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# Development of Soil and Groundwater in the Western Anbar Plateau


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**Abstract:** Water is one of the most natural resources in dry areas, as it controls the presence, distribution and density of plants, animals and humans. Water is scarce or non-existent on the surface of dry lands around the world, it is clearly characterized by the appearance of dry areas on the appearance of the adjacent rain areas, However, in order to utilize dry areas in grazing and in stable agriculture, in trade, in the utilization of mineral resources, and in the establishment of urban centers, water must be found in sufficient quantities that are reliable and have qualitative characteristics that allow for selected economic activity. The western Anbar Plateau (116,000), or 26.5% of Iraq's total area of 438,317 km2 and 84.2% of the Anbar region, is characterized by low water availability. It is therefore necessary to increase efforts and harness energies to discover new water sources which are represented by ground water that compensates for the shortage of surface water quantities, especially as its use (groundwater) began to increase in most countries of the world. Generally water is the source of life for all human creatures on the surface of this planet, In the near future; the conflict will also be over water rather than energy. Here the problem of the research appears which is identified by the following question: - Is there in the western plateau of Anbar, despite the large space occupied by the scarcity of water sources mature development projects rely primarily on the investment of groundwater reservoirs located therein, which contributes to the regular redistribution of the population. The hypothesis of the research was summarized as: - Defining the requirements of economic and social development that contribute to the foundations of human stability in that region by studying the groundwater and its areas of presence in the western plateau of Anbar.



**Keywords:** water ground, soil, Development.


## INTRODUCTION

### Groundwater and its suitability to establish development projects in the study area:

Development is a continuous process that requires efforts that are not easy on the ground, and also its programs can not all reach results that are consistent with the objectives set because of the constraints of the project during the implementation phase [1]. Therefore, the adoption of any development realistic project in the land of the plateau of western Anbar depends on the basis of ground water must study the specifications of those waters and their suitability for different uses in accordance with the standards adopted globally, and the characteristics of the water in the areas eligible for investment in the western Anbar Plateau will be considered as one of the best areas in the plateau in terms of the general characteristics first, and the ability of these projects to create the initial nucleus for pioneering development projects in different parts of the plateau second.

### The uses of Ground Water

### Water use to drink

The basic constituents of drinking water depend on the primary dissolved elements of positive and negative water (cations, and anions), on the rate of inorganic chemical properties and organic compounds, and on biological and radiation characteristics [2], and as the information available to us about the areas eligible for investment in the western Anbar Plateau indicates only the average soluble salts in those waters, so it will be compared with the limits proposed by the World Health Organization (WHO 1971), as well as the American Standards (1962, U.S.P.H.S.) shown in Table-1 and Map-1 and Map-2, which show the use of groundwater and saline groundwater in the study area as follows:

**Table-1: International Standards (1971 'WHO') and American (USA.S.S. 1962) for human drinking water.**

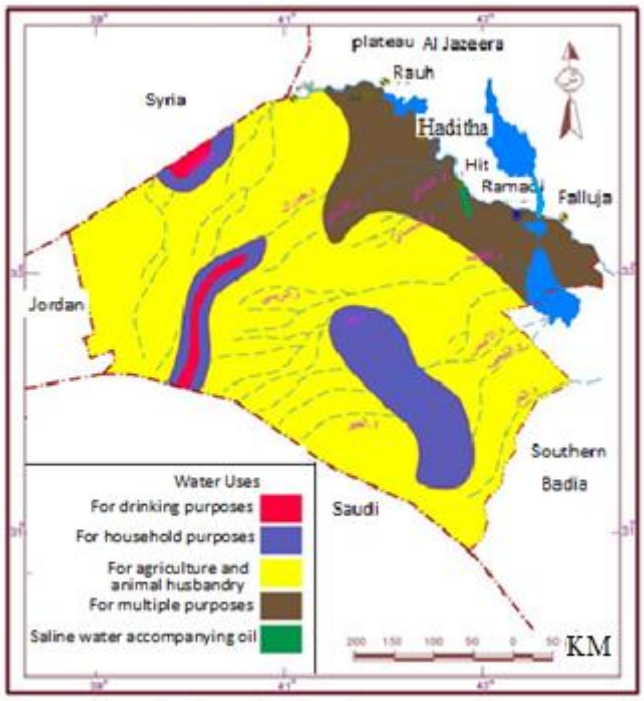
| Elements | International Standards (WHO, 1971) | | American Standards (U.S.P.H.S., 1962) |
|---|---|---|---|
| | Upper Limits | Lower Limits | Upper Limits |
| Positive ions + K | - | - | 20 |
| (Cations) Na + + | - | - | 200 |
| Mg++ | 30150 | | 125 |
| Part of Ca +++ | 75200 | | 200 |
| Mg / l | | | |
| Negative ions - CL | | 200600 | 250 |
| (Anions) - So4 | 200400s | | 250 |
| - HCO3 | - | - | 500 |
| Mg / l | | | |
| Total dissolved salts | | | |
| TDS | 500 | 1500 | 1000 |
| Mg / l | | | |

International (WHO, 1971) and American (U. S. P. H. S, 1962) standard for Human drinking water

- The average amount of salts dissolved in groundwater for the first area of investment promising west of Hadeetha lake ranging from (2500-4000 mg / L). therefore, the specifications of this water are not suitable for drinking when matched with the specifications of water suitable for drinking according to the World Health Organization,( 500 1500 mg / l) and American specifications (1000 mg / L) as a maximum limit of use. As it has harmful effects on human health so it is not appropriate to use groundwater located in that area for drinking purposes except after desalination. However, the proximity of this area to Hadeetha lake with low rates of dissolved salts ranging from (700 900 mg / l) makes it logical to invest the lake's water for drinking instead of dealing with underground water for this purpose.
- The average amount of dissolved salts in the water of the promising area of the second investment extended between al-Mohammedi al-Baghdadi, ranging in quantity between (3000 5000 mg / l), Therefore, the specifications of this water is not suitable for human use, and using this water for drinking has a negative impact on human health, so it is necessary not to invest water in this region to drink except after treatment (desalination) or rely on the water Euphrates near the region.
- The average amount of dissolved salts in the groundwater of the promising area of the third investment, which is in the west of al-Rehhalyia between (2000 4000 mg / L), which means that the water in this area is not suitable for human use through its conformity with the international standards of the World Health Organization and American specifications except after desalination, and it has a clear impact on human health in the case of direct use of water after extraction from the ground.
- The average amount of dissolved salts in groundwater for the fourth promising area of the so-called al-Mane'ai (1500 to 3500 mg / L), therefore, the minimum dissolved salt content corresponds to the maximum limit of 1500 mg / L and does not conform to the American drinking standards of 1000 mg / L, so the investment of groundwater in this area for drinking may have negative effects on human health.
- The average amount of dissolved salts in the groundwater of the fifth investment area known as Hauran (H.1) ranges from (1000 to 3500 mg / L), therefore, the water of the wells located there, where the average amount of dissolved salt (1500 mg / L) is suitable for human use according to the specifications of the World Health Organization for drinking water. While drinking water is less than 1000 mg / L according to US standards. Therefore, it is recommended to use groundwater in those wells with a minimum soluble salt content of 1500 mg / L, and treatment of water with a higher average dissolved salts (1500 mg / L).
- The average amount of dissolved salts in the groundwater of the promising area of investment called al Kasra Habbariya (600-3000 mg / L), So the wells' water there is safe to drink. If the amount of dissolved salts is less than (1500 mg / L) according to the specifications of the World Health Organization and valid according to American specifications, the average amount of dissolved salts is less than (1000 mg / L).
- The average amount of dissolved salts in groundwater for the seventh investment area south of Nukhayb, with an average salt content of 1000-3000 mg / l, therefore, the water is suitable for human use. The average dissolved salt content does not exceed 1500 mg / L in accordance with the specifications of the World Health Organization (1000 mg / l) according to the American specifications of drinking water.
- The average amount of dissolved salts in the groundwater of the eighth area of investment called the Wadi Soa is between 500 and 3000 mg / l. Therefore, groundwater is suitable for drinking if the average dissolved salts in the wells do not exceed 1500 mg / L according to the specifications

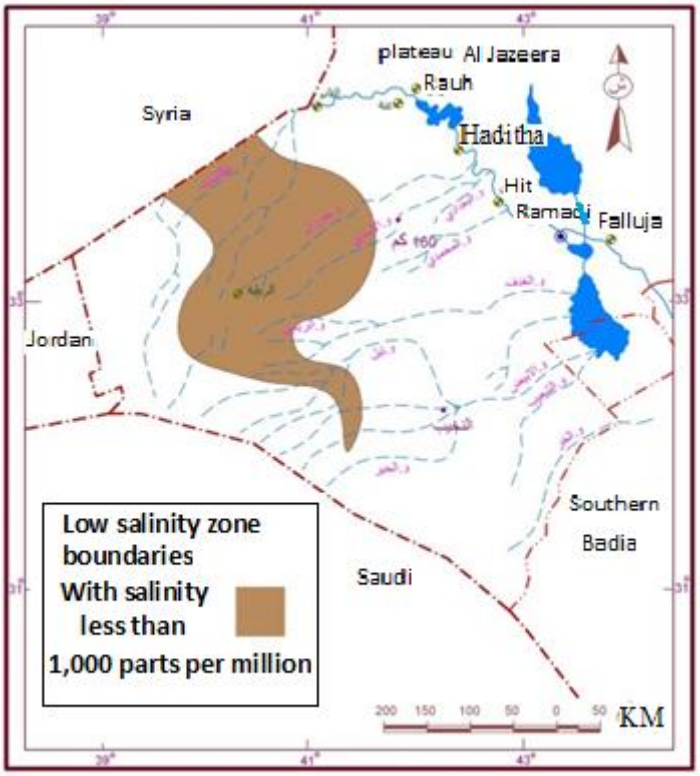
(1000 mg / L) according to the American standards for drinking water.

- The groundwater is located in the area of the most promising of the ninth investment called al-Ka'ara in the reservoir of Yenala and to a depth of 90-110 of the level of the ground, the average amount of dissolved salts there between (600 1500 mg / l), so it is suitable for human use according to the World Health Organization standard specifications and also suitable for human use according to the American standard specifications, unless it exceeds (1000 mg / L). The water in the underground reservoir and the other which starts at a depth of 180-200 m from the ground level, has an average dissolved salts (2000-3000 mg / L) and is therefore not suitable for human use in accordance with the World Health Organization standard and American standard specifications.
- The average amount of dissolved salts in the promising area of the tenth investment known as Hauran (H.2, H.3) is between 2500 and 2500 mg / L. Therefore, it is suitable for human use unless the dissolved salts exceed 1500 mg / in accordance with World Health Organization standard specifications and (1000 mg / L) according to American standard specifications.




**Map-1: Groundwater Uses in the Western Anbar Plateau**

Source: The researchers based on the Biaan of Mohi Hussein and Mushtaq Ahmed Oreibi, spatial distribution of the provinces nominated for the exploitation of groundwater resources in Anbar province, Anbar University Journal of Humanities, Volume 3, No. 11, 2008, p. 281.

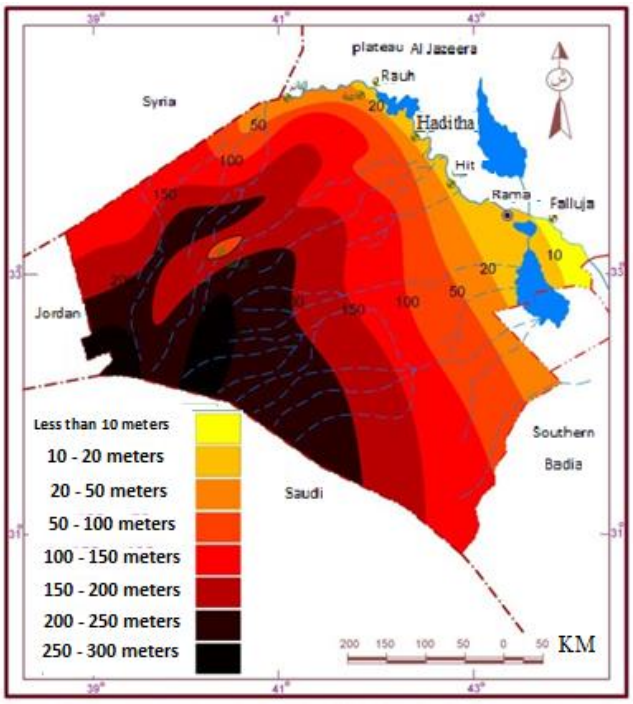



**Map-2: Less saline groundwater areas in the western Anbar Plateau**

Source: Ministry of Irrigation General Scheme of Water Resource and Land Development Report on Stage 2, OP,Cit, Reference Map,p.91.

**The previous analysis concludes**

- The groundwater available in the western areas of Haditha Lake, Al-Mohammadi, Al-Baghdadi, West al-Rahaliya, and al-Mana'i area are not suitable for drinking according to the specifications of the World Health Organization. All these areas are located in the eastern part of the western plateau of Anbar and west of the Euphrates river, which means that the needs of the population in these areas can be met by an advanced network of pipes to transport water from the Euphrates to relatively close areas as in the two regions West of Haditha Lake, and Al-Mahmoudi-Baghdadi and treatment of water located in the areas of West Rahaliya and Manai relatively far from the Euphrates river through the establishment of desalination complexes suitable for the number of residents.
- In Hauran, H.1, Habbariya, South Nukhayb, Suab, Ka'ara, and Hauran H.2 H.3, certain quantities of groundwater are safe to drink according to some of the approved international standards. The Euphrates River is the only source of permanent surface water in the land of the study area, which means that people in these areas can rely on underground water for drinking purposes due to the deep water of the study area (Look map-3).




**Map-3: Groundwater Depths at Ground Level in the Western Anbar Plateau (m)**
Source: the researcher depending on: Bayan M. Hussein, Hydrogeological Condition Within AL-Anbar Government, University of AL-Anbar, Center of Desert Studies, 2007

**Uses of water for industrial purposes**

Water is very important in the industrial field because it is used to supply steam boilers, cooling engines, chemical industries and other industries. Therefore, it is necessary to study the suitability of the water used for different industries through their conformity with the internationally approved standards for the requirements of each industry, Both the scarcity of the water and the rate of the amount of dissolved salts in water is one of the most important things that determine the suitability of such water for industrial uses or not, as high scarcity affects the emergence of a layer of calcareous steam boilers, which leads to a reduction in the rate of efficiency of the boiler due to lack of conductivity of the heat and thus lead to increased heating and burning of metals and therefore an explosion, while the presence of salts in high quantities in the water used for industrial purposes in the corrosion of parts of pipes and machines [3]. The water in the study area is generally scarce [4] Therefore, the establishment of industrial projects based on the investment of groundwater in the promising areas which are qualified for investment in the plateau of western Anbar means the disposal of a large part of the water which are not suitable for industrial projects in such projects and then deprive other uses of their share of water or affect them on the one side, and the need for those industries based on raw materials located in the plateau to large quantities of water is not compatible with the available water on the other side. Table-2 & 3 show the type of raw materials distributed in the study area, their location and the materials they produce. All the raw materials available in the area require water with low salt levels not available in areas qualified for internal water investment in the plateau, See map-1 West of Haditha Lake (2500 - 4000 mg / l) Mohammadi - Baghdadi (3000 - 5000 mg / l), West of Rehhalyia (2000 - 4000 mg / l) Basin of al- Mannai (1500 - 3500 mg / l), Hauran H.1 (1000 - 3500 mg / l), Kasra - Habbariya (600-3000 mg / l ), south of Nukhayb (1000 – 3000 mg / l), Sawab basin (500 – 3000 mg / l)---------- ( 600 – 1500 ) and ( 2000 – 3000 ) mg / l, (Hauran H.2- H.3 900-2500) mg / l.

**Table-2: Mineral wealth in the Northern Badia region according to their location and industrial uses**

| No. | Type of mineral | Location | Industrial uses |
|---|---|---|---|
| 1 | Phosphate | Akkashat, al-Rutbah, al-Husseiniat | Chemical fertilizers, Phosphoric |
| 2 | Limestone | A'ain el Arneb, the White Valley, H3, west of Ramadi, southeast of Ain al-Tamr | Cement - Sugar - Paper |
| 3 | Bentonite | al-Rutbah, Akkashat | Sulfur Filtering, Oils |
| 4 | Gasoline | El-Ka'arah, al-Husseiniat | Ceramics, Cement, Paper, Bricks, Pesticides, Fabric |
| 5 | Iron | al-Rutbah, al-Ka'arah, al-Husseiniat | Resistant cement |
| 6 | Silica | al-Rutbah, Kilo 160 | Glass, Plumbing |
| 7 | Dolomite | al-Husseiniat | Construction- Glass - Cement |
| 8 | Gypsum | Upper Euphrates Region in Heit, al-Qaim | Plaster, Noura, Wood panels, Cement |
| 9 | Gravel and sand | Ramadi, al-Haqlanyya, al-Qaim | Construction, Concrete structures |
| 10 | Alkear | Heit, al-Haqlanyya, aboul-Jeer | Paintings, Asphalt |

Source: Ahmed Fayyad Saleh Al-Mohammadi, Functional Composition and Regional Relations of the Northern Badia Cities, PhD Dessertation, College of Arts, University of Baghdad, 1999, 77.

**Water use for irrigation purposes**

The study of water used to irrigate agricultural crops is an important issue that has received special attention and care from specialists in agricultural activity, as this water affects agricultural production in quantity and quality, as well as its impact on varieties of agricultural soils, and determine its validity for agriculture. Water with good specifications reduces the probability of soil exposure to salinization and alkalinity and reduces the probability of agricultural crop poisoning by irrigation [5].

Water for agricultural activity is generally scarce in terms of quantity and species, making knowledge of the suitability of water used for irrigation a necessity to be undertaken prior before any agricultural project aimed at changing the economic and social reality [6].

The water used for irrigating agricultural crops is influenced by the basic factors of chemical composition of the water, the type of soil used in the agricultural activity, the prevailing climate and the methods adopted in irrigation and drainage. These factors interact with each other in determining the viability of the agricultural activity.

For each agricultural crop, certain irrigation water requirements are different from those of other crops because of the variation of agricultural crops among them in the degree of resistance to dissolved salts in water, which requires knowledge of the extent to which agricultural crops withstand this type of water before planting.

**Table-3: Proposed limits for water used in some industrial purposes**

| Different industries | PH | Total Alkaline Mg / l | Intractability Mg / l | Cl- Meg / l | So4- Meg / l | Fe++ Mg / l | Ca++ Mg / l | Mg++ Mg / l |
|---|---|---|---|---|---|---|---|---|
| Food packaging factories | 8.5 - 6.5 | 300 | 310 | 8.462 | 5.205 | 0.40 | 5.988 | 8.226 |
| Chemical industries | 6 - 9 | 500 | 1000 | 14.103 | 17.697 | 5.00 | 9.980 | - |
| Cement factories | 8.5 - 6.5 | 400 | - | 7.052 | 2.205 | 25.00 | - | - |
| Oil refineries | 6 - 9 | - | 900 | 45.130 | 11.867 | 15.00 | 10.978 | 6.992 |
| Paper industry | 6 - 9 | - | 475 | 5.641 | - | 2.60 | 0.987 | 0.987 |

The physical and chemical properties of soil are important in determining the type of water used for irrigation. The use of water with high salt concentration in irrigating non-saline soil leads to salinization of the soil, while the use of water with low saline content compared to the amount of salts present in the soil reduces the dissolved salts in soil and improves its properties [7]. The study area contains dry desert soil (saline, gypsum, calcareous) and young soil that is not dehydrated due to erosion (wind and water); this type of soil is characterized by its richness in salts which are necessary for the growth of agricultural crops with some determinants, perhaps the most prominent is lack of soil thickness, but the main

problem facing agricultural investment in this type of soils is the lack of water suitable for irrigation. The availability of adequate and adequate quantities of irrigation water means that the soil can be converted into sandy ones to farms producing many agricultural crops, With the need to compensate soil poverty organic and nitrogen substances by adding animal fertilizers when farming for the first time [8].

The climatic conditions are the main factors that have a significant effect in determining the quantities of irrigation water needed and the type of plant planted, and the study area with severe climatic conditions; as the temperature is rising clearly in the summer, which requires an increase in the water quota of the plant to meet this rise in temperature, these harsh conditions also play a major role in determining the type of crops that have the ability to resist and produce economically. Moreover, determining the appropriate method for irrigation of agricultural crops is one of the necessary issues for the existence of a correlative relationship between climatic conditions and irrigation methods [9]. Following modern scientific methods adapted to extreme climatic conditions to minimize damage to the soil and plant [10].

The validity of groundwater for irrigation in promising areas for investment:

By matching the specifications of groundwater in the promising areas of investment with the classification of the salinity laboratory in the United States in Table-4,

- The western reservoir of Haditha Lake, Al-Muhamadi-Baghdadi, the west of al-Rehhalyia, al-Mana'i Basin, Hauran (H.1), South Nukhayb, Low Alkaarh, the second reservoir, the average of dissolved salts is estimated (2000 - 4000), (1500-3500), (1000-3500), (1000-3000), (2000 3000) mg / l respectively, from areas which water is not suitable for irrigation under the ordinary circumstances. As it is possible to use its water only in certain cases: very high permeability soil, efficient drainage and highly tolerant crops for salinity.
- The areas (al Kasra Habbariya, Sawab Basin, Low Alkaarh, the first area, Hauran (H.2 H.3) with an estimated average of dissolved salts (600 3000, 3000 500, 600 1500, 2500 900) mg / l, Of which salinity is high in wells with a soluble salt content of less than 1500 mg / l. Therefore, its water is used for irrigation only with an efficient drainage network and high salinity tolerant crops.
- The promising areas for groundwater investment do not contain groundwater with low or medium salts that can be used to irrigate all crops and in most soils or to irrigate most of the medium tolerant crops for salinity without any emergence of problems that will be reflected on the crop and soil in the subsequent time.

**Table-4: Classification of irrigation water for salinity risk by salinity laboratory in the USA**

| Water class and symbol | Total dissolved salts TDS/ mg / l | Electrical conduction Micro -----/ cm | Water Validity |
|---|---|---|---|
| 1.Low salinity water C1 | Less than 200 | Less than 250 | Suitable water for irrigation of all crops and in most soils |
| 2.Medium salinity water C2 | 200 – 500 | 250 – 750 | Suitable water to irrigate most of the medium tolerant for salinity corps |
| 3. High salinity water C3 | 500 – 1500 | 750 – 1250 | This water is used only with an effective drainage network and high salt tolerant crops |
| 4.Very high salinity water C4 | 1500 - 3000 | 2250 – 5000 | Water which is not suitable for irrigation under normal conditions only if it is used in certain cases: highly permeable soils, efficient drainage and highly tolerant crops for salinity |

Source: Ahmed Haider Al-Zubaidi, Soil Salinity, Higher Education Press, University of Baghdad, 1989, p. 234.

Agricultural crops suitable for investment in areas eligible for groundwater utilization in the plateau. The lands located in the dry regions have the potential to invest in plants of economic, nutrition, medical and industrial value as long as sufficient humidity is available. These lands have the ability to produce grains, pastures, and some crops of vegetables, legumes and fruit trees such as olives, vineyards, almonds and forest trees, which means that there is a widespread perception that investment in these lands is limited to cereals and pastures, but extends to larger areas of production [11]. In 1954, the Salinity Laboratory of the United States of America prepared data on the classification of field crops, vegetables, fruit trees and feed crops according to salinity tolerance to sensitive, medium tolerance and high tolerance crops for salinity as a basis for selecting appropriate crops for investment [12]. See table-4

The groundwater investment process requires a pioneering development approach in the promising areas of investment to select agricultural crops that

have the potential to grow and produce economically in water that generally contains high quantities of salts, especially, because the crops differ in their ability to tolerate the salinity in irrigation water. As it is reflected directly on soil and plant because of this type of water. By matching the tolerance of the agricultural crops of salinity mentioned in Table-5 with the salinity of groundwater salts in the ten promising areas of investment the following:

- 01 The validity of the groundwater in the west of Haditha Lake (the average dissolved salts between 2,500 and 4000 mg / l ) to irrigate fruit trees with high tolerability of salinity, medium and high tolerances of salinity, medium and high tolerant field crops for salinity and medium and high salt yield crops.
- Validity of groundwater located in the area of Mohammedi – Baghdadi (average dissolved salts 2500-4000 mg / l) to irrigate fruit trees with high salinity tolerance, medium and high tolerant vegetables for salinity, in addition to medium and high tolerant field crops to salinity and high salt tolerant feed crops.
- Validity of groundwater located in West Rahhaliya area (average dissolved salts 2000 4000 mg / l) to irrigate high tolerant fruit trees for salinity, medium and high tolerant vegetables for salinity, as well as sensitive, medium and high tolerant field crops for salinity, medium and high tolerant feed crops for salinity.
- Validity of groundwater located in al-Mana'i Basin area (average dissolved salts 1500 3500 mg / l) for planting high tolerance fruit trees for salinity, medium and high tolerant vegetables for salinity, as well as sensitive, medium and high tolerant field crops for salinity and medium and high tolerant feed crops for salinity.
- Validity of groundwater located in Hauran (H.1) area (average dissolved salts 1000 - 3500 mg / l) to irrigate high tolerant fruit trees for salinity, medium and high tolerant vegetables for salinity, in addition to sensitive, medium and high tolerant field crops to salinity.
- Validity of groundwater located in Kasra-Habbariya, the north of Nukhayb area (average dissolved salts 600 3000 mg / l) to irrigate medium and high tolerant fruit trees for salinity, medium and high tolerant vegetables for salinity, medium- and high-tolerant field crops for salinity, medium and high tolerant feed crops for salinity.
- Validity groundwater located in the south of Nukhayb (average dissolved salts 1000 3000 mg / l) ) to irrigate high-tolerant fruit trees for salinity, medium and high tolerant salinity vegetables and irrigate sensitive, medium and high tolerant field crops for salinity, medium and high tolerant feed crops for salinity.
- Validity of groundwater located in Sawab Basin area (average dissolved salts 500 3000 mg / l) ) to irrigate fruit trees with high tolerance to salinity, medium and high tolerant vegetables for salinity. in addition to that the validity of water to irrigate sensitive, medium and high tolerant field crops for salinity.
- Groundwater in Alkarah depressed is found in two reservoirs, the first one (average dissolved salts 600 1500 mg / l) where water is suitable for irrigation of medium and high tolerant fruit trees for salinity and sensitive, medium and high tolerant salinity crops, as well as for irrigating field crops and sensitive, medium and high tolerant crops for salinity. The other reservoir (average dissolved salts 2000 3000 mg / l) the water there is suitable for irrigation of high tolerant fruit trees for salinity, medium and high tolerant vegetables for salinity, and for irrigation of sensitive, medium and high tolerant field crops for salinity and medium and high tolerant feed crops.
- Validity of Groundwater in Hauran Area (H.2 H.3) (average dissolved salts 900 2500 mg / l) to irrigate medium and high tolerant fruit trees for salinity, sensitive, medium and high tolerant salinity vegetables, as well as water to irrigate field crops and sensitive, medium and high tolerant feed crops.

**Table-5: The tolerance amount of agricultural crops for salt concentrations**

| Crop varieties | Crops resistant to low concentrations of dissolved salts in water (salts sensitive) | | Crops resistant to medium concentrations of dissolved salts in water (medium tolerance to salinity) | | Crops resistant to high concentrations of dissolved salts in water (high tolerance to salinity) |
|---|---|---|---|---|---|
| | 0 – 1920 mg / l | | 1920 – 2560 mg / l | | 2560 – 6400 mg / l |
| Fruits | Alarmoot<br>Apple<br>Orange<br>Pears | Alkogah<br>Almonds<br>Apricot<br>Peaches<br>Lemon | Olive<br>Figs<br>Pomegranate | | Palm trees |
| | 1920 – 2560 mg / l | | 2560 – 6400 mg / l | | 6400 – 7680 mg / l |
| Vegetables | Radish<br>Celery<br>Beans | | Tomatoes<br>Allahana<br>Pepper<br>Cauliflower<br>Lettuce<br>Potatoes | Carrots<br>Onions<br>Albazaliah<br>Pumpkin<br>Cucumber | Turnips<br>Spinach |
| Field Crops | 2540 - 3840 mg / l<br>Field beans | | 3840-6400 mg / l<br>Wheat (cereals)<br>Rice<br>White corn (cereals)<br>Yellow corn<br>Sunflower | | 6400 - 10240 mg / l<br>Barley (cereals)<br>Sugar beet<br>Cotton |

Source: Ahmed Haider Al-Zubaidi, Soil salinity, previous source, pp. 195-196.

## CONCLUSIONS

- The western plateau of Anbar, which occupies a large area of the total area of Iraq and the province, suffers from a clear lack of water quantities, whether surface or precipitation. The Euphrates River and the lakes depend on it mainly as the main source of surface water, which benefit the adjacent lands basically. For precipitation, the area has seasonal rains, (Autumn, Winter, and Spring). As there is no rain during the Summer and it is located between the equal rainfall lines (50-150 mm), which is not sufficient for continuous cultivation depending on this source of water.
- The region contains different geological formations due to different geological times, that is the characteristics of the aquifers are different from each other and directly affect water characteristics in terms of quantity, species and depth.
- The area of the study contains sedimentary soil, which was established by water, wind and dry desert soil, which is characterized by low depth and incomplete soil. Therefore, the utilization of the groundwater in the study area and the adoption of this soil is an uneconomic process.
- Groundwater is found in the research area at different depths of the earth's surface level, as the water level generally increases from east to west with some minor exceptions.
- The area contains promising areas for investment of groundwater in various fields (drinking, household uses, agriculture, etc.) scattered in different parts. Therefore, the utilization of this water means creating a state of relative equilibrium in the distribution of investments between the parts of the plateau.
- The general trend of the inhabitants of the plateau is witnessing a large trend towards digging wells for water extraction because of the lack of rainfall rates in recent years, the increasing need for water due to the increase in population preparation, and the multiplicity of uses. In general, there has been an increase in the production of wells drilled in recent years in all parts of the main surface area.
- The wells drilled in the province of the study area suffer a state of obvious neglect by the state, as there is no material support for people dependent on these wells whether these wells are dug by the state or the people, Which led to leaving many of them and the degradation of productivity or fill them because of the futility of utilization.
- The oases in the plateau suffer a state of apparent neglect, which led to leaving many of them much of them and the economic, social, political and environmental inefficiency of the other part of which is currently utilized, despite the impact of these oases in reducing the state of creeping sand dunes and desertification and reduce the phenomenon of environmental pollution suffered by the world in general.
- The population in the study area is distributed in the form of a longitudinal strip along the Euphrates River, while large portions of the western Anbar plateau have no or few population,

although they are rich in raw materials for many industries.

- The area contains good economic foundations that could reduce the costs to be incurred if a major development project based on the investment of groundwater resources is adopted.
- By matching the specifications of groundwater in the promising areas of investment with the approved international standards, we find the validity of some areas of water for drinking and household purposes, while the other areas are to irrigate some agricultural crops and animal husbandry.

## RECOMMENDATIONS

- The need to compensate for the shortage of surface water and the fall in the western Anbar Plateau, by relying on underground water in the areas that proved the results of studies as suitable areas for investment in various fields.
- Improving the soil properties available there, especially in places that have suitable potential for ground water investment, through the adoption of an efficient management system by qualified people or entities in the fields of agricultural activity, capable of selecting crops and plants that are able to live and produce under these ingredients and without affecting on the soil negatively in the near time of investment.
- In the case of development in the province of the study area, consideration should be given to the fact that the area contains different characteristics of water from each other due to the different geological formations of water there. It is necessary to determine the appropriate use of investment in each region or sector of the region, With the need to adopt pioneer economic projects in the province, from various transport routes, small dams .... and others. It helps to encourage the beneficiaries of ground water to invest and reduce the costs to spend in these lands.
- It must be borne in mind that the development to be achieved in the region does not concern the economic field alone, but extends to other fields that may be social, population, environmental and others.
- In case of the utilization of ground water by the state and citizens in the near and distant future, it is necessary to rely on the map of ground water depths, hydrological conditions, water use and production security until appropriate water investment in the region is determined.
- The necessity of the participation of the State in the management of existing groundwater resources through the provision of economic and service support to the beneficiaries of such water, which provides the population's demand for utilization.
- The establishment of pioneer projects in the region by the state, depends primarily on the utilization of groundwater, and to achieve a more equitable distribution of the population among the parties in the province, which suffers from the imbalance in population distribution.
- To benefit from the low lands in agricultural activity, especially the lands near the promising areas for the utilization of groundwater in the agricultural field by planting them with suitable crops.
- The government has effective effects through the allocation of some economic resources to invest in groundwater reservoirs and provide job opportunities for the unemployed and reduce the situation of forced migration.
- The State has the task of restoring the desert oases from the private sector with regard to the great importance these oases play in the economic, social, political and environmental fields.
- The necessity that the task of drilling wells has to be done by the state in the study area with regard that the drilling requires high economic and technical possibilities most of the dependents cannot afford the costs incurred by the drilling this is on one side, and the lack of expertise available to farmers there on the characteristics of water in terms of (depth, and the quantities of available water, groundwater reservoirs, and the amount of dissolved salts ... etc) on the other side.

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