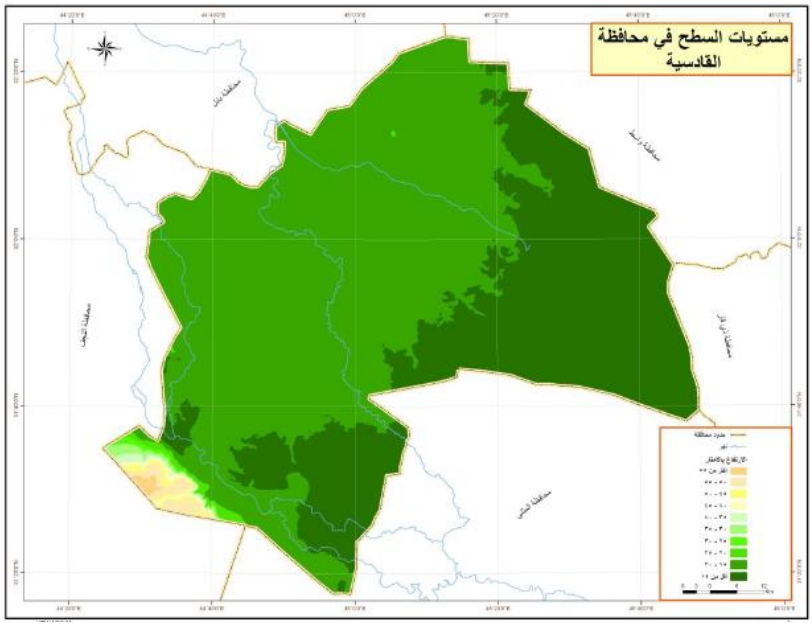


Figure (1) Water exchange between rivers and groundwater during times of drought and rain

Source: James F. peterson, and others, fundamentals of physical, geography, U.S. A, 2011, p: 314

Anthropogenic activities also contribute to the increasing effectiveness of rivers in polluting the quality of groundwater through agricultural practices, industrial secretions, and the disposal of used water. More salt enters the river water. If this water contaminated with salt reaches the groundwater, it may affect the salinity. Al-Jawf water [19].

In addition to excessive use of fertilizers, agricultural drainage water, and improper disposal of wastewater by introducing an additional amount of nitrates into river water [20], in some cases, the acidity of river water may be higher than the acidity of ground water. When river water interacts with ground water, it can The acidity of the river water reduces the acidity of the ground water, which leads to a decrease in its acidity [21]. What increases the chances of exchanging pollutants between the ground and surface water represented by river water is the low slope of the surface, which is reflected in the relative slowness of the movement of river water and streams in Al-Qadisiyah Governorate. See map. (4)



Map (4) surface levels in Al-Qadisiyah Governorate.

Source: Yahya Hadi Muhammad Al-Mayali, Atlas of Al-Qadisiyah Governorate (a study of regional maps), Master's thesis, College of Education, University of Basra, 2009, p. 11.

Table (2) shows the spatial variation in the concentration of indicators of the physical characteristics of surface water (rivers) in Al-Qadisiyah Governorate in terms of the standard degree for those indicators.

Table (2) Classification of the physical characteristics of river water within Al-Qadisiyah Governorate in terms of standard degree.

الموقع	الحرارة درجة(م)	الحامضية(ph)	الذائبة الاملاح(TDS)ملغرام/لتر	الكهربائية التوصيلةEC(ديسميتر/م)	النترات2Na(ملغم/لتر)
الديوانية شط-الدغارتصدر	-0.79	1.5	-0.61	-0.67	-2.02
الديوانية شط-الديوانية ماءمشروع	0.04	0.66	-0.55	-0.55	0.36
الديوانية نسيج معمل خلف الديوانية شط	0.04	-0.16	-0.45	-0.53	0.69
الشامية شط	-1.41	-0.16	0.31	0.48	0.15
الشنافية شط-الشنافية جسر	1.29	-1.83	1.9	1.88	0.58
الدغارة شط- عفك محطة	0.87	0.66	-0.59	-0.6	0.26

المصدر بالاعتماد على:

١- محمد خضير كلف الحويس، تقييم الملائم المكانية بين العوامل الطبيعية واستعمالات الارض بمحاصيل الحبوب في محافظات الفرات الاوسط باستخدام (GIS) ، اطروحة دكتوراه، كلية الآداب، جامعة القادسية، ٢٠٢٢، ص١٦٥.

٢- استخراج الدرجة المعيارية لمؤشرات الخصائص الفيزيائية بالاعتماد على

سامي عزيز عباس العتبي، اياد عاشور الطائي، الاحصاء والنمذجة في الجغرافية، مطبعة اكرم، بغداد، ٢٠٠٩، ص١٢٦.

Through Table (3), the highest concentration of physical indicators that have a negative impact on the quality of groundwater is represented in the Shinafiya River -

Shinafiya Bridge, while the lowest concentration of the same indicators appeared in the Diwaniyah River - Sadr Al-Daghara.

Table (3): Classification of physical water properties in terms of standard grade average

الموقع	معدل الدرجة المعيارية	تصنيف المياه بحسب الجودة
شط الديوانية-صدر الدغارة	4.2	درجة اولى
شط الديوانية -مشروع ماء الديوانية	3.6	درجة ثانية
شط الديوانية خلف معمل نسيج الديوانية	3.6	درجة ثانية
شط الشامية	3.6	درجة ثانية
شط الشنافية -جسر الشنافية	2	درجة رابعة
شط الدغارة- محطة عفك	3.4	درجة ثالثة

Source: Surface water classification was extracted by extracting the average standard score for all indicators of physical properties based on Table (2)

3- The effect of soil on the qualitative characteristics of groundwater

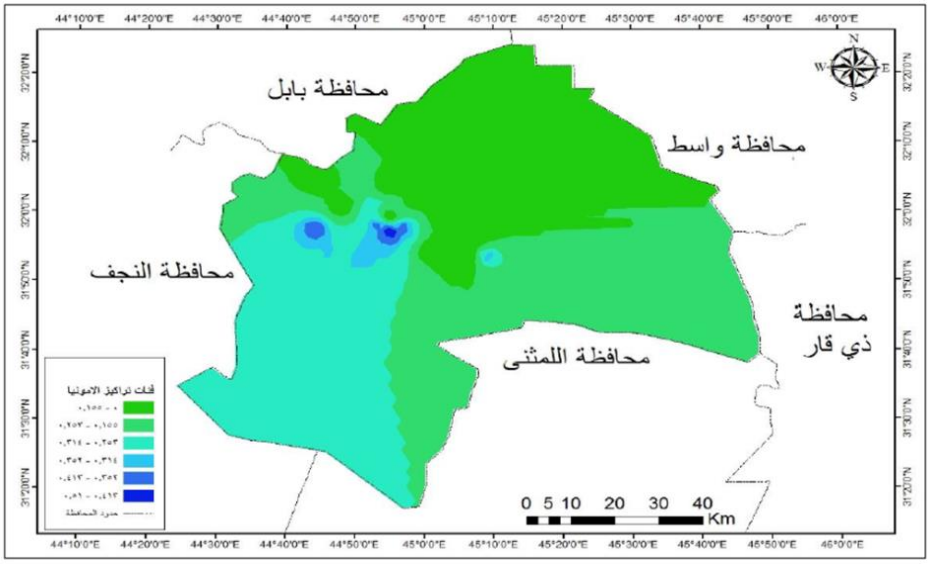
Saline soil in Iraq occupies vast areas estimated at about (60-70%) of the agricultural land area [22], but the rate of salinization has increased relatively in the last fifty years due to the adoption of intensive agriculture and the expansion of irrigation [23].

First: soil contamination with ammonia

Recent studies have proven that increasing ammonia concentrations in the soil have a negative impact on the quality of groundwater, as the transfer of ammonia from the soil to groundwater can occur through a process called filtration, where excess ammonia is carried to the aquifer through seepage [24]. Ammonia can dissolve in water and turn into ammonium ions (NH_(4+)), which are soluble Once they reach the groundwater, these ammonium ions can persist for a relatively long period of time [25].

Map (5) shows the relative increase in the level of ammonia concentration in the western parts of Al-Qadisiyah Governorate. This had a negative impact on the quality of groundwater in the western parts of the governorate due to the unregulated use of irrigation water.

Map (5) Spatial variation of soil pollution with ammonia concentrations (NH_3) in Al-Qadisiyah Governorate during the summer.



المصدر: زهراء مهدي عبد الرضا العبادي، التباين المكاني لمشكلات التربة في محافظة القادسية، اطروحة دكتوراه، كلية الآداب، جامعه الكوفة، ٢٠١٦، ص٢٨٦.

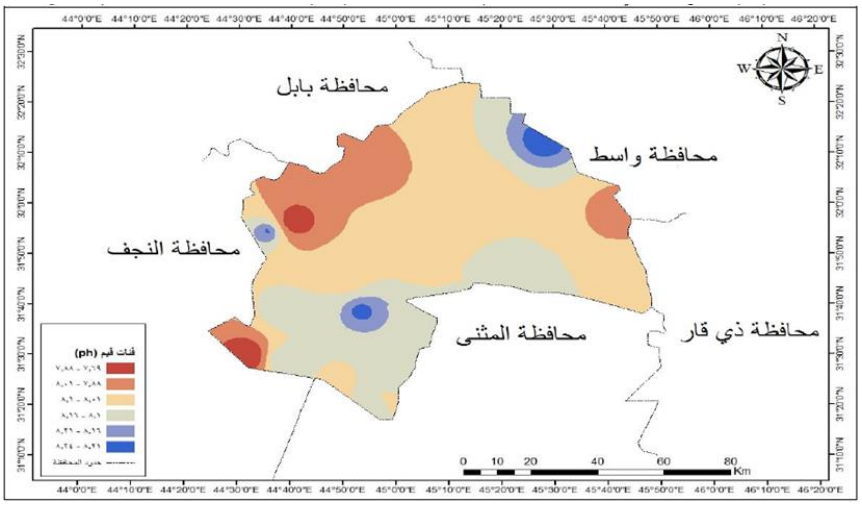
What explains the increased effectiveness of transporting soil pollutants through suboptimal use of water, especially in the summer, is the lack of water drainage due to the low slope of the surface across a wide area of Al-Qadisiyah Governorate.

Second: Degree of soil interaction (P^H):

It is the negative logarithm of hydrogen ion activity and is called the acidity and basicity values of the soil, which can be symbolized quantitatively by the degree of soil reaction (P^H), where the soil is acidic when the values of (P^H) are less than 7 and the reaction is basic when its value is (P ^H) is more than (7), but if the values of (P^H) are equal to 7, they mean neutral acidity values that express the degree of reaction of very pure water [26]. Determining the pH of water is one of the basic requirements because the hydrogen ion concentration is Important variables in all interactions related to water quality [27].

Through map (6), it is clear that there is a relative increase in the degree of soil interaction (PH) in the far northwest of the governorate and scattered spots in the far southwest and northeast, which indicates that there is an increase in the alkalinity of the soil in these places as a function of the (PH) index.

Map (6) Spatial variation of average soil reaction (P^H) values for the soil of Al-Qadisiyah Governorate during the winter.

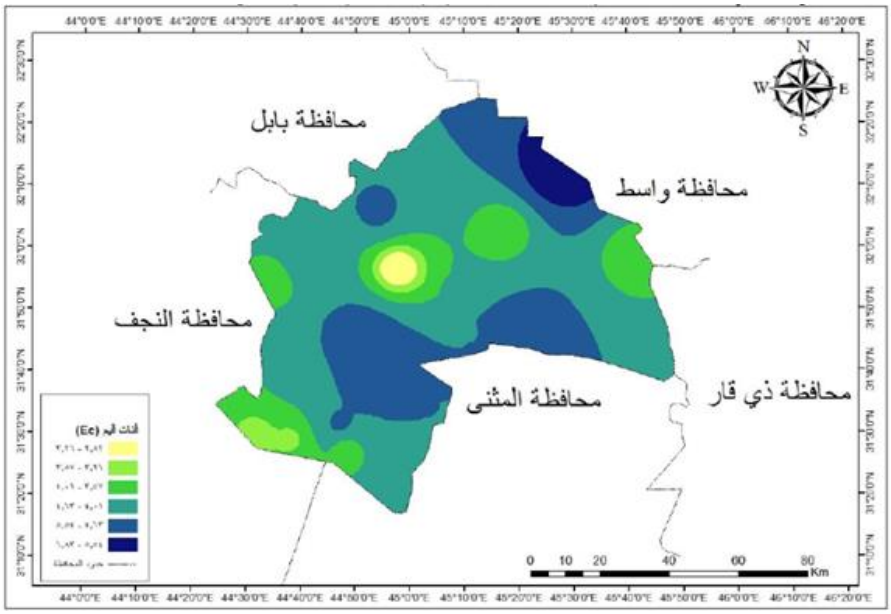


المصدر: زهراء مهدي عبد الرضا العبادي، التباين المكاني لمشكلات التربة في محافظة القادسية، اطروحة دكتوراه، كلية الآداب، جامعة الكوفة، ٢٠١٦، ص١٣٥.

Third: Electrical conductivity (EC)

It is the ability of soil to conduct electrical current. In water, electrical current is transmitted through the ions dissolved in it. Therefore, natural water is an excellent conductor, as electrical conductivity has a direct relationship with the concentrations of dissolved ions [28]. Electrical conductivity, as one of the general indicators, depends on the quality of water and soil, and it is the quickest estimate. It is an approximation of the total dissolved materials in water [29]. Thus, the EC index is one of the prominent features in the soils of dry and semi-arid regions and is considered one of the most common soil problems, as the excess amount of salts in the soil turns it into saline or saline-alkaline soil, and soil salinity is evidence of... The degree of concentration of total dissolved salts in the soil, which includes chlorides, sulphates, and carbonates of sodium, magnesium, calcium, and potassium [30]. Through map (7), the spatial variation in the level of electrical conductivity (EC) in the soil of Al-Qadisiyah Governorate in the winter is clear. It also provides the opportunity for salts to leak into Places with the highest electrical conductivity to increase the alkalinity of groundwater.

Map (7) Spatial variation of electrical conductivity values in decimens/m during the winter season for the soil of Al-Qadisiyah Governorate.



المصدر: زهراء مهدي عبد الرضا العبادي، التباين المكاني لمشكلات التربة في محافظة القادسية، اطروحة دكتوراه، كلية الآداب، جامعة الكوفة، ٢٠١٦، ص١٤١.

Salts leak from the soil into groundwater through the movement of water through the soil through seepage, which is the process of water flowing downward as a result of gravity, while the water seeps through the soil, carrying the dissolved salt with it and moving toward the proximity of the groundwater layer [31], after reaching the carrying capacity of the soil. The pores are full and excess water can escape from the surface and flow downward as gravitational water. seen form ( )

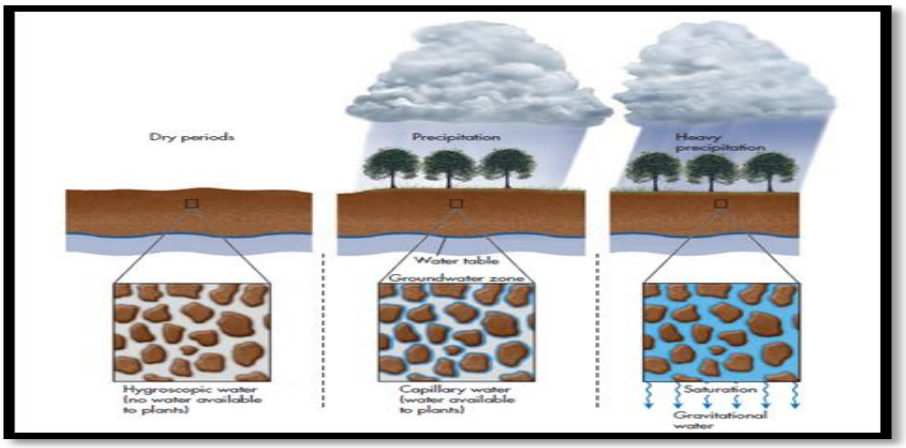


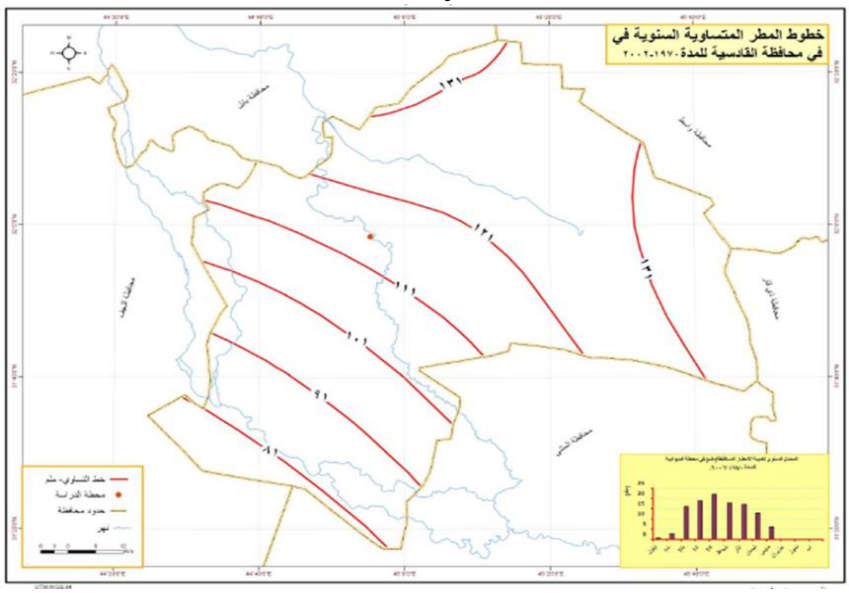
Figure ( ) Mechanism of water seepage as a source of groundwater during the wet and dry seasons.

Source: Alan F. arbogast, Dis Covering physical geography, third edition, Michigen state university, 2014, P: 390

When rain or excess irrigation water penetrates the soil, it may help filter out some of the salt and push it deeper into the soil structure, leading to salt accumulation in the root zone and ultimately in groundwater [32].

The reason for the accumulation of salts in the soil, especially in the upper part, is the result of the absence of complete natural or artificial drainage and the flatness of the ground, which led to a rise in groundwater levels that are charged with salts and have become part of the capillary property of the soil surface [33]. Also, the cessation of rainfall in the summer and its decrease in The winter season, see map (8), has a role in increasing the rate of evaporation and achieving a negative hydro-climatic balance due to the lack of relative humidity in the air and the rise in temperatures during the long hot season. The rise in temperatures works to increase the amount of evaporation from water surfaces or irrigated and wet lands, and this rise in Temperatures work to move the water vapor pressure in the soil easily within its areas. As in all gases, it moves from areas of high pressure to areas of low pressure. There is a control of water vapor at the surface, and throughout the hot season it is little due to the high temperatures and the absence of rain, while its amount is in the layer. The lower part of the soil is high, so the water in the soil moves from the bottom to the top according to the capillary property [34].

Map (8) equal annual rain lines in Al-Qadisiyah Governorate.



المصدر: يحيى هادي محمد الميالي، اطلس محافظة القادسية (دراسة في الخرائط الاقليمية)، رسالة ماجستير، كلية التربية، جامعة البصرة، ٢٠٠٩، ص٢٣.

Poor drainage of water from the soil due to the lack of a field drainage network in the soil of arid cultivated areas with a limited land slope, as well as limited

drainage, has an effective role in the accumulation of irrigation water in the soil and thus evaporation and the formation of salts [35], which leads to increasing concentrations of salts in groundwater. .

In addition to poor irrigation, the study area suffers from a lot of wastage of irrigation water. The percentage of water losses through filtration, transportation, and water regulation was estimated at 45%, surface runoff losses at 17%, ground seepage losses at 23%, and evaporation losses at 4%. Only 11% of the irrigation water remaining in the field remains. . This directly leads to an increase in salts in the soil on an ongoing basis as long as irrigation is in its current form [36].

The second section: Evaluating the quality of groundwater as a function of the average standard score for physical and chemical properties

1- Evaluating the quality of groundwater in terms of the average standard score for physical properties

A- Evaluation of the concentration of total dissolved salts (T.D.S).

Studies have shown that there is a temporal variation in the level of concentration of total dissolved salts (T.D.S.) within the groundwater in Al-Qadisiyah Governorate, as a relative increase was observed in the summer, with the average reaching (3590 mg/L), and decreasing in the winter to reach (3120 mg/L) (37 In both cases, the amount is higher than the Islamic Organization's standard (ISEC1), so groundwater is not allowed for irrigation. See Table (4)

Table (4) Water quality index for irrigation purposes according to the standard of the Islamic Educational, Scientific and Cultural Organization

معامل المياه	الرمز	الوحدة	المعدل المعتاد في مياه الري
الاس الهيدروجيني (الحامضية/القاعدية)	PH	1 – 14	6 – 8.5
التوصيلة الكهربائية	EC	ديسمينز / م	0 - 3
مجموع الاملاح الذائبة	TDS	ملغم / لتر	0 – 2000
النترات	No_3	ملغم / لتر	0 – 10
الكلوريدات	CL	ملغم / لتر	0 – 540
الكبريتات	So_4	ملغم / لتر	0 – 960
الكالسيوم	Ca	ملغم / لتر	0 – 360
المغنيسيوم	Mg	ملغم / لتر	0 - 90
الصوديوم	Na	ملغم / لتر	0 – 720
البوتاسيوم	K	ملغم / لتر	0 – 20

Source: R.S. Ayers and D.W. Westcot, Water Quality for Agriculture, Irrigation and drainge paper 29. Rev.1. FAO. Roma, Italy, 1985, p:10.

نقلاً عن: محمد خضير كلف الحويس، تقييم الملائمة المكانية بين العوامل الطبيعية واستعمالات الارض بمحاصيل الحبوب في محافظات الفرات الاوسط باستخدام نظم المعلومات الجغرافية (GIS) ، اطروحة دكتوراه، كلية الآداب، جامعة القادسية، ٢٠٢٢، ص١٦٣.

B- Evaluation of groundwater quality in terms of electrical conductivity (EC)

The latest study to measure electrical conductivity (EC) as a function of the concentration of salts in groundwater within Al-Qadisiyah Governorate revealed that the general average of the index reached (4.11 mm/cm). According to the American Salinity Laboratory classification standard for irrigation water, groundwater in Al-Qadisiyah Governorate is considered unsuitable. For irrigation of agricultural lands, despite the spatial variation of the index, as it reached its highest amount in Al-Hamza District, where it reached (4.50 mm/cm), and its lowest amount in Al-Diwaniyah District, where the index reached (3.83 mm/cm) [38].

2- Evaluating the quality of groundwater in terms of the average standard score for chemical and physical properties

The statistical treatment of indicators of the chemical and physical properties of groundwater quality in Al-Qadisiyah Governorate revealed that the lowest level of deterioration of groundwater quality appeared in Al-Budair with an index of (5) as an average of the standard score, while the highest level of deterioration appeared in well sites in Al-Diwaniyah District with an index of (1). ,44), At the same time, all of the studied well sites do not have water suitable for irrigation of agricultural crops or drinking purposes because they are outside international standards for water quality. See Tables (5), (6), (7), and (8).

Table (5): Chemical and physical properties of groundwater

موقع البئر	PH(1-14)	TDS(ملغرام/لتر)	EC(ديسمينز/م)	الكلوريدات (Cl)(ملغم/لتر)	الكبريتات(SO4) (ملغم/لتر)	الكالسيوم(CA)(ملغم/لتر)	المغنيسيوم(Mg)(ملغم/لتر)	الصوديوم (Na)(ملغم/لتر)	البوتاسيوم(K)(ملغم/لتر)
الديوانية	7.2	10004	13.31	1658.5	1701.2	561.1	234.1	1133.9	116.6
عفك	7.31	4122	6.35	770.9	979.9	293.4	118.6	557.1	35.2
الحمزة	7.3	5485	8.22	971	1222.6	365.9	182.3	675.4	48.1
الشامية	7.3	3000	1.26	308	665	182	81	326	4
النورية	7.5	5720	8.64	1062	1754	460	250	806	20
غماس	7.12	2050	3.14	265	595	142	100	150	19
ال بدير	7.2	1980	3.14	256	570	135	93	136	15
الانحراف المعياري	0.121361326	2810.472143	4.156865234	523.8279311	506.1823542	165.3535678	70.23827135	365.8797649	37.96585559
المعدل	7.27	4623	6.29	755.9	1069.67	305.62	151.28	540.62	36.84

المصدر: محمد خضير كلف الحويس، تقييم الملائمة المكانية بين العوامل الطبيعية واستعمالات الارض بمحاصيل الحبوب في محافظات الفرات الاوسط، اطروحة دكتوراه، كلية الآداب، جامعة القادسية، ٢٠٢٢، ص١٩٥.

Table (6): Standard score for chemical and physical properties of groundwater

موقع البئر	PH(1-14)	TDS(ملغرام/لتر)	EC(ديسمينز/م)	الكلوريدات (Cl)(ملغم/لتر)	الكبريتات(SO4) (ملغم/لتر)	الكالسيوم(CA)(ملغم/لتر)	المغنيسيوم(Mg)(ملغم/لتر)	الصوديوم (Na)(ملغم/لتر)	البوتاسيوم(K)(ملغم/لتر)
الديوانية	-0.58	1.91	1.69	1.72	1.24	1.54	1.17	1.62	2.1
عفك	0.33	-0.17	0.01	0.02	-0.17	-0.07	-0.46	0.04	-0.04
الحمزة	0.25	0.3	0.46	0.41	0.3	0.36	0.44	0.36	0.29
الشامية	0.25	-0.57	-1.21	-0.85	-0.79	-0.74	-1	-0.58	-0.86
النورية	1.91	0.39	0.56	0.58	1.35	0.93	1.4	0.72	-0.44
غماس	-1.25	-0.91	-0.75	-0.93	-0.93	-0.98	-0.73	-1.06	-0.46
ال بدير	-0.58	-0.94	-0.75	-0.95	-0.98	-1.03	-0.82	-1.1	-0.57

Source: Surface water classification was extracted by extracting the average standard score for all indicators of physical and chemical properties based on Table (5)

Table (7) Classification of groundwater quality in terms of the standard degree of chemical and physical properties.

موقع البئر	PH(1-14)	TDS(ملغرام/لتر)	EC(ديسمينز/م)	الكلوريدات (Cl)(ملغم/لتر)	الكبريتات(SO4)(ملغم/لتر)	الكالسيوم(CA)(ملغم/لتر)	المغنيسيوم(Mg)(ملغم/لتر)	الصوديوم (Na)(ملغم/لتر)	البوتاسيوم(K)(ملغم/لتر)	المعدل
الديوانية	5	1	1	1	1	1	1	1	1	1.44
عفك	3	4	3	3	4	4	4	3	4	3.55
الحمزة	3	3	3	3	3	3	3	3	3	3
الشامية	3	5	5	5	5	5	5	5	5	4.77
النورية	1	3	2	2	2	1	2	2	4	2
غماس	5	5	5	5	5	5	5	5	4	4.88
ال بدير	5	5	5	5	5	5	5	5	5	5

Source: Surface water classification was extracted by extracting the average standard score for all indicators of physical and chemical properties based on Table (6)

Table (8): Classification of groundwater quality in terms of standard grade rate, chemical and physical properties.

موقع البئر	معدل الدرجة المعيارية	تصنيف المياه بحسب الجودة
الديوانية	1.44	درجة سابعة
عفك	3.55	درجة رابعة
الحمزة	3	دردة خامسة
الشامية	4.77	درجة ثالثة
النورية	2	درجة سادسة
غماس	4.88	درجة ثانية
ال بدير	5	درجة اولى

Source: Surface water classification was extracted by extracting the average standard score for all indicators of physical and chemical properties based on Table (7)

The third section: Strategic management alternatives to reduce the deterioration of groundwater quality in Al-Qadisiyah Governorate

First: Strategic alternatives to reduce the negative impact of geological structure on groundwater quality

Many studies have proposed solutions in the form of alternatives to reduce the negative impact of the dissolution of limestone and salt rocks on groundwater quality. Here are some strategic alternatives:

(1) Water Quality Monitoring

Establish a comprehensive water quality monitoring program to continuously monitor and evaluate the quality of groundwater. This data will help understand the extent of the problem and evaluate the effectiveness of the strategies used [39].

(2) Managed Aquifer Recharge - MAR

Applying controlled charging techniques to the groundwater basin to refill groundwater with high-quality water, which reduces the dissolution of dissolved minerals from limestone and salt rocks. This can be achieved through industrial charging methods such as injecting treated surface water or treated wastewater into the basin.

Subterranean[40].

(3) Source Water Protection

Focus on protecting groundwater sources from pollution, as pollution can increase the impact of dissolved metals through the application of legal legislation that ensures the best management to prevent pollution resulting from human activities near groundwater recharge areas [41].

(4) Enhanced water treatment:

Developing advanced water treatment technologies specifically designed to remove dissolved minerals, salts, and other pollutants from groundwater affected by the dissolution of limestone and salt rocks. Technologies such as reverse osmosis and ion exchange can be effective in groundwater storage [42].

Second: Strategic alternatives to reduce the negative impact of polluted surface water on groundwater quality

The purpose of reducing the impact of surface water pollution on the deterioration of groundwater quality requires a combination of preventive measures and management strategies.

Here are some strategic alternatives to help achieve this goal:

(1) Water Quality Monitoring:

Establish a comprehensive water quality monitoring program to track levels of pollutants in river water and discover impacts on groundwater. This data can guide management decisions in a timely manner [43].

(2) Source control and pollution prevention:

Focus on preventing pollution to river water at its source by promoting responsible waste disposal, avoiding the use of harmful chemicals, and promoting sustainable practices in all sectors and economic activities inside and outside cities [44].

(3) Agricultural Best Management Practices (BMPs)

Encouraging and enforcing better agricultural management in accordance with the philosophy of sustainable agricultural development with the aim of reducing the use of pesticides and fertilizers, properly managing waste and plowing in a way that reduces soil erosion and runoff [45].

(4) Storm water management:

Implementing effective practices for managing flood water that flows into rivers to reduce the transfer of pollutants from urban areas and solid surfaces to river water that feeds groundwater. This can be done through the use of enclosed roofs, green roofs, and retention barriers [46].

(5) Public Awareness and Education:

Raising the public awareness about the interrelationship between surface water and groundwater and how pollution can affect water resources, educating communities about the ways in which they can contribute to maintaining water quality, given that humans are the focus of sustainable development in its comprehensive perspective[47].

(6) Collaborative Approaches:

Strengthening cooperation between government agencies, industries, communities, and non-governmental organizations to develop integrated strategies to reduce river water pollution, considering it a source of groundwater pollution [48].

Third: Strategic alternatives to reduce the negative impact of soil with a high concentration of salts on the deterioration of groundwater quality.

The purpose of reducing the impact of agricultural pollution and soil pollution on the deterioration of groundwater quality requires a combination of preventive measures and improvement strategies.

Here are some alternatives to help mitigate the effects of agricultural and soil pollution on groundwater quality:

(1) Environmental monitoring and early warning systems

Implementing a comprehensive environmental monitoring program to detect changes in groundwater quality at an early stage. Early warning systems can help determine the potential effectiveness of soil pollution in groundwater pollution and allow immediate action to be taken to reduce the impact of soil pollution in groundwater deterioration [49].

(2) Land Use Planning:

Implementing appropriate land use planning to ensure that activities that could cause soil contamination are far from groundwater well areas, can thus help reduce the risk of groundwater contamination due to contaminated soil [50].

(3) Permeable Reactive Barriers (PRBs):

Install permeable response barriers, which consist of reactive materials along the flow path of contaminated groundwater to intercept and treat pollutants. Permeable response barriers can help prevent the transfer of pollutants from soil to groundwater[51].

(4) Cleaning contaminated sites:

Identifying polluted sites and intervening to clean them to prevent the spread of pollutants into the soil and thus into groundwater. Techniques such as soil vapor extraction, biological cleaning, and chemical oxidation can be used to effectively clean polluted sites, as proven by the latest studies [52].

(5) Water purification with plants:

Using plants to absorb, accumulate, and decompose pollutants in the soil, and plant-based water technology can be effective in mitigating the impact of agricultural pollution on groundwater quality, especially in areas where traditional purification methods may not be possible [53].

(6)Source control and pollution prevention

Implementing source control measures to prevent pollutants from entering the soil from the beginning, and this includes implementing a strategy for managing and regulating agricultural, industrial, and sanitary wastewater to reduce soil pollution [54].

(7) Public Awareness and Education:

Educating the community and stakeholders within all economic activities about the risks of soil pollution and its effects on groundwater. Raising awareness can lead to achieving more responsible practices and community participation in protecting groundwater resources [55].

research results

1- The research yielded the result that the concentrations of total dissolved salts (T.D.S.) in all groundwater well sites within Al-Qadisiyah Governorate are higher than the permissible limit for the purpose of irrigation according to the Islamic Organization for Water Quality (ISEC1) standard.

2- The research also revealed that all locations of artesian wells for groundwater in Al-Qadisiyah Governorate are higher than the permissible limit according to the electrical conductivity index (EC) as a function of salt concentration, as the general average of the index reached (4.11 mmH/cm), which is an indicator outside the permissible limit. It is used for irrigation and drinking purposes according to the American Salinity Laboratory classification standard.

3- The process of classifying groundwater quality by adopting statistical treatment of a database that represents the chemical and physical characteristics of groundwater in terms of the average standard score was revealed as a tool for classifying groundwater quality according to the locations of wells within the districts and districts of Al-Qadisiyah Governorate. The results of the classification showed - that the lowest level of groundwater deterioration appeared in Al-Budair district, and the highest level of deterioration in Diwaniyah district, despite the fact that all

administrative units within the governorate are outside the permissible limit according to internationally and locally approved standards.

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