T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF SCIENCES AND TECHNOLOGY

THE IMPACT OF GROUNDWATER MANAGEMENT TO REDUCE DESERTIFICATION IN AL-ANBAR GOVERNORATE

THESIS

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Thesis Advisor: Assist. Prof. Dr. Umut Hulusi İNAN

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Not: Öğrencinin Tez savunmasında **Başarılı** olması halinde bu form **imzalanacaktır**. Aksi halde geçersizdir.

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears.

FOREWORD

This thesis is the end of my journey to obtain my M.Sc. It has been a challenging experience riddle of good and bad moments. However, I have felt supported during this time by several people. This thesis also belongs to them. I would like to express my gratitude to all of these people.

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July 2020 Bilal Ali Abbas AL-HALBOOSI

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ABBREVIATIONS

CIS : Geographical Information Systems
DEM : Digital Elevation Model
E.A : Energy of Absorption
EC : Electrical Conductivity
EVAP : Evaporation
E-W : Faults system in the area
GEF : Global Environment Facility
IEA : International Energy Agency
Na : Sodium
NE-SW : Transferred Fault Systems
NW-SE : Najid Fault system
OCHA : Office for the Coordination of Humanitarian Affairs
SAR : Sodium Adsorption Ratio
TEMP : Temperature
UNDG : United Nations Development Group
US-EPA : United State-Environmental protection Agency
WQI : Water Quality Index

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THE IMPACT OF GROUNDWATER MANAGEMENT TO REDUCE DESERTIFICATION IN AL-ANBAR GOVERNORATE

ABSTRACT

The phenomenon of desertification is one of the aspects that threaten plant and animal life in general. The spread of this phenomenon has led to a lack of natural vegetation as well as agricultural production. Hence, desertification is a threat to human life. Therefore, the countries of the world collectively, through international organizations such as the United Nations and other regional organizations, make tremendous efforts to stop this dangerous phenomenon. The problem of the study was about - What are the limits of the available groundwater in Al-Anbar Governorate. To what extent is the maximum utilization of groundwater to reduce desertification. What is the possibility of expansion in the fields of investment in groundwater? Because of the great importance of natural resources in general. The study found out the following:

1- Loss of a total of 50% of Al-Anbar's water resources due to either wasting or worn out facilities, as well as using old irrigation methods.

2-The water needs for all uses activities will increase shortly.

3-It was concluded that, in addition to the natural factors that are primarily drought and which cause desertification, there are human factors represented by the rational behavior of humans towards natural resources, which deepens the problem of deserting

4-The problem of desertification did not arise at once in the study area. Still, its emergence in this size was a result of the synthesis between the drought factor and the accumulation of irrational dealing with natural resources for a long time.

5-Due to the dire effects of desertification and the costs involved, the issue of combating desertification in Anbar Governorate has become one of the most critical issues that require a speedy solution due to the exacerbation of the scale of the problem and the accelerating pace of deserting

Despite the efforts made by Anbar Governorate, the process of monitoring desertification and combating desertification still needs more efforts and unification, and for this, we propose the following recommendations;

1-Help farmers who are living in the desert dig artesian wells and raise awareness about planting trees bearing salinity and drought.

2- The necessity of using modern irrigation methods and advanced methods in agricultural uses would raise irrigation efficiency to 90% instead of the current traditional process of 40% efficiency.

3- Developing irrigation projects in Anbar Governorate and reviewing them according to the new global variables to raise the level of their efficiency to reduce leakage and evaporation and to adopt advanced electronic control systems in distribution.

4- To enhance cooperation between institutions concerned with combating desertification and other institutions working in the field of environmental.

5- Adopting an integrated approach to combating desertification that addresses all physical, biological, and social aspects and economics.

6- Participation of stakeholders in Anbar Governorate in enhancing awareness of the local population in efforts to combat desertification.

7- Promote the mobilization of public funding and encourage the mobilization of private sector funding to implement desertification control operations in Anbar Governorate.

Keywords: *Orogeny, Classification, Layers, Groundwater, Desertification.*

AL-ANBAR İLİNDE ÇÖLLEŞMEYİ AZALTMADA YERALTI SUYU YÖNETİMİNİN ETKİSİ

ÖZET

Çölleşme olgusu, genel olarak bitki ve hayvan yaşamını tehdit eden unsurlardan biridir. Çölleşmenin yayılması, doğal bitki örtüsünün yanı sıra tarımsal üretimde azalmalara yol açmıştır. Dolayısıyla çölleşme insan yaşamı için büyük bir tehdittir. Bu nedenle, dünya ülkeleri Birleşmiş Milletler ve diğer bölgesel kuruluşlar gibi uluslararası kuruluşlar aracılığıyla toplu olarak bu tehlikeli olguyu durdurmak için büyük çaba sarf etmektedir. Bu araştırmanın problemi Al-Anbar ili'ndeki mevcut yeraltı suyunun sınırlarının neler olduğu hakkındadır. Çölleşmeyi azaltmak için yeraltı suyunun maksimum kullanımı ne ölçüdedir?. Doğal kaynakların genel olarak büyük önemi nedeniyle, yeraltı suyu yatırım alanlarında genişleme olasılığı nedir? Çalışma sonunda şunlar bulunmuştur;

1- Al-Anbar'ın su kaynaklarının tesislerde gerek boşa gitmesi, gerekse harcanması ve eski sulama yöntemlerinin kullanılması nedeniyle toplam % 50 su kaybı mevcuttur.

2- Tüm kullanım faaliyetleri için su ihtiyacı kısa sürede artacaktır.

3- Başta kuraklık olmak üzere, çölleşmeye neden olan doğal faktörlerin yanı sıra, çölleşme sorununu arttıran nedenin, insanların doğal kaynaklara yönelik rasyonel davranışlarının temsil ettiği insan faktörleri olduğu sonucuna varılmıştır.

4- Çalışma alanında, çölleşme sorunu, bir anda ortaya çıkmamıştır. Yine de bu boyutta ortaya çıkışı, uzun süre boyunca doğal kaynaklarla olan akıldışı bir yaklaşımın birikmesi ve kuraklık faktörünün birleşiminin bir sonucudur.

5-Çölleşmenin korkunç etkileri ve söz konusu maliyetler nedeniyle, Anbar ili'nde çölleşmeyle mücadele konusu, çölleşmenin hızlanması ve sorunun ölçeğinin şiddetlenmesi nedeniyle, acil çözüm gerektiren en kritik konulardan biri haline gelmiştir.

Anbar İli'nin çabalarına rağmen, çölleşmeyi izleme ve çölleşmeyle mücadele süreci hala daha fazla çaba ve birleşmeye ihtiyaç duymaktadır ve bu yüzden, aşağıdaki tavsiyeleri öneriyoruz;

1- Çölde yaşayan çiftçilerin artezyen kuyuları kazmalarına ve, tuzluluk ve kuraklıkta yaşayan ağaçların dikilmesi hakkında farkındalık yaratmalarına yardımcı olmak.

2-Tarımsal kullanımlarda, mevcut geleneksel kullanımla elde edilen % 40 verimlilik yerine verimliliği % 90'a çıkaracak olan modern sulama yöntemlerinin ve gelişmiş yöntemlerin kullanılması gerekliliği.

3- Anbar ili'nde sulama projeleri geliştirmek ve bunları yeni küresel değişkenlere göre gözden geçirerek sızıntı ve buharlaşmayı azaltmak için verimlilik düzeylerini yükseltmek ve dağıtımda gelişmiş elektronik kontrol sistemlerini benimsemek

4- Çölleşmeyle mücadele ile ilgili kurumlar ile çevre alanında çalışan diğer kurumlar arasındaki işbirliğini geliştirmek.

5- Çölleşmeyle mücadelede tüm fiziksel, biyolojik ve sosyal yönleri ve ekonomiyi ele alan entegre bir yaklaşım benimsemek.

6- Anbar ili'ndeki paydaşların çölleşmeyle mücadele çabalarında yerel halkın farkındalığını artırmaya katılması.

7- Kamu finansmanının seferber edilmesini teşvik etmek ve Anbar ili'nde çölleşme kontrol operasyonlarını uygulamak için özel sektör finansmanının seferber edilmesini teşvik etmek.

Anahtar Kelimeler: *Orojenez, Sınıflandırma, Katmanlar, Yeraltı suyu, Çölleşme.*

1. INTRODUCTION

Water assets, which are of focal significance to farming on the planet. It is mainly considering the shortage of these assets. Point out for coordinating suitable examination. Study and exploration are all issues and perspectives. That would add to the turn of events and the upkeep of these assets. Moreover, accomplishing the most noteworthy potential degrees of value and effectiveness of utilization. As the expansion in Population, development rate has prompted the ascent in water utilization. Numerous voices are being heard to a great extent, cautioning of lacking freshwater because of the diminishing in global stocks, which led people to use alternatives to fresh water, which is awful water, including sewage and modern and wastewater. As it turned into a critical need to accomplish the gardening turn of events, as all examinations and exploration on the planet and the Arab locale underscored the chance of utilizing saltwater in agribusiness. Regardless of whether it is well water or sewage, yet it must be accessible Good administration of water and soil using washing necessities extending between 10-40% or by blending. Substituting or integral water system and unprogrammed use will prompt salt development. Concerning Iraq, which is portrayed by a pace of precipitation of around 150 mm/year, Evaporation rate Over 2,400 mm/year. The renewable resources in the desert areas are few. The water reserves invested by the wells vary from one region to another and with different varieties ranging from freshwater to very salty. It was estimated at 8.45 billion cubic meters/year, and this constitutes 40% of the lowest water requirement required to secure existing irrigation projects. Show S deficit plentiful water for agricultural purposes is suffering as well as human consumption and, on this basis, went concerns about the use of alternative water resources for fresh surface water and poor quality for agricultural expansion horizontally to ensure food security. They are using saltwater to develop an appropriate strategy for the economical use of this water. Therefore, according to context, this research aims to analyze the water of some underground wells and indicate the extent of their impact to eliminate and then experiment.

1.1 Importance and Need for Research

The phenomenon of desertification is one of the phenomena that threaten plant and animal life in general. The spread of this phenomenon has led to a lack of natural vegetation, in addition to agricultural production and crawling of forests for housing, overgrazing, and logging. Hence, desertification is a threat to human life.

Therefore, the countries of the world collectively, through international organizations such as the United Nations and other regional organizations, make tremendous efforts to stop this dangerous phenomenon. Where the United Nations General Assembly passed in December 1974, two decisions:

The first: An invitation to states, in general, to study desertification studies and cooperate in investigating this phenomenon and how to combat it.

The second: A decision to hold an international conference in 1977 on desertification. The conference was held from August 29 to September 9, 1977, where the word desertification began as an alternative to previous terms such as desert encroachment and the word desert. Its impact is horrific—weeds and savannahs in the southern bands of the Great African desert. Perhaps the reason for this deterioration is what we see when dunes crawl over villages and oases and farms and destroy them, as well as when they crawl on paved roads and railways.

1.2 The Study Problem

The main research problem was how to invest groundwater in desert areas to reduce desertification, and the following questions are added to it: What are the limits of the available groundwater in Al-Anbar Governorate?

To what extent is the maximum utilization of groundwater to reduce desertification?

What is the possibility of expansion in the fields of investment in groundwater?

1.3 Study Hypotheses

The amount of groundwater available in Al Anbar Governorate meets the requirements. Groundwater investment has a definite impact on reducing desertification. Groundwater can be invested to expand agricultural areas.

1.4 Objectives of the Study

Because of the extraordinary importance of natural assets, when everything is said to work and plants, specifically, in the national economy, the dilapidated conditions are what led to desertification in certain areas. The Environmental Quality Authority has placed this issue at the top of its restoration needs. Moreover, revitalize this region through direct or non-direct intercession to stop this weakness and desertification. The intervention policy adopted by the Authority is centered in two directions. The first of them: to stop attrition in lands and soil, on the one hand, the second: Finding local solutions to the high cost of agricultural production on farms due to the tendency to rely on inputs from the ready market to grow it from another side. What causes him to refrain from cultivation in degraded pastoral areas because they are farther and more expensive than others for a reason above. Encouraging the residents of decertified regions to take advantage of available and available lands wherever they are, even if they are far away in cultivating forage plants and pastoral shrubs, and helping them in kind and morale in digging wells and efficiently providing water. Analyzing the socio-economic environment of the study areas through sensitive and measurable indicators (population, infrastructure, the pattern of agriculture, relationship to land, income, holdings,) and identifying the changes resulting from its impact on the project and the extent of its successes in intervening to stop desertification. Providing detailed data on the economic and social environment of the study areas, the various causes that led to desertification, and the policies followed to limit its aggravation. To suggest activities that depend on the participation of the local community in combating desertification, taking into consideration the socio-economic situation of the project beneficiaries in the study area. Identify obstacles to combating desertification efforts.

1.5 Study Methodology

A descriptive analysis method is for the economic and social characteristics of the groundwater use project areas in combating desertification. This method focused on examining the physical characteristics of the project areas and the environment, also. Political factors for it to accurately describe the reality as it is and on expressing it quantitatively by giving a numerical description clarifying the amount and extent of

the phenomena related to each other, as it expresses a qualitative expression by clarifying its properties and analyzing the results.

1.6 Previous Studies and Research

Multiple parties have paid attention to the water resource in contemporary life, such as international and regional organizations, scientific research centers and related institutions in the study, research, and analysis of this resource, including official government studies and research, including:

In 1984, the Iraqi Ministry of Planning (the Agricultural Planning Commission) prepared a study on the optimum utilization of water in the agricultural sector. The results of the study estimated the number of water needs in 1984 at about 41.5 billion m 3, and it was among its expectations that there would be a concrete water shortage when the development of agricultural projects and the cultivation of land with crop yields. The study concluded that losses in the use of water. Due to the low efficiency of the irrigation and drainage system. It stressed the need to achieve a balance between the volume of water and the area of agricultural lands together, taking into account the population distribution in the country, agricultural specialization, and the state of the land The irrigated and the prospects for expansion. However, this study did not specify the size of the water and what measures to address this problem.

In 1991, the Iraqi Ministry of Planning (the Agricultural Planning Commission) prepared a study on the evaluation of water resource planning. This study aimed to identify the water sources in the Tigris River. The rivers of the Euphrates have multiple possibilities and know the amount of water available for storage use. (Installation curve) Moreover, the results of the study were that there is an inverse relationship between the volume of water supply and the probability of its occurrence, and it confirmed the dependence on the annual insured water supply and the calculation of the water classification for the need - one dunum of 3563 m / dunum. Thus, this study estimated the volume of water used for agricultural purposes at about 44,43 billion m in 1990, while only 5,633,000 dunums were cultivated.

In 1992, the Iraqi Ministry of Planning (Agricultural Planning Commission) prepared a study on the working paper on water use in agriculture. This paper aims to determine the incidence of water precipitation in general and to determine the areas of irrigated lands, to know whether the incoming water is sufficient or not.

Therefore, this paper discussed four axes: the reality of the available water in Iraq, the irrigated lands in the country, and its water needs. Moreover, finally, uses of wasted water. The study concluded is surplus in the water if we take the difference between the incidence with a probability of 9680 and uses (agricultural and non-agricultural) and that the amount of this surplus amounted to 11.63 billion m. However, in the case of adopting the incoming rate that was calculated in the study, the surplus will represent 41.32 and conclude the paper has recommendations for water scarcity.

The study aimed at Al-Ghamdi's study (2009) to survey groundwater in the Kingdom of Saudi Arabia, explain the depletion of water reserves, study and analyze the most critical factors that led to the high rate of groundwater consumption and assess the impact. They were expanding the cultivation of crops (wheat, barley, fodder). On depleting water reserves, and providing appropriate recommendations to policymakers and agricultural programs, and the results of the study showed the necessity of stopping government support for wheat and barley, importing crops that require large quantities of water, following up on the size of water depletion and benefiting from rainwater. In Heil (2008), The study examined the evaluation of groundwater in the Al-Musayyib project area (Iraq). The study found that well water contains salt concentrations, which makes it unsuitable for crops. It also showed that the percentage of magnesium in (20%) of wells exceeded the legal standard, which hurt the production of crops. The study recommended that the agricultural lands in the study area need continuous management of their irrigation projects to increase crop production and protect water from pollution.

In Thabet (2004), The study dealt with well water in the Wadi Year region and chemical, physical and bacteriological analyzes. The study also showed a marked difference in some chemical, physical, and bacteriological properties with the standards set by the World Health Organization. The study recommended improving the sewage network, treating wastewater, and benefiting from it in the agricultural field.

Rabiha (2005), this study was conducted to identify the social and economic variables that resulted from the various project activities, to compare them with the prevailing conditions before conducting the study, so that the inputs and outputs of the study allow the generalization of the results. Which controls desertification

conditions in the Hebron area - in particular - and Palestine - in general. - Consequently, the formulation of recommendations and strategies to help achieve the set goals, and the results of this study were that the project did not contribute to achieving any kind. The change in several areas includes the number of herds owned by the farmer, the size of the family in all aspects related to it, as well as the type of work that women contribute, whether in the field of agricultural work or animal husbandry, as they continued to do the same work. And with the same contribution.

2. HUMAN FACTORS AND THEIR IMPACT ON DESERTIFICATION

2.1 The Concept of Desertification

Desertification is a term that appeared in the 1940s and was popularly used in the late 1970s. From the same century, it means a decline in the productivity of dry areas, especially those that depend on irrigation due to salinity Semi-dry and semi-humid as a result of lack of rain, or because of the irrational exploitation of human resources Natural (Baqer Taha, 1997). In 1977 the United Nations Conference defined desertification as "the degradation of the biological production capacity of the land, which ultimately leads to the creation of desert conditions." Thus, it indicates the extension of the desert to include areas that were not originally desert; that is, the spread of desert characteristics outside the desert domain (Al-Atrash, 1998).

The phenomenon of desertification is one of the manifestations of the change in the elements of the environmental system of a region, causing a deterioration in the productive capacity of land resources. Therefore, looking at it in isolation from the comprehensive concept of all elements of this system is an unscientific view, as each of these elements has a role with us in creating change, whether that change is positive or negative. The concept of desertification does not refer to the expansion of the current deserts. Instead, it occurs because of the dryland ecosystems - which cover more than a third of the world's lands. They are highly exposed to excessive exploitation and inappropriate use, and land fertility can be damaged as a result of poverty, political instability, removal of overcrowding, overgrazing, and inferior irrigation methods.

Moreover, the climate, through its relationship with other environmental pollutants, is one of the most important natural elements that determine the features of the environment for any region. Also, human factors are among the abnormal components that have a definite effect on disturbing the ecological balance as well. Therefore, the interaction between natural and abnormal factors is the basis for understanding the mechanisms of desertification, on which strategies are

From a change in the ecosystem for obedient reasons, the ability of a person to stop or reduce this degradation is limited. Thus the techniques of combating desertification depend only on corrosion with these changes. However, if human factors cause these changes, then it is possible to limit their effects or even stop them because they depend on the ability of a person to change his behavior by causing economic changes and some social behaviors. The topic of the project and the study is to address these two factors. For example, plants able to withstand drought were cultivated in an attempt to find a natural adaptation to changes in natural conditions, and the second part examined the study of the behavior of local people in an attempt to reduce the role of humans in environmental degradation. The degradation of rangeland, grassland, forests, and cropland begins with the deterioration of vegetal cover due to overgrazing, deforestation, and improper cultivation (Kassas, 1970).

2.1.1 Methods used to assess desertification

Methods used to desertification assessment phenomenon – has considerable international importance because it highlights the complexity and urgency of management challenges in drylands (Reynolds et al. 2007). Furthermore, These methods are intended to use quantitative criteria to describe the processes responsible for the occurrence of desertification, one of the most important of these criteria.

1. The state of desertification: This criterion expresses the evaluation of the characteristics of the elements of the environment at a specific time through comparison with the same characteristics at an earlier time.

2. Desertification rate: It reflects the extent of any change in the environment during a specified period.

3. Desertification risk: The extent of the impact of inherited or introduced factors that make the environment vulnerable or difficult to various degradation processes, it can be said, for example, that the risk of desertification inherited in dry areas is higher than in wet areas.

4. General risk: This criterion is based on an assessment of the criteria for the status, rate, and risk of desertification combined, and it helps to update the area's most vulnerable to and affected by the desertification process.

2.1.2 Causes of desertification

Desertification is another primary environmental concern and a significant barrier to meeting basic human needs in drylands and is being constantly threatened by increases in human pressures and climatic variability (Anyamba, 2005). Before starting the topic of treating and reducing desertification. One must give a clear and simple idea about desertification and the causes of dunes. Therefore, there are two main movements behind the occurrence of desertification, the first is a natural movement (drought), and the second is a movement caused by humans and also due to another. The following is a presentation of the essential factors of desertification.

2.1.3 Natural factors due to dehydration

From the archaeological then historical evidence in desert regions in the world, which confirms that were areas in the past times. characterized by the manifestations of moisture in the Arabian Peninsula and North Africa and that their transformation into arid regions is explained as returning to the recent changes in the world climate that occurred during the past 5000 years where Droughts increased and deserts expanded.(Baqer Taha,1973). Furthermore, it appeared from the statistical data on the ancient world's climate, and the analysis of rock layers and tree rings, variables in the world's climate proved. Geologists believe that we are now living in a warm period, and its thermal peak reached in the period between 3000-5000 BC, which is the period during which most significant deserts were formed as In the Sahara Desert, the Arabian Peninsula, and the Mongolian Desert. Evidence of desertification due to drought is the presence of traces of some people working in agriculture, as well as stubborn vegetation in semi-humid environments. These indications of the existence of lakes are found in desert areas that dominated by desert vegetation, and this confirms these areas have transformed over time into a dry environment. The studies were conducted on the deserts of the Arab world. Asian and African indicated successive periods of rainfall followed by periods of drought, and it was possible to infer several phenomena, most notably the presence of dry valleys, such as: as well as the presence of terraces of ancient rivers (Quality, 1980). Accordingly, the areas depressed due to drought are affected by their area and the opportunities for expansion and contraction movement from one period to the next. natural factors for the causes of desertification due to drought, namely:

1- Flatness of the Earth:

The surface of the earth is characterized by areas dunes are formed by long distances and almost devoid of heights. Those distances became vulnerable to winds, as their speed increases due to the absence of beams and vegetation, so the subtle soil atoms fly with the wind and shovel rough soil atoms, forming what is known as a dune.

2- The high amount of evaporation:

The rise in temperature on the one hand and the decrease in the amount of relative humidity, on the other hand, led to a rise in the monthly evaporation factor, which amounts to about 3353-4515 mm annually, so high evaporation worked on drying soil, and decaying vegetation and the soil became more vulnerable to erosion.

3- The rise in temperature:

A large amount of sunshine and the corresponding lack of clouds and the lack of relative humidity during the heat months for an extended period of the year worked to dry out the soil and disintegrate its particles, which makes the wind easy to shovel and thus become desert barren topped with dunes. The reason for this is due to the factors mentioned earlier of low humidity, increased temperature, and fewer clouds (Abdul Makhour,1984).

4 - Lack and scarcity of vegetation

The high temperatures and evaporation accompanied by a decrease in the annual rainfall amount did not help the establishment and growth of vegetation that protects the soil from wind erosion, except for some small weeds that grow in seasons or during the period of rainfall. However, soon the rain cuts out or disappears before that as a result of overgrazing. Which usually prevails without controls.

5- Wind

The wind is a powerful natural transportation agent, as it carries enormous amounts of sand and dust. The Arab parts of the Middle East are exposed to the trade winds and the monsoons that are affected by different climatic pressure bodies in winter and summer. There is fluctuation for the low-pressure area (orbital pressure zone) whose center is winter in the Gulf of Guinea while the summer is heading to the significant rocks. Only the southern is one determines the effect monsoons in Sudan through the summer .whereas in the Sahara and Arabia. As for the west in

Mauritania, the trade winds prevail, and the climatic side here has some coldness and humidity.

2.1.4 Human factors and their role in the occurrence of desertification

Experts in the field of geography confirmed that the expansion of the deserts that predominate in dunes was caused mainly by humans, so the decertified areas were called the human desert. Perhaps the most important reasons that a person has done and assisted in the scientific and desalination of deserts are the random, irregular logging of trees to be used for heating and cooking, as well as unjust grazing that prevails without regulation. is grazing at the expense of a small land that cannot support these numbers of livestock, as once these herds run, the upper layer of the soil will be destroyed, and in both cases, the soil becomes loose and an essential source of dunes feeding through the wind (Majid, 1987).The role of farmers in soil consumption due to weak cultivation. Moreover, continuous cultivation consumes the capacity of the soil. In this way, it increases soil looseness and its ability to move with the wind. Inadequate investment of natural wealth resources is the expansion of its activities, especially economic ones, which led to the disappearance of large areas of forests due to excessive logging. Also, overgrazing in natural pastures and the consumption of a large amount of water is an inconspicuous consumption in irrigated agriculture and cultivation of the land without paying attention to the use of agricultural cycles that return the land to some of its fertility. Hence, people harm the soil when randomly plowing the land. Soil is exposed to erosion, especially in sloping land when people plow the land vertically from the bottom up and vice versa without the process of planting with contour lines, as the role of human sabotage appears when plowing the land during seasons when wind speed increases in dry and semi-arid regions because the wind plays a significant role. In the process of sweeping the soil and dispersing it in the air, which facilitates the movement of soil from one region to another (Ibrahim, 1983). The production of the land began to decrease from one season to another due to the aforementioned human activity.

The expansion of various human activities led to the expansion of arid lands with low productivity per unit of cultivated area, as it has been proven that the expansion of the area of irrigated lands without regard to the means of surplus disposal. The need for water from cultivated plants led to the emergence of the problem of salinity

spread in those areas, as more than 25% of the cultivated land in the world became unfit for agriculture due to the increase in salinity. This problem is one of the most prominent problems in the Middle East and the world that have emerged in its land. Hence, desertification affects about (1/6) of the world's population, and that about (2/3) of the drylands amounts to 3.6 billion hectares, and 3.3 billion hectares of the total grazing lands deteriorate (Al-Barazi et al., 1980). In the world, i.e., 73% of the grazing land due to the proliferation of people, animals and ages, low soil fertility about 47% of the drylands, and the degradation of the cultivated land amounts to 30% of the drylands. The human resort to cutting off natural plants for different purposes, especially using them as fuel in some developing countries, has made large areas lose natural vegetation cover. The soil is subject to various factors, which led to its removal in many parts of the world and the inability to cultivate it, and it appears from what was previously mentioned that a person has a role. It cannot be overlooked or underestimated in the emergence of the problem of desertification of Human activity, mainly arid and semi-arid regions inhabited by man since ancient times, and built on its flourishing civilizations, whose effects are still common until now. Given that agricultural activity, especially irrigated agriculture, is the economic basis upon which these civilizations are based, the human use of soil and water resources in these areas has made various aspects of desertion, especially soil salinity, and the emergence and expansion of geography over time. Due to the interaction that we referred to earlier without taking into account the treatment of the roots.

2.1.5 The causes of desertification and their severity

Desertification cases and the degree their severity differ from one region to another according to the different environments, nature of the region, and the prevailing climate in it. Therefore, there are four cases of desertification in the world:

1- Light desertification

It is evidenced by the presence of very little damage or destruction of vegetation and soil, with no apparent impact on the natural ability of the environment.

2- Moderate desertification

It is indicated the occurrence of medium damage to vegetation and the formation of small dunes, as well as a clear case of salinization of the soil, which causes a decrease in agricultural production ranging between 10 - 50%.

3- Severe desertification

It is considered a pneumatic or hydro-sweeping process in this degree of desertification, which leads to the removal of vegetation and the appearance of undesirable weeds and shrubs at the expense of the original and desirable pastoral species as well as increasing soil salinity. These features reduce production by more than 50%.

4- Very severe desertification

The area is hugely decertified when large, naked, and active dunes are formed, and the degree of salinity increases, which reduces their production capacity permanently. This degree of desertification is considered one of the most severe cases where the entire area transforms into an exact desert pattern. Thus, reclaiming it and restoring its biological capabilities becomes a challenging process. It is often not economical. Confirms the importance of combating desertification in its early stages before spreading and then losing control over it. It is useful to mention that the areas affected by severe desertification were lands with huge plant production potential, such as the Middle East and Northeast Africa, especially the Sahel, China, and Mexico.

2.2 The Results of Desertification in the Arab World

The Arab land extends (about 14 million square kilometers) from the Atlantic Ocean to the Arabian Gulf. The heart of this land is the Sohar and Dry Lands (64%), the non-arid regions on the southern sides of Sudan, the coastal ranges of the Maghreb, the coastal elevations in the Levant and the Iraqi mountain (Bryson, R. 1972). One of the harmful effects of desertification in the Arab region is the productivity of most natural pastures Covering the largest area of land suitable for exploitation in the region, forest degradation, Decline in vegetation, loss of biological diversity, and declining productivity and characteristic of agricultural land (Irrigated and rainfed). Desertification contributes to the spread of poverty and undermines the necessities of

living in the regions Rural women, which causes men to migrate from the countryside to the cities and increase the burdens on women And children in the countryside Since the United Nations Convention to Combat Desertification entered into force. The subsequent agreements Instruments on sustainable development, especially the Johannesburg Plan of Implementation, is being made by Arab countries Regional organizations working in the region make great efforts to tackle desertification. It is the essential Achievements in most Arab countries:

1- Ratification of the United Nations Convention to Combat Desertification, and countries have drawn up plans National implementation, based on the guidelines established by the conferences of the parties The Convention, and incorporated standards and work programs to combat desertification into national development plans.

2- Establishing competent national councils and institutions concerned with coordinating efforts within the framework of Cooperate with the ministries of environment and other relevant ministries.

3- Enact the necessary legislation and laws to reduce resource degradation, especially about By urban sprawl on productive land resources, pollution and resources, and population activities that Contribute to it. However, the mechanisms to enforce this legislation are either absent or insufficient.

4- Initiate initiatives to take a participatory approach and support stakeholder participation In planning, designing, and implementing activities and related projects.

5- Achieving success in meeting a large part of the financial needs for reduction projects Desertification at the national level.

6- Implementing several capacity-building and awareness-raising programs on desertification issues in the region at various levels, they include decision-makers, specialists, as well as all beneficiaries.

7- The implementation of some integrated projects aimed at combating desertification in all Land use, with support from relevant international funds and mechanisms such as a Global fund Environment, United Nations Environment Program, United Nations Development Program, and Food Organization Agriculture to the United Nations.

8- Launching initiatives to strengthen national efforts to combat desertification, such as reinstatement Rehabilitating degraded areas, improving their productivity and expanding the use of unconventional water resources such as reinstatement Rehabilitating degraded areas, improving their productivity and expanding the use of unconventional water resources developing the use of remote sensing techniques to monitor desertion.

2.2.1 The social system

Desertion is first of a person's actions as we saw under the title Causes of desertification, whether practices are at the level of the individual, mobile or reckless, or the level of government institutions in the Arab world - and the tangible and most important result, reverting to the existing social systems. In Egypt alone, 52 million people live on only 4 percent of the land, and the rest is desert or desert. Dune encroachment threatens massive residential communities, even on the banks of the Nile. The sand in the Al-Kharja oasis covers new roads, fields, and villages, and strikes power and telephone lines. As for Farafra Oasis, which is located in the Western Desert, where evaporation is more than 200 times more than the humidifying moisture force (Khawli,1990). While in the same region, in Jabal Al-Uwaynat, he discovered traces indicating that she was enjoying green, fertile and human life, plant and animal life from about 8000 years, and the drawings that were found in the caves show the forms of lions, giraffes, ostriches, and deer, from about 6000 BC. Found traces of social stability in a spot-on Mount Nabata, and its use in agriculture and animal husbandry, so where are we now from all this?

The influences in the social system or the influences in this system stem from it and flow into it, so we have to take into account what are the basics of life in a particular environment. In Sudan, for example, about 500 km west of Khartoum, there are the Khawala tribes from the Bedouin Arabs who see in their stability state only weakness and poverty. Therefore see them never leave with their camels, especially from north to south or vice versa, every quarter, to seek water. While the Dinka tribes live in the al-Sadd region on the White Nile, stable around the swamps, and the Aweh live in a desert area, and they are delighted with their lives, and if we want to change their way of living, then we are like someone who robs them of the meaning of their lives. Indeed, the government's attempts in this regard have had negative impacts. The

same applies to the Dinka tribes and their swamps, which the government wanted to draw its water through the Al Janfalati long channel (360 km) to the north and east (Farouk El-Baz,1986).

It is useful to note here that the human movements that occur as a result of reckless practices such as wars, and here we mean the displacement of hundreds of thousands of people. When communities are transferred to severe environmental conditions, and they were living in a deplorable psychological state that contributes to environmental degradation, and the difficulty of maintaining this leads to more human and environmental problems. This situation applies to Somalia and the problems it faces in its borders with Abyssinia and Kenya. Somalia is an impoverished country with a deficient standard of living. Sixty percent of its population is nomadic tribes, 15 percent are farmers, and the rest are urban residents, and what is happening now is the displacement of the Bedouins from one place to another. We do not forget the dignity of these people who refuse to become refugees, as well as the farmers and people of crafts in the cities migrate abroad. How do we want these people to realize the problem of desertification, which is the scourge of pests in Somalia? As for Tunisia, to the southwest of the mountains, where Arab Bedouins and Berbers live, dunes appear and have traces of life that are the last drops, some trees in the last breath, the grass here and another there, the dust cover a few meters deep threatens to disappear. The water, however, tends to saline (Majid, 1987). A man and his sheep traveled several kilometers to reach this spot, for how long will these conditions remain. Moreover, the same customs apply, and perhaps on a larger scale, to the Tuareg tribes that roam the marginal areas of the Sahara in North and West Africa because drought means displacement, as well as the political borders of countries, means restricting freedom of movement, so how do we expect these people to face these natural social difficulties At the same time. In all the examples we have mentioned, the phenomenon of rural to urban migration exacerbates in particular with advancing age and the consequent change in the social and economic life of the countryside and the city at the same time.

2.2.2 The environment

The disruption of the life cycle as it is a continuous interaction between nature's data and man's exploitation of these data, such as the animal, plant, soil, and water

conditions of the earth, necessarily leads to water degradation. Human use of Earth is the consumption of environmental resources. Therefore, this quality and intensity of use are variable according to specific social needs, either it leads to environmental degradation or to maintain its balance. In simple words, the manifestations of the degradation of the environment are where we see the deterioration of natural plant and animal life, moreover. the degradation of soil in areas of agriculture and pastures and even forests, the loss of agricultural land or that can be reclaimed, and a decrease in the quantity and quality of water resources, especially the increase in water salinity (Nahal, 1982). These are manifestations that we find in many places in our Arab world. The area of natural pastures in Sudan has declined significantly in the last ten years, and forest wealth has decreased to a low level. In Somalia, 400,000 hectares of central forest was removed.

Only half of the pine forests were left in Tunisia. The southern slopes of the High Atlas in Morocco were stripped. As for Algeria, the forests lost at least four million hectares during the War of Independence. Fifty percent of the lands of the Euphrates in Syria and 70 percent of the lands of the sedimentary plain in Iraq have been affected, and the picture in Egypt and countries of the Arabian Peninsula is no better. (Muhammad Abd Al-Fattah,1999). A significant degradation has appeared in the forests of the semi-arid regions. In several places of Syria, and the pine, oak, fennel, fodder and acacia trees have become very weak and on the way to extinction, as has the case with the forests of the ducks in the northern part of the Arabian Peninsula. The value and inadequate protection of the soil, in the Levantine Badia, and due to the overgrazing, useful fodder plants such as Ruwaisa, Al-Azm and others decreased, and those with poor fodder and even sublime ones increased.

Oh Jordan, Iraq, and the United Arab Emirates, these pastures turn into a semi-desert covered with a layer of gravel and sand. One of the natural environmental manifestations is the spread of forests in some regions. Where we note that many of these areas in the Arab world have retreated from forests and become barren lands, we realize the magnitude of adverse effects on the environment is. Most countries of the Arab world face severe depletion in terms of firewood and construction as well (Herrmann, S., 2005). In Jordan, for example, about 182 million trees are uprooted annually for fuel. In Tunisia, the consumption of firewood reaches about two million cubic meters annually, and in Sudan, an individual needs more than half an acre of

trees annually. Moreover, acacia trees have been abundant around Khartoum for decades.

People now have to walk hundreds of kilometers to find traces of acacia trees in order to cut them down. Forests are receding due to the uprooting of trees used in fuel construction, or the fires that devour these forests, either for natural causes such as high temperature or for humanitarian causes. The desert advances at least 3 miles per year to the south in Mauritania. The stripping of the land from its trees leads to hitting the environment from several angles by affecting the vegetation, earthy, and water cover system. As a result, the quantities and types of animals present in this Arab land are accompanied by severe damage to environmental resources leading to desertification. In central and northern Somalia, most of the plants are destroyed. Destruction and spoilage continue due to the overgrazing of goats and livestock. If this pressure remains the same, it is estimated that in the year 2000, Somalia will witness complete desertification, except river valleys (Nicholson. S., 2005).

This pressure is also reflected in plant substitution, as we mentioned earlier, and unpleasant varieties replace suitable species. That comes as a result of selective grazing, that is, the selection of a particular plant. That happened in the Al-Batana region in eastern Sudan, as it was spreading weeds and obnoxious weeds in exchange for the desirable weeds. In Darfur, the plant has disappeared to replace weak plants. Another example is that plowing and cultivation of rangeland in marginal areas of the desert in Tunisia towards the center and south. The upper layer of the soil, which is generally shallow, was subjected to an extensive ablation process. It was stripped naked for years and began to appear the rocky substrate (Nicholson, S.2005). The last decades of this century witnessed the most critical stages of desertification because they were associated with the rapid increase of the population, so their pressure on the land increased. The size of the farms decreased, forcing the farmers to exploit new lands by cutting more vegetation, and this led to further erosion and destruction of the environment. Indeed, the streak of barren surfaces stripped from vegetation or very dry, and shallow soils have been observed in broad sectors of the margins of deserts in North Africa, Arabia, and Iran, which has increased in quantities Reflection of solar radiation (Elpida). That is very negative if we consider that the rain in these areas comes from water that is re-evaporated at a rate of 60 percent. On the other hand, we should be aware of the consequences of misuse of

water if available also, the abundance of irrigation water often leads to the increased alkalinity of the soil. Consequently, soil degradation may reach the degree of complete sterility, and information indicates the presence in Egypt of massive wastewater in the use of irrigation water, which reduces the return on production, as about 30 percent of the salty agricultural lands suffer.

2.2.3 Drought

More than ninety percent of the total area of Arab lands is located in climatic regions Arid and dry arid, covering arid areas 67 percent of the total area and does not exceed with average.Precipitation is 100 mm per year. The dry areas cover 23 percent of the square.The total area of the region ranges between average precipitation rates, between 100 mm$_{A}$ and 300 mm$_{A}$. Climate change and water availability in the Middle East are important in understanding human adaptive capacities in the face of long-term ecological changes. The key role of water availability for inactive and nomad populations in these arid to semiarid landscapes is understood. However, the millennium-scale influence of hydrologic instability on vegetation dynamics, Droughts are unique in that unlike floods, earthquakes, or hurricanes (Mather, 1985) and historical land use are unknown, which has led to a stochastic view of populace responses and adaptive capacities to precipitation anomalies. Inside the time-frame of the last two global climate events, the Medieval Climate Anomaly and the Little Ice Age, Hydrological drought is the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels causing an imbalance (Linsley et al., 1982)." The chronicled area of Northern Mesopotamia was as of late exposed to a serious and delayed dry season scene during the four hydrological years between A.D. 2007 and 2010. Pitiful precipitation created a precarious decrease in agrarian efficiency in the downpour, took care of Euphrates and Tigris seepage bowls, and dislodged countless individuals (Chenoweth J et al. 2011). The worst drought-affected regions were eastern Syria, northern Iraq, and Iran, the major grain-growing areas of the northern Fertile Crescent. This episode corresponds to the driest 4-y period for the Fertile Crescent since A.D. 1940, just slightly drier than the 1998–2000 event, and is predicted to become more common as warming proceeds (Chenoweth J et al. 2011). The socio-economic implications of the latter are to challenge the widespread belief that socio-

agrarian systems. mechanical development adaptively protects themselves from inconstancy in regular precipitation (Lobell DB et al. 2008). The large arid and semiarid zones of the Middle East rely on fragile systems of rain-fed or irrigated cultivation. They are especially vulnerable to periodic fluctuationsin climate and, most of all, to changes in hydrology. Anticipatedrepetitive drought episodes may exacerbate the vulnerability of communities unprepared to mitigate their adverse effects (Sowers J et al., 2011). The Middle East has extended since exceeded the water capitals necessary to supply its populace, and has sought to enlarge water distribution and storage systems through dams and canals until droughts and falling water supplies in aquifers became critical. Throughout the recent crisis and its aftermath, and water supply are exacerbated, and the load increases. It is not possible to give a final. Consequently, the causes of desertification are more complex to unravel. A group of core variables drives desertification, most prominently climatic factors that lead to reduced rainfall (Rowell et al. 1992) and human activities involving technological factors, institutional and policy factors, and economic factors in addition to population pressures, and land-use patterns and practices. Technological factors include innovations such as the adoption of water pumps, boreholes, and dams. The institutional and policy factors include agricultural growth policies such as land distribution and redistribution. These variables drive proximate causes of desertion, such as the expansion of cropland and overgrazing, the extension of infrastructure, increased dryness, and wood extraction. There was also a breakdown of traditional grazing patterns due to the construction of deep wells and pressure created by cultivators. seeking more land to farm in the north, especially during the preceding 15 year period of above-average rainfall conditions (Glantz, 1977) measures that have been applied in several countries:

1- Providing additional feed to protect livestock, as most of the funding is directed towards support. The cost of providing and distributing feedstuffs;

2- Encouraging well drilling and support for the purchase of irrigation equipment;

3- Including debt cancellation, rescheduling, and job creation in rural areas. Drought management programs in some countries;

4- Monitor the availability of water resources in dam reservoirs, to rationalize their use over blood Drought, to meet the needs of people and people, and from drinking

water, and to protect the crops of perennials, such as Trees, meeting the annual water needs of crops;

5- Providing an agricultural trustee to specify the droughts in drains and to increase the production of seeds, to ensure their satisfactory performance. Farmers need the agricultural season that follows droughts. Many Arab governments are aware of the urgent need to develop long-term strategies in them.

2.2.3.1 Drought-induced migration

Between 2000 and 2010, 75% of the land area in Arab republics was affected by drought for two years or more: 38% of the area was affected for three or more consecutive years (Erian, 2011). These events exposed 156 million persons to moderate or high levels of drought stress, most severely in northeast Syria, southern Sudan, the northern areas of Tunisia, Algeria, Morocco, northeast Somalia, northeast Iraq, and the northeast of Saudi Arabia (Erian, 2011). Protracted periods of drought and their related effects are among the reasons for population movements in Iraq. Between December 2007 and June 2009, 4,263 families (25,578 individuals) were displaced due to drought, with more than 80% from Salah al-Din and Ninewa governorates.iv In 2012, the International Organization of Migration (IOM) reported that 11% of the assessed Internally Displaced People migrated from their place of origin due to water scarcity. In some governorates, drought-induced migration far exceeded migration related to security, conflicts, or lack of employment opportunities. In Muthanna, 94% of the assessed IDPs were displaced for drought reasons. Hydropower generation represents the most important source of renewable energy in Iraq, accounting for nearly 10% of the electricity generation mix in 2010 (around five TWh). The declining precipitation rate projected for the future years and the related reduction in water availability is expected to impair hydroelectric production in the future, adding to environmental issues in the country. Higher shares of electricity production will need to be derived from combusting oil, gas, and coal resources to buffer the capacity losses on the side of hydropower plants.

2.2.3.2 Drought effects on poverty, unemployment and food security in Iraq

Water scarcity impacts poverty and socio-economic development in different ways. Some effects can be easily observed, while others are harder to assess and to

quantify. A reduction in the availability of water negatively affects the welfare of the population. It slows economic growth and undermines the livelihoods of a large number of people, often contributing to poverty. The earliest and most visible consequences of drought-related to agricultural production (Erian, 2011). Agricultural yields depend mainly on the availability of water, via precipitation or irrigation, and any respective shortage translates directly into production losses. In general, people living in rural areas whose income depends on agricultural production, livestock, forestry, and fishery are the most vulnerable to the effects of drought. Drought causes food insecurity and increases poverty, particularly in rural areas where most of the population trusts on agriculture as its primary source of livelihood.

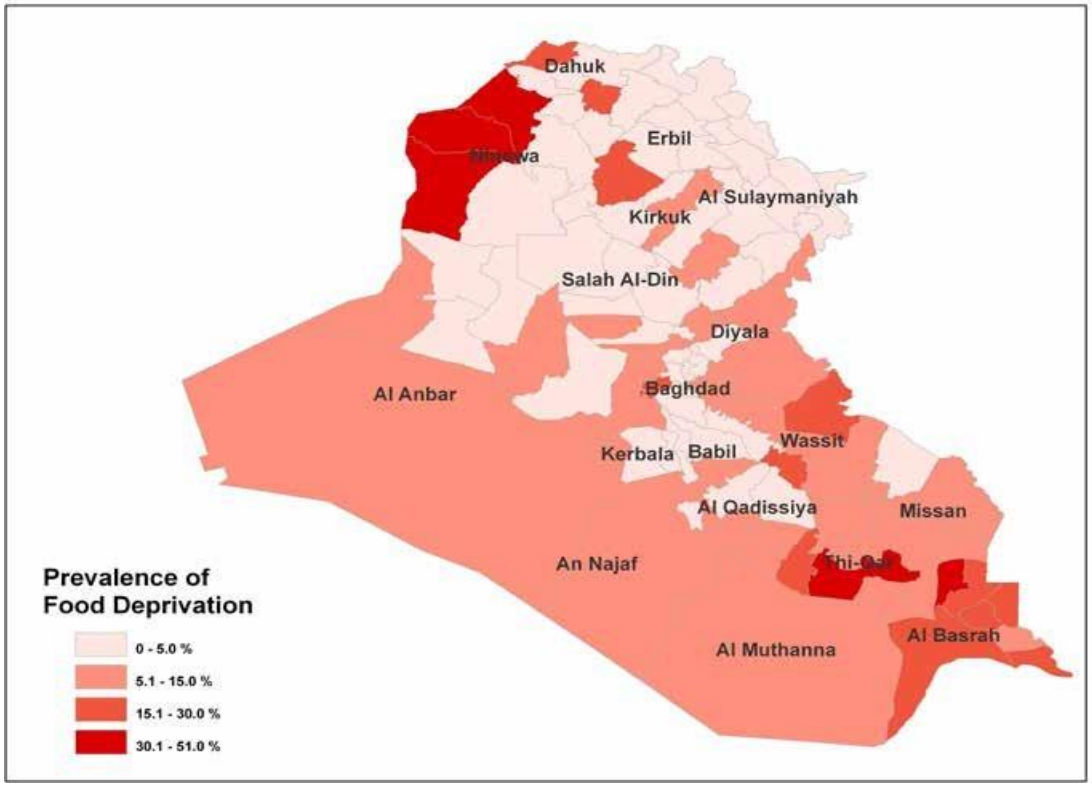

Figure 2.1: Food deprivation in Iraq

Source: (World food program, 2012)

3. GROUNDWATER

3.1 Definition of Groundwater

Groundwater is a valuable water resource that is stored inside the earth in the voids between sand, soil, and rock crumbs. These waters form aquifers known as aquifers that form a reservoir or water basin (Shiklomanov, 1993) Groundwater is considered part of the natural water cycle on the ground, as it leaks into the ground when it rains through the soil and crumbs of rock, and filters through the porous rocks to reach an area where it collects, and the level of water collected separates the waterlogged area or the groundwater layers (Aquifer zone) The saturated area or the Vadose zone wet area just below the surface of the earth through which water passes but does not fill all the spaces between rocks and dust - as water tends to move downward through the unsaturated region until it reaches the saturated region, but in the region, The saturated water moves horizontally depending on the water slope or the pressure of the water is directed from the upper slope to the slope, and some of this water may filter during its horizontal movement outside the basin to join the ocean water This leaching process can deplete the topsoil of essential nutrients (Hess, 2014).

Groundwater can be defined as water that fills pores or cracks in the rocks beneath the surface of the earth. When the rain falls, or the snow melts on the surface of the earth, some water goes to low areas, lakes, or streams. The soil can absorb the remaining water, Or it leaks into deeper layers inside the soil and rocks or evaporates into the atmosphere. They constitute 95 percent of total freshwater. Lakes, swamps, reservoirs, and rivers account for 3.5 percent, and soil moisture accounts for only 1.5 percent (Freeze and Cherry, 1979). The dominant role of groundwater resources is transparent, and their use and protection are, therefore, of fundamental importance to human life and economic activity. Groundwater formation factors two critical factors that help groundwater formation, and they are (Dieter, 2018).

Gravity: Gravity pulls water toward the center of the Earth, meaning that the water on the surface of the earth tries to leak beneath the surface. Water under the influence of gravity leaks into the layers of the Earth.

Rocks: There are many definitions of rocks, according to (Ehlers and Blatt, 1997). He defines rocks as the stuff in which the earth is made off. A more acceptable scientific definition of rocks is that; a rock is a naturally occurring, reliable, cohesive aggregate of one or more mineral or mineral materials. Rocks are broadly The rocks below the surface of the earth consist of many types, including sandstone, granite, and limestone. If these rocks consist of dense material, such as solid granite, it is difficult for gravity to pull water down. The empty spaces may vary between these rocks, Where groundwater accumulates in it, and the rocks beneath the surface can be broken, or cracked, creating areas that can be filled with water. Some rocks are dissolved with water, such as limestone, which leads to the emergence of large cavities filled with water. The changes in mineral assemblages are due to changes in the temperature and pressure conditions of metamorphism. Thus, the mineral assemblages that are observed must be an indication of the temperature and pressure environment that the rock was subjected to (Spear, 1993) , which gives the water more areas to remain in it, and some rocks such as sand rocks may dissolve the water, which increases the volume of voids, and consequently, the amount of water stored increases. In some regions, there may be layers of sedimentary rocks that appear excellent when looking at a cross-section of the earth. Rocky R has a higher porosity than other rocks, which allow water to move more freely through them. Suppose these porous layers are above the layers formed by dense rocks such as granite or clay layers, which does not allow the passage of water to recharge the groundwater. Usually, groundwater recharge methods differ according to the natural groundwater levels from one season to another, and they increase at the end of the rainy seasons and decrease at the end of the dry seasons, so rainwater is the primary nutrient for groundwater. The regions where rainfall amounts rise are classified as areas near to Mountain peaks, to the groundwater recharge areas in comparison with the low-lying areas surrounding them. As for the discharge of groundwater depends on its depth, where a natural discharge of shallow groundwater occurs in valleys and low areas, while deep groundwater occurs to Here is an ocean dump (Freeze and Cherry, 1979). Groundwater may be exposed to artificial discharges by humans, as it is pumped from the water layers in it to meet human needs, and some developed societies in the process of feeding groundwater basins artificially to preserve water resources. Depending on the geological and hydrological conditions of an underground water basin, the water level may drop dozens of meters and continue for

long periods, which may lead to droughts and the disappearance of groundwater wells.

3.1.1 Groundwater movement

3.1.1.1 Movement speed

The movement of groundwater is continuous but slower than the speed of surface water, because of the passage of groundwater between narrow paths and friction with rocks. Because of its effect by static forces, its speed reaches about 0.00002 km/hour. In comparison, the flow of river water is about 30 km / h, the velocity of movement of marine currents 3 km / h. (Hussein, B. M., 2010).

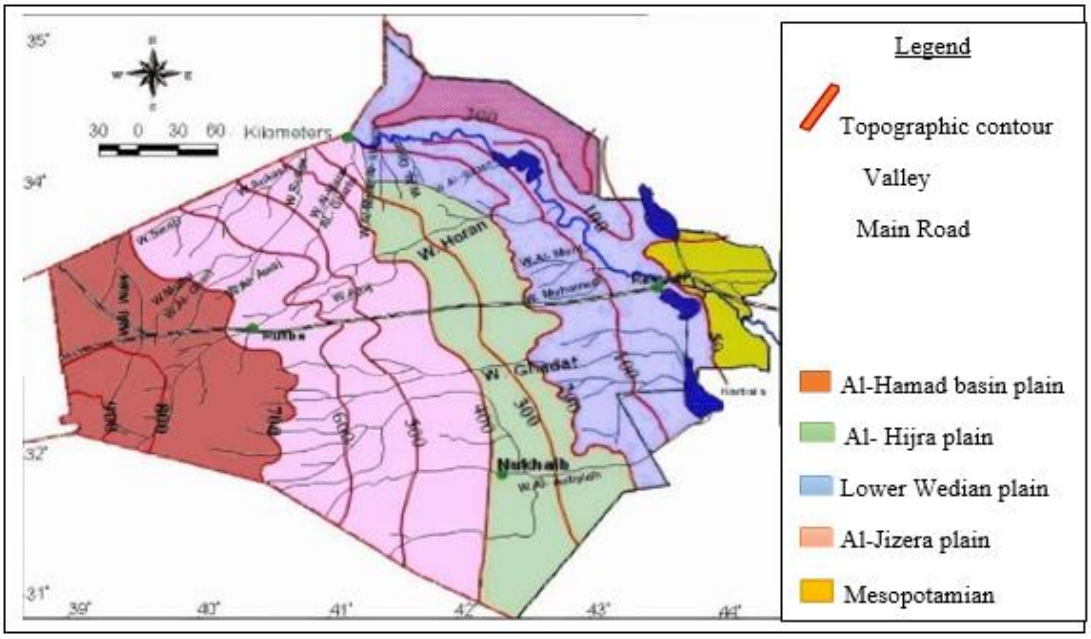

Figure 3.1: Physiographic map of al- Anbar Governorate

Source: (Hussein, B. M. 2010)

3.1.1.2 Movement direction

Water usually moves vertically downward due to the effect of gravity, and it may move upward under the influence of different pressure. It moves from areas of high pressure such as strata under mountain peaks to areas of low pressure such as strata under valleys, just like water that is placed in a U-shaped tube, it decreases on the side that is affected by high pressure and rises on the other side. The surface of the earth can be divided according to the movement of the groundwater into two parts.

3.1.1.3 Groundwater feeding areas

Recharge areas filter the water and move downward to the wet area or the groundwater basin. Groundwater discharge areas: They emerge from discharge areas and move toward the surface to lakes, streams, and springs.

3.1.2 The importance of groundwater

Groundwater is an important natural source of fresh water, as it represents 30% of freshwater in the world, and the remainder is distributed between water and ice in the form of 69%. Only 1% of fresh water is found in rivers and lakes, and Precise unsaturated layers usually reduce numbers to acceptable levels (Lewis et al., 1982). Furthermore, about a third of human consumption depends On freshwater to groundwater. In some areas, it is entirely dependent, and groundwater has an essential role in the economy, irrigation of crops, and in the manufacture of foodstuffs. As for its importance to the environment, groundwater plays an essential role in maintaining the water level in rivers, lakes, and wetlands At What flows to it from inside the ground, especially in dry seasons when direct feeding from rainwater decreases, and this contributes to preserving the wildlife and plants dependent on it. Its role in maintaining the water level in dry seasons keeps the movement of navigation through the inland waters and rivers. Groundwater is stored in layers deep under the surface of the earth, which maintains its quality and protects it from pollution (Freezer and sherry, 1979). Different velocities of groundwater flow are in channels or fissures of different widths. So it is suitable for direct consumption without the need for high costs to extract or treat it, but it is essential to maintain this vital resource from depletion or pollution.

Mean annual of maximum air temperature values, that were recorded in Ramadi, Haditha, Ana, Al-Qaem Al-Nukhaib, and Al-Ruttba gauge stations for the period (1967-2000) are ranged between, (15-28.9)^{0}C, (14.2-28.5)^{0}C, (13.3- 27.9) C^0, (13.2-27.7) C^0 (12.7-26.5) C^0 and (11.4- 25.5) C^0, respectively, see Figure 2. The mean heat degrees seasonally in the govern ranged between (28-34) C^0 in summer and between (8-12) C^0 in winter. The mean monthly air temperature within the governorate are ranged between (2-42) C^0 for the period(1967-2000). Finally, the minimum and maximum air temperatures, which were recorded within the

governorate, are (-7.6 and 50.7 ^{o}C), respectively. The annual sun issue energy within the studied area ranges between (240-750) milliwatt /cm2 in every 8.8 hours of daily radiation.

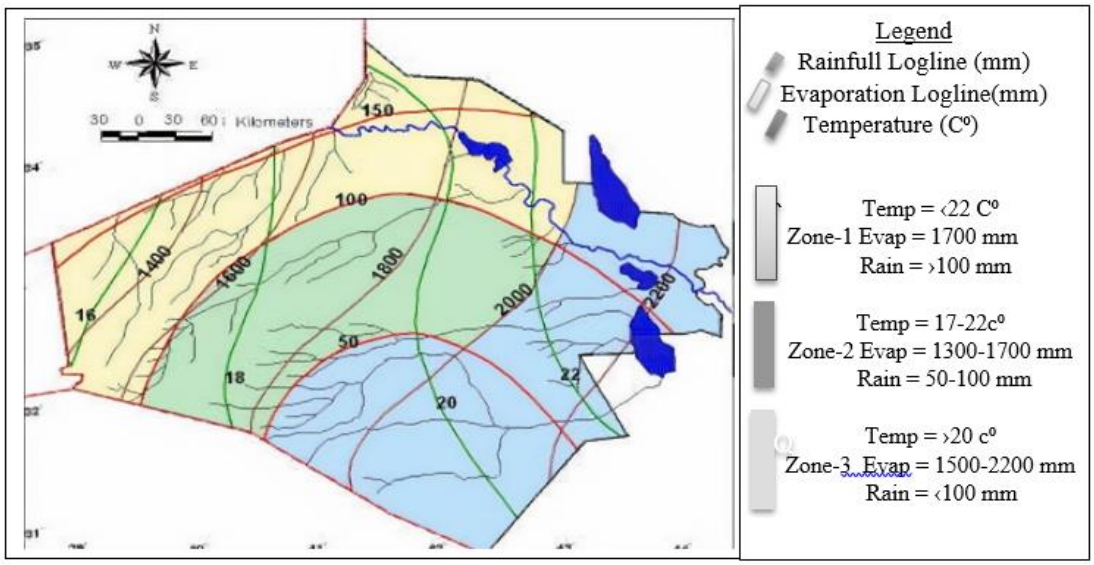

Figure 3.2: Distribution map of rainfall

Source: (Hussein, B. M., 2010)

3.1.3 Groundwater properties

The groundwater moves from the feeding areas to the discharge areas, and it passes through chemical and physical changes, where it mixes with other groundwater and interacts with the minerals in the soil and the rocks that flow through it, which may affect the quality of the water, and since the water is a natural solvent for several materials, we find the groundwater Flowing in the form of springs contains minerals and dissolved gases, which give the spring water the distinctive taste, and the most common dissolved minerals are: calcium, magnesium, sodium, potassium, chloride, carbonate, and bicarbonate, but the amount of minerals dissolved in water is more than a thousand milligrams per liter It does not make it salty and not suitable for drinking, and the water may contain a lot of element and magnesium to become hard water, and hardness of water is expressed through the amount of calcium carbonate dissolved in it, which is mainly found in limestone, and water is classified as not hard if it contains less than 60 milligrams / Liter of salts, and very hard water contains more than 180 mg / l. Groundwater is a valued freshwater resource and constitutes about two-thirds of the freshwater reserves of the world (Chilton, 1992).

Groundwater types Before displaying the types of groundwater, it must first be known that most of the groundwater comes from rain, as precipitation falls below the surface of the earth until it accumulates in an area of thick rocks. Groundwater is extracted through hand-dug wells Manual pumps run on shallow and submersible wells. The pump works for a deep well or wells (Ojo, 2002). The water that leaks into aquifers can be classified, and groundwater types can be classified in several ways; Classify believers according to the following key saltiness of the most acidic groups: brackish groundwater, Brackish groundwater, and Acid groundwater.

It can also be classified according to its layers in terms of its accessibility to the surface. In this case, it can be classified into two types of aquifers as follows:

Confined aquifers: These are the layers that have impermeable dirt or rock layer that prevents water from leaking to the surface of the earth. Instead, the water escapes to layers farther from the surface of the earth.

Unconfined aquifers: those from which water escapes to the surface of the earth. If the groundwater exits to the surface of the earth, either naturally or by digging it by drilling operations, it is noticeable that the underground water comes to the surface in several forms, including the following:

Artesian wells: the pressure pushes the water up towards the surface of the earth. The artesian well is free to flow and has enough pressure to push the water to the ground level.

Springs: The surface layer of the earth is eroded by the action of water to expose the aquifer. That allows water to flow to the top. If the water is not under pressure, a natural pool of groundwater may be provided.

3.2 Natural Characteristics and Their Relationship to the Nature of Groundwater in the Study Area

The quantity of groundwater in any region is related to the characteristics of the dominant natural factors in it. Accordingly, this axis included discussion and analysis of the natural characteristics and their relationship to the nature of groundwater in terms of its quantity, quality, and spatial distribution in the study area as follows.

3.2.1 The geological structure

The geological structure has a direct effect on the properties of groundwater in terms of quantity, quality, and spatial distribution, as it forms underground reservoirs for it, and the theological features of these rock formations and their structural composition are among the most important natural factors. Affects the qualitative and quantitative are properties of groundwater. We can show the nature of the geological structure and its relationship to the characteristics of groundwater through the following:

1- Tectonics of the region:

The lands of Al-Anbar Governorate are distinguished by the fact that the base rocks contain shallow depths ranging between (5-9 km) (Al-Bassam, K. 1986). The study area lies within the stable sidewalk. At the same time, the northern part of it is located within a block belonging to the western zone, which is an extension of the surface of the western plateau, where the area is characterized by the absence of slopes of the layers and is characterized by a decrease in the thickness of the sedimentary cover. There are also groups of separators and faults towards the north-south and east-west, and the region of these faults are essential areas because they contain groundwater and large quantities of contact with more than one reservoir, as well as the speed of the water flow in it (Al-Bassam, K. 1986).

2- Geological formations (theological):

The geological formations in the study area reflection of different sedimentary environments, some of which are exposed at surface and others under the surface. Their thickness varies according to the different climatic and geomorphological factors that affect them and which in turn affect them. Water properties, existence, and origins. We can briefly outline the nature of the geological formations in the study area Palatine:

1- Euphrates formation (lower myosin)

This formation is widely exposed west of the Euphrates River, as it forms in some places rock ridges that oversee the course of the Euphrates River, and the height of these edges reaches 17.5 meters.

This formation consisted of limestone, as many other geological conditions made the formation. The Euphrates is an essential underground reservoir for feeding springs in

the study area, including the approximate length of its line span. of spreading eyes between the skies and Anbar, and its superior ability to store water, due to a large number of cracks and openings And interfaces created by dissolution in its calcareous components (Al-Bassam, K. 1986).

2- Composition of the aperture (lower myosin):

Deposition of this formation under shallow marine conditions or a semi-isolated beach lakes environment, which consists of evaporated deposits such as gypsum and anhydrous gypsum. Gypsum and anhydrous gypsum.

3- Anjana composition (the upper myosin - Pliocene)

This formation is exposed east of the Euphrates. Its rock components are alluvial stone, mudstone, sandstone, limestone, and lamellar clay at the bottom. As well as the presence of secondary gypsum in some of its parts, it is a famous geological formation that stores groundwater, water quality primarily due to the insolubility of its components.

4- Quaternary era sediments They are new deposits, the components of which date back to the Pleistocene era and the modern era. These deposits cover a large area of the study area. These deposits consist of young materials of clay, silt, sand, and gravel of various sizes. These deposits are of economic importance, as they are a source of gravel, sand, and clay, as they are a source of many from the shallow subsea watershed (Buday. T. & Jassim, S. Z., 1987). Their high permeability characterizes deposits of this age, and reservoirs can be if layers under which impermeable layers are found. The effect of these deposits on the groundwater increases the dissolution of sulfate ion and gypsum deposits. And its transfer within the filtered water to the groundwater. These deposits are divided into the following units: River terraces (Pleistocene). Slope sediments (plasticine-Holocene). Ancient soil deposits (plasticine-Holocene) Deposits of floodplains (Holocene) Sabkha.

3.2.2 The roof

The study area shows that the rocks exposed on the surface in the northeastern part of the region are alluvial deposits of the Eulocene and Pleistocene. The surface was studied by analyzing DEM spacecraft visuals, the digital elevation model, and the scale of the topographic map (1/100000), which were handled in the Arc GIS

program. 9.3 It is then processed and extracted in the form of maps and data consistent with the purpose and requirements of the research. Where it appears that the study area has an undulating plateau surface, it is an extension of the surface of the western plateau within the lower valleys. (AL-Badiwi J. M. 1997). Its height ranges between (60 m) above sea level near the Euphrates River and between 260 m. M above sea level in the western and southwestern parts, and thus it gradually decreases from the western, southwestern, northern, and northeastern sides towards the Euphrates River and the eastern sides. Occurrence and distribution of vegetation in the Al Anbar are generally determined by the amount and distribution of the rainfall. However, topography and soil texture also play an essential role in a detailed description of the distribution within areas receiving similar amounts of rainfall (Abu Sin, 1970). The study area also features a network of valleys with different patterns and trees. Additionally, some of them feature full channels.

Moreover. Which contains river sediments. Others are narrow streams. The many directions of its slopes also distinguish this region. That made the valleys differ in their drainage and slope. One group opera, internally towards lakes and salt depressions, while the other group operates from valleys outside the region. Towards the Tharthar and Haditha lakes, as well as the Euphrates, which indicates the abundance of local slopes of the earth's surface in different directions. Moreover, wadis formation with various water discharges, the most important of which is Wadi Houran. Wadi al-Marj and Wadi Muhammadi, which in turn affected the different depths of groundwater spatial variations, as well as its effect on the amount of feeding the underground reservoirs and the regularity of the flow of water from those wells.

3.2.3 Climate

Climate affects water resources, and by studying the nature of climatic characteristics in the study area. It became clear to us that the number of precipitation reached 142.6 mm annually, with an evident fluctuation in the amount of rain during the different months of the year as it begins to fall in October. The rain continues until it reaches its peak during the winter months, then begins to gradually decrease until it ends at the end of April and the beginning of May, In keeping with low climates, while summers are dry (Ali H., 1966). February is the rainiest month of the year in the

study area, and the region is characterized by high degrees. Heat with less rain and fluctuation. M0rover, the evaporation values increase with increasing temperature, which affects the quality of groundwater, especially useful on the amount of rain leaking into the ground, as well as the loss of part of the water reservoirs near the surface of the earth by activating the capillary property. For the soil. From the preceding, it is clear that the characteristics of the climatic zone are characterized by a lack of rain and high temperatures. The values of the evaporation rate indicate Climate change generally acts as a threat multiplier, exacerbating existing social, political, and economic vulnerabilities, undermining livelihoods, inflating the risk of conflict, and making it difficult for people to stay on the site. Social and economic are conditions affected all over the world and Iraq. That leads to What can be described as a failed state, in a recent report entitled "The Axis of Climate Change and Security: A New Geostrategic Scene and Anthropocene" (Werrell et al., 2017). The authors emphasize that the impacts of climate change contribute to a wide range of destabilizing trends within countries, including population displacement, migration, political upheaval, state fragility, and internal conflicts. It also means that the transboundary nature of some of the impacts of climate change may lead to conflicts between nations. Reduced water resources due to natural climate change impacts alongside unfair participation Water from Turkey and Iran may lead to armed conflicts between Iraq and these two countries or with the other riparian country, Syria. Such measures may be taken in despair, under popular pressure and upheaval.

3.2.4 Hydrological is characteristics of groundwater in the study area.

The Euphrates River provides the primary source of water supply in the governorate. The upper section between Husaiba and Rawa, the river generally flows due east along the northern flank of Al-Ana Anticline, which is mainly composed of Miocene and Oligocene rocks. The river cuts the Al-Ana anticline in the environs of Rawa and Ana. Then the valley widens and flattens where the terrace relics scattered far from the river course. This axis included an analysis of nature, quality, and spatial distribution of groundwater in the study area. To reach a comprehensive assessment of EA by focusing on the characteristics of water wells and their levels in the area, and clarifying the relationship between the type of underground reservoirs, their

depths, their spatial movement and their suitability for human, agricultural and industrial uses.

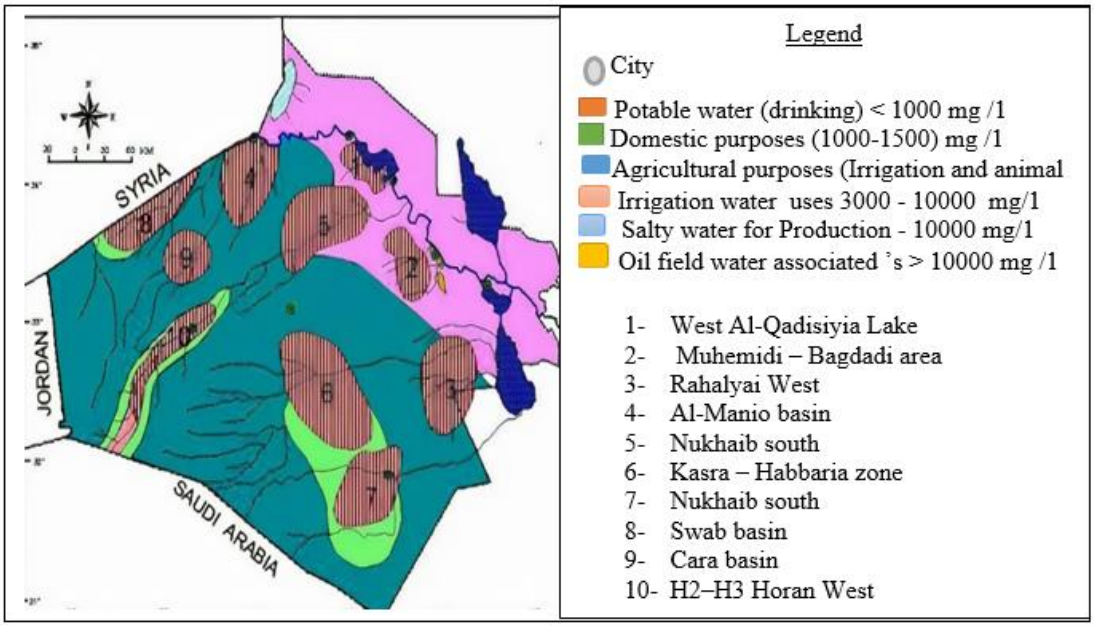

Figure 3.3: Spatial distribution of groundwater districts of exploitation

Source: (Hussein, B. M., 2010)

3.2.4.1 Spatial analysis of the depths of wells

There are more than 200 wells in the study area, most of which are concentrated in specific locations, compared to their scarcity in sites Others, for natural and human reasons, are as follows:

1- Terrain, as the higher the area, the greater the depth of the underground water, while its depth will decrease in the flat areas.

2- The type is geological formations and their underground reservoirs.

3- Underground is reservoirs containing water.

4- Urging machines.

5- Financial is capabilities.

6- Economic is activities.

1- The depths of the wells in the study area vary, as said by the aforementioned natural characteristics. The depths were ranged among (less than 10 m) in the areas

on together sides of the Euphrates and between more than 50 m in the areas far from the river, and between these two boundaries, Other values range.

2- The depths of the wells increase as we move towards the southern and northern ends due to the height of those parts above (200) m above sea level, and this results in it after the underground reservoir above the ground.

3- The different depths of the wells and their spatial diversity are due to the different topography of the region and the direction of the regional rock layers towards the northern parts on the one hand, which helped in the presence of underground water of relatively few deaths in the region. The central and near parts of the river compared to the northern and southern parts of the study area.

4- Moreover, the difference in depths. The wells in the study area are related to the costs of exploiting them, which increases with the increase of the depths. Accordingly, the economic feasibility of groundwater investment in developing levels of economic development within the study area will be determined in the light of it.

3.2.4.2 Groundwater movement

The hydrogeologic zone was observed in the zone of Al-Hijra province and detected in Hy-5, 6 (Nukhaib Graben, (Hussien, B.M & Gharbi, M.A,2008). As the groundwater moves towards this region from three directions (northwest, west, southwest), this phenomenon shows that groundwater appears to be discharged in this region. However, the groundwater leftover in this region is reflected by the low-speed groundwater moving inside the pores of the rocks vertically. And horizontally as a result of the geological location and inclination of strata. Cracks and fissures increase the speed of groundwater movement and flow from one place to another. The movement of the groundwater in the study site is characterized by its multiple directions and its conformity with the topographic situation of the region as we have shown it, as it moves from the high hydraulic pressure levels towards the low pressure. The movement is slow compared to the movement of surface water and in hydraulic conditions and the general direction of water movement from the west and southwest towards the north and northeast in the western plateau and from northwest to southeast in the Jazirah region, general slope of the area, some local differences in movement due to the direction of the structures Linear.

3.2.4.3 Productivity well drainage

The study of the characteristics of well water discharge is an essential topic in hydrological studies because it determines the reality of withdrawal rates from the underground reservoir and its storage limits. It is necessary for determining the economics of optimal water use, as excessive exploitation of groundwater leads to lower levels, which causes the existence of hydrological and environmental problems. Balance condition between groundwater extraction and compensation amounts in wells helps to achieve safe conditions for groundwater investment, which is the most crucial stage of groundwater conservation and sustainability. The productivity of wells in the study area ranges between (100-1900) m 3 / day. Generally, the depth of the water table or piezometric surface range between (0.0 -350)m, increasing westwards near the Jordanian Iraqi border (Hussien, B.M & Gharbi, M. A, 2008).

Furthermore, the reason for the abundance of productivity and its stability in several wells is due to the extension of subterranean tanks Shallow groundwater salinity map (fig. 5) (Hussien, B.M & Gharbi, M.A,2008). It generally shows an increase in the TDS values with the direction of flow (from west to east). The salinity of the groundwater of the western hydrological units of Al-Hamad and Upper Wadis governorates is of low saline water.

It is noticed from the map. That the depths of the underground water lie between (0 - 350) meters from the surface of the earth, and its depth increases towards the Iraqi-Jordanian-Saudi border. Its depth ranges between 150-300m in the Al-Hammad area. Between 150 - 250 m in the upper valleys. Between 100 - 150 m in the Hajar area. Between 0 and 100 m in the lower valleys. Between 5-20 m in the areas of the island and the sedimentary plain (Hussien, B. M & Gharbi, M. A, 2008).

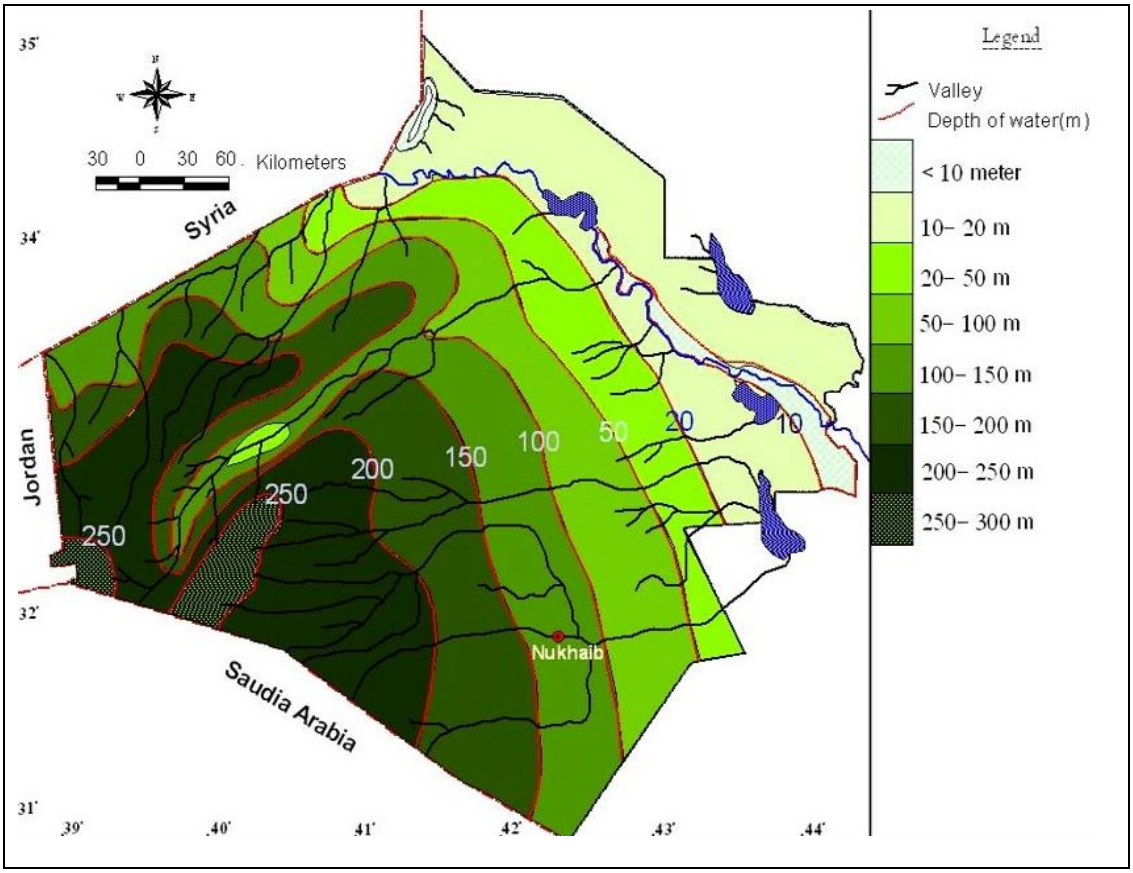

Figure 3.4: Ground water depth within Al- Anbar governorate

Source: (Hussein, B. M., 2010)

3.2.4.4 The chemical properties of groundwater in the region

In the western plateau of Iraq, the groundwater is the primary source of water supply because of the insufficient surface water, (Fetter, C. 1988). Knowing the chemical properties of groundwater is necessary. It is no less important than knowing where it is. Knowing the nature of these properties will determine their suitability for different uses. And so is its investment, especially in light of the increasing importance of its use nowadays besides. The housing crisis and economic development that accompanied this also exacerbated the development of techniques for searching and extracting groundwater. That led to the investment of groundwater in areas that lack surface water sources, as is the case in the study area. The climatic system is the soil moisture where it represents an essential parameter for water and energy storage in the regional climatic system (Seneviratne et al. 2006). The total dissolved salts were approved in determining the validity of groundwater in the study area for human, agricultural and industrial uses, and the water wells in the region are characterized by the concentration of dissolved salts in general, as well as the variation of their values

from one well after the other, due to the presence of gypsum, limestone, and dolomitic rocks within the gates of known formations. For its ability to dissolve with water, and the different locations of these wells from the sources of nutrition. Relationship between the water superiority parameters using correlation analysis and application of water quality index (WQI) (Ramakrishnalah et al., 2009). there is an apparent variation in the values of dissolved salts in the groundwater. Within the study area, wells ranged between 1085-7000 mg / l. It is also clear that the salinity of groundwater increases in the areas gypsum formations represented by the formation of the Euphrates and the formation of the hole. At the same time, it decreases in the areas where the formations of the quaternary era are widespread. Shows that the effect of geological formations and their types are on the properties of groundwater. For the flow of water between the pores of the rocks. Is to dissolve the components of these rocks and concentrate the salts in them.

3.3 Evaluating the Characteristics of the Groundwater and Development Orientation

The primary goal of analyzing the characteristics of well water is to determine its suitability in human, agricultural, and industrial uses based on established criteria and measurements. Groundwater is an essential and renewable resource that has many intrinsic advantages over surface water. It is recognized as a safe source of freshwater worldwide. The order for water has more significant than before overtime, and This has resulted in water scarcity in many parts of the earth (Nandini, 2018). The increased demand for water is a result of the increase in the world population along with the improvement of living standards. Agricultural request for water continues to increase with the adoption of supplemental irrigation in regions where rainfall is insufficient to meet the best crop water requirements. Water shortage is a significant restraint growth of agricultural production in many countries (Mohammed et al., 2013). The reason for increased demand for water is a result of the increase in the world populace as well as improved living standards. Many countries have relied on groundwater for agriculture. The quality of watering water has a significant impact on soil salinity, the increase, and yield of crops.

In general, water used aimed at irrigation always contains different absorptions of dissolved salts, which are generated naturally by enduring rocks and melting of other

salt sources) or anthropological (Jarvie et al., 1998). Thus, the study of irrigation water excellence has developed essential because it shows whether the quality of the water appropriate for irrigation and does not cause the formation of saline or alkaline. Earths, besides, to be an indicator of regardless of climate, this A type of water that causes toxicity to plants and crops. The most useful tool for monitoring and evaluating water quality is the use of the Water Quality Index (WQI). (Al-obaidy et al., 2010).

3.3.1 Evaluation of well water for drinking purposes in the study area

The geological formations of the study area which contain groundwater are varied widely because of the variety of geologic time of the stones; be that as it may, it shifts in states of significance for water quality dependent on the physical and concoction properties of the stones and revive hotspots for springs. There are a few lithological units in the territory of study, going in age from Permian to Eocene. Most kinds of residue accessible in the investigation zone are phosphorite stores of Late Cretaceous – Early Tertiary age. These stores stretch out to Pakistan and maybe to India from the northern pieces of South America. Besides, it is a piece of the gigantic Tethyan phosphorite territory. The central springs are sand, rock salt, and sandstone. Since, of the arrangement and properties of get together, it is considered as the best store sew, (Horton, R. K., 1965). It is additionally assessed the water put away in the western level; it was around 1080 million m3 for each year. In this district, the measure of the year hold of water put away around 930 million m3 for each year (Shihab, S. Sh., 1992). The amount of water calculated in any case is about 1447.51 million m3 per year, the amount of reliable investment in farming and mechanical turn of events, particularly in regions where concentrated monetary amounts. The profundity of groundwater is extraordinary. It is commonly developing towards the west and south-west of the western level; along these lines, the groundwater profundity shifts even at the level of the same site. To calculate the water quality index, the water of the Iraqi standard for drinking purposes, 1992, was taking into account (Khalid H, L., 2011). The initial step to figuring WQI is relying upon the general significance of the substance boundaries in drinking water, so specific loads are doled out to them, as indicated.

Table 3.1: Shows the calculated relative weight (Wi) values of each parameter

Chemical parameters	Sl	Weight (wi)	Relative weight (Wi)	Chemical parameter	Sl	Weight (wi)	Relative weight (Wi)
pH	8.5	4	0.121	HCO_3^-	200	3	0.091
EC	200	2	0.061	Cl^-	600	3	0.091
Ca^{2+}	50	2	0.061	SO_4	500	4	0.121
Mg^{2+}	125	2	0.061	NO_3^-	50	5	0.152
K^+	12	2	0.061	PO_4^{2-}	0.9	4	0.121
Na^+	200	2	0.061	Total		33	1.000

3.3.2 Well water evaluation for agricultural production

According to the hydrologic properties of the groundwater. that Euphrates river losses 40% of its water through concentrated agribusiness purposes, the high pace of vanishing, and capacity in lakes, in this manner, causing diminishing in water release downstream (Al-Jabbari.et al,1985). In general, the depth of the groundwater level or the piezometric surface ranges between (0.0 -350) meters, and it increases westward near the Jordanian-Iraqi border (Hussein et al., 2008). The international organization has issued an amendment to the Water Quality Index for irrigation purposes. The arrival of the Food and Agriculture Organization (FAO) to 4,700 mg/liter as a maximum in agricultural use by elaborate methods in crops and irrigation, and this increases the percentage to 5% as the water of all wells in the study area becomes suitable for production. Plant except for only two wells 11 and 16 where salts are highly concentrated. What is about Iraq, which is characterized by a rate of rainfall of about 150 mm / year, and the rate of evaporation more than 2400 mm/year (Al-Hadithi et al., 2000). The renewable resources in desert areas are few. The stock that the wells invest in varies from one region to another and with different types ranging from fresh to very saline water, even if the majority of the groundwater is of poor quality (Mustafa, MH, and KT 1998, through this presentation of irrigation water specifications and comparing them. With the characteristics of well water. We find its occurrence from brackish water to brackish water, where there is a proportion of well water suitable for irrigation purposes, and this means an essential component of agricultural production in this economically backward region. Especially since the results of analyzing the feasibility of water for animal consumption also indicate the health of the water wells covered by the study for animal consumption, and this in

itself is an essential center for development that must be invested in the development of agricultural production in the study area.

3.3.3 Well water evaluation for industrial production

It has been shown from the above that 20 percent of the freshwater used globally goes to industrial use, "while 10 percent goes to domestic or municipal use and 70 percent to agricultural consumption." This percentage is affected by the state's industrial progress, of course. In African countries and some Asian countries, this percentage drops to less than 10 percent, and in developed countries, it rises to a double sometimes twice as much. It is expected to increase this percentage as a result of population growth and industrial development globally, "especially in Asian countries," where industrial water demand is expected to increase to twice the current amount after less than 15 years from now. It is not surprising, as demand has more than tripled in the past 50 years.

Industrial production processes require the use of water in specific quantities. Specifications commensurate with the nature of each product, In addition. Often high-quality water specifications reach the best products, along with avoiding the adverse effects that may occur when using poor water, especially water that covers salts in high proportions since it negatively affects the quality of production. Industrial, as well as its corrosion effect on pipes, appliances, and equipment, in both cases, increases economic costs. Many industrial managers today understand that waste is simply a resource out of place–a through concentrated agribusiness purposes, high pace of vanishing, and capacity in lakes, in this manner causing diminishing in water release downstream (von Weizsacker et al., 1997).

Moreover, industries that invest in water-saving and waste Minimizing .Methods could place themselves in a superior showcasing position as individuals are getting more worried about the actual utilization of unique assets. Moreover, since the internationally permissible limit for the percentage of salt concentration in the water used industrially is 500 mg/liter.

What must be mentioned here is that this water is not suitable for use. The industrial sector, in light of the current reality, did not negatively affect the stability of industrial activities within the study area due to the availability of surface water resources represented by the Euphrates River. Economists regard environmental

capacity as a resource with the universality and non-exclusivity of supply. It is a highlight of the open cargo mill, and the pollution release has a strong negative external impact. Regions involve more assets in a natural limit as the degree of contamination increments. A few researchers assess strategies that cause the least hurtful release to amplify monetary advantages. Water demand management can be considered a part of water conservation policies, describing initiatives to protect the aquatic environment and make more rational use of water resources (Brooks et al., 1997).

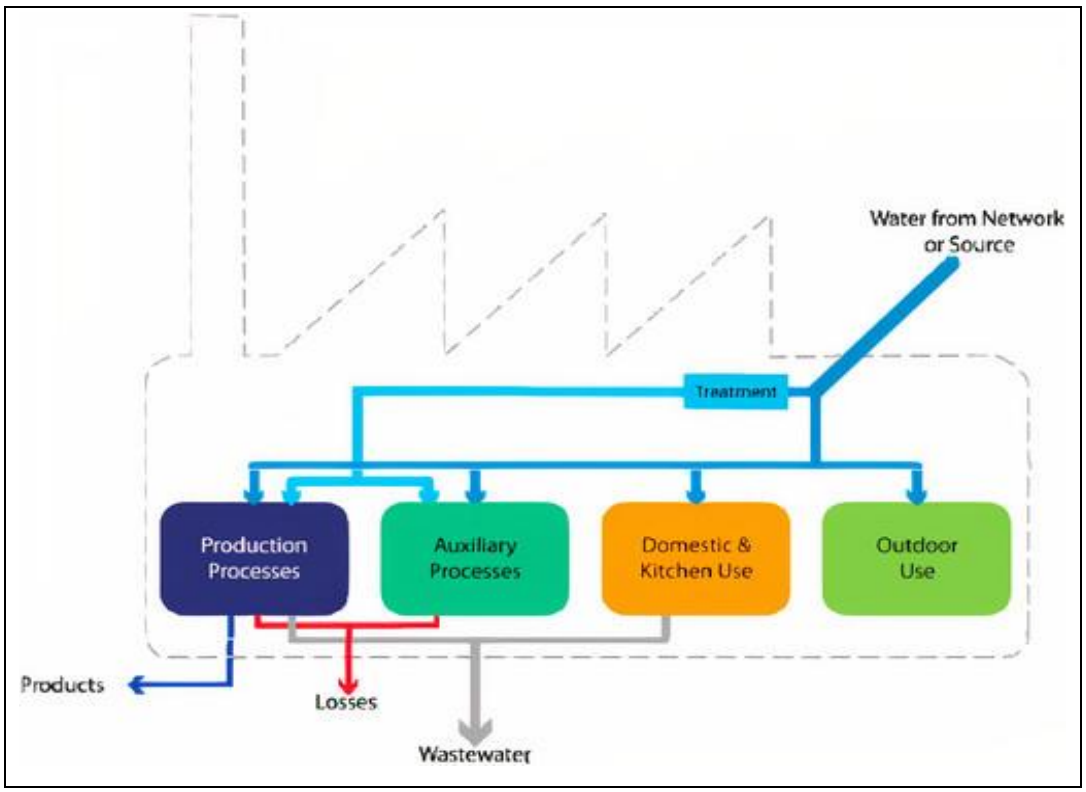

Figure 3.5: Water use in industrial plant.

Source: (Pham, 2016)

The reasons and instruments for demand management within industries vary; they include financial incentives, environmental balance, image and competitiveness, environmental stewardship, and moral responsibility (Lallana et al., 2001). The water demand is increasing, especially in the form of water recycling and reuse. It has many advantages to reduce water consumption. At the same time, it reduces pollution produced by its discharge. The government worked on this kind of project in the 1960s. The project was the beginning of a comprehensive and detailed analysis of the Iraqi water resources development and management needs, opportunities, and plans. Over the years, investments in water resource development have been applied

based on plans generally mentioned in these documents. These plans have not been updated or reconsidered since they were issued. Although the population has increased dramatically since then, many projects have been completed and launched Several wars, institutions and systems changed, and regional and global markets for products succumbed to it.

3.3.4 Water well design and installation

Once the well location has been determined, a preliminary well design is completed. For many large production wells, a test hole will be drilled before well drilling to obtain more detailed information about the depth of water-producing zones, confining beds, well production capabilities, water levels, and groundwater quality. The final design is subject to site-specific observations made in the test hole or during the proper drilling. The overall aim of the design is to create a structurally stable, long-term, and efficient well that has enough space to house pumps or other extraction devices and allows groundwater to move quickly. Casing (tube) enclosed in a bundle of gravel and seals suitable for roofs and walls. Water enters the well through perforations or openings in the top screen. Wells can be screened continuously along the bore or at specific depth intervals. The latter is necessary when a well taps multiple aquifer zones, to ensure that screened zones match the aquifer zones from which water will be drawn. In alluvial aquifers, which commonly contain alternating sequences of coarse material (sand and gravel) and elegant material, the latter construction method is much more likely to provide clean, sediment-free water. It is more energy-efficient than the installation of a continuous screen. Hardrock wells, on the other hand, are constructed very differently. Often, the borehole of a hard rock well will stand open and will not need to be screened or cased unless the hard rock crumbles easily

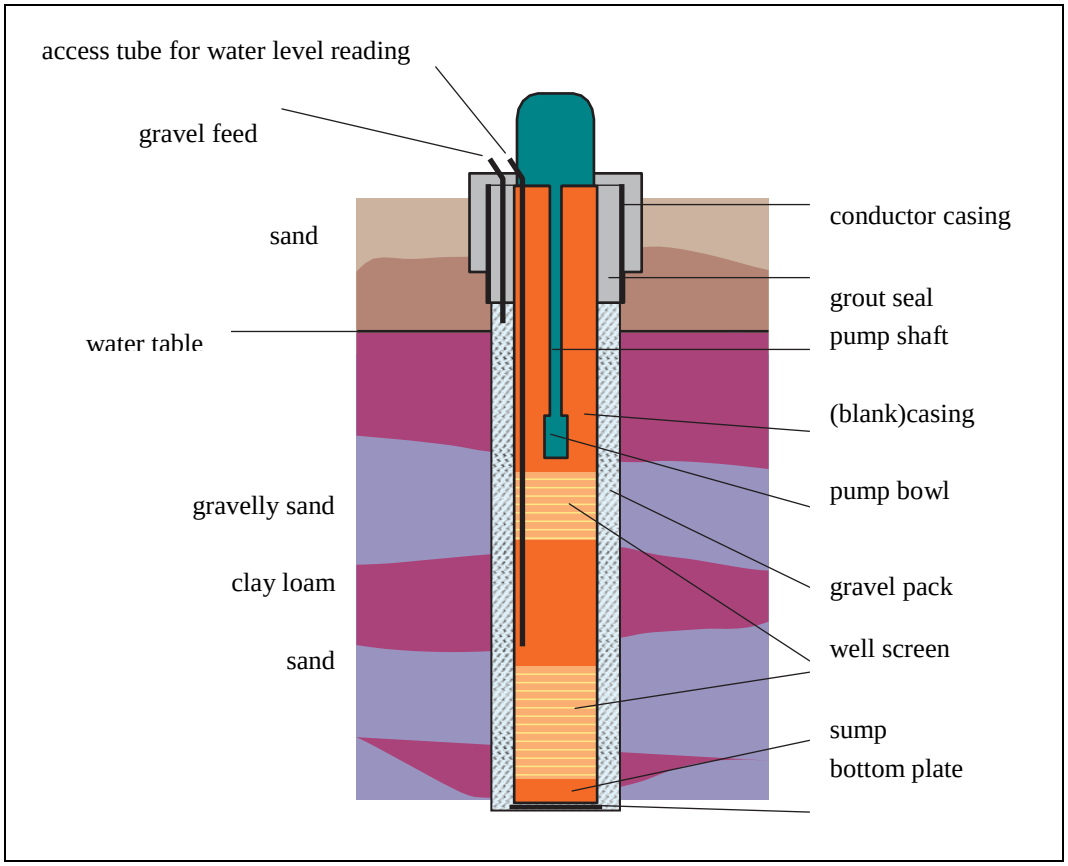

Figure 3.6: Components of a well.

Source: (Davis, 2020)

4. COMBAT DESERTIFICATION

4.1 Evaluation of Desertification

Desertification is a single word used to cover a wide variety of effects involving the actual and potential biological productivity of an ecosystem in the arid, semi-arid, and dry sub-humid regions (Hillel and Rosenzweig, 2002). A large scale integrated assessment of land/soil degradation and desertification is required in the study area, to define the related avoidance and alleviation procedures. Appraisals should start at the nearby levels instead of starting at the global or provincial levels. The assessment should include past patterns, current status, and imminent progress in soil degradation and desertification, which should be based mainly on indicators related to soil hydrology. The most severe limitations are because of the dirt information gave by the national soil studies, which is predominantly static data with no sign of changes and patterns, significant for environmental protection purposes. Desertification includes not only soil erosion but also potentially genetic erosion of the plant, animals, and microorganisms that form the living elements of the dryland environments. The soil is a medium to fine-textured light clay, sandy clay, or silty clay, which contains more than 40% expanding clay (Khalil, 1986). There are also required soil monitoring systems, aim to deliver information on changing soil parameters, necessary for soil functions, based on systematic sampling and Measurements. To check desertification. Likewise, careful follow-up of vegetation and soil conditions is needed. A watershed approach for the biophysical assets would assist with coordinating the data for evaluating corruption forms adequately. For handling vast watersheds, it is prescribed to do initial a surveillance level examination of the issues to distinguish the regions that need centered consideration, and afterward, dispatch a point by point investigation in the focused on little zones. The primary goal is to assess the state of desertification. It is to warn of some imminent crises of land degradation and desertification, as well as to find appropriate solutions to them.

The actual cause of land degradation? Other methods are required, based on hydrological assessments, to assess the problem. In most cases, poor knowledge of relevant hydrological processes and the nature of desertion, and insufficient assessment and monitoring methods for these processes impede the adoption of the integrated use and management of soil and water resources rehabilitation policies and programs (Pla, 1998).

Oversimplified indices like drought, using climatic maps, vegetation cover, using satellite imagery, and others, which fluctuate year after year, have limited diagnostic criteria (UNCCD, 2003). When mostly qualitative indicators are used, elements of subjectivity are many times involved in the assessment of desertion, depending on interpreters' experience or bias. There is a need for searching more acceptable and readily determinable criteria that are measurable. It may be concluded that to assess and to predict desertification adequately. There is required the collection of sufficient field observations and data, mainly of hydrological nature, to reflect temporal and spatial conditions and variations. This information would be used for the identification of the causal processes and for the development, calibration, and use of simulation models that can predict future changes. In all cases, the used criteria must be clear, relevant, environmentally specific, and scale-specific.

4.2 Modeling Desertification

Desertification is a major environmental problem. It is the result of land degradation in areas that are water-poor and have little vegetation cover. The human factor is also a major cause of desertification (Bauer & Stringer, 2009). Many practical experiences have proven that desertification is a significant problem in the future. There is neglect from several countries in this aspect. Unfortunately, the increasing need for more quantitative results in the potential and risk of land degradation and desertification inland continues to decline. Qualitative rather than quantitative methods mainly measure it. That is, sometimes, it becomes a more natural way to exaggerate the situation to get it funding (Warren and Olson, 2003). Appropriate analysis and data modeling and processes help to know desertification trends and responsible factors, under different biological, physical, social, and economic conditions. Modern technologies for digital remote sensing and geographic information systems may be beneficial in analyzing and processing the original and

generated information. Modeling desertification requires prior identification of major desertification processes. Appropriate models should help to gain more insight into the processes and understanding of the system as a whole. Although models cannot replace rapporteurs, they provide them with correct and quantitative alternatives, which are required for success. In any case, simulation modeling should be used with caution and should be based on sufficient local information. Field information is necessary, and the data obtained through digital remote sensing in the field must be verified to be useful. Experimental models, such as so-called Universa Empirical models, like the so-called Universal Soil Loss Equation (USLE) and its revised version RUSLE (Renard et al., 1991) have been commonly used in the countries of the Mediterranean region, frequently without verification, for large scale water erosion (one of the more critical soil degradation processes leading to desertification) risk mapping. Although the outputs and mapping using GIS may be impressive, they can hardly be used with a guaranty of success for the development or prevention of desertification purposes. The biophysical data, mainly of hydrological nature, may be taken as surrogates for human impact. However, in some models, the social-economic data are also fed into calculation procedures with variable success. Simulation models based on hydrological processes may be constructive to integrate and convert the measured or estimated soil, climate, plant, and management parameters into predicted soil water balances and soil moisture regimes for each particular combination of them, actual or previewed (Pla, 1998). These models not only help to understand the complex process of desertification, but they may also serve as decision-making tools to reduce or to avoid negative environmental impacts leading to desertion under different and changing scenarios (Richter and Streck, 1998).

4.3 The Causes of Desertification in Iraq

The causes leading to the increase and the expansion of desertification in Iraq are divided into two groups:

The first group includes natural causes.

These include factors related to climate and soil. The following are examples of these factors: cessation of rain, drought years, and soil erosion. Statistical pieces of training indicate that (90%) of the total area of Iraq lies within the arid and semi-arid climatic

zones. In summer, the temperature rises to around 52 degrees Celsius. The average rate of evaporation increases significantly, and the number of sunny days reaches 260 days per year. Also, the northwest winds are dry, hot, and bring local dust. He is accompanied by a long hot summer that dries u (Alfarajy, 2001). The second group includes human causes. It includes a massive increase in population, which leads to a similar increase in the degree of consumption. The following are some of the most significant critical human factors for desertification:

1- Population growth and population increase: The population of Iraq is expected to reach about 33.5 million in 2015. That was affected by the decrease in the individual land share from 1.2 dunums in 1970 to 0.43 donuts in 2012 (Bruinsma, 2003).

2- Random and random cutting of forest trees: a statistical study indicates a continuous shrinkage in the Iraqi forest areas. The forest area was estimated at 1.9 million hectares in 1970, and it decreased to 1.5 million hectares in 2005, which means that these areas lost about 12 km2 on average annually. That is due to the human activity in cutting trees to use the wood in house building, heating, and cooking. In addition to palm trees, whose numbers have decreased from 30 million to 11.5 million due to wars and military operations (Ministry of planning, 2007).

3- The deterioration of pastures: the area of pastures in Iraq is estimated at around 44 million hectares in 2005. It is shrunk to 32.1 million hectares in 2010.

4- Decline in land productivity: The rate of cultivated land in Iraq decreased (12.2%) of the total area of the republic to (8.3%) during the period 1970-2010. The annual growth rate of agricultural productivity in the cultivated area decreased from 3.7% in the 1980s to 0.2% in the 2000s.5- Urban development: The quick and immense numerical increment of the populace was joined by the subsequent increment of the zone assigned for urban extension., It was accomplished at the expense of fertile agricultural lands. The rate of the urban population in Iraq has increased from 39% in 1957 to 67% in 2010, and it continues to increase (Alatraqchy, 2012).

The table shows that the vast majority of the all-out regions of Iraq were presented to desertification in its various structures and degrees, which speaks to practically 70% of the entire nation. Plant spread was lost, and ridges showed up. Military action took its toll in this respect from 1981 till 2003 and after. The economic blockade did the rest. It left Iraq in ruins, equally shown in Table 4.1.

Table 4.1: The degrees of desertification in Iraq

The Degree of Desertification	The Estimatd Area(in 1000's Dunams)	The Percentage	Plant and Land Characteristics
Slight desertification	45.138	25.8	The plant cover is lost
Moderate desertification	99.950	57.5	Plant cover is lost and erosion of soil begins
Severe desertification	22.908	13.5	Increasing appearane of decertified spots
Very severe desertification	5.823	3.2	Appearance of sand dunes and disappearance of the upper layer of soil
Total		%100	

Source: (Ministry of planning, environment statistically, 2007).

4.4 Symptoms of Desertification in Iraq and their Economic Consequences

1- The salinization of the soil became sterile as a result of incorrect irrigation and the absence of proper drainage (Alhakeem, 2009). can be shown in Table 3 for areas of salinometer in Iraq, and Fig. 2 for the desertification land in the middle and south of Iraq.

Table 4.2: Areas of salinization in Iraq

Governorate of Districting	Area (In Dunams)
Babell	743776
Anbari Saqlawiyahy – Ramadi	12500
Anbari Al – Khouraa – Rawah	625
Wasit	%75 of the area of the governor
Al – Muthanna	360325

Source: (Ministry of planning, environment statistically, 2007).

Figure 4.1: Desertification lands in the middle and south of Iraq

Source: (Abdul and Siham, 2013).

2- The deterioration of vegetation cover that rapid grazing due to the increase in the number of animals that exceeded the ability of the pastures to feed them (Al-Anny, 2013).

3-The Development of Sand Dunes This is because of a few climatic conditions, which incorporate the accompanying: the falling paces of the downpour, the increasing paces of warmth, and the blowing of dry and quick breezes. That is specifically true in the southern regions of Iraq, particularly in the summer season. The area affected by the dunes in Iraq has reached 30.6% of its total area.

4- The deterioration in the output of the agricultural lands.

Table 4.3: Desertification Areas in Iraq As said by the environmental belts

The Geographical Position	Decertifid Areas
The upper Euphrates district and Al–Badiyah	6000000
South Al–Basrah governorate and Al–Najaf Governorate	1684000
Northwest to Karbala governorate and Al–Anbar governorate	380000
Al–Nukhaib district and Anah district	369000
East Tigris and Ali Al, Gharbi district	42600
Between the double rivers Tigris and Euphrates and in the governorates of Al-Muthanna, Babel, Al–Qadisixah, and Thi-Qar.	448800

Source: (Ministry of planning, environmental statistical, 2007).

5- Depriving these areas of contributing to the domestic agricultural production and Gross Domestic Production GDP.

6- The large amounts of money burdened by the state in the process of reclaiming these lands, which is costly economically

7- The immigration of the inhabitants of the desertification lands from country territories to urban zones, rivaling the neighborhood populace in the accessible assets of food, lodging, and work.

8- The advancing sands will have a direct and severe effect on the irrigation projects.

9- The desertification is hinder the development projects.

10- The decrease of the individual share in the planted area, which is below the international rate (1.2 dunams per person).

11- Desertification that has caused an abatement and termination of various plant and creature species during the period 1990–2010, which brought about crushing 6,000 plant species.

4.5 Methods and Methods to Combat Desertification In the Study Area

Desertification has become a severe problem on a global scale; therefore, combating desertion has become a fundamental task (Pastemak and Schlissel, 2001). These included specifying the negative factors and the causes of the deterioration of natural resources as a result of human mal-practices. It is also to specify the decisive factors in dealing with those resources to enhance their preservation and continuity. It is also, to compose the relations among man and the unique assets by enacting legitimate laws and by correcting the current laws, lastly raising the social and monetary degree of the neighborhood populace. These incorporate limiting migration from rustic territories to urban regions. Every one of these measures and they are like requires national arranging in participation and coordination with the universal network, especially the UN. Requires are building a PC database on desertification (Chouan, 1992).

The first step in the method of combating desertification is the availability of financial resources. The costs are high, but the significant gains by far surpass them.

This is shown in Table 4, for the estimated annual costs of protective and corrective lands.

Table 4.4: Estimated yearly costs of protective and corrective trials for the degree of land deterioration, for dissimilar lands in US Dollar per one Hectare

Degree of Deterioration	Cost of Measures in River Irrigated Manors	Cost of Measures in Rain Irrigated Manors	Cost of Measures in pasture Manors
Slight Deterioration	100 – 300	50 – 150	5 – 15
Moderate Deterioration	500 – 1500	100 – 300	10 – 30
Severe Deterioration	2000 – 4000	500 – 1500	40 – 60
Very Severe Deterioration	3000 – 5000	2000 – 4000	3 – 7

Source: (UNEP, 1992)

Iraq faces the most significant environmental problem in its history of severe desertification, which endangers its food security. Many natural and human factors coexist in making them. It has dire environmental, economic, dries long summer (Alfarajy, 2001), social and civilizational results, the most prominent of which is the loss of productive lands, the movement of dunes, the severe sand and dust storms, and the resulting increased air pollution. This study attempts to identify the development of the problem and analyzes its causes and results and suggests some solutions to address it. It may seem easy to distinguish desertified land, but in reality, it is difficult to define and describe it using simple terms (Chouan, 1992). As an accurate diagnosis requires identification of a large number of factors, even after that, the problem remains complicated due to differing opinions regarding the relative importance of the various factors. Desertification is accelerating in Iraq, and the proportion of lands exposed to it is estimated to exceed 92% of the total area. Since 1981 this percentage has increased, mainly due to the military operations, which have destroyed both soil and plants and have had other harmful negative consequences for the environment. Desertification can be classified according to its density and the affected lands (Haktanir, 2002).

The State exerts strenuous efforts to combat desertification and reduce its hazards through soil conservation and fertility conservation, and reclamation of lands that have been subjected to deserts to restore its biological capacity. It also makes

continuous efforts to conserve water resources and protect trees and natural vegetation. These methods are as follows:

4.5.1 Soil Maintenance

The soil conservation process is to protect it from wind and water erosion and to preserve the surface layer rich in organic materials for the growth of vegetation that provides permanent protection.

4.5.2 Obstructive dams

They constructed several dams, including the obstructive dams, which are stone blocks that are tightened by a network of strong wires and then stacked adjacent intercepting the course of the valley. As these dams stop the runoff of water and thus keep the soil from erosion, it also covers a higher chance of water leaking into the ground and feeding the underground water tanks (Alhakeem, 2009).

Fixing the dunes: To combat desertification, fixing the dunes is one of the essential methods used in the study, and it serves for the following methods:

4.5.3 Confirmation with plant materials

Fastening is carried out either with dry vegetable material or with live plants that can resist dunes encroachment.

A- Fixing dunes to dry plants:

This method uses locally available dry plants such as dis, tribe, rum, and palm leaf, as these plants are buried in trenches with a depth of 15 cm and a height of 35 cm. These trenches are dug in the form of chess boards or rectangles or triangles of 5 square meters on coarse dunes, And 16 m 2 on hills with moderate inclination, where it works to reduce the speed of the wind, And weaken its ability to move the sand. but topography and soil texture also play an essential role in a detailed description of the distribution within areas receiving similar amounts of the rainfall (Abu Sin, 1970)

Despite the success of this method, the expansion of dune fixation operations on the one hand and the severe decrease in plants used in this way, on the other hand, led to the trend towards using other methods.

B - Fixing dunes with live plants:

Because fixing dunes with dry plants is a temporary fixation and it always needs to be renewed, the tendency has been to cultivate some types of plants such as castor, dirt, and oxea (pure acacia).

Eucalyptus, where these types work to reduce the speed of the wind and hinder the encroachment of dunes, and the logs work to stabilize the soil, especially the trees, whose roots extend superficially over long distances.

4.5.4 Fixing the dunes with oil derivatives

The significant expansion in the field of desertification control requires searching for more effective and less expensive ways to install dunes (Ahmadi et al., 2002). One of the most important of these methods is the use of petroleum materials. The first field experiment was conducted in southwestern Tripoli. Where an area of one hectare was sprayed with oil with fuel, it was found that this area that was sprayed with oil fuel was not significantly affected by the wind, which encouraged the expansion of the use of this method.

4.5.5. Trees and shrubs in dry areas have several functions, the most important of which are

In nature, different trees and shrubs thrive in different places. Some grow along flood plains where there is lots of water and low oxygen in the soil. Others may live in areas where the soil is fertile but where water is easily absorbed and does not stand for long periods. Land managers and landlords must understand and respect the natural preferences of different trees and shrubs. Otherwise, they will encounter an endless succession of planting the wrong items in the wrong place and then replacing them in a few years. Floodplain trees, such as river birches, should never be planted in hot or dry streets or the middle of parking lots. Likewise, oak trees whose roots cannot "breathe" in compacted soil with high alkalinity will not thrive in a landscape.

With this type of soil. The lack of trees increased, Which, in turn, plays an essential role in the environmental balance (Hasler et al., 2009). Trees play an essential role in our lives, by entering into the design and coordination of gardens, cities, villages, and all the sites that we deal with daily. Woody plants differ among themselves, leading plant scientists to divide them into three types: trees, shrubs, and palms. (Plants) They described the tree as a wooden plant more than 5 meters high and has an

original standing stem (stem) free from branches for several meters above the surface of the earth, and it holds ahead or crown (a summit of leaves) specific shape. (Abu Sin, 1970). While they described the tree as a wooden structure that does not exceed Height from (5 m), it does not have an original trunk (except for a few cases). However, preferably it has several legs that leave the ground or close to the surface of the earth, and they may be spreading and have no specific shape or head summary of the essential benefits of tree planting in arid regions. Let us summarize the benefits of growing dryland plants:

1- It can be a factor in stabilizing the soil and preventing the water from being lost or eroded. The woody vegetation provides better protection for the soil and longevity. The tree roots help in deepening and improving the soil.

2- It represents an essential source of animal feed and wildlife.

3- Source for wood products. And firewood.

4- It plays a vital role in maintaining ecological balance.

5- Protection of farms, housing, and roads from sand encroachment. Moreover - trees provide pastures for beekeeping.

Proper management of trees and forests is essential to make the resources sustainable. Trees or rather woody plants, in general, play an essential role in traditional farming systems in the tropics, not only as food and cash crops but also as suppliers of fuelwood and fodder. The farmers are also aware of the environmental benefits and use trees such as fallow plants, hedges, windbreaks, erosion barriers. As these traditional roles of trees diminish due to increasing population pressure and or changing land use, it is imperative to encourage and support local tree-planting initiatives.

5. THE STUDY AREA

5.1 Location

Al-Anbar Governorate is an Iraqi governorate located in western Iraq. The largest governorate of Iraq is an area where it forms the equivalent of a third (1/3) of the Iraq area. It covers an area of 138,500 square kilometers and has a total population of 1 million and 600,000 people (January 12, 2014 census). Historically, the governorate was known as the al-Dulaim Brigade before 1961. It is bordered to the north by Salah al-Din and Nineveh and the Syrian Arab Republic from the northwest. Jordan from the west. Baghdad governorate from the east. From the south, the Kingdom of Saudi Arabia, and the southeast, the governorates of Karbala and Najaf.

Figure 5.1: Study area map

Source: (Karim et al, 2016)

5.1.1 Geography

Al-Anbar Governorate is part of the Arabian Peninsula plateau. Its surface is undulating, showing some small hills and a large number of valleys such as the Houran Valley. Because of its sloping lands and natural plant poverty, it is subject to severe erosion. Surface, underground, and wind waters diversify their surface, with the highest elevation of the western plateau near the Jordanian border reaching more than 800 meters above sea level and decreasing in the Habbaniyah areas to 75 meters above sea level. The Euphrates River crosses its path in the western plateau, the rocks of which gradually slope towards the Tharthar, Habbaniyah, and Razzazah depressions. In some areas, the course of the Euphrates River is rough and, therefore, limestone, and gypsum rocks appear on the river's path.

5.1.2 Climate

It is characterized by its semi-desert climate, low rainfall, and the high contrast between night and daytime temperatures and low humidity. In summer, the temperature rises to 52 degrees Celsius, and in winter it drops to 9 degrees Celsius. The wind has northwesterly and southwesterly, sometimes with a top speed of 21 m / s. The average annual rainfall is 115 mm.

5.2 Analyzing the Socio-Economic Environment of the Study

Regions differ and vary widely according to the nature of condition and geology and the example of social and monetary relations, including desert areas, which are characterized by unique environmental characteristics besides its distinctive pattern of social relations. The pattern of desert regions has a hot and dry climate, 70% of the total land of Iraq. Consequently, these regions suffer from the lack of adoption of a regional planning pattern, the waste of economic resources, and the decline of secular states. The economic development of any republic depends on the extent of planning for investment and preservation of natural resources in order to employ them in the service of the environment and achieve continuous and balanced development. It is assumed that it adopts special planning programs within the comprehensive planning and development programs of the state, by not leaving any deserted areas such as vulnerable areas to ensure the natural extension of urban development in the future. It is developed through its available natural resources to

consolidate the national economy by establishing human settlements that contribute to attain settlement and avoid spatial isolation (Al-Kubeisy, 2019).

5.2.1 Population centers in the desert of Anbar

The desert areas represent vast areas, and they are, in general, the available sites and the potential establishment of human settlements. Spatial diversity process and its evaluation is an essential issue according to the availability of existing capabilities in the field. Because urban land is used, planning in desert cities must be based on awareness, rationality, and management by evaluating available resources. The process of sustainability (desert) in these particular urban areas in Anbar Governorate is built through integration and urban uses (residential, commercial, industrial, agricultural).

Table 5.1: Population size and growth rate in the study area

Administrative units	Population	Their percentage %	Growth rate
Fallujah	529598	35.6	3.8
Ramadi	540475	36.4	3.8
Hit	129003	8.7	3.7
Haditha	78656	5.2	3.6
Anah	21866	1.5	3.7
Rawa	18755	1.3	3.7
Al Qaim	137567	9.3	3.7
Rutba	30065	2	3.7

Source: (Rawi, H. A., 2013)

5.2.2 The urban development that spread in desertification areas

The traditional image rooted in the minds of modern city dwellers about "desert life" is to live in tents and camel transport, within unclear borders, taking into account only the alliances that exist between the tribes. The tribe may leave, and leave its site with its livestock in seasons, wandering throughout the desert in search of grass and water, and the best place to graze the sheep that drink its milk and make cheese from it, and its wool, it weaves the simplest and the tents fabrics, it is his wealth. Today, however, we see rapid urban development in the desert. For example, the houses in the Anbar desert were a tent. It does not contain the necessities of living, but the

construction of houses is now more developed. Often the houses are close together. The reason is due to the tribal groupings, which usually prefer to converge in the desert for assistance and exchange of resources. The second reason is that the majority of people living in the Anbar desert are relatives. The norm in Anbar is the closeness of relatives.

5.2.3 Agricultural crops, methods and irrigation systems approved in desertification study areas

Al-Anbar Governorate is considered one of the desert regions in the eyes of geographers, but its residents are practicing agricultural activity with bright features. This activity is carried out in the Euphrates Valley individually, which includes population centers and rural settlements, due to its geographical advantages that are unique to the rest of the governorate. Where it contains the most prominent natural factors suitable for agriculture, from climate, surface, soil, and water source, all these natural elements are supported by a human element through the availability of agricultural labor in the productive rural areas.

The rural population in Anbar Governorate is growing various crops, the oldest of which is wheat and barley, the most recent of which are potatoes and pistachios. Despite the age of onion cultivation, others have entered the commercial area recently (Alfarajy, 2001).

The wheat crop is considered one of the most prominent crops that the governorate's farmers practiced long ago. Because of the ancient production of the crop, with its great importance in the food of the population, it has become a traditional crop, which the rural people cannot do it. Moreover, wheat represented the first place in growing crops during the winter season in Al-Anbar Governorate. Agricultural activity is concentrated in Al-Anbar Governorate in general, in the Euphrates Valley, starting from the Iraq-Syria border in the west and ending with the borders of the governorate with the eastern province of Babel. The study lands are distinguished by being flat and flat as we head towards the Euphrates River and its surfaces and rise to the west to form wavy lands with some mountainous rocky heights. On the origin and composition of the soils of this governorate with a desert environment, climate factors and parent matter are the most dominant and affect soil properties among the soil formation factors. The essential formations that arose are gypsum and limestone

rocks. Because of the dry climate factor, sparse vegetation, and low organic matter, and due to intense wind erosion, this region has formed shallow soils with little or no development As for the irrigation methods used in the study area, and there are several methods:

1- Surface irrigation.

It is also called dipping irrigation, and it is one of the oldest traditional methods used in the process of irrigation of crops, as this method is used in many primitive agricultural societies. It is used depending on the Euphrates River, and this method is accessible on both sides of the river. This method has advantages and disadvantages

Advantages of surface irrigation.

1-Easy irrigation, as this method, depends on submerging the crops with water

2- Did not require a lot of equipment and devices for the irrigation process

Disadvantages of surface irrigation

1_More wastage of water during irrigation than actual utilization, as part of this water, evaporates or infiltrates into the soil

2_Losing part of the area of land allocated for cultivation, as this method requires a system to get rid of water more than the needs of crops, and therefore needs more excavation work, which will deduct more of the agricultural land area.

2- Sprinkler irrigation

This method is used in limited areas in the study area, but it is used in the Amiriya area. It is an Iraqi city located in western Iraq in Anbar, about (40) km west of the capital, Baghdad, and (30) km south of Fallujah. Moreover, the method of sprinkler irrigation is considered one of the modern irrigation methods, and this method is in the form of drops similar to raindrops, sprayed to cover all the agricultural areas with water through the sprinkler holes under an absolute pressure. This method has some advantages and disadvantages. Advantages of sprinkler irrigation:

1. Sprinkler irrigation has the same advantages as drip irrigation, but it differs in that it is suitable for large areas, and is less expensive than laying irrigation pipes

2. This method does not require a special water purification or filtering system

Figure 5.2: The surface irrigation used in the study area

Source: (Abu Ghraib, 2020)

Figure 5.3: The surface irrigation used in the study area

Source: (Gomes F. R., 2016)

3. It provides a favorable climate for the growth of crops, as it acts as a heat tenderizer

Disadvantages of sprinkler irrigation:

1. It needs a large water tank.

2. It needs a worker that monitors the amount of flowing water and organizes operating and stopping times.

3. The efficiency of this method decreases in open areas.

Figure 5.4: Irrigation system used in the city of (Amriya) from the study area

Source: (Anbar Provincial Council, 2020).

3- Drip irrigation

This method is used in small areas and select areas. Most farmers only use this method on particular crops. It is usually used in private gardens within cities. However, the local government in Al-Anbar Governorate is encouraged to encourage the use of drip irrigation.

Figure 5.5: Drip irrigation method used in the study area

Source: (Khalifa, I. M., 2019)

5.2.3.1 Artesian water and artesian wells

Artesian wells are used to extract groundwater in the study area. These wells are spread in areas far from the water source (Euphrates River). These wells dug in the study area have low water productivity ranging from (2-6) liters/second compared to the depths of (150-150) m The wells dug in the study area are not suitable for social drinking to bypass the concentrations of chemical and physical properties. Nevertheless, they use this water for animals, because the water in these wells is salty, so people use it for salt-tolerant plants. Soil type, so different classification systems have been developed for these uses, including a classification (Wilcox, 1955), which is based on ion ratio (Na), electrical conductivity (EC), and classification (Richard, 1954), which is based on sodium absorption ratio (SAR)), As it appears that this water is not suitable for irrigation purposes, except for watering the salt-tolerant plants.

Table 5.2: Rechared Classification for water uses of irrigation purposes

Ec * 106 µs/cm	SAR	Water Class	Group
100-250	10	Excellent	Low
250-750	10-18	Good	Medium
750-2250	18-26	Fair	High
2250	26	Poor	V.High

Source: (Wilcox, 1955)

Figure 5.6: Water extracted from artesian wells in the study areas

Source: (Abu Ghraib, 2020).

Table 5.3: Quality of water for irrigation

Water Class	Percent Sodium	Ex×106 µs/cm at 25 C°	Boron, ppm		
			Sensitive crops	Simitlerant Crops	Tolerant crops
Excellent	< 20	< 250	< 0.33	< 0.67	< 1.00
Good	20–40	250 – 750	0.33-0.67	0.67-1.33	1.00-2.00
Permissible	40-60	750-2000	0.67-1.00	1.33-2.00	2.00-3.00
Doubtful	60-80	2000-3000	1.8-1.25	2.00-2.50	3.00-3.75
Unsuitable	> 80	> 3000	> 1.25	> 2.5	> 3.75

Source: (Wilcox, 1955)

One of the most famous plants grown in this water is Medicago sativa, which is called locally (Jet), and it is one of the most important forage crops in the world, and it is a natural source of nitrogen.

Figure 5.7: Medicago sativa plant

Source: (Abu Ghraib, 2020).

5.2.4 The individual entered in the study area and its impact on the development of the regions

The study area suffers from many problems. For example, lack of industrial plants, the collapse of infrastructure, and mismanagement of the agricultural, commercial sectors. And the exacerbation of security problems, the weakness of the legal sector,

and widespread unemployment. Despite the significant increase in Iraq's oil exports and its financial revenues, it did not contribute to solving the worsening crises in the cities of Iraq, especially in Anbar Governorate (study area).

The local government in the study area confirmed that the unemployment rate in the governorate had reached 60 percent. Most of the people who live in the study area have a reduced income; therefore, people do not have sufficient money to develop their lands. Those lands need to dig wells and need settlement operations, which helped to degrade those lands.

5.3 Provide Detailed Data on the Social Environment

Most of the people who live in the study area are from the Arab tribes of a rural nature. Among the customs of these tribes is to preserve the land without selling it or allowing it to invest in it. We find some farmers who inherit the land from their ancestors using the small part of it and leave the rest of the land because they do not have enough money and agricultural machinery. What has increased the degradation of those lands and their exposure to desertification, and one of the traditions of these tribes is not to sell their lands to people without their families, so we find a large land area, and there are one or two houses. The rest of the land is barren, as well as causing government neglect, and the scarcity of water from an agreement M desertification phenomenon lands in the study area, and even agricultural lands that are still being used by farmers and farmers in the study area. Threatened by desertification due to the low water level of the Euphrates River, groundwater, and the lack of fertilizers to activate it.

Strategies promoting impractical asset use and the absence of a steady foundation are vast supporters of land debasement. On the other hand, this makes open approaches, and physical foundation helpful mediation focuses. In this manner, horticulture can play either a positive or a dangerous job, contingent upon how it is overseen. Thus, it relies upon the financial assets accessible, the strategies received, and the nature of administration. Neighborhood institutions, for example, dynamic network-based land-use bodies and free societies, can add to the prevention of desertification by allowing land clients to oversee the benefits of the ecosystem and make more meaningful use of them by improving access to land policies, capital, labor, and innovation. To replace grazing with plant cultivation in rangelands can contribute to

desertification. Policies and infrastructure that promote farming in rangelands that cannot sustain viable cropping systems contribute to desertification. The majority of dryland areas in the study area are rangelands that are more fit to reasonable pastoralism than crop creation. For instance, migratory pastoralism is rangeland the board practice that, throughout the hundreds of years, has ended up being feasible and fit to the biological system conveying limit (Khalid H, L., 2011).

At the point when ranchers and herders lose control or long haul security over the land they use, the motivating forces for keeping up naturally reasonable practices are lost. Issues of water shortages, groundwater consumption, soil fragmentation, and salinization were seen as the results of a more critical strategy and institutional disappointments. Security of residency does not suggest private property rights; some since a long time ago settled group and network-based administration rehearses have worked successfully. (Karim et al., 2011). N fruitful group frameworks, the most prominent integrity, and reasonableness of the asset portion of all partners are essential. Private land residency frameworks in drylands have been less effective in guaranteeing that pastoralists approach different environment administrations, for example, provisioning of water and field.

5.4 To Suggest Activities That Depend on the Participation of the Local Community In Combating Desertification

Desertification can be combated by a set of measures in the study area by the local community. From these suggestions

1- Spreading a culture of prevention by taking preventive measures to protect the lands, and this requires motivation between the local government and the residents of the lands to adopt positive attitudes because the inhabitants of these lands are the most capable of combating desertification

2- Integrated management of lands and water: Desertification is caused by soil degradation due to erosion and increased salinity. Therefore, effective and integrated measures must be taken to protect the soil and water as well, by:

Preventing overgrazing, which causes the exploitation of plants in a certain area, and the trampling of livestock on its soil greatly, through alternating or continuous use of

pastures to give the lands a chance to recover before returning to use them again. Ecosystem to support.

Improving water management practices: including continuous periodic use of well sites, use of traditional water harvesting and storage techniques, and improving water storage techniques during periods of heavy rains to prevent runoff that helps infertile surface soil erosion, enhance the amount of groundwater, and provide backup water for its use During the dry period, encourage germination and greening (Bauer & Stringer 2009).

3- Plant Cover Protection: The plant cover helps prevent desertification, prevents loss of ecosystem services during droughts, and promotes rainfall; therefore, it is necessary to protect the vegetation that could be threatened by logging, excessive cultivation, overgrazing, over-harvesting of medicinal plants, and mining activities. All of the above is related to the effect of low surface evaporation transpiration and increased ablution; That is, the Earth's ability to reflect the light shining on it

4- Using appropriate technology: Desertification can be combated through the use of both traditional technology, indigenous techniques, and skills acceptable to dryland dwellers, working for and not against ecosystems operations, and dispensing with unsustainable technologies used for irrigation and rangeland management, including growing crops that are inappropriate for agricultural ecological areas (Alfarajy, 2001).

5- Empowering local communities to make decisions and support them: local communities are often the ablest to manage dryland resources successfully as a result of experience and knowledge of the surrounding environment.

6- Improving the economic conditions of the population of areas affected by desertification: by creating new economic opportunities for people to earn money and alleviate the pressures resulting from deserting, and by providing infrastructure services and facilities for them.

7- Stopping soil degradation: Soil degradation and fertility decrease as a result of erosion, intensive cultivation, and accumulation of harmful elements such as some salts Soil degradation can be stopped by using synthetic and natural fertilizers to supply the soil with the elements needed for plant growth such as nitrogen, phosphorous, calcium and magnesium to control erosion caused by wind movement

by building fences of native plants surrounding crops with mineral coverings and planting plants that protect the roots and stabilize the soil. The plants. Identify Obstacles To Combating Desertification Efforts.

5.4.1 The depth of the groundwater and the cost of drilling

Groundwater is available at various depths in the ground. Further, depending on the geological formation of the area, it is extracted by drilling wells. Simple machines are used, which are the most widespread and invested in Anbar Governorate, and are found at depths far from the surface of the earth. The land ranges between (10-700 m) below the surface of the earth, as the proximity to the earth's surface draws its water from the falling rain, and it is renewable as it is spread in areas such as Rutbah, Akashat, Al-Habbaria, Haditha, Ramadi, and others (Hamad 2015).

As for the depths far from the surface of the sea, the origin of its water returns to sedimentary sea waters or the remnants of ancient salt basins, as the geographical distribution of the depths of the wells is according to the surface sections, where the higher the height from the sea surface the more significant the depth of digging wells, in the (Hammad) area the depths of the water ranges The subterranean is between (135-390) m, which is the highest elevated area above the sea surface by (713) m, while the depths of groundwater (45-135) m in the island area at an altitude of (217) m above sea level (Hamad, 2015).

The number of wells dug in the study area varies according to different cities, as Al-Rutba city acquires the most significant number of wells with a percentage (28%) to irrigate an area (26 km), and the least in the city. He narrated it, where the percentage of wells is (6%) for irrigating a cultivated area (4 km).

The cost of drilling is prohibitive, each meter is 400,000 dinars, equivalent to 40 dollars, if a 100-meter depth is drilled, equivalent to 4000,000 dollars, and this is a prohibitive amount for farmers.

5.4.2 The lack of electricity in the desert areas

The study area suffers from a severe shortage of electrical energy, especially in the desert part, almost non-existent, which increases the migration of farmers to cities. The lack of electricity in desert areas leads to an increase in the cost of production,

which keeps farms from exploiting these areas, which leads to leaving them and heading to areas near the river.

5.4.3 Lack of government support for the farmer financially

One of the most critical obstacles to combating desertification is the lack of government support for farmers from not distributing fertilizers or even not providing them at an appropriate price, as the state does not provide seeds with high productivity. The lack of water has pushed farmers to rely on wells, which affects the quantity of the crop. Also, it is considered an additional cost to buy fuel to run irrigation machines. At the same time, the farmer must make the local crop prices uncompetitive with the imported crops. In Iraq, the state interferes with every step of the nutritional value chain. Iraqi state imposed on its citizen's dependence on the government, from the stage before planting seeds to the provision of food at the table of every Iraqi citizen, the continuous interference and engagement of the state. That is similar to what is happening trendy other Arab countries known throughout its history for its socialist systems, such as Egypt and Syria. In the field of food production, state-owned companies subject to the authority of the Ministry of Agriculture provide support to farmers from preparing the land to harvesting the crop by providing tools, machinery, seeds, fertilizers, and pesticides at reduced or free prices. The Ministry of Water Incomes and the Ministry of Finance also provide water and irrigation almost without cost and provide financial support to farmers through low-interest loans, which are often not repaid. Then the state-owned companies, under the direction of the ministries of commerce and industry, store or buy crops for Iraqi farmers and process and distribute them in the markets. These companies use social safety net programs, such as the public distribution system, or state stores, and a series of stores and separate ovens to distribute state food products. Besides, state-owned companies compensate for the shortage of food supplies by importing food and agricultural products. Iraq imports about 50 percent of its food needs. Therefore, in the event of shocks in the global food supply chains or the collapse of the state budget - Iraq relies on oil for 90 percent of the state's revenues - the food system suffers from disruption, and the government becomes unable to advance a system that relies entirely on intervention and support from the state.

5.4.4 Immigration to the city

He farmers who live in the countryside, just like other societies, have been tempted by migrating from the village to the city to search for livelihoods and the desire to provide a decent life for them. There are several reasons for migration, including the countryside to the city, and there are excellent motives that prompted some farmers to migrate to cities. Availability of health services in cities and their shortage in cities. There are more job opportunities in the city than in the villages. Also, the development of the industrial sector is in the city, and it is a need for human resources significantly, other than the increase in job opportunities in government jobs. The educational institutions of all kinds, universities, schools, and cultural centers are available in the city. Excellent transportation links in the city; This allows residents to move to markets and workplaces quickly. Most of the people who live in the study area moved to cities for several reasons;

1-The availability of health services in cities and the lack of them in the countryside, such as hospitals and health centers

2-There are more job opportunities in the city than in villages; the development of the industrial sector in the city and its need for Labor is significantly increased, as is the increase in employment opportunities in government jobs

3-Educational institutions of all kinds are available, including universities, schools, and cultural centers in the city.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Among the most relevant results of the research is;

1- A total loss of 50% of Anbar's water resources because of waste or depletion of the soil, also, to use old irrigation methods, and because of the lack of awareness of most farmers of this wealth.

2- The wrong people realize that "water is an inexhaustible wealth" and that it is a commodity of little value

3- The water needs for all uses activities will increase shortly, not numbers

It can be addressed if the same methods continue in the uses currently used in Anbar province, and there will be a crisis that cannot be addressed even at the level of drinking water.

4- It was concluded that, in addition to the natural factors that are primarily drought and which cause desertification, there are human factors represented by the rational behavior of humans towards natural resources, which deepens the problem of desertification

5- The problem of desertification did not appear at once in the study area. However, its emergence of this magnitude was a result of synthesis amongst the drought factor and the accumulation of irrational dealing through natural resources over a long period.

6- Due to the dire effects of desertification and the costs involved, the issue of combating desertification in Anbar Governorate has become one of the most critical issues that require a speedy solution due to the exacerbation of the scale of the problem and the accelerating pace of desertification.

6.2 Recommendations

Despite the efforts made by Anbar Governorate, the process of monitoring desertification and combating desertification still needs more efforts and unification, and for this, we propose the following recommendations;

1-Help farmers who were living in the desert dig artesian wells and raise awareness about planting trees bearing salinity and drought.

2- The necessity of using modern irrigation methods and advanced methods in agricultural uses from It would raise irrigation efficiency to 90% instead of the current traditional method of 40% efficiency.

3- Developing irrigation projects in Anbar Governorate and reviewing them according to the new global variables to raise the level of their efficiency to reduce leakage and evaporation and to adopt advanced electronic control systems in distribution.

4- To enhance cooperation between institutions concerned with combating desertification and other institutions working in the field of environmental protection and the conservation of resources from lands and groundwater to avoid duplication when implementing operations to combat desertification.

5- Adopting an integrated approach to combating desertification that addresses all physical, biological and social aspects and economic

6- Participation of stakeholders in Anbar Governorate in enhancing awareness of the local population in efforts to combat desertification.

6- Promote the mobilization of public funding and encourage the mobilization of private sector funding to implement desertification control operations in Anbar Governorate.

7- Increase and expand efforts to establish accurate databases on land degradation using identical and standardized standards.

8- The necessity of adopting is the tillage method to a minimum, even in deep soils, to conserve the soil from the dangers of active, seasonal, and wind erosion during the rainy season.

9- Adopting the cultivar method perpendicular to the nature of the downward trend, especially in desert soils.

10- It is not preferable to burn agricultural crop residues in locations where the proportion of gypsum is above 25 %.

11- Consider a periodic evaluation of the quality of the water wells used.

12- We follow a sound soil management system, and by that, we mean to follow all means and methods of controlling the soil conditions and organizing them to reach a balanced soil environment and economically suitable crop production.

13- The need to find a kind of economic and social stability in Western Sahara through the restructuring of the Reconstruction Authority for Reconstruction and the establishment of various agricultural and service projects by investing in the development of desert oases and agricultural investment in the lands of the Euphrates and this will lead to increased production. Animal husbandry and the development of social and living conditions for the residents of these areas.

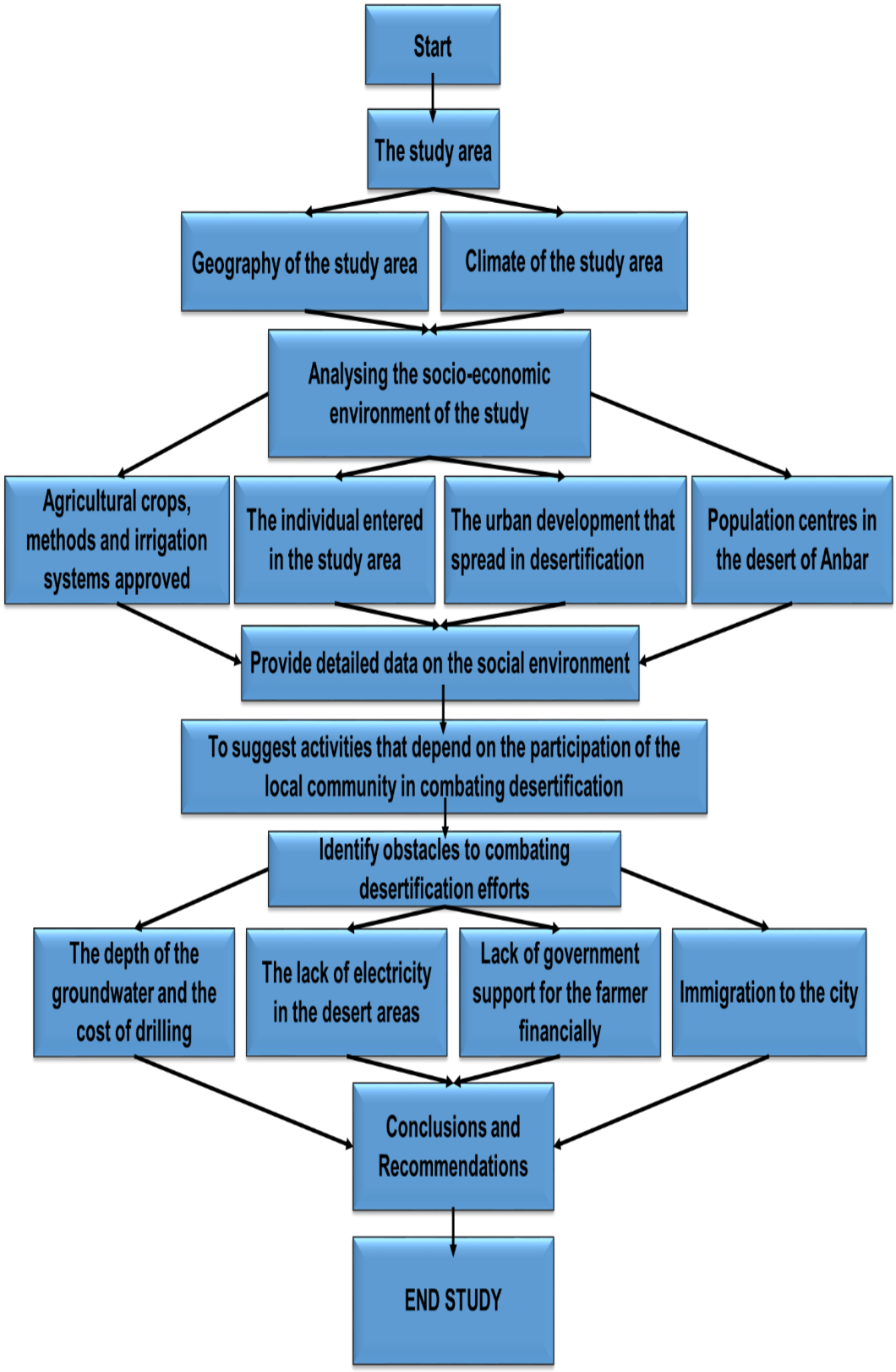

Figure 6.1: Flow chart of the study

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APPENDICES

Appendix A: Maps

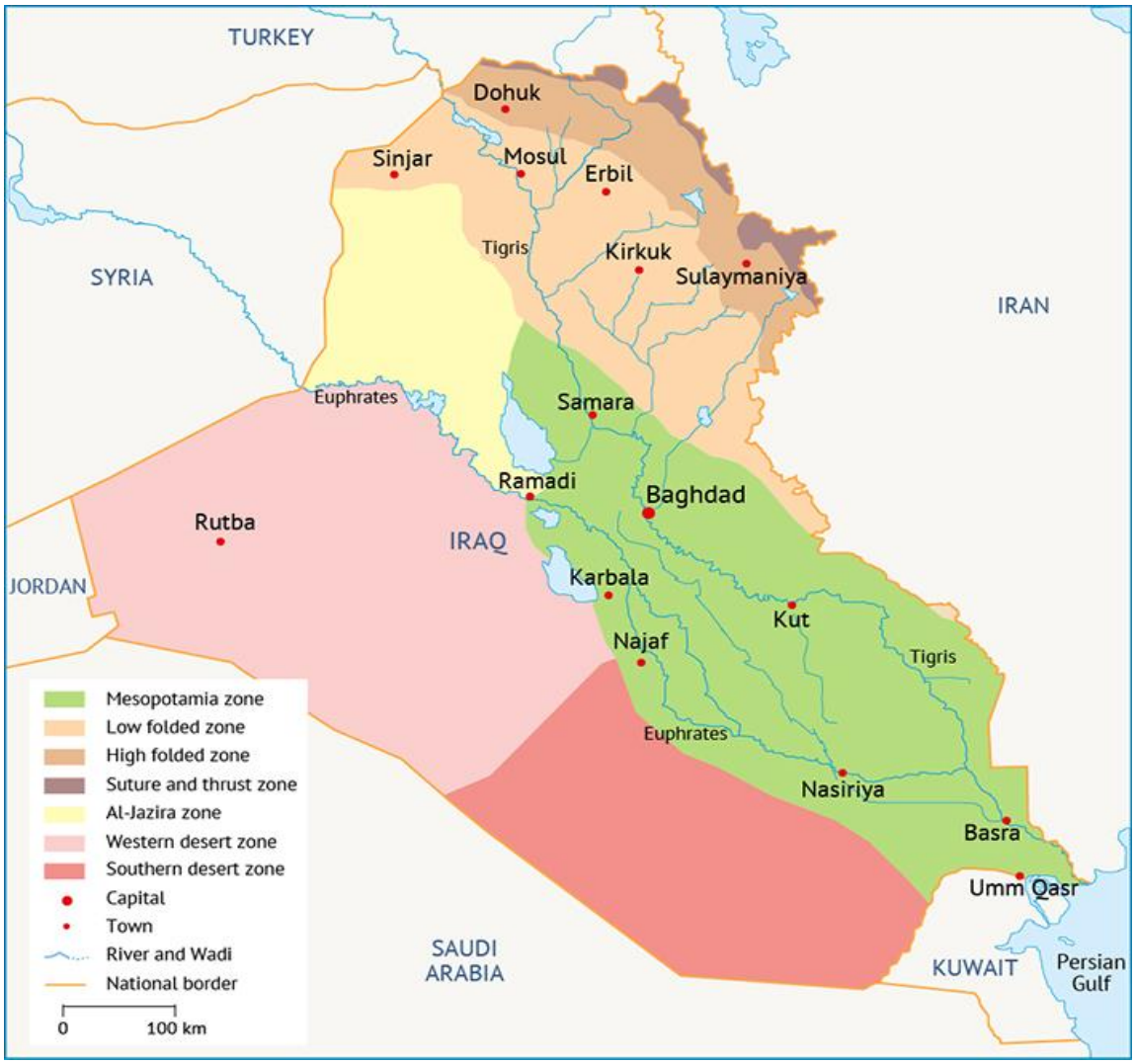

Figure A.1: Hydrogeological regions in Iraq

Source: (Hatem K. al-Jiburi, 2013).

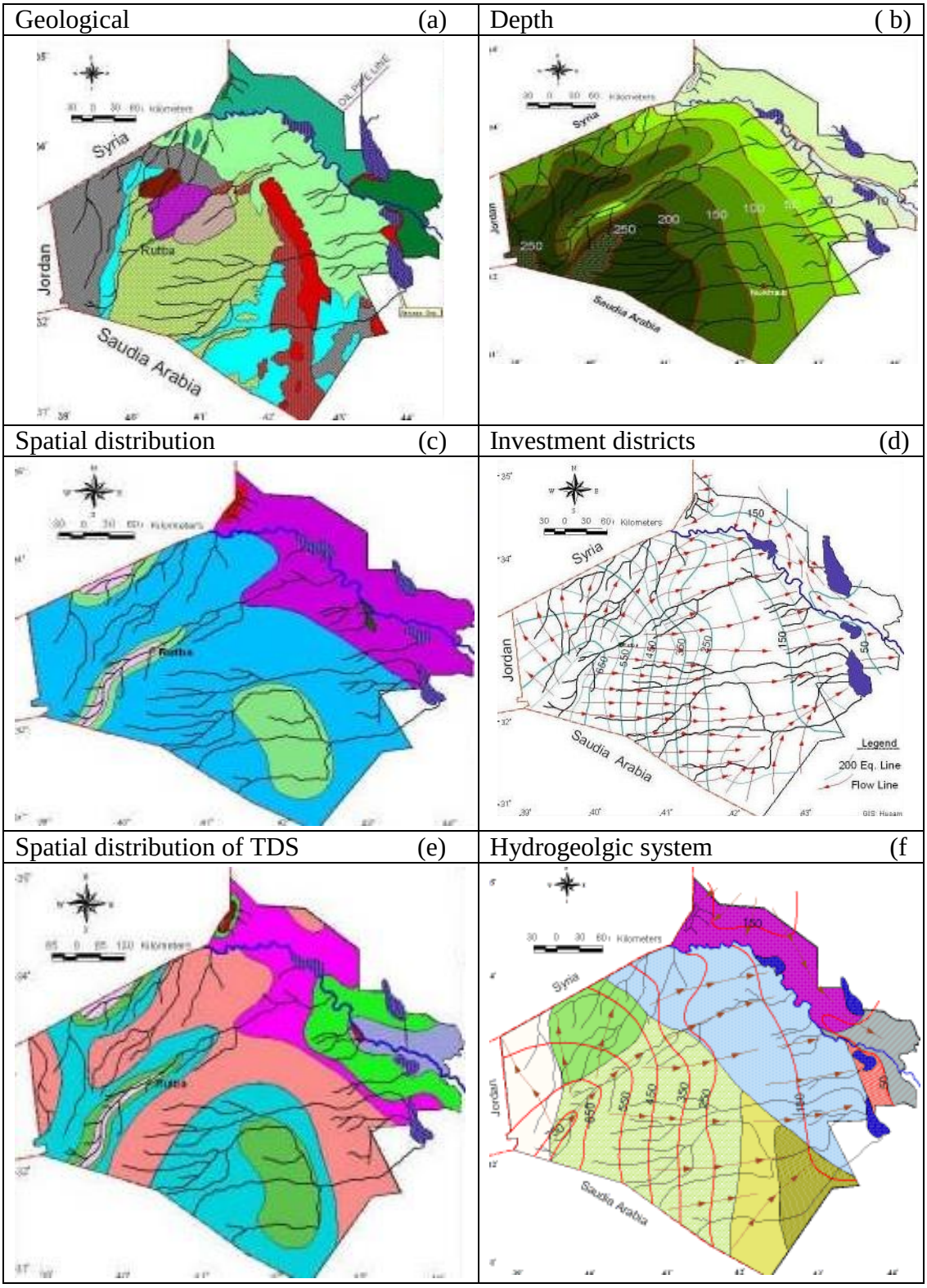

Figure A.2: Hydrogeologic conditions within al-Anbar governorate

Table A.1: Hydrogeologic properties of preferable groundwater zones

Hydrogeologic properties of preferable groundwater zones								
Zone No.	Zone Name	Area Km^2	Groundwater Depth From Land Surface (m)	Well Depth (m)	Discharge l/sec.	Specifc Capacity l/sec/m	TDS mg/l	Remarks
Zone 1	West of Al-Qadisiya Lake	900	30-50	100-150	10-25	1-10	2500-4000	Tertiary Sediments
Zone 2	Mohemidi-Baghdadi Areas	2000	0-20	80-100	< 20	1-12	3000-5000	Tertiary Sediments
Zone 3	West Rahaliya one	3200	0-50	100-150	1-15	1-10	2000-4000	Tertiary Sediments
Zone 4	Al-Manie Basin	4000	100-230	230-320	4-10	< 1	1500-3500	Tertiary Sediments
Zone 5	Horan East (H1)	4400	150-200	250-350	10-20	5-13	1000-3000	Tertiary Sediments
Zone 6	Kasra-Habbaria Zone	5500	100-150	350-400	10-30	10-25	600-3000	Cretaceous Sediments
Zone 7	South Nukhaib Zone	3600	100-150	100-300	> 15	8-12	1000-3000	Cretaceous Sediments
Zone 8	Swab Basin	2000	35-200	100-300	5-10	1-2	500-3000	Tertiary Permo-Carboniferous Sediments
Zone 9	Ga'ara Basin	2000	40-110 180-200	100-150 250-350	5-30	1-2	600-1500 2000-3000	Tertiary Permo-Carboniferous Sediments
Zone 10	H2, H3 Horan West	1500	35-150	50-250	< 1-5	1-10	400-2500	Triassic-Jurassic Cretaceous Sediments

Table A.2: The depths of the groundwater in the main

The depths of the groundwater in main & secondary hydrologic units:			
Hydrologic unit No.	G.W depths in the main aquifers (m)	Depths of the exploitation boreholes (m)	G.W.D in the secondary perched aquifer
7- Hy - 1	8- 175-350	9- (120-200),(200-10- 330),(330-400)	11- 100-120
12- Hy - 2	13- 125-250	- (200-400),(400-700	15- 20-90
16- Hy - 3	17- 175-250	18- 150-350	19- 35-70
20- Hy - 4	21- 0.0-150	- (50-100),(110-150)	23- 20-30
24- Hy - 5	25- 100-175	26- (50-250)	27- < 50
28- Hy - 6	29- 100-200	30- 100-250	31- < 50
32- Hy - 7	33- 10-20	34- 10-30	35- /
36- Hy - 8	37- 10-20	38- 10-70	39- /
40- Hy - 9	41- < 10	42- 5-20	43- /

Table A.3: Hydraulic Parameters of the Hydrologic System

Hydrogeologic System	Transmissivity m^2/day	Storage Coefficient	Specific Capacity m^3 / hr./m	Safe Yield m^3 / year
44- Hy - 1	10-350	45- $1.0x10^{-4}$ 46- $5x10^{-2}$	7- - 48- 0.5-2.0	$0.725x10^6$
49- Hy - 2	30-250	50- $1.0x10^{-2}$ -9x 51- 10^{-2}	52- 0.1-3.0	$46x10^6$
53- Hy - 3	200-1200	54- $1.0x10^{-4}$ 55- $9x10^{-4}$	5- – 57- 0.2-7. 5	$800x10^6$
58- Hy - 4	10-1600	59- $5.0x10^{-5}$ 60- $3x10^{-3}$	1- - 62- 3-36	$100x10^6$
63- Hy - 5	0.9-2000	64- $1.2x10^{-4}$ 65- $1.0x10^{-2}$	6- - 67- /	$75x10^6$
68- Hy - 6	100-1500	69- $1.0x10^{-2}$ 70- $3.0x10^{-2}$	1- - /	/
72- Hy - 7	1-400	73- /	/	/
74- Hy - 8	75- 30-200	76- $1.0x10^{-3}$ 77- $5.3x10^{-3}$	8- - 79- 0.1-1.0	/
80- Hy - 9	10-200	81- 10^{-3} - 10^{-3}	82- 3.0-10	/
83-		84-	85-	

RESUME

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