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The Impact of Groundwater Salinity on the Quality of Agricultural Crops in Ishaqi Area Using GIS

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Abstract: The study of the effect of groundwater salinity on the quality of agricultural crops in the Ishaqi area aims to identify the percentage of salts of groundwater in the region and to identify areas of high and low percentage as well as to determine the spatial distribution of groundwater abundance to be relied upon in determining the areas of distribution of different agricultural crops from Through the adoption of modern geographic technologies (GIS) to advance the reality of groundwater in the region and benefit from it in various investments by analyzing the hydrological characteristics of the groundwater spatially and its chemical analysis, studies have reached several The most important results:

- The diversity of agricultural crops, the diversity of water quality and the percentage of their salts.
- Increase in the number of wells in the area due to the lack of an irrigation project and the expansion of the area of cultivated land.
- The presence of variations in the proportions of salts and the concentrations of negative and positive ions, which in turn affected the difference in the type of crops grown in the region.
- The obvious variation of groundwater in the region in terms of density and numerical distribution affected by climatic fluctuations and other natural factors as well as the influence of human factors.
- The importance of using modern technologies in the study of groundwater through the analysis and conversion of raw spatial data into a digital database for the benefit of them in the analysis and preparation of hydrological models.

Keywords: Groundwater Salinity, Agricultural Crop Quality, GIS Analysis, Hydrological Characteristics, Irrigation Water, Spatial Distribution, Soil Salinity.

Introduction:

Water is the backbone of life as the oldest civilizations were established on the banks of rivers such as the Mesopotamia civilization in Iraq, as water was used for various purposes in life in conjunction with scientific and technical development and a steady increase in the population, especially after the human life took its industrial, agricultural and commercial directions a broad horizon which This is offset by the limited water source on the one hand, and the damages suffered by the water sources in Iraq due to the neighboring countries represented by building dams on the rivers of Iraq from the source areas on the other hand, which led to heading to groundwater as an alternative to compensate for the shortage in the amount of surface water and from Na came the importance of research to clarify the role and importance of groundwater and investments in various fields (agriculture, industrial human residential) confirmed research specifically on the agricultural side.

1. The study problem: The research problem represents the first step of the research steps, and it is an unanswered question. The study started from a major problem: Does the salinity of groundwater affect the diversity of agricultural crops in the Ishaqi area? Secondary problems can be formulated with the following questions: Does the climate of the region affect the high level of salt in the groundwater in the region? What is the nature of the relationship between the salinity of the region's soil and groundwater?
2. The study hypothesis: The study hypotheses are an initial solution to the main problem and the secondary problems related to it, which can be formulated as follows: The salinity of groundwater has an impact on the diversity of agricultural crops in the Ishaqi area. The fluctuation in the climate of the region has an impact on the high percentage of salts in the groundwater. Mutual between the salinity of the region's soil and the salinity of the groundwater.

Objectives of the study: Targets are focused on ...

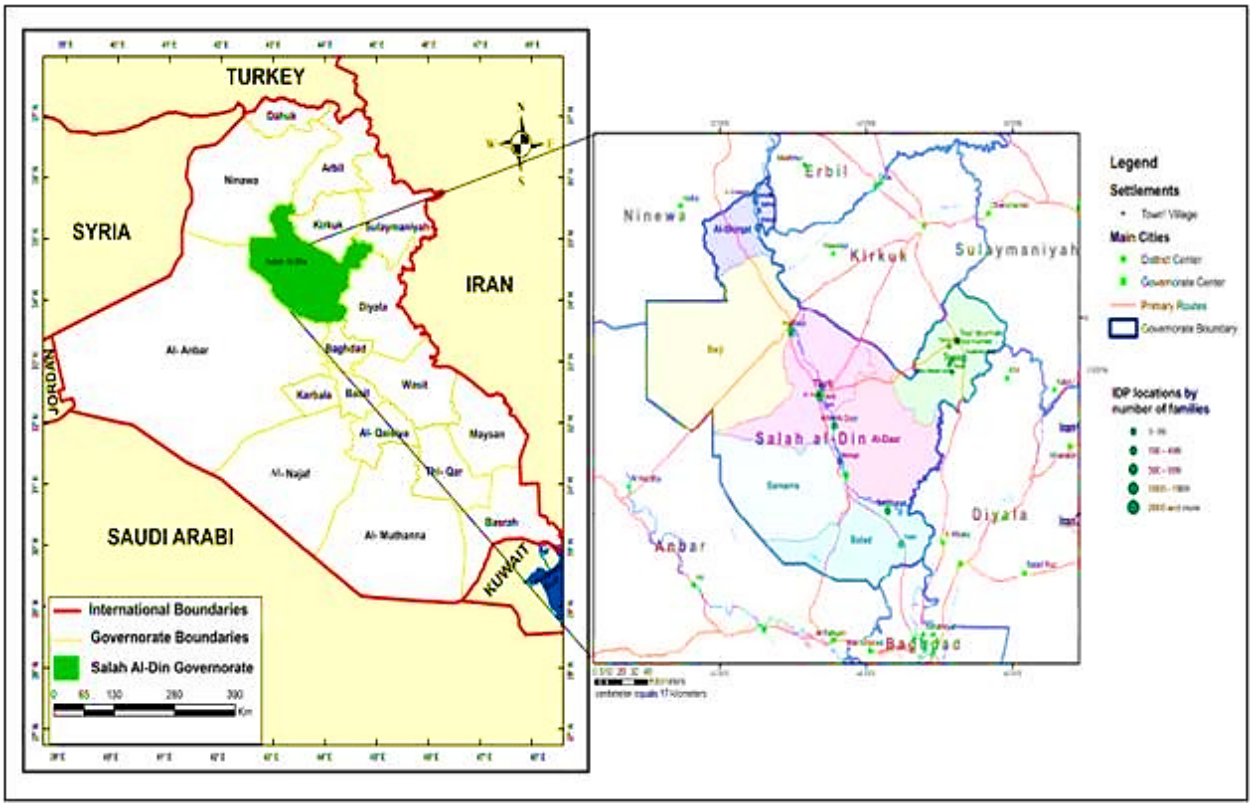
1. Explain the impact of the salinity of groundwater on agricultural production in the region.
2. To clarify the role of the human factor in the fluctuation in the percentage of salts, to indicate the degree of agricultural production dependence on groundwater and to determine the quality of the crop in the region.
3. Identify the effect of the region's climate on the fluctuation in the percentage of groundwater salts.

The importance of the study came to highlight the extent of the salinity of groundwater on the diversity of agricultural crops in the study area, as the problem of salinity of groundwater began to appear to threaten agriculture in the region, and reduce its productivity at a time when farmers are looking to increase production and improve its quality, because agricultural activity It is the economic basis in the region, therefore this study came to research the reasons for the high salinity in order to seek solutions and ways to limit its expansion.

The location of the study area: The coordinate site: Ishaqi is located between the latitudes (39, 33 and 051, 34) north and longitude (56, 43 and 05, 44) east and an area of 1779 km^2.

Geographical location: Ishaqi is in a district in the south of Salah al-Din Governorate, bordered on the north by the Samarra district, and on the south by the Faris district, and on the east by the course of the Tigris River, and on the west by the countryside of the Samarra district and Tharthar Canal, as shown in map (1)

Study methodology: An analytical method was used to clarify the effect of different natural factors on the study. In addition to adopting the descriptive approach to describe the natural position of the region through field studies, the adoption of climatic data for the Samarra station, topographic and geological maps and the use of geographical techniques (GIS) to facilitate the task and obtain more accurate results.



Map (1): Geographical Location of the Study Area

Source: The researcher depending on the outputs of the program (Gis v 10 3) **Section one: The natural factors affecting the groundwater in the study area.**

The natural factors of any region are of great importance, as geographical phenomena cannot be understood unless the natural properties are determined. Climate elements of heat, rain, and wind affect the amount of groundwater, as well as the geological structure, whose impact through nature and properties of rocks on the quality and movement of groundwater.

1. Geological structure: the natural characteristics of any region are exposed to many changes that occur to it, while a portion of it remains unchanged for a period of time in order for a simple change to occur and this follows the type of formations that have arisen from it and the extent of its influence on natural and human factors (1), as the structure The geology of any region has an influential role when studying groundwater, as it is determined through the knowledge of the structure of the region the location and depths of groundwater reservoirs, in addition to the fact that the structure has an effect represented by the nature and properties of general rocks in terms of their areas and chemical properties that affect the quality and movement of the groundwater (2). The geological structure includes several formations (Map 2) that represent the geology of the region, which is represented by the following:

The formation of the terrain opening: This composition consists of the succession of layers of gypsum rock and rock salt interfered with limestone, as well as marl rocks and soft rocks, which alternate in a systematic order in the form of successive cycles and the formation of the hole is one of the widespread and economically important structures in Iraq and spread in the southern part And southwest of the region (3).

Anjana Formation: This composition consists of the recovery of sandstone and red-colored clay rocks that have been deposited in river environments consisting of torsional and piezo rivers, which have traces of gradient upward and indicates the riverine and deltoic environment deposited in continental environments and spread in the top of the region Northwest.

Al-Bukhtari Formation: Late pliocene, which consists of traces of formation rocks and from two basic units, the lower and upper Bukhari, and it consists of girls' successions of agglomerated

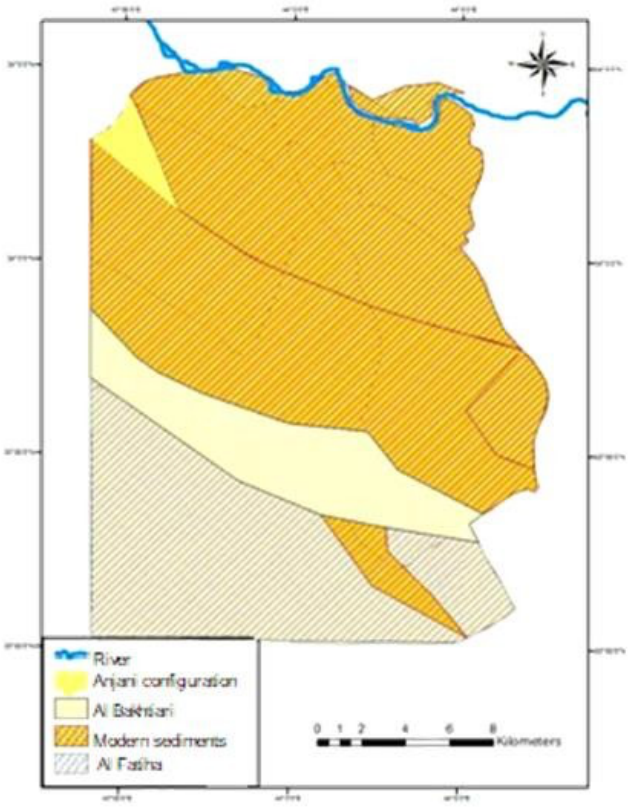
rocks, sandstone rocks, and alluvial stone containing mud lenses, which appear on the field in the form of solid layers showing their discoveries in the form of high antiweathering barriers Due to its high thickness it spreads as a strip that extends from southeast to central and southwest of the region.

Modern sediments: It consists of modern deposits from:

✓ Flood sediment deposits: which consist of successive high-porous, sedimentary deposits that represent reservoirs of water collected within fist fan environments.

✓ Flood plain deposits: Consists of successive crumbly sandy, alluvial and muddy sedimentary deposits deposited within riverine and valley environments. These sediments occupy areas in the form of narrow strips that follow the course of major rivers and valleys and represent the largest area of the study area from the center to the northeast and northwest, as shown in Map (2). (4).

2. **Surface manifestations**: surface manifestations mean the variation in the form of terrain, the degree of its slope, the amount of height and decline above sea level, and the surface of the study area is characterized by general extinction, as it falls within the sedimentary plain that is characterized by levelling in general and can be described as a flat area interspersed with some light terrain, and surface manifestations are One of the important geographical factors in the exploitation of groundwater by drilling wells of artesian and spring types and determining their water features (5), and surface features in the study area can be divided into the following divisions:



Map (2): Geology of the study area

Source: The researcher depending on the outputs of the program (Gis v 10 3)

Flood Plain: The study area forms the beginning of the customary sedimentary plain and the flood plain that appears as a lower area than its adjacent lands on the western side in the form of a longitudinal strip that extends along the Tigris River from entering the study area until it leaves it

on the south side. This plain is characterized by the level of its surface as General except for the small hills and what was found is the work of rivers or people, which helped to focus the population on this region because the lands are suitable for agricultural exploitation, especially the orchards and vegetables (6).

The area of the river terraces is one of the widest sections of the surface area in the study area and the oldest formation, and its surface is predominantly flat, and these are general manifestations in the region especially in the western parts of it and its extension outside the region until the low chatter and is characterized by the spread of gravel phenomenon in its formations. And the increase in the percentage of gypsum that ranges between (50-60%) mixed with sandy and salty beads, and this area rises from the flood plain area by between (7-12 m) and reaches its height in some areas to (54 m) above sea level.

The area of ancient river courses: This area extends to the south from the center of the Ishaqi side towards the southeast side to the outside of the study area, with the extension of the Tigris River and this area is lower than its adjacent lands, and the surface of this region consists of silt and silt and because of the decrease in parts of it, especially the course of the Tigris River The old ones were turned into brine depressions and intermittent swamps where reed and papyrus plants grew.

3. **Climate**: the climate means the average daily weather conditions throughout the period of observing years, and the extension of these years will be over a period of up to (30) years. Climate of any region), and the data of the Samarra station was relied upon to clarify the climatic elements in the region, and we will address the climate elements in detail, as follows:

Temperature: Temperature is one of the most important climatic elements that controls the distribution of water on the surface of the earth (8). Temperatures are one of the climate elements that affect the agricultural exploitation of the land. The reason for this effect is due to the nature of the relative difference in temperature in the study area. As temperatures rise to their highest levels in the month of July and reach (9-35) m and fall to their lowest levels to reach (9.7) in the month of January. As shown in Table 1, which clarifies climatic elements:

Table (1): Climatic Elements of the Study Area of the Year (1992-2022)

Months	Temperature ° Celsius	Rain mm	Relative humidity%	Evaporation mm	Wind m / s
January	7.9	29.2	78	70 .7	1.8
February	11.9	28.9	66	96.9	2.4
March	16.3	25.7	60	100.4	2.6
April	22.7	18.2	49	231.8	2.9
Mace	28.5	8.1	36	341.1	3.9
June	32.6	0.0	30	426.5	3.4
July	35.9	0.0	27	486.2	3.4
Father	35.4	0.0	30	464.2	3.1
September	31.5	0.75	33	337.8	2.5
October	25.0	8.4	45	256.7	2.3
November	16.7	23.9	60	140.3	1.9
December	11.6	28.3	77	78	1.6

Source*: Ministry of Transport and Communications, General Authority for Weather Forecast and Seismic Monitoring, Climate Department, Baghdad (unpublished data), 2022.*

Evaporation: Evaporation is defined as the transfer of water to the atmosphere from water bodies and transpiration from the plant. It also converts water from the liquid state to the gaseous state in which the air can carry vapor atoms, and the values of evaporated water depend on the nature of the air temperature and the degree of wind humidity that affects the movement Air and its renewal,

as the evaporation is directly proportional to the temperature, wind speed and breadth of the water surfaces, while inversely proportional to the relative humidity and salinity of the water, as it has a role in removing the moisture resulting from the evaporation over a specific area (9).

By observing the above table, the highest evaporation sum reaches (486.2) in the month of (July), but it is slowed down in the month of January to reach (70.7).

Relative humidity: Relative humidity is defined as the percentage of water vapor that is in the air and the amount of water vapor needed for the air to be saturated at the same temperature and pressure (10). From Table (2-1) the relative humidity rate increases in the winter season to reach its highest in the month of January, reaching 78%, while in the summer season in July it decreases to 27%. And that the variation between the summer and winter seasons in the amount of moisture led to a variation in the amount of evaporation from water bodies, soil and plants, and this in turn led to a variation in the ratio of the water leaking into the subterranean.

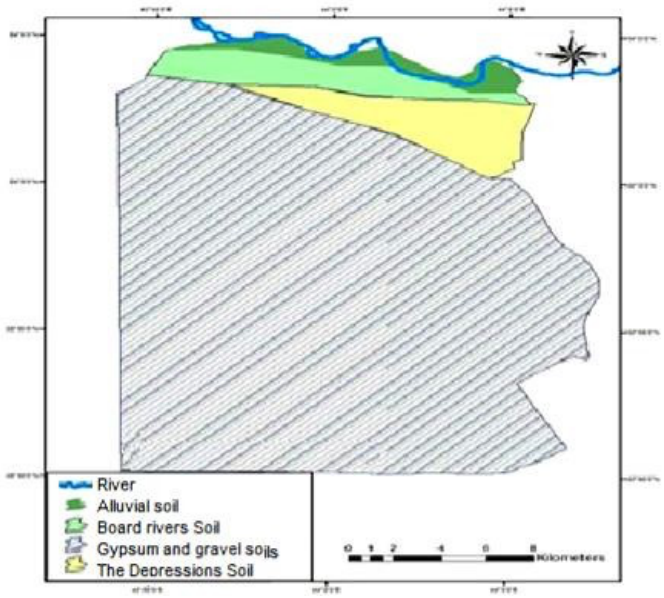
Wind: is the movement of air parallel to a certain surface, which may be part of land or water. The wind occurs due to the differences in air pressure between two points on the same level of the surface of the earth due to the difference in temperature and humidity, as the air goes from the areas of high pressure to the areas of low pressure and the wind speed increases as the difference in air pressure increases, and it becomes clear to us through Table (2_1) that The highest wind speed was (3.9 m / s) in May and the slowest in December was 1.6 m/s.

4. **Soil**: The soil represents the fragile surface layer that covers the rocks of the earth's crust and with an altitude that is between a few centimeters to several meters, which is a mixture or mixture of mineral and organic materials, water and air in which the plant fixes its roots and derives its food, and the soil has a great importance when studying groundwater, and that It is not its quality, texture, and depth that determines the degree of its depletion, then the amount of surface leakage towards this groundwater reservoirs along with the apparent effect of the soil components of its composition on the leachate salinity that the study area consists of riverine soil which consists of gravel deposits that fill its voids with gypsum. The transformation of the course of the Tigris River and the diversion of the estuary of the Great River, as well as the remains of the ancient irrigation networks in the area, gave the topography of this region a special characteristic, which in turn led to the formation of soils that are different in its components (11). The size, proportion of organic and mineral substances in it and their difference between one soil to another. The soil of the study area is divided into the following sections: As shown in the map (3).

The sides of the river's soil: This soil is one of the best types of soil in the Ishaqi area due to its richness in organic materials and mineral elements, which led to the diversification of agricultural production. These soils are characterized by medium-soft tissues and are free from harmful salts and are of natural drainage. This soil is suitable for growing various types of agricultural crops without any obstacles or restrictions and spreads in the form of a strip in the far north of the region (12).

Map No. *(3) spatial distribution of the soils of the study area*

Source: *The researcher depending on the outputs of the program (Gis v 10 3)*



- Swales Soil: This type of soils is closer to the mixture soils in terms of their natural components, but due to their occurrence in low areas where there is no natural discharge of groundwater and water surplus to the need of agricultural crops, its fertility has fluctuated, and then the level of ground water in it and by capillary property has increased The salts gathered in them and became decertified due to the high salinity therein, where some parts grow resistant to salinity, and other parts turned into ponds and swamps where the reeds and papyrus plants grew, and the highlands were used to grow some field crops and orchards, especially Grape harvest and extends to the far northeast region (13).
- **Gypsum and gravel soils:** It is defined as those soils that contain quantities of gypsum and calcium sulfate more than (2%) gypsum in the area of effective roots and contain the subsurface layer on (14%) or more of gypsum, and the proportion of lime increases to (40%) (14), this soil is located in the western parts of the study area and contains a mixture of sandy or clay materials and gravel components, and that gravel components come at a depth of between (70-150 cm) and spread widely throughout the study area.
- Alluvial soil: This soil is located within the southeastern borders of the study area, and this type of soil has a high percentage of clay until it reaches (35%) and the ability of this soil to absorb groundwater is slow due to the fact that its atoms are smooth and their pores are few and spread as a strip extending maximum North of the region (15).

5. Water resources: Water resources are one of the most prominent natural ingredients that affect salts and their spread, because there are no water free of salts in nature, but they are in varying proportions, as large quantities of them are added through irrigation to agricultural land, and this leads to salinization of the soil and thus affects production Agricultural and that water is an important factor in the establishment of agriculture, without it there can be no agriculture, because by its availability the area of land expands (16). Water resources include:

- **Surface water:** It is the water resulting from rain and melting snow, which is the main source in providing irrigation water in dry areas. Exploitation of stream water for irrigation is done either by flowing or by pumping it by pumps to major irrigation channels, which in turn transport it to agricultural fields, as water provides the spread of agriculture and its expansion throughout the study area, and this led to the spread of orchards and agricultural crops. As the residents of the region depend on the water of the Ishaqi project for various agricultural, domestic and other uses, and the Tigris River, which borders the study area from the eastern side, plays on irrigation from it through the pumps installed on it (17).

- **Groundwater**: It is the layer containing widespread water and located above the first impermeable layer of water from the surface of the earth, and the container layer is layers of loose or cracked rock carrying water, and groundwater is one of the water resources for agricultural production and the main factor in increasing the percentage of salinity in the soil This in turn affects agricultural production by increasing the salinity of groundwater in the study area, in addition to the fact that groundwater is an important source in the western parts of Ishaqi, especially those that are far from the Ishaqi irrigation project, and the groundwater is different in From the province, revive Ishaqi to another in number and quality. The number of wells reached about (240) wells, which are distributed in three provinces (17 wells of watermelon, 14 Al-Farhatia, 33 Al-Jazeera) (18).

6. **Natural plant**: A natural plant is defined as a plant that grows spontaneously without the intervention of a human being under its care, as it is subject during its growth to the natural conditions surrounding it, especially climatic and surface conditions (19), where the natural plant has a big role as it helps to hold the soil and helps to leak rain water Into the ground and its return to the stream in the form of groundwater (20), rain water to the underground and its return to the stream in the form of groundwater and there are many types of natural plants in the study area including (reeds, papyrus, allies, and bows) and in the region there are trees from Natural plant such as (blink, the west, lick L) There are also other types of weeds and seasonal herbs, including (ornaments, oats, and silhouettes) as shown in the picture (1).

Picture *(1) the natural plant (Al-Awasj) in the study area Photo by the researcher on 3/18/2023.*

The role of the natural plant lies in the presence and abundance of groundwater during the obstruction of running water on the surface, thus increasing the amount of rainwater leakage into the ground, as it is It works in several ways to increase the groundwater reserves through its role affecting the feeding properties, as it works to maintain the soil from the cliff because it is the medium storing water and reduces the intensity of evaporation when the wind speed increases and the temperature rises and has a role in reducing and reducing the intensity of the falling rain and it preserves the soil in Winter season Its freezing is a cover for it, and during the spring, snow melts and high river levels, the amount and volume of water leaking into the ground increases.

The second topic: groundwater hydrology in the region

The study of groundwater hydrology aims to identify the specific characteristics of that water and thus determine the percentage of salts therein and the locations where the water level rises in relation to other sites through which to determine the optimal investment for each type of water depending on the percentage of salts in the underground reservoir.

1. **Numerical distribution of wells**: To give a clear idea of the size of the groundwater, its level, and its production capacity as well as the depths of these wells in the region, a spatial analysis of these characteristics is required. One province to another, where the provinces (33 Al-Jazeera, 14 Al-Shuraniya, 17 wells of watermelon) came first in terms of wells due to the large area in addition to their agricultural investment as they depend on groundwater in the first place and then

surface water, so the number of wells in these provinces Respectively (1290, 670, 560) Wells. (21).

2. *Table (2) Numerical distribution of wells in the region*

	The provinces	**Number of wells**
1	33 islands	1290
2	14 Al-Suryania	670
3	17 watermelon wells	560
4	13 riverways	60
5	10 trees and cactuses	50
6	16 cabans	160
7	15 Abu Haffa	110
	Total	2900

Source: *Ministry of Water Resources, Water Resources Directorates at (Balad Center, AlDhuluiya, Yathrib, Al-Ishaqi) Planning and Follow-up Section, 2022 (unpublished data).*

3. Groundwater movement: Groundwater is characterized by its movement from high-pressure levels towards the lowest pressure level. This movement is slow compared to the movement of surface water, and the movement of groundwater takes two directions.

- **Vertical movement:** It is either a downward movement found in the ground or an upward movement in the areas of discharge that is represented by surface flow.
- **Horizontal movement:** Sometimes called the gravitational movement and this movement is more important than the previous one, because it influences spatial variation in the quality and quantity of water from one place to another. Some minor hikes, which increase as we head northwest. The area is made up of modern sediments (gravel, sand, and the west) as well as a hydraulic connection between ground and surface water and that surface water sources rise above the groundwater level, and they represent the hydraulic of the reservoir, so they are in the movement of water and its direction is evidence of knowing the feeding places and determining the appropriate sites for drilling wells In the future. The movement of groundwater is subject to some natural factors, including (22) porosity and permeability.

4. **Ground water level:** the water level in the underground reservoir where the atmospheric pressure is equal to the hydrostatic pressure and this level is often a counterbalance to the topographical surface of the region, so it rises under the high areas and approaches the surface of the earth under the low areas. As there are several factors that affect the level of the internal water in terms of height and decline, and from these factors, the water level depends on the level of the internal water on the type of sediments, whether gravel, sand or mud, as well as depends on the climatic characteristics of the region, which are the amounts of rain, humidity, drought, evaporation and runoff, as it depends on Porosity and permeability of the underground rock layers of groundwater (23). There are two types of groundwater levels.

- **Stable ground water level (constant):** means the constant water level is the level in which the atmospheric pressure and hydrostatic pressure at the surface of the groundwater are equal to the confined groundwater. Or is the level represented by the surface of the water in the well if no water is drawn from the underground reservoir, whether by pumping or free flowing (24). From Table (3), which shows the fixed depths of the appropriate, as the wells

of low depth vary between (6 m) in well (2) and between (9 m) in well (4) and well (6), while the depths of fixed levels in the wells medium depth is between (15 m) in well (9) and between (26 m) in well (3).

The provinces	sequence	The name of the owner of the well	Depth (m)	Height above sea level (m(	Groundwater level above sea level (m)
33 islands	B 1 B 2 B3 B4	Najih Ahmed Hassan Haj Ahmed Musalli Farhan Adeeb Abbas Haji Diab Hassan	9 6 26 9	48 .45 47 .77 49 .10 52 .01	42 .44 41 .77 42 .26 43 .1
17 Bateech wells	B5 B6 B7	Abdullah Faisal Dawood Hasan Dawood Ismail Shaker	7 9 25	57.55 62. 15 58 .12	48 .57 53 .16 46 .30
Farhatia	B8	Jassim Mohammed Saleh	13	42 .51	37 .15
15 Abu Saffa	B9 B10	Hammoud Khalaf Hassan Jarallah, Mahdi	15 8	52. 24 55. 26	46 .15 47 .26
16 cabans	B11 B12 B13	Hamed Sultan Aziz Sarhan Khazaal Mezher Ahmed Jamil	8 8 9	53 .13 49 .38 54. 16	49 .59 42 .11 48 .01
10 trees and giants	B14	Ismail Ibrahim	4	49 .62	45 .12
13 riverways	B15 B16	Dhaif Hussain Hussein Mohamed Deif	7 8	48. 57 46 .15	42 .26 39 .31

Source: Al-Ishaqi Water Resources Division, unpublished data for the year (2022).

- **The variable (moving) ground water level:** It is the water level of the wells when the pumping of water from the well is running and continuous (25).
- **Depth of the wells:** The depth of the groundwater depends on the geological, libographic and structural nature of the area. This, in turn, was reflected in the variability of the depths of the wells, where they are deep in the high areas and shallow in the valleys (26). Accordingly, the wells of the region are divided according to their depths:
- Small (surface) depth wells, which are represented by wells whose depth is limited to (4_12 meters), as their depth does not exceed (12 meters) and they are all manual wells, then dug by the people.
- Medium depth wells: They are welling whose depths range between (12_28 meters) and are mechanical wells in which pumps are used to raise water to the surface as shown in Table (4), which shows the depths of wells in the region.

Table (4) the depth of the wells in the study area

	The provinces	**The name of the owner of the well**	**Depth (meters)**
1	33 Aljazera	Najih Ahmed Hassan	9
2	33 Aljazera	Haj Ahmed Musalli	28
3	33 Aljazera	Farhan Adeeb Abbas	12
4	33 Aljazera	Haji Diab Hassan	10
5	17 Batech wells	Abdullah Faisal	12
6	17 Batech wells	Dawood Hasan Dawood	9
7	17 Batech wells	Ismail Shaker	25
8	14 Alfarhanah	Jassim Mohammed Saleh	13
9	15 Abu Dafah	Hammoud Khalaf Hassan	5
10	15 Abu Dafah	Jarallah, Mahdi	8
11	16 caban	Hamed Sultan Aziz	8
12	16 caban	Sarhan Khazaal	8
13	16 caban	Mezher Ahmed Jamil	5
14	10 Shejer and Sabarat	Ismail Ibrahim	4.5
15	13 Nahrawan	Khudair Nassif	7

16	13 Nahrawan	Mohamed Nassif	8

Source: Al-Ishaqi Water Resources Division, unpublished data for the year 2022.

- **Chemical analysis of groundwater in the study area**: that the goal of studying the physical and chemical characteristics is to determine the origin and quality of groundwater and determine the degree of its salinity, and therefore the quality of the groundwater varies from one place to another as well as from one region to another (27) that the quality of groundwater depends primarily on the quality The source water and any change that occurs in the quality of this water changes according to it, as the type of groundwater is affected by the quality of the rocks and salts containing them or passing through them to other layers, in addition to being affected by the prevailing climatic conditions and organic factors scattered on the land surface (28). It relied on groundwater analysis, which were collected samples and then laboratory analysis and the number (10) samples to study the properties of water. As shown in Table (3_4), which clarifies the chemical analysis of groundwater.
- **Physical properties Electrical conductivity (EC)**: it is the ability of water to conduct electrical current, i.e. conduction (cm^3) of water at (25) degrees Celsius. The quality electrical conductivity is measured in micros / centimeters. Electrical connection (52%) when the temperature increases by one degree Celsius. As shown in Table (3_4), which shows the height of the electrical connection.

2_6_1 Taste, color, and smell: It is well known that drinking water has no taste, color, or smell, but the water contains certain elements that cause it to change its color, taste, or smell. The color of the groundwater is a measure of the type of organic and mineral substances concentrated in it and during the melting of chemical, organic and inorganic compounds, it adds to the taste and aroma of the water that depends on the type and amount of the dissolved substance (29).

2_6_2 pH: It is a measure of acidity and basicity under normal conditions of temperature and pressure. The pH is an important variable that has a direct impact on the assessment of groundwater quality. And that it has a significant impact on the mobility of many elements in the groundwater, except for sodium, potassium ions, tensions and clauses that do not leave the solution important.

The value of the (PH) was. The value of (PH) ranges from (0_14). Acid solutions range between (0_7), while the basic one's range between (7_14), and neutral solutions have the (PH) in them (7) (30). Through the chemical analysis of the models in the table previously, it was found that the pH values range between (7, 5) and (7, 7) in the whole study area.

2_6_3 Salts (TDS): It is a group of dissolved salts in the groundwater resulting from the melting of the mineral elements present in the rocks. The total dissolved solids are a general indication of the amount of salty water, its quality and origin, and it represents the disparate and asymmetric ions that are measured (mg / liter). Knowing the concentration of salts in the groundwater is of great importance, as the high percentage of salts in them leads to raising the percentage of salts in the agricultural soil that you seek to the point that they become invalid for agricultural production and it has been shown through chemical analyzes as shown in Table (3-4) that higher The percentage of salts is (3611) in the province of (17 wells of watermelon) and the lowest percentage is (225) in the province of (13 Nahrawat).

2_7 Chemical properties

First: positive ions

3_7_1 Calcium Ion (ca^+): It is one of the main positive ions in groundwater and one of the most important sources for it are calcareous rocks, dolomite, gypsum, and phosphates due to chemical weathering processes. The lowest calcium content was (307) in the province of 16 Kabban (31).
2_7_2 Magnesium Ion (Mg^+): It results from the dissolution of some rocks in groundwater, such as dolomite, lime, clay and algebraic auxiliaries, and these minerals are from magnesium. It is less concentrated than calcium in groundwater (32). It is noted that the highest percentage of

magnesium ion reached (227) in the province of (17 wells of watermelon) and the lowest percentage (177) in the province of (13 Nahrawat).

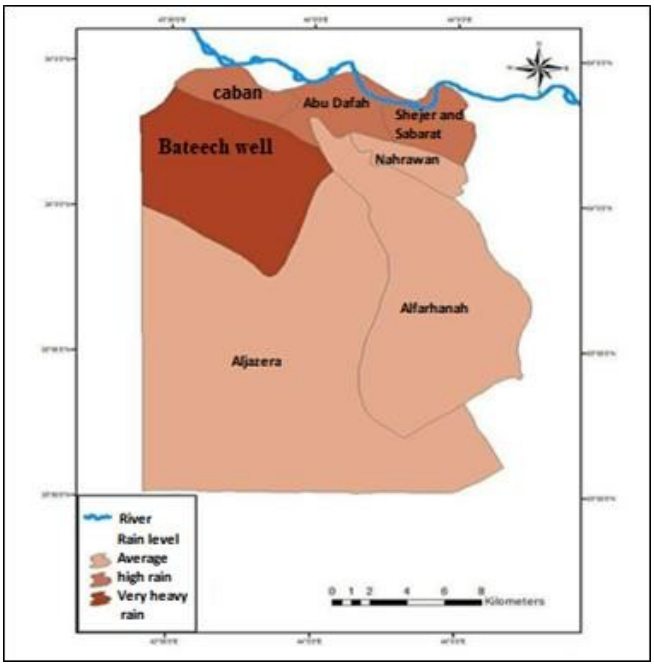
2_7_3 Sodium ion (Na): The appearance of sodium compounds in groundwater is attributed to the presence of rock salt and clay stone, evapotranspiration as secondary gypsum (sulfur) in water-forming formations. Through the above-mentioned table (3_4) for chemical analysis, the highest percentage of sodium ion is (125) in the province of (33 Al-Jazirah), while the shores of the ratio reached (70) in the province of (13 Nahrawan).

Second: negative ions

2_7_5 Chlorides (CL): The chlorine ion is one of the negative and important ions present in the groundwater and the water acquires the salty taste, especially if it is associated with other ions such as magnesium and calcium, and the high content of chloride ion in the water has harmful effects on the metal tubes as well as negative effects on plants. According to the results of the chemical analysis, the highest percentage of chlorine ions was (465) in the province of (17 wells of watermelon) and the lowest was (378) in the province of (14 Al-Shabaniya).

2_7_6: Sulfur ions (SO4): Sulfates are produced from the oxidation of sulfides and the solubility of gypsum minerals and anhydrates. Rainfall also contains greater concentrations of sulfates, not exceeding (2) parts per million, and gypsum soils within the area benefit from one of the sources of sulfate formations. As the sulfur ion has a negative role in the investment of groundwater for agricultural purposes, increasing its concentration leads to soil salinization as a result of calcium sulfate precipitation, and it is noted that the highest percentage of sulfate reached (964) in the province of (17 watermelon wells) and the lowest percentage (811) in the province of (15 Abu Sefsa).

2_8 Models: The term paradigm is used in the sense of representation, degree of perfection and clarity to illustrate some of the distinguishing characteristics of the trampled phenomenon (33).



Map *(4) spatial distribution model of groundwater abundance in the study area*

Source*: The researcher relying on the outputs of the program (Gis v 10 3)*

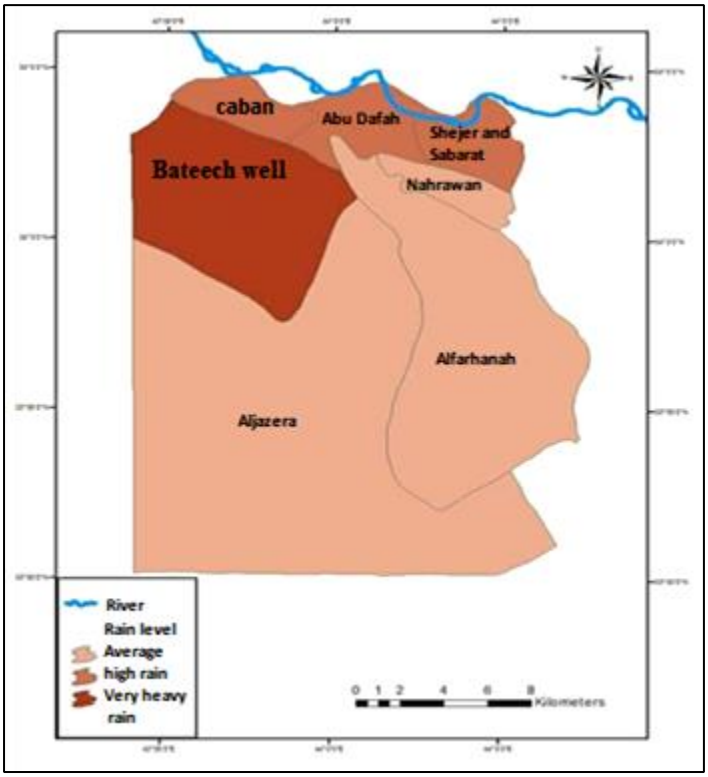
2_8_1: the spatial distribution model of the groundwater abundance: the abundance of water is distributed in the wells of the study area, as its abundance varies between a few, medium and high abundance and from map (4) that shows the spatial distribution model of groundwater abundance according to which the region is divided into three ranges in terms of abundance (a few, Medium, high abundance), as abundant intermediate areas are spread in most of the study

area from the far north and northeast to the far south and southwest. As for the abundant areas, they spread in the form of a longitudinal belt extending to the far north of the study area, while the very abundant areas spread in the northwest of the study area.

➢ **Spatial distribution model for groundwater quality:**

The quality of groundwater in the study area varies according to the variation of the geological formations containing it, and according to the variation of natural and human conditions in the region, and from the map (5) that shows the spatial distribution of the groundwater quality as the percentage of salts in it varies from one region to another where few salts are concentrated. Groundwater is in the far north and northwest of the region, while the saline medium is represented by a small region in the far northeast, while saline areas are concentrated in very wide areas of the same region, and a high salinity area is also noted in the far northwest.

The third topic: determining the quality of agricultural crops according to the percentage of salts.



Map ***(5)*** *spatial distribution model for groundwater quality in the study area*

Source*: The researcher relying on the outputs of the program (Gis v 10 3)*

Agricultural crops differ in their degree of tolerance to salinity, and some can be produced if there is little salinity. But if this salinity increases, productivity decreases and sometimes reaches zero, and it also differs in terms of endurance in the germination period and there are plants that are inherently resistant to salinity such as wheat and barley.

➢ **Cereal crops:** The cultivation of cereal crops is of great nutritional and economic importance in the region and includes (wheat, barley, and yellow corn. Cereal crops of various types constitute the basic food material for humans, as they are used primarily for their cereals as well as their importance as animal food, where they are used directly or indirectly (34).

➢ **Wheat:** Wheat tops the crops of cereal grown in terms of its nutritional and economic value, as it is a staple in human food. Wheat needs during the germination season a warm climate that occurs in late winter and spring, and the optimum temperature for growth and germination (25 ° C). Also, wheat needs water in sufficient quantities to grow the wheat crop, as wheat needs a number of irrigations ranging between (5_6) irrigations during the season, including (3) irrigations

during the growth period and (2_3) irrigations during the ripening period, and the wheat crop is a crop The resistance to salinity, therefore, it withstands high salt content. Through table (4_1) and figure (1), we note that the province of (33 Al-Jazira) occupied the first rank in terms of area and production, as the cultivated area in this province reached (13000_ dunums), with a percentage of (43.3%) and productivity (650 kg / dunum). A boycott (10 trees and giants) comes last in the production quantity, as the production amount reached (390 kg / dunums) with an area of (1180 / dunums), at a rate of (3.9%), as shown in table (5).

➢ **Barley:** Barley is an important and major cereal crop in dry areas. Barley is grown for many uses, including human food or used as animal feed. It is considered one of the most tolerant crops for drought, salinity and frost, and one of its most prominent characteristics is resistance to salinity, an important characteristic that helped in reducing its needs of moisture and early maturity to adapt to dry areas, and the barley crop is an important crop because of its protein and sugar materials, and that its cultivation begins During the months of October and November. From the note of Table (6) and Figure (2), the highest percentage of production in the province of (33 Al-Jazira) reached (494 kg / dunum) with an area of (1650 dunums) and at a rate of (36.2%). As the amount of production reached (280 kg / dunums) and an area of (363 dunums), at a rate of (7.9%).

Table (5) The cultivated areas of wheat crop and the productivity rate in kg / dunums in the study area for the year 2022

	District number and name	**Area / acres**	**The ratio%**	**Rate of production Kg / acre**
1	33 Aljazera	13000	43.3	650
2	17 Alfarhanah	6400	21.3	600
3	14 Batech wells	4280	14.3	720
4	13 Nahrawan	1367	4.6	500
5	10 Shejer and Sabarat	1180	3.9	390
6	16 caban	2263	7.5	494
7	15 Abu Dafah	1510	5	570
Total		30000	100	

***Source**: Ministry of Agriculture, Salahuddin Governorate Agricultural Directorate, Ishaqi District Agriculture Division, Planning and Follow-up Section 2022 (unpublished data).*

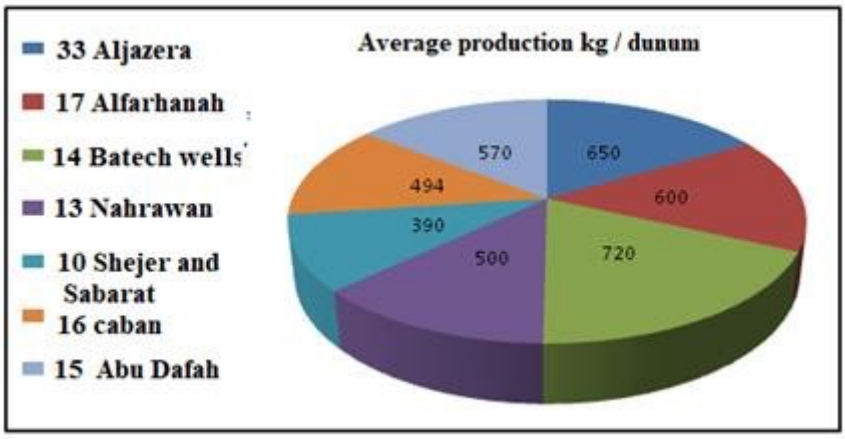


Figure *(1) production rate Kg / dunum of wheat crop* **Source**: *Based on Table (5)*

➢ **Yellow corn:** Yellow corn is a food crop for developing and poor countries. As for the developed countries, it is used as food for animals, and it is one of the important dye cereal crops

that need a period of frost-free, up to about (149 days) and have a tractor degree ranging between (27_20 m 3). The maize crop needs a number of irrigation ranges between (15_10 irrigations) during the growing season and according to the stages. Where its cultivation begins in the month of March at the spring date, whereas the autumn date will be in the second half of June and the first half of July, and the harvest will be after the full ripening of the crop, which is known from the yellowing of arnus and its drought (35). From Table (7) and Figure (3), we note that the province of (33 Al-Jazirah) occupies the first rank with a production of (800 kg / dunums) and an area of (2700 dunums), with a percentage of (38.5%). As for the province of (10 trees and giants), it occupies the last rank in production amounting to (324 kg / dunums), with an area of (380 dunums), at a rate of (5.4%).

➢ **Vegetable crops:** Vegetable crops come after grains in terms of their nutritional importance as they are one of the main crops grown in the study area, which depend on groundwater for their nutritional and economic importance, and their nutritional importance is represented by the vitamins, proteins and minerals contained in these crops.

➢ **Summer vegetable crops:** It is one of the most important types of vegetables that are grown in the study area, as it depends on groundwater.

Table (6) cultivated areas Barley yield and productivity per kg / dunum in the study area for the year 2022.

	District number and name	**Area / acres**	**The ratio%**	**Rate of production Kg / acre**
1	33 Aljazera	1650	36.2	494
2	17 Alfarhanah	850	18.7	483
3	14 Batech wells	491	10.8	490
4	13 Nahrawan	442	9.7	320
5	10 Shejer and Sabarat	363	7.9	280
6	16 caban	321	7.0	340
7	15 Abu Dafah	440	9.7	400
Total		30000	100	

Source */ Ministry of Agriculture, Salah Al-Din Governorate Agricultural Directorate, Ishaqi District Agriculture Division, Planning and Follow-up Department 2022 (unpublished data*(

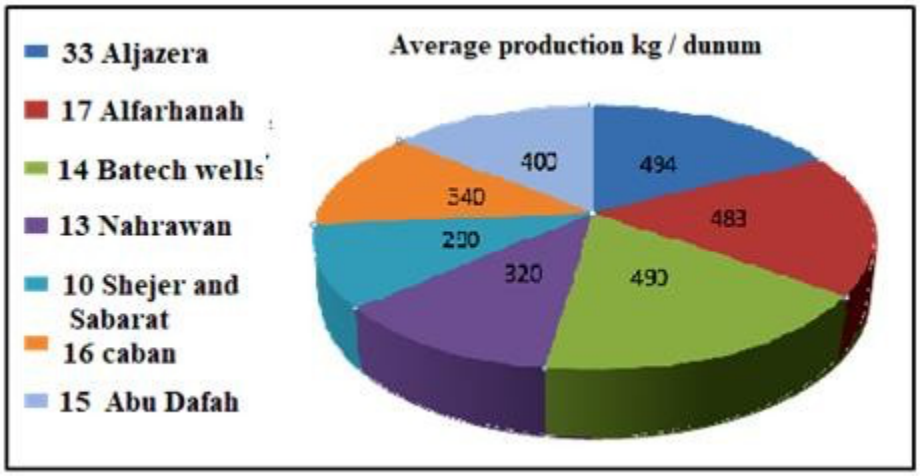


Figure *(2) production rate Kg / dunum of wheat crop* **Source***: Based on Table (6)*

These crops are grown protected and exposed. In general, these crops are grown in mid-spring and give their fruits in the month of May until August. They include summer vegetable crops (grace, tomatoes, Cucumber, eggplant, watermelon, pepper, okra, pumpkin, cowpea, potatoes). And the

summer vegetable crops require frequent irrigation, while those periods extend for the winter crops, and from the vegetables are the soft plants that enter the water by (90%) of their weight. From table (8) and figure (4), we note that the province of (33 Al-Jazirah) occupied the first rank, as its production reached (5620 kg / dunums) and the area reached (5760) with a percentage of (22.9). As for the province (10 trees and cacti), it ranked fourth and last, with production (3512 kg / dunum) and area (2750 dunums), at a rate of (10.9%).

Table (7) The areas planted with yellow corn and the productivity rate in kg / dunums in the study area for the year 2022.

	District number and name	**Area / acres**	**The ratio%**	**Rate of production Kg / acre**
1	33 Aljazera	2700	38.5	800
2	17 Alfarhanah	1440	20.5	463
3	14 Batech wells	1300	18.5	480
4	13 Nahrawan	500	7.1	390
5	10 Shejer and Sabarat	380	5.4	324
6	16 caban	360	5.1	414
7	15 Abu Dafah	420	6	490
Total		7000	100	

Source / Ministry of Agriculture, Salah Al-Din Governorate Agricultural Directorate, Ishaqi District Agriculture Division, Planning and Follow-up Department 2022 (unpublished data(

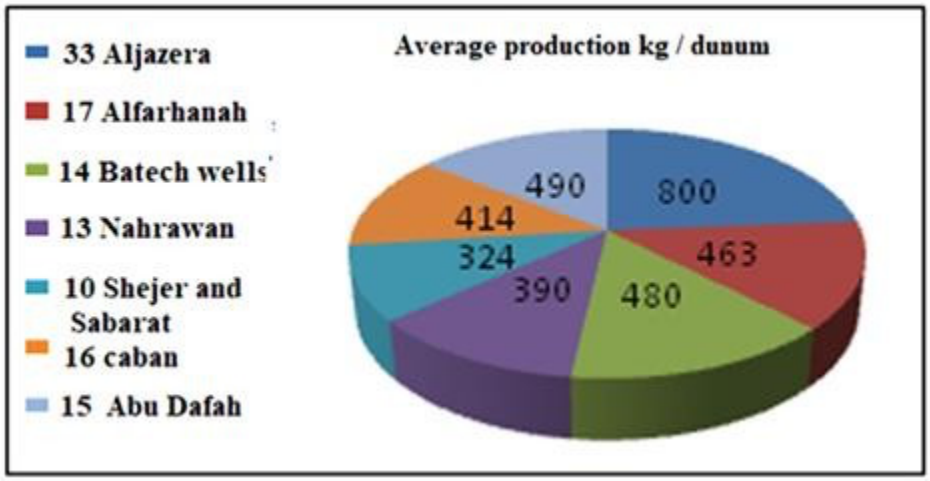


Figure *(3) the production rate of kg / dunum for yellow corn*

Source*: Based on Table (7)*

➢ **Winter vegetable crops:** Winter vegetable crops are important crops and include crops (onions, potatoes, radishes, lettuce, celery, cress, raspberries, grapes, cauliflower, chard, garlic, carrots) and are characterized by their multiple types and competing with other crops that have great returns.

Table No. (8) the areas planted with summer vegetables and the productivity rate in kg / dunums in the study area for the year 2022.

	District number and name	**Area / acres**	**The ratio%**	**Rate of production Kg / acre**
1	33 Aljazera	5760	22.9	5620
2	17 Alfarhanah	4080	16.3	4720

3	14 Batech wells	3500	13.9	4640
4	13 Nahrawan	3200	12.8	4110
5	10 Shejer and Sabarat	2750	10.9	3512
6	16 caban	2093	8.4	3900
7	15 Abu Dafah	3713	14.8	4502
	District number and name	30000	100	

Source / *Ministry of Agriculture, Salah Al-Din Governorate Agricultural Directorate, Ishaqi District Agriculture Division, Planning and Follow-up Department 2022 (unpublished data)*

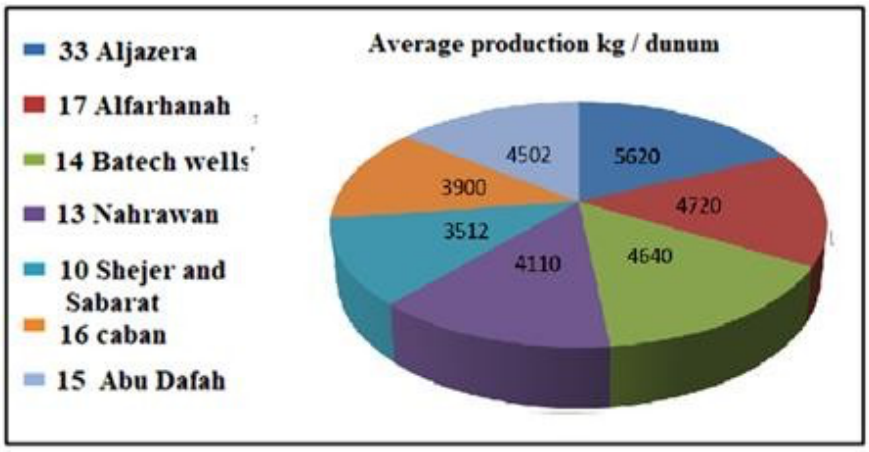


Figure *(4) average production kg / dunums for summer vegetable crops*

Source: *drawing on table (8)*

➢ The winter vegetable crops are characterized by low prices compared to other crops, as well as the majority of them are perishable and not stockable, in addition to their need for many labor hands in the process of planting and harvesting the crop (36) and from Table (9) and Figure (5) shows that the highest rate of production in The province of (33 Al-Jazirah) reached (1900 kg / dunum) with an area of (1350 kg / dunum) with a percentage of (29.2%). As for the lowest percentage of production, it is in the province of (16 Kaban), as it reached (940 kg / dunum) with an area of (340 dunums) and a percentage of (7.4%).

Table (9) the areas planted with winter vegetables and the average productivity per kg / dunum in the region for the year 2022.

	District number and name	**Area / acres**	**The ratio%**	**Rate of production Kg / acre**
1	33 Aljazera	1350	29.2	1900
2	17 Alfarhanah	1010	21.9	1680
3	14 Batech wells	886	19.1	1830
4	13 Nahrawan	380	8.2	1000
5	10 Shejer and Sabarat	200	4.3	8020
6	16 caban	340	7.4	940
7	15 Abu Dafah	454	9.8	1220
	District number and name	4620	100	

Source / *Ministry of Agriculture, Salah Al-Din Governorate Agricultural Directorate, Ishaqi District Agriculture Division, Planning and Follow-up Department 2022 (unpublished data)*

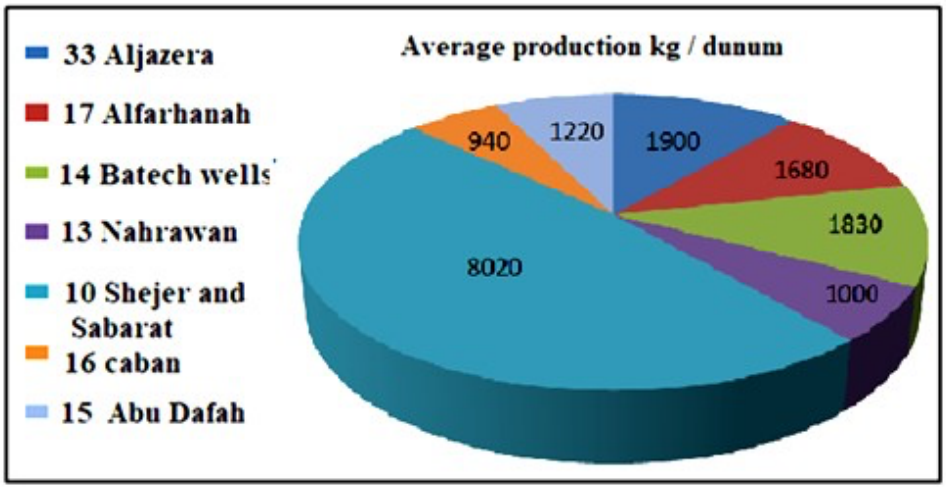


Figure *(5) average production of kg/ dunum for winter vegetable crops*

Source*: Based on table (9)*

First: Conclusions: The study concluded that grain crops occupied the first rank in terms of the amount of production and the cultivated area. The wheat crop occupied the first rank among the grain crops, as the area planted with wheat reached (30000) acres, while summer vegetable crops came first from summer vegetable crops. The area planted with summer vegetables reached (25,096 dunums.

The study showed that the natural plant has an impact on the groundwater and its quantity through obstructing the running water and consequently leaking from rainwater and surface water towards the underground.

Increase in the number of wells in the area due to the lack of an irrigation project and the increase in the percentage of cultivated land in the region.

The presence of variations in the proportions of salts and the concentrations of negative and positive ions, which in turn affected the difference in the type of crops grown in the region.

It was found through the study that most soils in the study area are soils with gravel sandy formations, and thus they contribute to increasing penetration and leakage of large quantities of water, whether it is rain or surface water towards the ground and contribute to increasing the underground stock.

The clear variation of groundwater in the region in terms of density and infectious distribution affected by climatic fluctuations and other natural factors as well as the influence of human factors.

The study showed the impact of groundwater salinity on agricultural production in the region and salinity-resistant crops have been identified, such as barley, which is one of the most saltresistant crops.

The importance of using modern technologies in the study of groundwater through the analysis and conversion of raw spatial data into a digital database and the use of them in the analysis and preparation of hydrological models.

Second: Recommendations: To carry out governmental support to farmers and set controls to extract and use groundwater, dig wells, and expand the provision of modern irrigation methods that reduce the waste of large quantities of groundwater and reduce the salinization of water in the region.

Carry out analyzes continuously and through successive stages to see the extent of the salinity of the groundwater in order to preserve agricultural crops from salinity.

The necessity of using quantities of water according to the need of the crop because the excess irrigation water will remain above the surface of the earth for a period and when evaporation

increases, salts are deposited with the water into the ground and this in turn leads to an increase in the salinity of the groundwater. Comprehensive hydrological and petrochemical studies are required because they are considered one of the important studies to obtain groundwater sources that can be used for agriculture. Using the water desalination system for the purpose of increasing production on the one hand, improving the quality on the one hand, and getting rid of salts on the other hand.

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