

**REPUBLIC OF TURKEY  
UNIVERSITY OF FIRAT  
SOCIAL SCIENCES INSTITUTE  
DEPARTMENT OF GEOGRAPHY**

**NATURAL ENVIRONMENTAL FEATURES OF KALAR  
CITY AND ITS SURROUNDING (NORTHEAST IRAQ)  
IN RESPECT OF THE ESTABLISHING SITE**

**MASTER THESIS**

**SUPERVISOR  
Prof. Dr. Murat SUNKAR**

**PREPARED  
Aram Hassan Ali al-BARZANJI**

**ELAZIĞ-2017**

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Our juries, 14 / 12 / 2017 after the thesis defense exam held on the date of this Master's thesis has been successful with the vote / vote majority.

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**Director of Social Sciences Institute**

**ABSTRACT****Master Thesis****Natural Environmental Features of Kalar City and Its Surrounding (Northeast Iraq) in Respect of The Establishing Site****Aram Hassan Ali al-BARZANJI****Republic of Turkey****Ministry of Higher Education****University of Firat****Department of Geography****Elazığ-2017; Page: XI+92**

This study is aimed to natural environmental features of Kalar city and surrounding. The study area lies in the north-east part of Iraq. It is separated from Khanaqen district by Sirwan River. This river forms the eastern boundaries of it. So, it lies between the longitudes (34. 32. 45) to (35. 09. 53) east and latitudes (45.09.19) to (45.37.13). The total area of the district is about 323.7 km<sup>2</sup> which are consisted of Rizgary district 529.3 km<sup>2</sup>, Shex tawel 346.7 km<sup>2</sup>, Pebaz 496 km<sup>2</sup>. Physical geography as a branch of geography takes care on a study and analysis of physical features on earth planet. The topography of the studied area is greatly influenced by lithological characteristics of the geologic units. The factors, which influence the geomorphology of the studied area, are tectonics, lithology, climate, vegetation. Hence the geomorphologic evolution is controlled by many geomorphologic processes. The main endogenic process is uplifting of the western and northwestern sides of the studied area which was the final stage of Zagros Fold-Thrust Belt formation during the Arabia-Eurasia collision. The main exogenic processes include weathering, erosion, fluvial, hillslope processes, certification, and anthropogenic processes. The main geomorphologic landforms recognized in the studied area are structural, denudation, fluvial, solution and anthropogenic landforms. Anthropogenic landforms produced by excavation by road cuttings, quarrying, and farming. The geomorphic landforms indicate that deformation is propagating from northeast to southwest. For this, our study involved following a scientific course in settling the research steps in five main chapters to attain the main goal of the study and as follows.

**Key Words:** Kalar City, Northeast Iraq, Natural Environmental Features.

**ÖZET****Yüksek Lisans Tezi****Kuruluş Yeri Bakımından Kalar Şehri ve Çevresinin (Kuzeydoğu Irak) Doğal Ortam Özellikleri****Aram Hassan Ali al-BARZANJI****Fırat Üniversitesi****Sosyal Bilimler Enstitüsü****Coğrafya Anabilim Dalı****Elazığ-2017; Sayfa: XI+93**

Bu çalışmada, Kalar şehri ve çevresinin doğal ortam özelliklerinin incelenmesi amaçlanmıştır. Çalışma alanı, Irak'ın kuzeydoğu bölümünde yer almaktadır. Bu alan Khanaqen Bölgesi'nden Sirwan Nehri ile ayrılmıştır. Bu nehir çalışma alanının doğu sınırlarını oluşturur. Bu nedenle, 34.32,45 ile 35.09,53 doğu boylamları, arasında ve 45.19,19 ile 45.37,13 enlemleri arasında yer almaktadır. İlin toplam alanı 323.7 km<sup>2</sup> olup bunun 529.3 km<sup>2</sup>'sini Rizgary ilçesi, 346.7 km<sup>2</sup>'sini Shex tawel, 496 km<sup>2</sup>'sini Pebaz ilçeleri oluşturmaktadır. Coğrafyanın bir dalı olan Fiziki Coğrafya, dünya gezegenindeki fiziksel özelliklerin incelenmesi konusunda üzerinde önemlidir. İnceleme alanının topografyası jeolojik birimleri oluşturan litolojik özelliklerinden büyük ölçüde etkilenmiştir. İncelenen alanın jeomorfolojisini tektonik, litoloji, iklim ve bitki örtüsü faktörleri etkilemiştir. Bu nedenle, jeomorfolojik evrim birçok jeomorfolojik süreç tarafından kontrol edilmektedir. Ana endojen süreç, Arabistan-Avrasya çarpışması esnasında Zagros bindirmesinin son aşamasında oluşan formasyonların batı ve kuzeybatıda yükselmesidir. Başlıca eksojenik süreçler hava şartlarına bağlı olup erozyon, flüvyal süreç, yamaç süreçleri ve antropojenik süreçleri kapsamaktadır. Çalışılan alanda tanınan başlıca jeomorfolojik yer şekilleri yapısal, denudasyon, akarsu, çözünme ve antropojenik faaliyetlere bağlı oluşmuştur. Karayolu yapımı, taşocağı, tarla açma gibi kazılarla üretilen şekiller antropojenik yer şekillerini oluşturmaktadır. Jeomorfolojik şekiller, deformasyonun kuzeydoğudan güneybatıya doğru yayılış göstermektedir. Bu amaçla araştırmanın hedefine ulaşması için konu beş ana bölümde bilimsel bir yöntem izlenerek açıklanmıştır.

**Anahtar Kelimeler:** Kalar Şehri, Kuzeydoğu Irak, Doğal Ortam Özellikleri.

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## CHAPTER ONE

### 1. INTRODUCTION

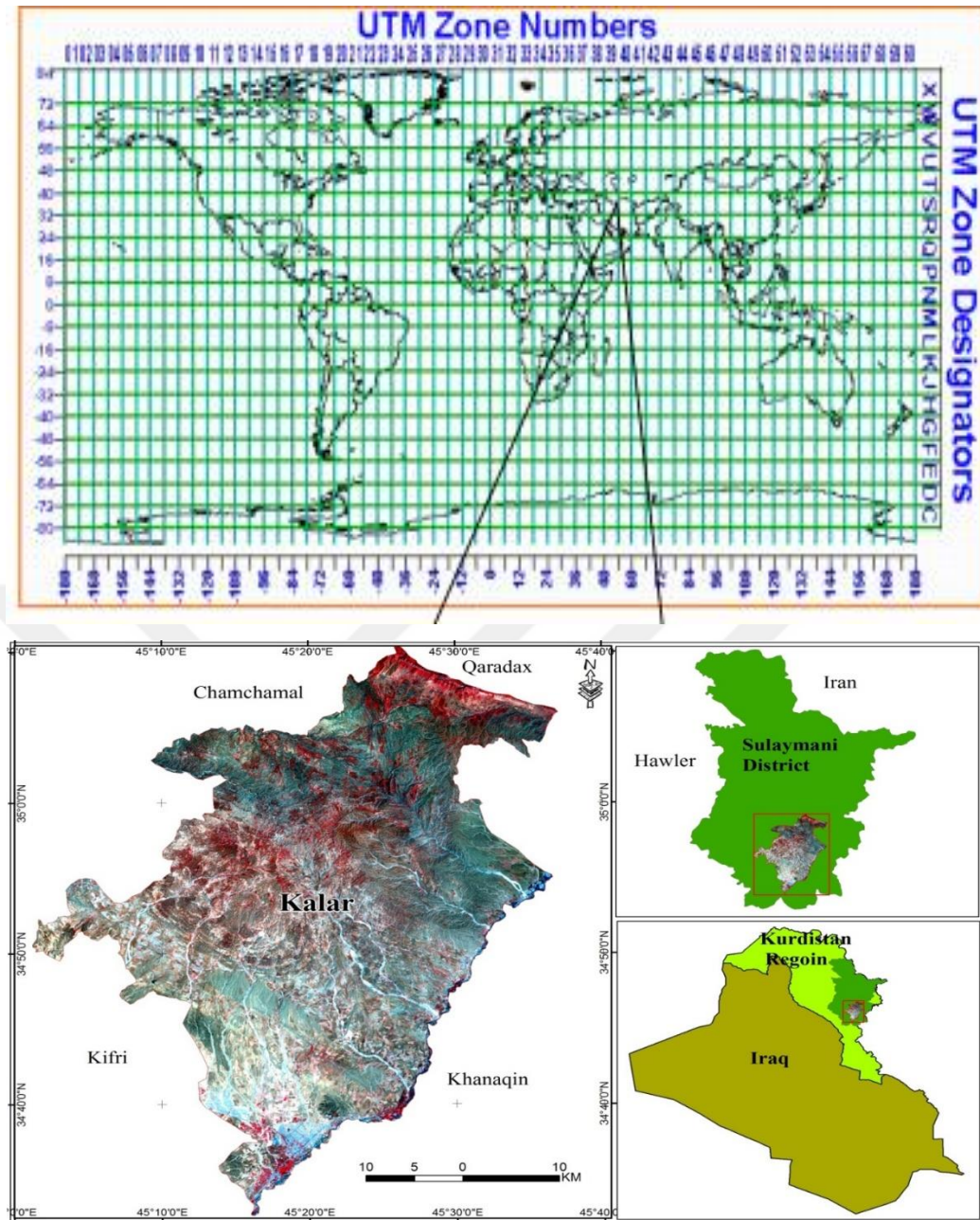
#### 1.1. General Physic Geography Properties of Kalar District

The goals of the present study are to investigate, general physic geography, natural geographic characteristics anywhere on its own interest and need to analyze and scientific research, physical geography or is the science that studies natural phenomena on the Earth's surface in terms of the distribution of dry, water, terrain and forms the surface, atmosphere, hydrosphere, geosphere and biosphere, which the man did not intervene. Landscape geography aims to understand the shape of the earth and its variability and climate characteristics of plant and animal their cover and geomorphological.

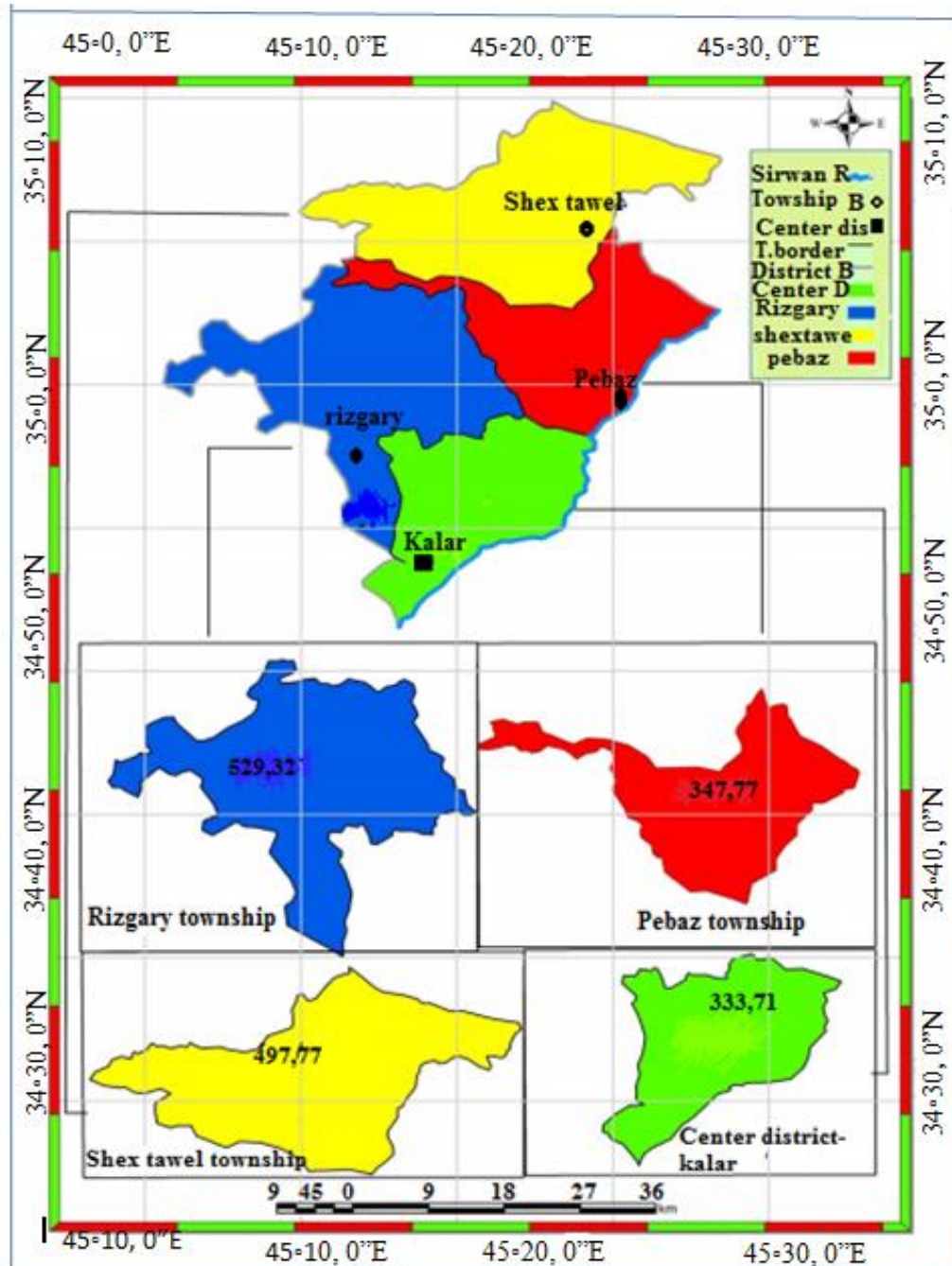
Geology forms a science that studies the Earth's surface and origins, evolution and the factors that influenced the forms. Hydrology, a science that studies water sources and distribution of motion and quality of the Earth's surface. Glaciology is the science that studies the distribution of ice on the surface of the earth and its effects on them. Geographically biological or dynamic they knew the distribution of organisms geographically. Climate science is the science that studies the case of air temperature, wind, humidity and rain for a period ranging between six months and a year.

Which is a science that deals with the soil as an essential component in the natural geography, studying the characteristics of the soil, and their components, and the factors that led to the formation of soil in the place where they were found on the surface of the Earth? Petrology: is a branch of physical geography, which is interested in studying the nature and types, characteristics, recipes, and forms of rock found in the earth, whether on the surface or within the inner layers.

Kalar is one of the districts of Sulaymani governorate within the Garmayn administration border. It is located in the southeast of Kurdistan, and eastern parts of Iraq between the longitudes (34. 32. 45) to (35. 09. 53) east, and latitudes (45.09.19) to (45.37.13). The total area of the district is about (1695) km<sup>2</sup> which is consisted of Rizgary Township 529.3 km<sup>2</sup>, Shex tawel 346.7 km<sup>2</sup> Pebaz 496 km<sup>2</sup>. It is far from governorate capital about (142) km, Sulaymaniya, with altitude around 580 meters above sea level (Table 1; Figure 1, 2).



**Figure 1.** Location of study area, Resarchers work depending on (Muhammed and Xalil, 2015).



**Figure 2.** Administrative unit of Kalar district (Reference prepared by researcher depending on file DEM- 30 MT).

Physical Geography also is known as the science that analyzes and examines the role of the natural and climatic factors in the change of the nature of the planet, and that there is no direct role for humans or organisms that live on the surface of the earth in influencing this geographical changes. Physical geography properties characterized by physical geography natural geographic characteristics anywhere on its own interest and

need to analyze and scientific research, Physical Geography or is the science that studies natural phenomena on the Earth's surface in terms of the distribution of dry, water, terrain and forms the surface, atmosphere, and biosphere, which the man did not intervene. Landscape Geography aims to understand the shape of the earth and its variability and climate characteristics of plant and animal their cover and geomorphological.

Physiography, which is aware of the specialized study of the impact of natural phenomena on the topography of the Earth science and Geography, and interested in learning about the proportion of the presence of bodies of water, mountain ranges, and the plain areas.

Water science scientifically known by the term hydrology, the natural geographic science that studies the water as a component of the natural geography components; and provides a description of the nature of water in all parts of the world, and contributes to the development of studies to illustrate the properties of water, and its interaction with the surrounding environment, and the impact of living organisms and human on water in the ground. Climate science: is the geographical science naturally associated with climate study and its impact on the earth by linking it to the atmosphere and the components of him as the weather, the temperature, and the movement of wind, pressure air, as it is interested in studying the effect of the nature of the bad weather in the area, and determine the degree and nature of its impact through a certain period of time. Soil Science: scientifically known by the term pedology.(Figure .3).

**Table 1.** Area of administrative unit to spend Kalar district according to an area of justice Kalar district

Administrative unit	Area (km <sup>2</sup> )	Surface area (%)
Center district	323.4	19.2
Rizgary	529.2	31.2
Shex tawel	346.3	20.4
Pebaz	496.1	29.2
Total	1695	100 %

Researchers work depending on (Muhammad, 2015).



**Figure 3.** Kalar District

### 1.2. Aims of the Study

The main aim of this research in order to get the answer to the question raised in the premise of the research and its problem.

The main objective of the study is to show the features of the natural phenomena in Kalar district by using maps and charts especially the natural phenomena like

geological and morphological structures, relief land, natural vegetation-climate elements hydrology such as the distribution of watershed, the division of landform.

This is to show the characteristic of the areas natural geography for the purpose of scientific development in all the aspects and providing the necessities of the population on a scientific basis as well as drawing basic maps and data to revitalize and develop the area.

1 - To reveal the correlation between these features.

2 - Indicating the natural capacity of the area, that we could say this zone has an important natural if a scientific and detailed program is conducted in this area, it will be helpful to develop the area in the future.

### **1.3. Method and Material of the Research**

There aren't any researches to be conducted without having a method or some methods to achieve the main objective and detailed result, here the researcher has used some methods such as (descriptive method, analytical method, and comparative method) in which the analytical method is used to analyze the influent factors on the natural geography of the area, etc.

The researcher also has used the science of research and drawing charts and maps for the lakes and rivers, this is apart from depending on the other ways of research such as using books, water intensity, different measurements, and astronomy. Despite using many official statistics and data as well as many special geological and geomorphological charts, we can explain the research project in the following points.

1. Data collection and special data of the study area in terms of geology, geomorphology, climate, soil, natural vegetation, and water resources, DEM 90 resolution Google satellite image.
2. Fieldwork, collection data, and information about study area; it was by field visiting, interview and uses of fieldwork requirement device, for collect information about it.
3. Analysis for climate, geomorphology, geology, structure, by topographic map and also satellite image for land cover and land use analysis.
4. Using information online. And the interpretation of collected data, information and analysis of the result, also using of office information like (books by English, Kurdish, Arabic language, magazine, newspaper).

5. The lack of data from several public departments such as weather station in Kalar, Pebaz, and Kifri as well as the general directorate of agriculture in the Garmeyan area.

#### **1.4. Previous Study**

Although there are a few studies about Kalar district it included within many geologic, geographic studies about Sirwan river basin and Kalar city, such as

1- Shakaly (2016) A studies in urban geography, In the term of general Physic Geography the study area is deference such as climate, the climate elements deferent from another area in summer temperature is high some times go ut to (45°) degree and the land is suitabel for agriculture and in the term of geography humanity high population ratio consistently, high birth rate continuously.

2- Ali (2014) Groundwater in the Kalar district and the possibility of expanding investment, In terms of hydrogens, in general, the Kalar district is characterized by natural miasma resources such as groundwater, such as wells, springs and water well.

3- Amin (2014) Analysis of geography for Problem of water pollution of the Sirwan River in the Kurdistan region, Environmental pollution investigation, The study area is characterized by the passage of the Sirwan River on its eastern side and the length of (29 km), adding to the importance of the area especially for the eastern parts of the study area, where the total discharge rate of the river is about (163,6m<sup>3</sup>/S) for the period between (1970-2006).

4- Ali (2014) Kalar district, a realization of Regional geography, the most important factors influencing the geomorphology of the studied area are tectonics, lithology, climate, vegetation and humans.

5- AL- Palani (2009) Evaluation of the Sources of Feeding of the Sirwan River Corridor on the Monthly Drainage Rate. The main endogenic process is uplifting of western and northwestern sides due to continuous collision of Arabian and Eurasian plates. Where as the main exogenic processes include weathering, erosion, fluvial, hill slope processes karstification and anthropogenic processes which are responsible for final stage of painting and shaping the ground surface.

6 - AL- Palani (2010) Geomorphology of Kalar, Terms of geomorphology, A- The study area is composed of several different topographic units such as the plain, hill and mountains. The B-Study area is located in north and northeast of al-Menta. Its

height is 1800 meters and the lowest level is located in the south of the study area. And the highest line of equator line (1800 m) and the lowest line of (200 m).

7 – Mohammed (2015) cartography of natural geography features in Kalar town, Collage of Social Scenes, Sulaimany University. The study area has a number of important properties in terms of soil, water resources and geological formation, which can be used in economic development, while trying to reach the most important data provided by natural phenomena. And the climate of the study area with semi-dry climate (STEPS) is known to be average The annual rainfall (293 mm), the annual temperature rate (23 ° C), the highest temperature for July, and the lowest temperature for the month of January.

8 - Palani (2011) water resources in Kalar area magazines of tragedy study center, number 65 publishing of tragedy study center Kurdistan sulaimany. A number of river valleys are also in the area And the Wadi Qayyid and Wadi And a number of karstian springs and springs spread in the northern parts And east of the study area add to a large number of artesian wells and group Large hand wells.

9 - Muhammad,D (2010) from village to town , in the term weathering, temperatures average above 40 °C for most of the country and frequently exceed 48 °C (especially in the center of city ). Winter temperatures infrequently exceed 21 °C with maximums roughly 15 to 19 °C and night-time drops to 2 to 5 °C.

10 – Salahalddin S. Ali and et...4, 2016, Geomorphology of Garmiyan Area Using GIS Technique, Kurdistan Region, Iraq. The results of morphogenic classification show that the northern part subjects to chemical weathering relatively more than southern part and vice versa. The geomorphologic characteristics of apartof Garmiyan area through; first by highlighting the forming and controllingfactors of geomorphology like tectonic, lithology.

### **1.5. The Significance of the Research (Importance)**

The significance of this research is to show a valuable and in fluent nation aspect of natural geography about the natural features of Kalar town using maps and chart.

1. Identifying and analytical practice for the features of the hydrology of the watershed.

2. Identifying of analytical practice for the geographical features and geomorphological and topographical features of the area.
3. Analysis of the soil features and natural vegetation of the area.
4. Identifying and analytical practice for the features of climate elements in Kalar town as well as showing the reality of the weather condition of the study area.



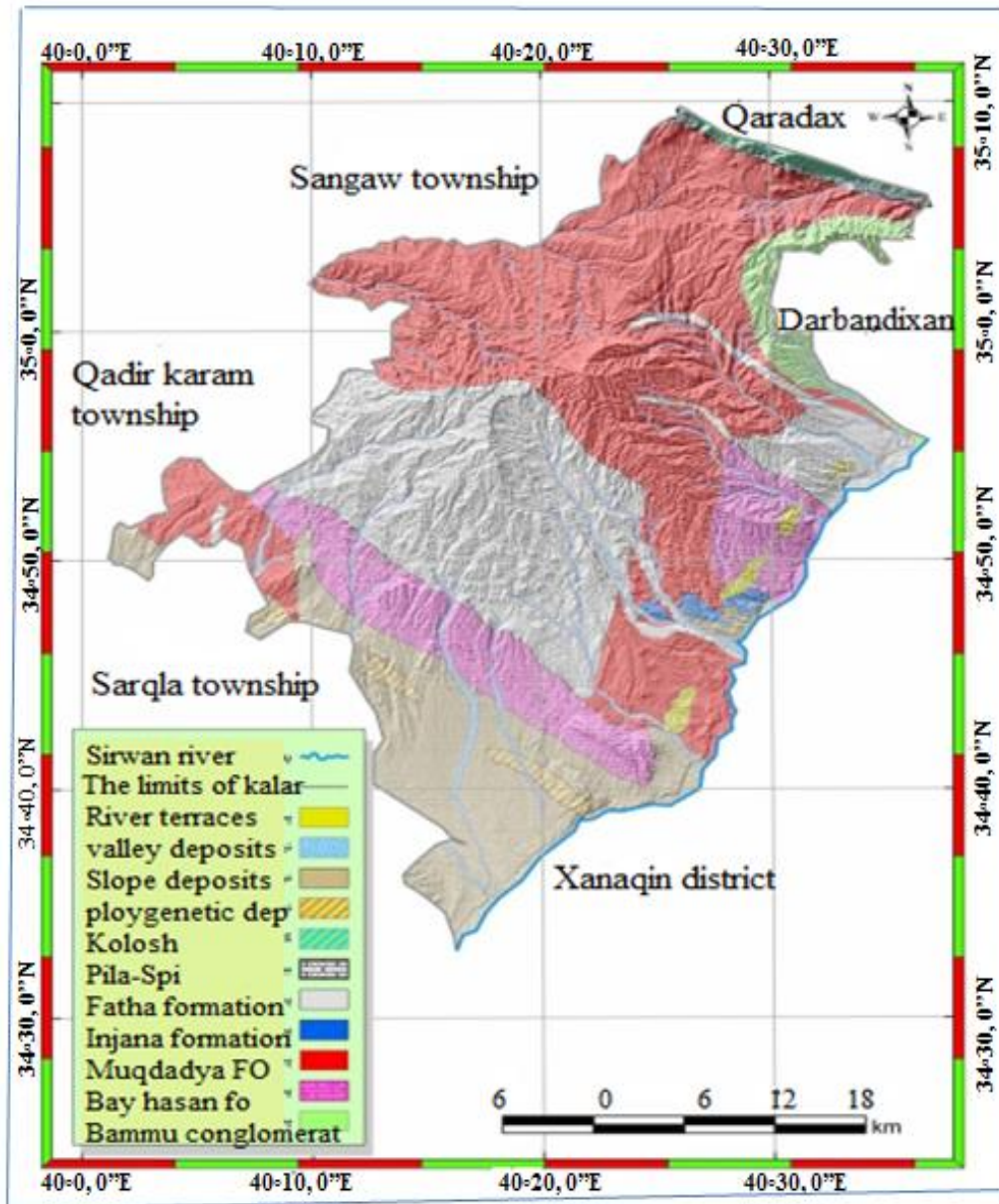
## **CHAPTER TWO**

### **2. GEOLOGICAL, GEOMORPHOLOGICAL AND TOPOGRAPHICAL FEATERS OF THE STUDY AREA**

#### **2.1. Geology of the study area**

The object of this chapter is to mention and indicate the tectonic locations of Kalar district, geological formations according to the periods, morphological shapes of the areas surface and topographical analysis of the area by maps and charts as well as topographically in the following ways.

Several folds form the geological structure of the studied area as a result of the Arabian and Eurasian plate's collision. They extend northwest-southeast parallel with the main axes of the watersheds. These anticlines are separated by broad gently dipping synclines forming wide and expanded plains occupied by the Bardasur and Palkana anticline. The area of the geologic formations that crop out in the studied area is more than the area that is covered by recent or quaternary deposits and most of the formations outcrops are located at the north and western parts of the studied area. This declares that the studied area is subjected to erosion processes more than sedimentation processes especially the mentioned parts and this will be illustrated more within the lithological controlling factor description sub-basin of ephemeral streams and agricultural croplands geological structures of the study area often date back to the late epoch of third geology; most of the structures belong to the period of new life between small Eocene and big Pliocene (Figure 3; Figure 4). The formations are from the types of (Fatha, Injana, and Mikddadiya, et al.).



**Figure 4.** Geological structure of Kalar district. (Prepared by researcher depending on geological map of xanaqin-Iraq. area scale, 1/250.000, 2003)

**The study area could be divided into the following models geologically**

A - Stratigraphy geology.

B - Structural geology

A - Stratigraphy geology

Appearing the rocky structures at the Earth's core in some parts of Kalar town, their ages started from Triassic in the Eocene Epoch until Quaternary, (Saood, 2009).

Which include the new sediments, these formations change in terms of the rock types and their reactions to the geomorphological actions? Geological formations and the layer of the dominant rocks in the study area are like the following from the past to the current time.

### **2.1.1. Tertiary Formation**

The difference of the deposit's age of this period between (Lower Eocene reached upper Pleistocene) in the late Triassic period. The common geological structures in this period consist of the following formations.

**Fatha Formation;** Generally the distribution of this formation is wide. Its sediment covers the marginal area of the Stable Shelf and almost the Unstable Shelf. The age of Fatha Formation is Middle Miocene. The sub-cycle marked by calcareous conglomeratic sedimentation at its beginning and then by calcareous evaporate sedimentation. Lithological the main character of Fatha Formation is the prevalent evaporate (sulphatic and halogenous) facies. The rocks composing the formation are anhydrite, gypsum and salt, interceded with limestone, marl and relatively fine grained clastics, (Budy and Jassim, 1980) the age of formation goes back to the Middle Miocene epoch. This structure considered as a significant formation because it creates a store of oil in most of the north, south and middle fields (Ali Saeed et al. 1982).

This formation has a good impact on the ground water because of much holomorphic deposits around this formation and it consists of impermeable cap rock and non-porous cap rock (Baba Shekh, 2000). Meanwhile, the rocks of this formation are weak against the process of erosion and melting. Therefore, it contributes in the geomorphological actions such as car sty phenomenon (Al- shamzini, 2003). The deposit of this formation consists of gypsum rock, calcareous rocks, marl and limestone. In addition, this formation includes or contains sediments of mud, marl, limestone and red clay (Abdul-Haq I. Mahdi, 2007). The thickness of this structure in the study area is approximately (650 m) and it has an aquatic environment.

**Injanah Formation;** The Injana Formation is wide-spread in Iraq. It covers large areas in the unstable and the marginal parts of the stable shelf. The age of Injana Formation is Upper Miocene-Pliocene. The formation consists of brown and gray sandstone interbedding with brown siltstone in cyclic nature (Al-Rubuiay and Al-Maamar, 2010). The history of the creation of this formation goes back to Miocene

period. In addition, its structure is from the layer of sandstone and its color is red and greenish, with the diameter of (1m) in height. This formation is the continual and semi-continual deposits which consisted of the calcareous rocks and marl. Furthermore, it is the source of fresh water because this formation is porous (Al-Umri and Ali Sadiq, 1977).

In general, this structure in the study area is mixed with Mikdadiya Formation in the upper part and it is mixed with Fatha Formation in the lower part (Jassim and Jermy, 2006). Injanah formation is often seen at the Bardasur eminences.

**Mikdadiya Formation:** The exposed part of the formation lies within the Unstable Shelf area. The formation is composed almost purely of terrigenous clastics from silt size to boulder conglomerates. In general, the grain size of the clastics increases upward, (Buday and Jassim, 1980).

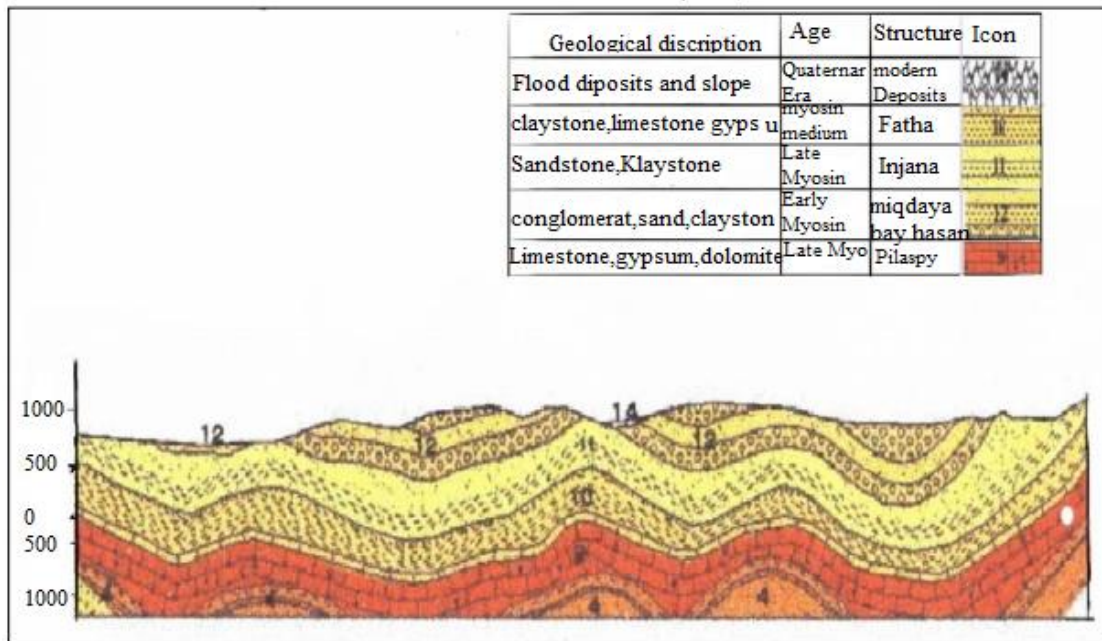
The grain size of the terrigenous clastic is increasing vertically towards the top. In the central parts of the basin, on the foothill zone the history of this structure goes back to the Early Pliocene and it consists of deposits of sandstone, clay stone and siltstone, what's more, it is a porous formation that helps gather ground water, (Muhammed, 2007).

The thickness of this formation is between (300-1300) meter and in some places it is (3000) meter in the study area, especially in Sirwan Rivers edge and periodical ponds. This formation has also gone down to inside the earth vertically and it reaches Injana Formation below (Al- Sayab and et al., 1982).

**Bai Hassan Formation:** The general description of Bai-Hassan Formation is the same as Mukdadiya Formation. However the main differences between both formations are in the age and grain size. Bai-Hassan Formation has coarser grain size than that of the Mukdadiya Formation and is younger in age. Bai-Hassan Formation consists of two members, the conglomerate member (conglomerate with lenticular bed of sandstone) and the clay stone member (salty to sandy, calcareous clay stone), (Deikran, 2003). The history of this formation dates back to Later Pleistocene period (Al-Palani, 2010, Figure 4).

In addition, this formation consists of the different accumulated deposits of sandstone, clay stone, calcareous rocks ( $\text{CaCO}_3$ ) and the thick layer of conglomerate. The accumulated deposits spread over the plains and plateaus due to the erosion actions and then to the other areas because of floods (Ameen, 2008). Its alluvial environment is

continental shrinkage river, this formation is appeared in the north eastern parts of the study area river (Al-Jburi, 2006) (Figure 5).



**Figure 5.** The cross section for Kalar area, Prepared by researcher depending on (Al-Palani, 2010)

**Bamo Conglomerate Formation;** The basis of this formation dates back to Pliocene period. This formation is formed of a successive layer of smooth tiny sand, clay stone and calcareous stones between the layers. Furthermore, the thickness of this formation is over (450m) (Al- Palani, 2010). The environment of the formation is a continental shrinkage river (Al- Jubouri, 2006).

### 2.1.2. Quaternary Deposits

**Poluentic Deposits;** The history of the creation of these deposits dates back to Pleistocene epoch (Al-Sayab and et al., 1982). These deposits are various mixtures of rocks, sand, gravel and soil. Sometimes the formation of these deposits looks like gypsum. In the plains, these deposits are formed from erosion action and the periodical ponds (Ali, 2014). These deposits settled randomly and the thickness of their layers is influenced by the topography of that period. In addition, this type of deposits in the study area's southern part from the western plain of Kalar town to the east. What's more, the thicknesses of these deposits are (10m) in the central parts of Kalar's plain, but in the edges it decreases to (1m) (Palani, 2010).

**Slope deposits;** The creation of these deposits dates back to Pleistocene period. (Baba Sheikh, 2000). Also, these ones which slope from the eminences and then fall off. After that, they accumulate in the bottoms of the mountains and concave bows, the main factors of rolling these deposits down are causes such as slope degree of water running, climate plants cover and earth movement thus, they form the pediment deposits, which develop along with the anticline layers, and then with the surface water, they slope towards the center of the low lands. After that, they will be a part of the flood plain deposits (Saad and Jeremy, 2006; Figure 5).

These deposits are formed from a mixture of various gravels, clay, conglomerate salty sand and a little gypsum. (Al-Naqash and Muhammed, 1989), this type of deposits appears in the north and south of Kalar town such as in Bardasur bow belt and Kalar's first bow. Generally these deposits have a thickness between (1m) and several meters (Palani, 2010; Table 2).





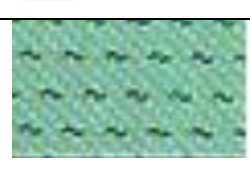



**Flood plain deposits;** A flood plain is broad strip lands built up by sedimentation on either side of stream channel. During floods, flood plains may contain water carrying suspended silt and clay, when the flood waters recede; these finegrained sediments are left behind as a horizontal deposit on the flood plain. A river has one flood plain and may have one or more terraces representing abandoned flood plains. Sandy and claye sediment deposited by river water that was spread out over a flood plain; a deposit beneath and forming a flood plain, being thickest near the river and thinning out toward the valley slopes (Way, 1983).



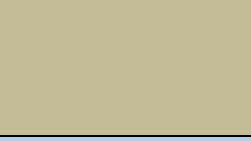
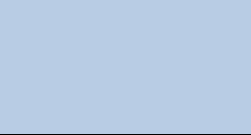
The creation of these deposits date back to Holocene period and they are formed from the deposits of Sirwan River, rainfall water and those deposits which are formed from the flood plains the thicknesses of these deposits are between (0, 5 and 3m). (Al-Jburi, 2006). In the study area, gravel, sand and clay are seen (Palani, 2010).

**Valley Fills Deposits:** Valley fills are alluvial materials transported from surrounding uplands which occupy valleys and basins. They occur in semiarid and arid climate. Valley fills are initiated by the formation of alluvial fans; these coalesce and fill the valley with alluvial materials. This landform is discussed as a type of alluvial deposit (Way, 1983). The formation of these deposits dates back to Holocene period. These deposits are considered as the newest deposits of Quaternary. (Al- Palani, 2010, Table 2). Weathering and water erosion help transfer these deposits from eminences to the low lands especially in heavy rainfall and then they settle in the valleys. The

deposits are various and they are formed from gravel sand, clay and silt. (Muhammed, 2007). These deposits include the valley areas, which are filled up, such as those valleys though which water runs and in the study area there are some valleys which have these deposits, for example, the valleys of the valleys (Ísay, Tim Timan, Parewla, Tazade) (Fao, 2002; Table 3).

**Table 2.** Parallel columnar of the geological formation of the Kalar area

Period	Epoch	Bulk	Class Structure	Characteristics	Symbolism	
Quaternary recent deposits	Holocene	0.5-105	Valley fill deposits	Gravel, sand silt,clay		
		0.5-3	Flood plain deposits	Gravel, sand silt,clay		
	Pleistocene	New	10	Sediments of the river Amphitheater	Gravel, sand ,clay	
			1-several meter	Slope deposits	Sand,siltysoil	
			10	Polygenetic deposits	Loam	
Tertiary	Pliocene	450	Bammu conglomerate	Conglomerate, sand		
		300-190	Bai hassan	Conglomerate. Sand,clay, stone		
		300-1200	Muqdadiyah	Sandston,siltstone,,clays tone		

	Miocene	Upper	700-1200	Injana	Sandstone, clay stone	
	Miocene	Middle	650	Fatha	Red claystone, limestone, gypsum	
	Eocene	Eocene upper	200-1200	Kolosh	Gravel, sand, silt, clay	
		Eocene lower	300-1000	Pila -spi	Limestone, gypsum, dolomite	

Researchers work depend on, (Palani 2010 and geological map of Khanaqin-Iraq, sheet NI-38-7, scale 1:250000.2010)

**Table 3.** Geological Composition in Kalar District and Percentage According to the District Kalar.

Geology structure	Area (km <sup>2</sup> )	Percentage %
River Amphitheatre deposits	12.4	0.72
Valley fill deposits	53.4	3.7
Flood plain deposits	13.1	0.77
Slope deposits	228.3	13.4
Polygenetic deposits	19.9	1.17
Bammu conglomerate	52.4	3.4
Bai Hassan	200.4	11.7
Mukdadiyah	598.8	35.34
Injana	36.4	2.14
Fatha	456.9	26.38
Kolosh	12.9	0.76
Pila -spi	10.1	0.59
Total	1695	% 100

## **2.2. Tectonic of Kalar District**

The studied area is a part of Zagros Foreland Basin and Zagros Mountain in Iraqi Kurdistan Region. Zagros Mountains are the result of the collision of the Eurasian and the Arabian Plates starting in the Cenozoic up to the present day (DeVera and .et.al, 2009) Many researchers carried out research on division of Iraq for several main and medium belts by the renowned geologists of the world in 1950s and 1960s of the last century, one of them was Downingtown 1958. Who divided Iraq's geology into Thrust zone, Folded zone, and Un folded zone. But (Button 1958) separated folded zones and in its division he depended on the geomorphological forms as well as he used both the terms of high fold and low fold. (Al-Rashedi, 2005). Later on, after appearing the theory of plate tectonic in 1963, another division was done to Iraq geological; For instance, famous geologists (Budy and Jassim, 1987) have divided Iraq's tectonic into stable shelf, unstable shelf and geosynclinals unit. (Surdashi, 1998).

But scientist (Numan, 1997) has a different view about Geosyncline. As are suit, he has another division for Iraq in terms of geology. This scientist mentioned and did a research on Iraq's plate tectonics historically from Cambrian period and Recent (Al-Rashidi, 2005). Thus, the study area occurs in the foothill zone belt in the frame of unstable shelf according to the Iraq's tectonic division by (Budy and Jassim, 1987). In addition, the study area occurs in the semi-mountainous area at the topographic level of Northern Iraq.

## **2.3. Geological Structure**

The study area is formed from low fold in terms of geological structures. It is divided into Hamrin minor belt and Hawler-Chamchamal belt. In addition, there are some main structures in Bardasoor Kalar in which they form a noncom formable convex structure as well as those structures are separated by a group of irregular concave folds. What's more, they from a wide plain and they are filled up with the deposits of Triassic period. Here, we mention the most significant elements of the study area's geological structures.

### **2.3.1. Anticlines (folds)**

This action takes place as a result of the tectonic movements and forces inside the earth and. In addition, anticlines cause the relief in the area, and therefore,

sometimes the folds are called anticlines and sometimes they are known as Syncline. (Mustafa, 2003) The study is formed from a group of anticlines and Synclines. From the north to south of the area like following (Palani, 2010).

**Bardasur Anticline:** This fold is long and it has a large expansion, the basis of its formation is due to the locates in the north of the Centre of Kalar town at the distance of (3 km) from the northwest to the southeast. Furthermore, this fold cuts through many valleys of the study area such as the valleys of the (Said Khali, Pungala and Qarachel).

**Kalar Anticline:** This type of folds locates in the western part of the study area, and it is from anticlines of the mountainous region as well as it is united with Kirkuk Formation. This fold is formed from the earth's Rizigzay and the sinuous formation of the mountainous, which is Zakros Zone. Kalar Anticline is an irregular convex structure. This fold is recognized by a low angle which is around (16-27) in the northeastern edges. What's more, this fold is separated by a strike-slip fault (Kalar fault) in the south western part as well as it brought Injanah formation opposite Mikdadiya formation a part from the new sediments which date back to Quaternary.

### 2.3.2. Synclines

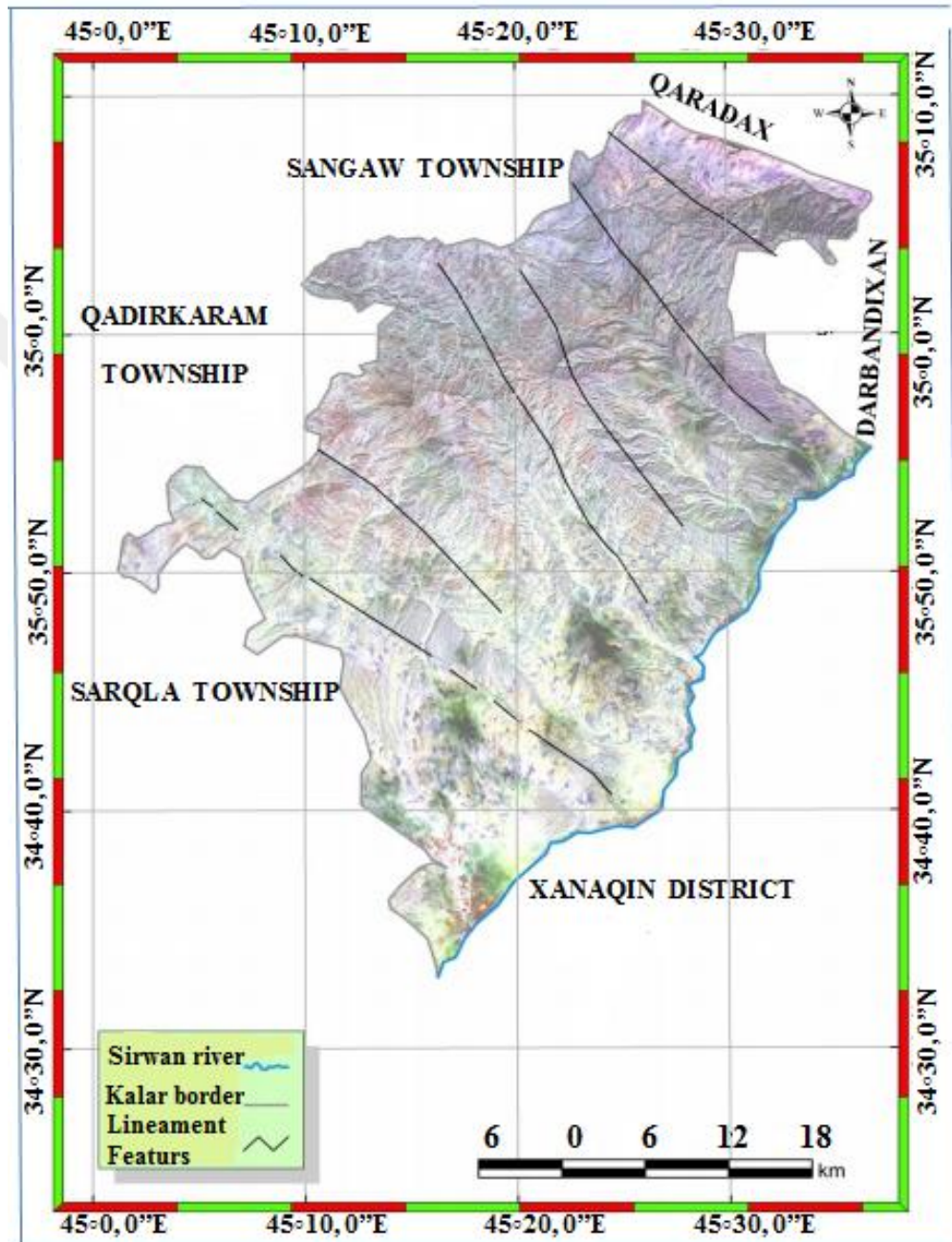
**Syncline in the north of the Bardasur anticline;** This fold is long and cylindrical with a large expansion. What's more, it is irregular and parallel, with the reverse and strike-slip faults cut through some valleys such as (Qarachel and Pungala.)

**The Syncline between Kalar anticlines near Shakal Mountain;** This fold is also called Palkana, which is axial and cylindrical with a large expansion, Pungala valley cuts through this fold and the quaternary structures appear in the Centre of the fold such as the deposits of the area's valley a part of the slope deposits.

### 2.3.3. Lineament Features

The aim of this study is to show the impact of these lineament features on the folds and bows of the river valleys as well as the direction of the rivers and valleys water. In the study area. Also, these lineament features have effect on the ground water, the development of the cover and geomorphological actions with changing the geomorphological shapes according to the direction and length of the lineament features in the study area. (Al-Dlemi, 2006 Figure 6), Apart from these, there are several lineament features in the area and the study become intensive in the southern parts of

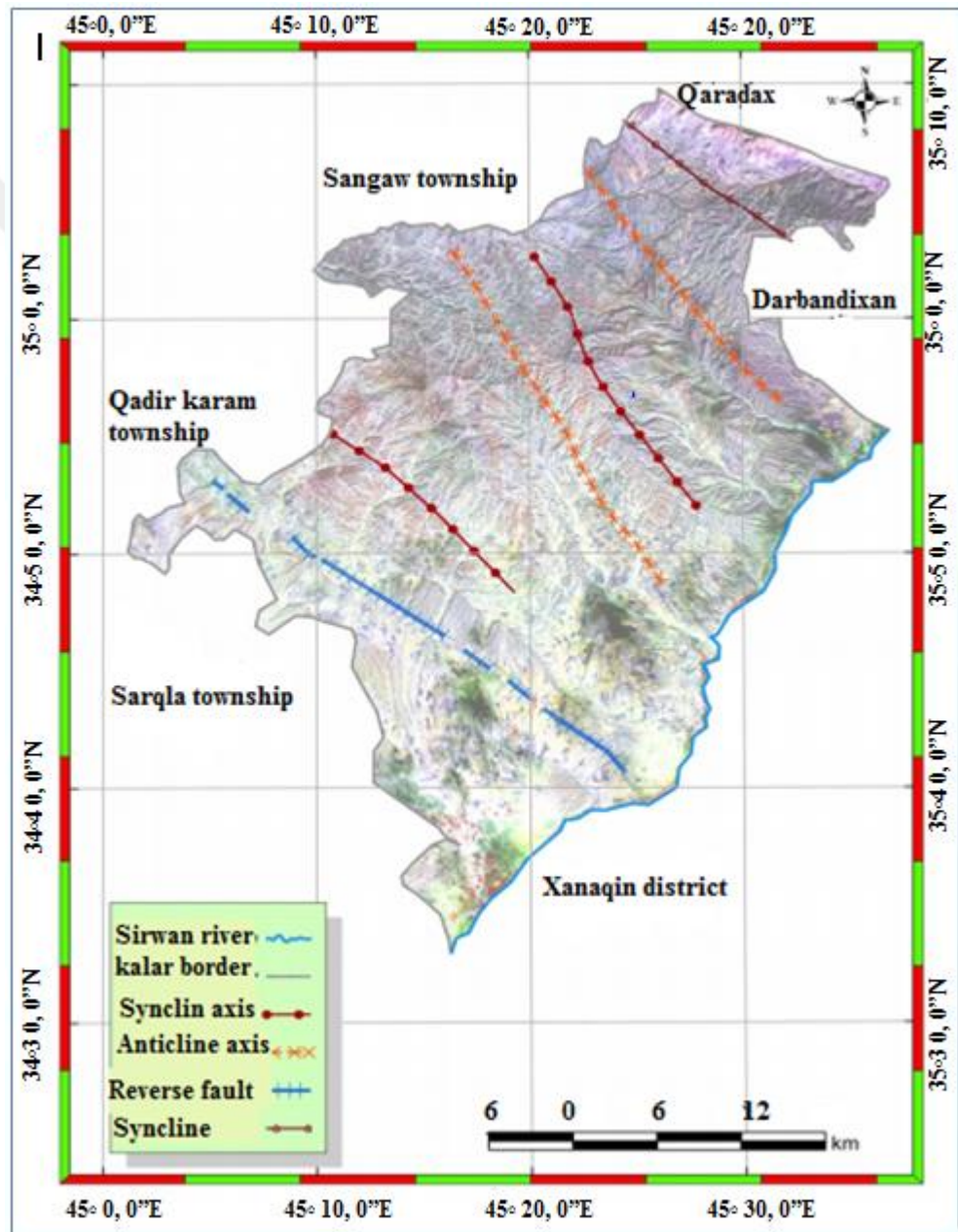
the study area as they are shown in the table (4). Therefore, the lineament features have impact on the water sheds network of the area in a way that in the southern parts of the area the length of the water sheds is short with high density, and in the northern and middle parts of the area, their length decreases with low density (Figure 6).



**Figure 6.** The lineament features map of Kalar area, Prepared by researcher depending on, FAO, H. Vol 2003, Edition, Erbil, 2000)

### 2.3.4. Faults

Faults are the fractures of the rocks of the Earth's crust due to the action of plate tectonic inside the earth. In addition things of the fault area move vertically and horizontally along with the line of the fault (Hassan, 2010). In the study area, there are some long faults, which lengthen to the north western and south eastern directions, or they are the same parallel with the areas of convex and concave folds. Also, most of the faults are reverse faults, but some of them are horizontal and vertical or they are oblique faults or normal ones (Figure 7).



**Figure 7.** The anticline and syncline map of the Kalar district, Prepared by researcher depending on (FAO, 2000).

The most important fault is Sirwan River's fault in the east of the study area and the length of this fault is around 90.3 km (Muhammad, 2015). The main faults and folds of the study area are (Chawrmilan fault which starts from Chawrmilan village to Tapaka Rus village) direction of the study area to the south eastern part of the area, the other folds of the study area are the two concave folds of (Dari Khla and Toqut; the first one lengthens from Gulla Kawa village to Turkna village), the second one lengthens from Toqut village to Challa village as well as these folds lengthens parallel with each other along the directions north western - south eastern.

## **2.4. Geomorphology of Kalar District**

Consider the Zagros Mountains as a young active fold and thrust belt. Recent GPS measurements showed that the shortening between these two plates is about 20 to 40 mm/year most of which are distributed within Zagros collision orogeny (Tucker, 1998).

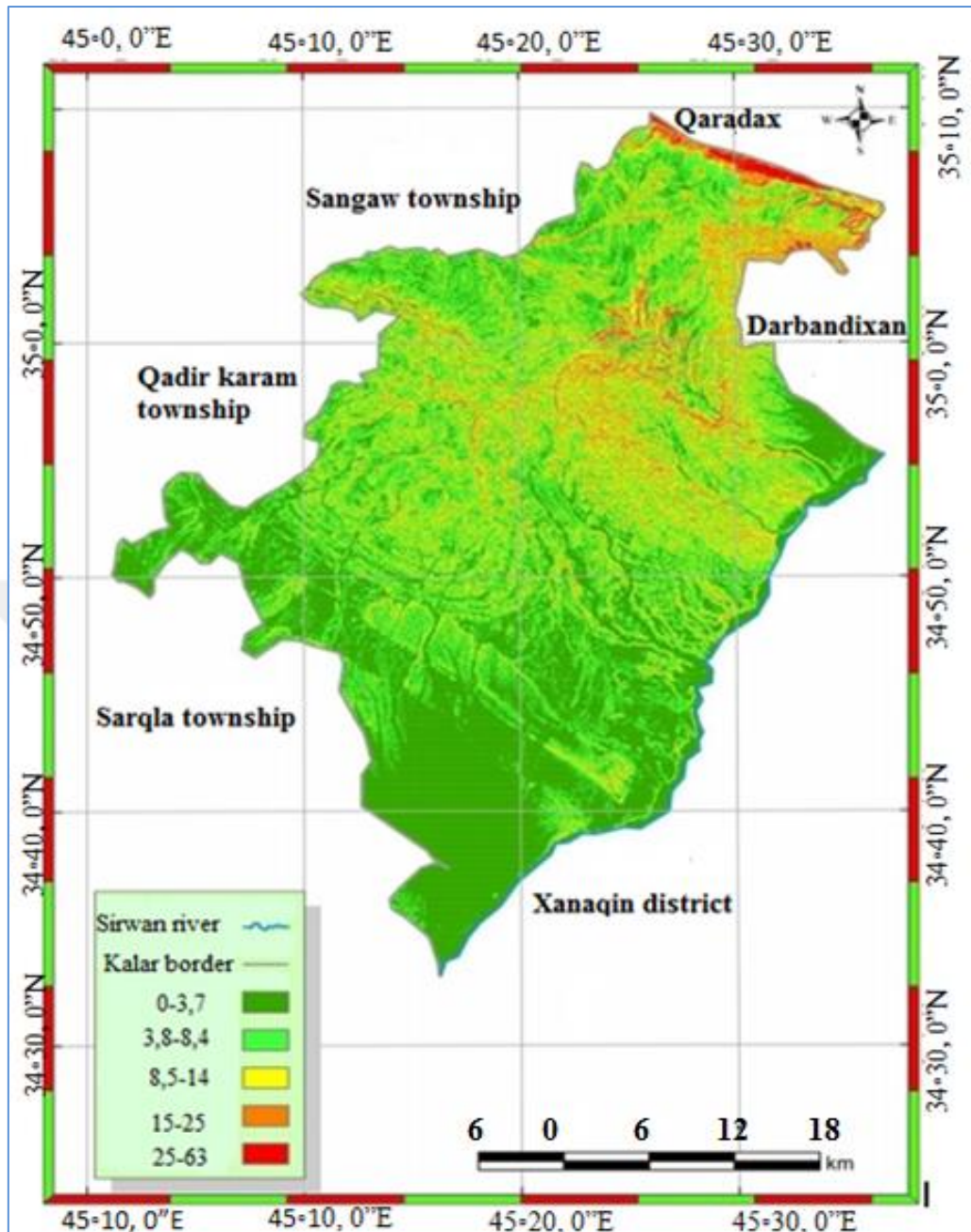
### **2.4.1. Slope**

The slope is defined on the angle between the horizontal plane and the inclination line. Its study helps analyze the different geological variations by means of regression ratios and gradient degrees, all of which depend on the vertical separator which is the difference between the values of the contour lines. Horizontal distance is the distance between the line and the horizontal line. The previously mentioned slope changes determine the type of geological processes in the region and the extent of their strength and their strengths within the study area. Due to its close association with various human activities, it is influenced by the construction of reservoirs and various engineering projects, depending on the nature of the area's slope and the extent of its impact on the geological processes and their stability. The regression is a significant determinant of the flow of water and the amount of sediments loaded by the rivers due to erosion factors, And the unit of the area of 2.5 times in the case of the multiplication of the degree of regression. The regression with erosion is associated with a positive negative relationship. In order to analyze the importance of the slopes and their role in the formation of different geological manifestations and to clarify their impact in the overall human scraper, Researcher with regression maps to determine the regression of the study area (Fleijah, 2007 Figure .8).

Zagros Mountain showed shortening, folding, thrusting and thickened during (Miocene-Eocene) and the final closure of Neo-Tethys was in Pleistocene which is represented by the deposition of the Bai Hassan Formation. Barbarian and King (1981) estimated that the deformation began about (5 M). This means that the studied area, which was a part of Zagros Foreland Basin, was covered partially with marine till the early Pleistocene. Then it began to appear on the ground surface in Pleistocene where it was formed at the final stage of Zagros Fold-Thrust belt during the Arabian–Eurasia collision. This is due to the fact that the stratigraphic and geomorphic evidence indicate that Deformations increased northward

The studied area is located within unstable shelf represented by foothill and High Folded. The zone which is trending NW-SE. About 3.9 % of the of the studied area is located within (Table 4).

The High Folded Zone which is characterized by Gulan anticline of high amplitude with Paleocene carbonates (Pilaspi Formation) exposed in their cores. The remainder 96.1% is Located within the Foothill Zone that is characterized by long anticlines with Neogene's Core and broad synclines containing thick Miocene-Quaternary molasses of which 75% Comprises Chamchamal-Butmah (structurally lower blocks) sub-zone and 21.1% consists Hemrrin-Makhul (Kirkuk Embayment) the sub-zone (Salahuddin and et al., 2016; Figure 9,10).



**Figure 8.** Shows degree slope for Kalar district, Prepared by researcher depending on, (Muhammad, 2015).

**Table 4.** Show classification slope for study area

The degree of slope	Type of slope
More than 45°	Cliff
30-40	Very steep
18-30	Steep
5-10	Moderately steep
	Moderate
A few from 2	Level

Researchers work depending no (Muhammed.2015. AL- dlemi, 2010).

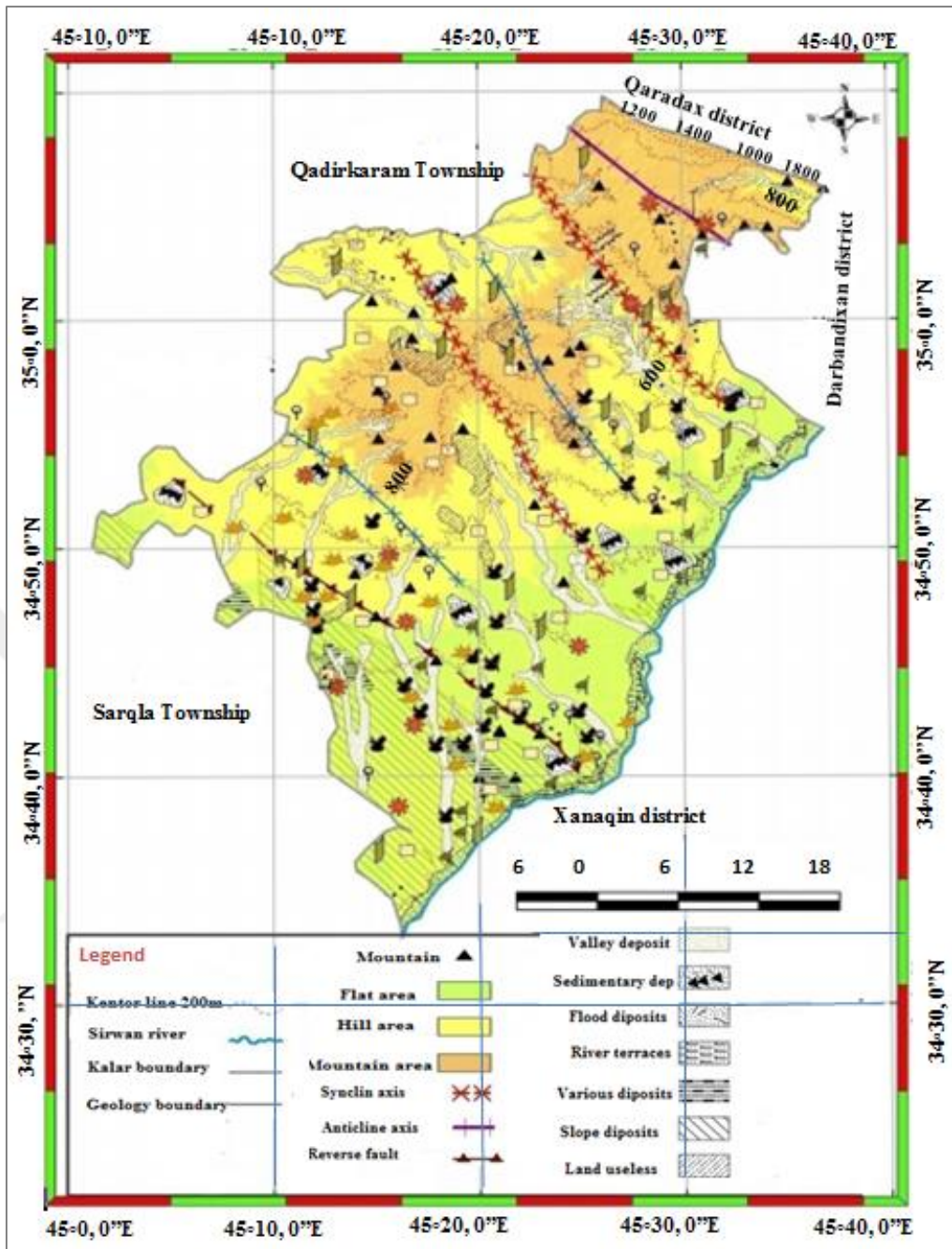
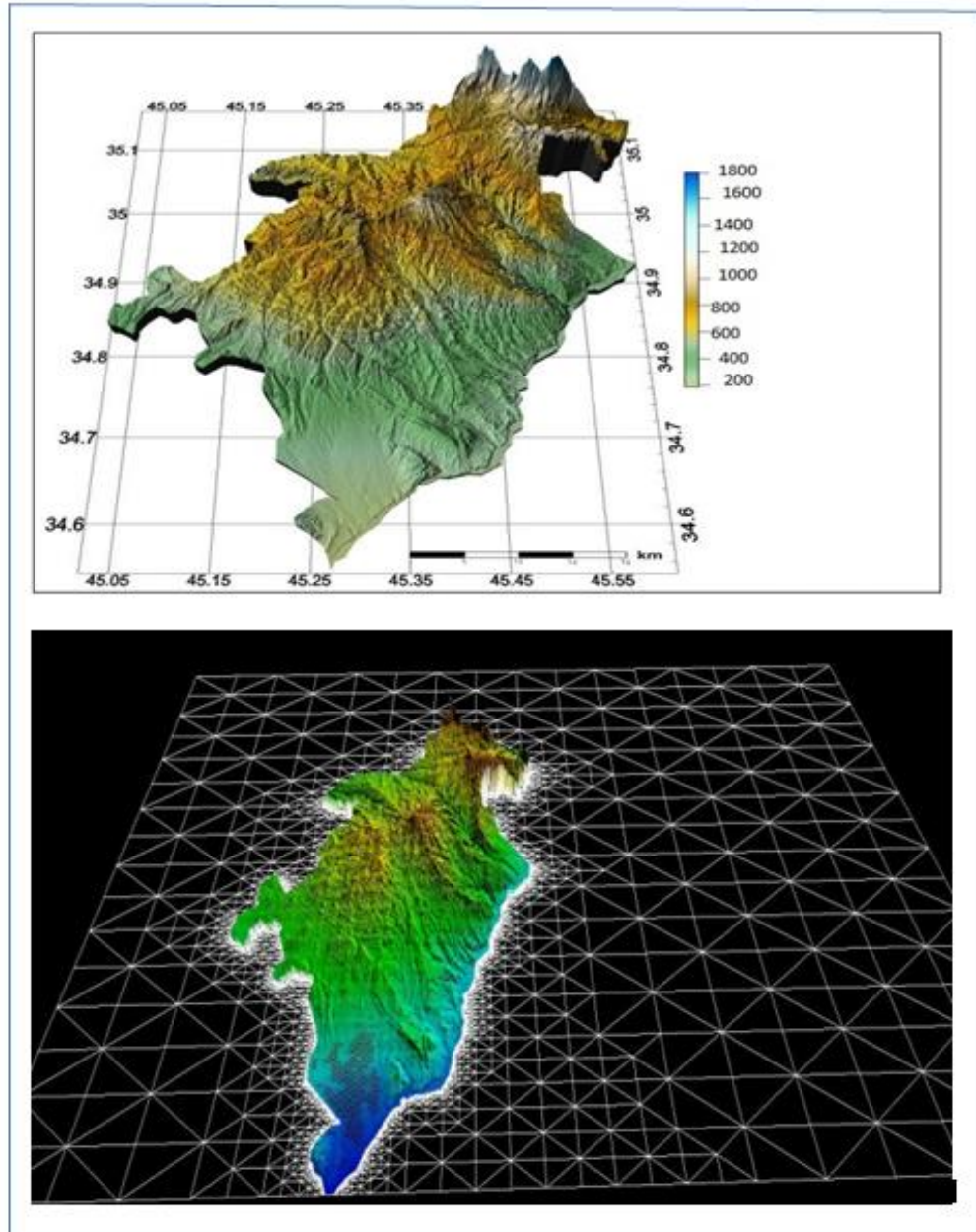


Figure 9. Geomorphological map of the Kalar district, Prepared by researcher depending on Fao and Muhammed, 2015).



**Figure 10.** 3D images for study area (Muhammed, 2015).

It is clear from the geological formations of the studied area; all the rocks that appear, and crop out are sedimentary rocks. They are of two types; clastic and non-clastic sedimentary rocks, sedimentary rocks vary greatly in their ability to resist weathering and erosion. Clastic sedimentary rocks cover more than 99% of the studied area and are represented by different types of conglomerate, sandstone, siltstone and clay stone (Howard, 1997; Huggett, 2007). Relief and landform are the main locates features of Kalar's natural environment (Shakali, 2016).

Geographically, the studies are in the semi-mountainous areas or the Plateaus and hills which are known as the semi- mountainous Zones (Omar, 1998). In general, the study area's Earth's surface is simply sinuous and the plains are also sinuous. There are also mountains which are not very high and expansive. In addition a few plateaus are seen in the area (Al-Toey, 1969; Figure 11,12).



**Figure 11.** The phenomenon of the coista between Rizgary Township and Telco.



**Figure 12.** The highland near in qala rewela.

The classical sedimentary rocks are responsible for the formation of most of the landforms in the studied area that are located in south of the Gulan mountain ridge.

They form Pulkana, Qarachil, Saidkhalil, Tazade, Isayi, Parewla, Qalatopzan watersheds with the southern part of Daradoin watershed. They form many mountain ridges in the region like Shakal Mountain at the south and Seyara, Dari Khila and Chwarmilan mountains at the western side.

Concerning the study area's relief is between (180 and 173 m) above sea level, the more we go from the south and southeastern to the north and northeastern part, its height increases in a way that the highest point locates in (Zarda) mountain across the northeastern part of the study area in the north of Sheikh Tawel district and north of Chrcha Qalla village as well as it is (1800 m) above sea level. What's more, the lowest point, which is (183 m) above sea level, locates in the south of the study area between Gizhakan village and Grda Gozina area (Ahmed, 2015).

#### **2.4.1.1. Mountainous Zone**

This zone locates between the two reliefs lines (800-1800m) above sea level. Its area in the study area is over (185, 3 km<sup>2</sup>) (Ahmed, 2015) it covers 10.9 / of the study area. In addition, its mountains expand from north western part to the south eastern except Barbara mountain which is (805 m) high and it expands from north to the south. Although the study area locates in the semi-mountainous zone. It has several eminences and mountainous such as Zarda (1800m) across the northeastern part of the study area in the north of Sheikh Tawel district near Chrcha Qalla village as well as there is Gullan mountain with height (1100 m) in the northeastern part of the Kalar town, another one is Barbara mountain with the height (805 m) in the northeastern part of the area near Gulla Kawa village. These hills and mountains have many advantages for the area in terms of hydrology since the rainfall amount and features in Kurdistan region are influenced by the mountains and eminences, thus the highest average of the rainfall throughout Iraq occurs in the mountainous zones and hills (Al-Taey, 1969).

#### **2.4.1.2. The Plateaus and Hills Zone**

A land area having a relatively level surface considerably raised above adjoining land on at least one side, and often cut by deep canyons. (www.google.com) This zone locates between the two relief lines 400-800 m above sea level. In addition its area is over (1045 km<sup>2</sup>) in the study area, and therefore, it covers 61, 62/ of the study area. Furthermore, the main hills and plateaus are Dary Khla with height (750 m) in Sheikh

Tawel district. Batewa hill (850m) in the north, Shakal eminences (415m) in the west of Kalar town in Rizgary district, Kusian hills which are (920m), Kalda Briaw with the height of (408 m) in the southern parts of the study area and Bardasur eminences which are (337 m) high in the north of Kalar town. In the north of Kalar town there are also too many eminences, summits and mountains particularly in the north and northeastern parts of the study area (Figure 13).

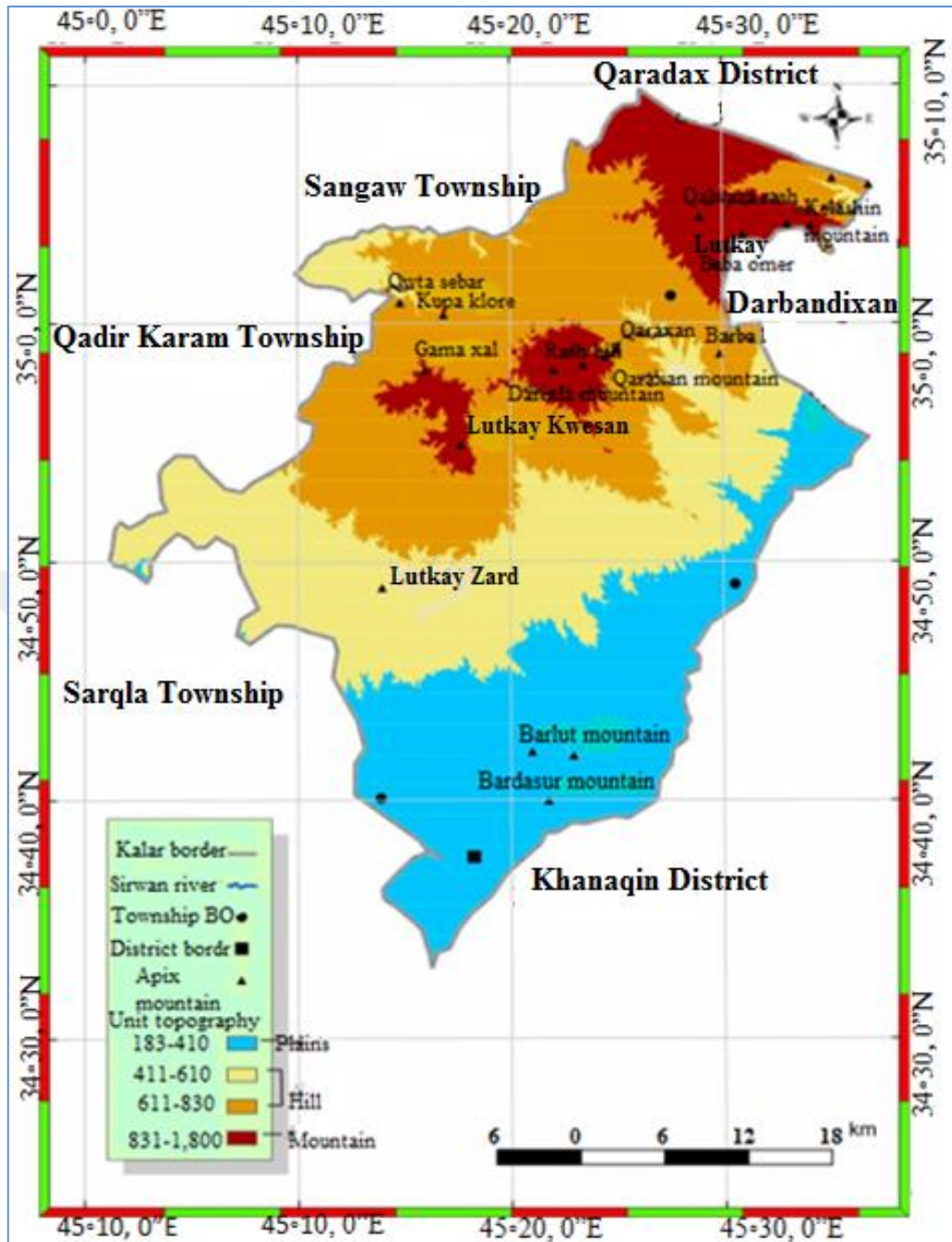
#### 2.4.1.3. The Zone of the Plains

This zone locates between the two reliefs lines (300-360 m) above sea level. (Palani, 2010). It has an area of over (464, 5 km<sup>2</sup>) in the study area, i.e. it covers 37,4/ of the study area (Table 5). Sirwan River in the east of the town there is a fertile and quite flat floods plain which is formed from the floods of Sirwan River and it is known as (Sherwana) plain. What's more, this plain extends from Barlut village along with Sirwan River's edge towards Kalar town and both the villages of Grda Gozina and Sheikh Langar; this plain is very useful economically for the area's population especially for summer agriculture such as growing vegetables and fruit as well as for winter farming like growing wheat and barley



**Figure 13.** Plains said khali.in the study area.

There is (Shakal) plain in the south west of the town and (Saed Khalil) plain in the south of the study area. In the east of the study area there is (Pebaz) plain (Ahmed, 2015; Table 6 ,Figure 14.).



**Figure 14.** Unit topography of Kalar district, Researcher’s work depending on File (DEM 30 MT).

**Table 5.** Famous Hills and The Highest Hill at Kalar District.

Number	Name of hill top (mountain)	Altitude (m)	Longitude	Latitudes
1	Grda Rasha	963	45:23:25	34: 58: 15
2	Bardasur	327	45:21:45	34:40:0
3	Kal dabryaw	408	45:22:56	34:41:53
4	Dari xla	750	45:22:4	34:58:3
5	Kela shin	1004	45:33:4	35:4:8
6	Chwar Milan	1173	45:30:59	35:3:43
7	Qara jan	883	45:24:29	34:58:37
8	Grdi baba umer	978	45:34:11	35:4:4
9	Grdi bar ba	805	45:29:52	34:58:43
10	kwesan hill	920	45:17:39	34:54:54
11	Grdi zarda	595	45:13:58	34:58:55
12	Tuna krkana	251	45:19:58	34:39:59
13	Dala rasha	304	45:21:0	34:41:58
14	Quta sebar	655	45:14:49	35:0:53
15	Kuba klor	694	45:16:52	35:0:21
16	Qara jan	834	45:25:1	34:58:55
17	Hamda said	1018	45:29:38	35:2:28
18	Baykul	680	45:35:10	35:6:4
19	Barlut mountain	307	45:21:0	34:42:3
20	Kama xal	823	45:16:0	34:58:4
21	Qalwaza rash	1084	45:28:56	35:4:27
22	Kolan	1100	45:36:55	35:5:47
23	Shakal	415	45:13:58	34:48:55

Researcher's work depending on. (Topographical map, 1:100.000, Kalar, wgs 84, sheet, 4959, 2002).

**Table 6.** Sections of The Study Surface Area and Percentage According to Kalar Discrete Area.

Unite highest and lowest	Altitude	Area (km <sup>2</sup> )	Percentage %
Flat	183-410	464.5	27.4
Hill and plateau	411-610	497.1	29.3
	611-830	548.3	32.3
Mountain	831-1,800	185.3	10.9
Total		1965	% 100

## **CHAPTER THREE**

### **3. ANALYSIS OF THE FEATURES OF CLIMATE ELEMENTS IN KALAR DISTRICT**

#### **3.1. Climate**

The consequences of those stable and unstable factors which affect Kalar town climate as we mention later, those factors cause the appearance of a special feature of climate in the study area. As a result, the object of this chapter is the analysis of the features of climate elements in Kalar district.

The evolution of any landscape is the result of interactions between the flow of matter and energy entering and moving within its limits and the resistance of the topographical surface. The interrelationships between these factors and their distributions in time and space govern to a great extent the evolution and the present state of drainage basin topography. Climate controls erosional processes both directly and indirectly. The direct control is exerted by the climate elements; temperature, rainfall and wind that show a wide variability not only from one part to another of our planet, but also within very restricted areas, as for example from one slope to another on the same mountain (Goudie, 2004).

The studied area represents the eastern part of Garmiyān area in Kurdistan region between Kalar and Darbandikhan districts. The term (Garmiyān) is a Kurdish word used to denote the hot and dry area in Kurdistan, which describes, indicates and gives information about location and climate, in this chapter we can count on climate station in (Kalar and Pebaz, and another station around study area such as Xanaqin-Darbandixan, Qaradax, Chamchamal, Kifri, Duzz (Table 7).

**Table 7.** Information About Unit Climate for Kalar Metrological Station and Stations Around It.

No	Station	Xanaqin	Kalar	Kifri	Pebaz	Shextaweel	Darbandixan
1	Altitude	202	254	228	335	525	513
2	Years period	1987-2000	2000-2013	conjectur	2013-2014	conjectur	1997-2010
3	Longitude	45.26.24	41.18.45	33,58.44	33.30,45	0.1,11.45	0,941.45
4	Latitude	3418.56	40.16.34	29,43.34	29.49.34	16,0,2,35	29.0,6.35
5	Ave.a.rainfall	326	293.5	343	356	389	511
6	Ave.A.Temperature	23	23.5	42	22	22	21
7	Ave.A. Humidity	27.5	43	39.4	43.5	32	44
8	// .wind speed	203	2012	201	201	2	2
9	Ave.a.Evaporation	259	247.2	262	241	225	213
10	T.A.Rainfall	4564	4110	4802	4984	5446	7745
11	T.A.Temperature	322	329	336	308	308	294
12	T.A.Humidity	525	603	551,5	609	609	616
13	T.A.wind speed	2302	2907	2904	29.4	28	28
14	T.A.Evaporation	3626	3462	3668	3774	3150	2928

Prepared by researcher depending on (General directorate of agriculture in Germiyan, 2014; Muhammed, 2015).

### 3.2. Solar Radiation

Incident of the solar radiation which can be recorded by a specific solar system is main source of energy and it moves all the natural actions of the atmospheres. It has influence on the climate on the earth (Ghanm, 2009). Incident of the solar radiation and the number of solar radiation incident which can be corded by a specific device, it has a great impact on all the action, which occur in the aerospheresuch as atmospheric turbulence, cloud, rain fall and climate change (Ali.O, 2014).

It is necessary to state that the magnitude of the solar radiation which reaches earth is not the same in every place or every time; this is due to the incident of the solar radiation angle as well as the astronomy of the study area. Therefore, we see that lowest level of the slope angle of the solar radiation incident is in winter in January which is (5.3 time/day) the highest degree is in July which is (11,9 time / day ) by looking at the (Table 8). The difference of appearing of the solar radiation hours between month and season of the year is clearly seen in the (Table 9).

**Table 8.** Center of Monthly and Annual Angle of Solar Radiation Incident (time /day) for Kalar metrological station for during (2003-2013).

Monthly	The fall of sunlight the real
January	5,2
February	6,3
March	7
April	7,4
May	9
June	11
July	11,9
August	11,4
September	10,7
October	5,8
November	7
December	8
Total annual	8,4

Reference, Researchers' work depending on (Al -Palani, 2010)

**Table 9.** Center of Monthly and Annual Angle of Solar Radiation Incident (time /day) for Kalar metrological station for during (2003-2013).

Year	Spring			Summer			Autumn			Winter			Av.annual
	March	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2000	14.5	18.9	23.3	29.2	34.6	32.4	27	21.2	14.7	9.1	7.6	13.6	23.5
2001	16.1	21.5	26.4	31.5	33.1	35.7	29.8	23.1	15	11	7.1	13.2	24
2002	14.8	18.3	22.6	28.6	34.7	31.9	30.9	23.7	14.1	9.1	8	9.6	24.5
2003	15.5	18.1	24.1	31.2	34.5	30.9	27.7	24.7	13.7	11.8	10.1	12.4	21.2
2004	16.2	21.3	24.5	32.6	33.4	31.6	29.1	29.2	12.9	11.1	8.2	14	23
2005	15.3	18.6	23	29.8	31.3	31.3	28.6	23.4	14.2	12.2	9.3	11.1	23.7
2006	13.2	21.1	25.9	28.1	34.8	32.1	27.4	24.4	12.7	8.8	8.4	14.2	22.9
2007	14	19.4	22.1	29.9	32.7	32.2	28.3	22.1	15.1	9.2	6.1	9.1	22.1
2008	13.5	17.5	23	30.1	33.2	32.3	30	22.7	15.9	9.4	6.9	10.2	23.4
2009	15.5	22	24.6	29.8	34.4	32.6	30.2	23.3	12.3	10.6	9.1	11.8	24.4
2010	13.6	20.3	24	24	47.7	41.6	27.8	23.2	13.9	9	7.3	11.6	24.7
2011	14.5	19.7	23.8	41.9	45.8	40.9	30.1	23	14.1	10	8	11.7	23.6
2012	14.5	21.2	24.3	43.4	46.1	40.1	31.2	25.7	16.8	11.5	8.2	11.5	24.5
2013	15.5	21.6	23.5	35.5	40.9	41.6	30.6	24.3	15.4	10.7	9.7	12.2	24.5
Av.Mounthly	13.8	20	23.9	33.3	36.9	34.9	29.2	23.9	14.3	10.3	8.14	11.9	329
Average annual 23.5													
Av.seasonal	19.5			35.4			22.4			10.4			

Researchers' work depending on (General directorate of agriculture in Germiyan, 2014; Muhammed, 2015; AL-Palani, 2010).

### 3.3. Temperature (T)

Temperature is one the most significant elements of climate because it has direct and indirect impact on the climate elements and phenomenon. The temperature of the any place at any time is due to several factors which are the magnitude and type of the solar radiation to the earth surface, the capacity of the place for that temperature and temperature trans ferrying from one place to another (Amen, 2007). Temperature is to

fell cold or heat, or it is a sort of energy that can be felt, touched or recorded by a thermometer, and so it known as sensible heat (Ghanim, 2009).

The climate of Kurdistan is characterized by extreme conditions, the large temperature difference between day and night and between winter and summer are noticed (Sharif, 2001). The minimum, maximum and the mean of the air temperature and the relative humidity of the study area districts provided from the Ministry of Agriculture (Table 10).

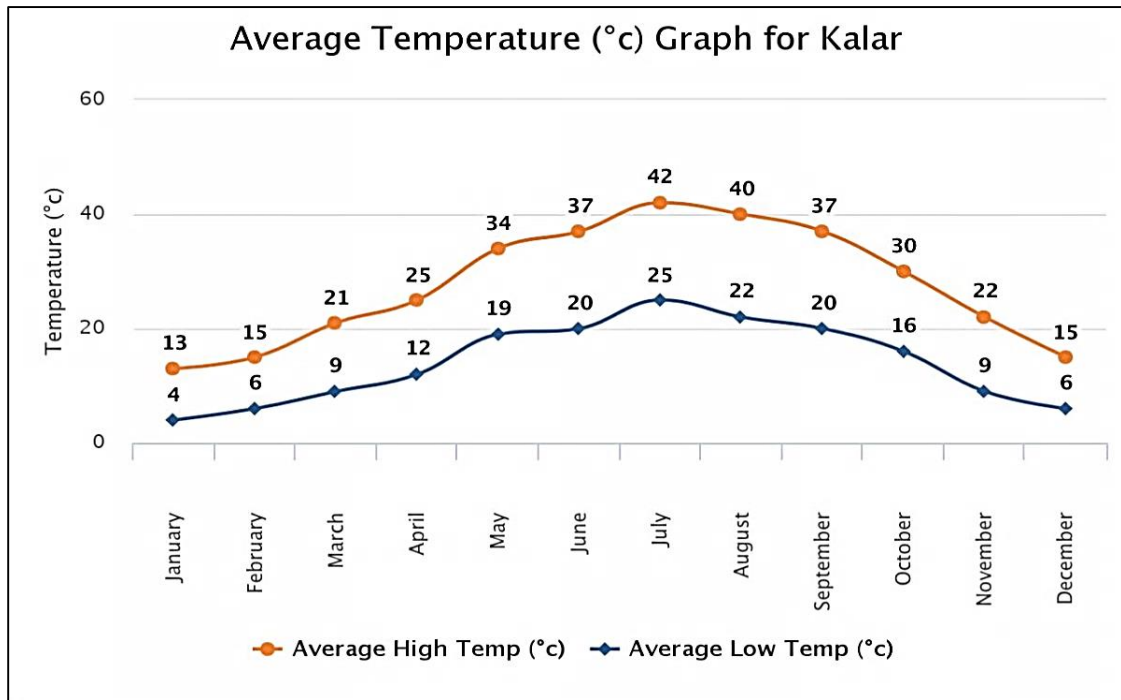
**Table 10.** The Air Temperature of the Kalar for July in years 2000, 2007 and 2015.

Region	Air temperature ( <sup>0</sup> C), Years								
	2000			2007			2015		
Kalar	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
	35	7.6	21.3	38	8	23	37.5	10.5	24

Kalar district has extremely hot summers, with temperatures ranging from 39 to 48°C. Winter is wet and moderate with temperatures between 13° and 22°C. The average annual precipitation in the district is 350 mm. In the winter the region is invaded by Mediterranean cyclones moving east to northeast over the region. Arabian Sea cyclones moving northward and passing over the Gulf usually carries the great amount of moisture which causes a large amount of precipitation.

The highest average of temperature is recorded in July which is (44.8 °C)) and this is due to the incident angle of solar radiation in the summer in a way that approaches vertical line, cloudless sky of the study area, the longevity of the daytime and the effect of continental tropical air masses (CT) (Abu Alainin, 1981 )

Winter season in Kalar consists of December, January and February, during these months temperature drops, daytime because (10 hours) and nighttime are (14 hours). In addition, in December temperature average is (10, 30 °C)) in January it is (8.3 °C) and in February it reaches (13 °C) besides, the highest average was recorded in (February 2006) which was 14,3 °C but the lowest average was (6,1 ) in January 2007.,2006) which was (14,3 °C) but the lowest average was (6,1 °C) in January 2007 (Amen, 2011; Figure 15).



**Figure 15.** Means monthly average temperature for study area.

It means the Centre of winter temperature has reached (10,1 °C)), low temperature in winter returns to the angle slide of the solar radiation on the tropic of Capri can and the daytime is shortening with a cloudy weather in most of the times.

Despite the fact that cold wave overcomes the heat wave, winter season in the study area is not long enough as well as it is not very cold. But it affects the roles of planning, development and work in a great way, sometimes it causes day-off in work places. But it doesn't stop it because temperature average in the area rarely reaches below (0 °C), and it is only for a very short period of time in several years, according to the data of the chart. The average of the monthly and annual highest and lowest temperature in Kalar station weathering for the period (2000-2013)=(total annual), highest =28.4) and lowest =16.5 ) and different=11.8). According to general directorate of agriculture in Germiyan and weathering of Kalar station 2014, unpublished data.

In Kalar high average of temperature is much more than the low average of temperature, and therefore, it is known that summer season in this area is too long because in the late summer and early autumn the average of temperature is high; meanwhile spring and autumn are known as short seasons in comparison with summer and winter season. What's more? Temperature is cool and temperate during autumn and spring.

### 3.4. Precipitation (p)

Rainfall is the main feature of precipitation in the studied area, but snow fall also exist along the northern part of the studied area and more exactly at the top of Gulan mountain and the upper part of Daradoin drainage basin (e.g. in Feb. 2012, a layer with few centimeters of snow persisted for two days at Gulan mountain and the upper part of Daradoin stream watershed). It can also be observed that mean annual precipitation increases gradually northwards, heaviest precipitation takes place at Darbandikhan station. Sometimes precipitation is erratic and a pronounced drought may even extend over two years like that of Kalar in 2006 and 2007.

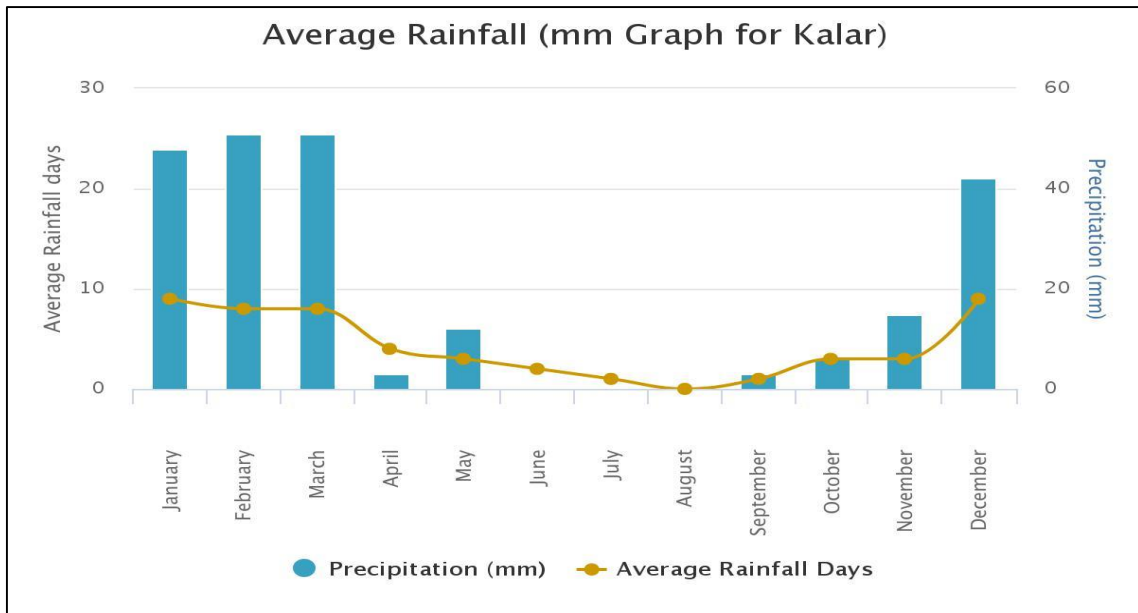
The general trend lines for both stations shows the decline in rainfall. These declines lead to predicting future environmental geomorphic change toward more severe aridity especially in southern part of the studied area. The alternation and oscillation between the arid and humid year affect the earth surface (Anab, 2006). The arid years cause soil dryness that makes it friable, cracking and ready for different types of erosion by precipitation and water flow in the region during the humid years.

Rainfall is an important element of the climate elements; it has a big effect on human life. Rainfall is different according to the area when it rains, sometimes it is similar to water drops or it rains with a shower whereas it sometimes freezes and because of hail (Ghanim and Rashid, 2009). The total annual rainfall of the study area districts was obtained from the Meteorological Station for the years 2000, 2007 and 2015 (Table 11).

**Table 11.** Total annual rainfall (2000, 2007 and 2015) for the studied area

Region	Rainfall (mm), Years			
	2000	2007	2015	Av.
Kalar	312	106.9	558.9	325.93

Rainfall is bimodal with annual averages of 350 mm. The long rains fall between January and February, while the short rains are experienced from July to August. It is interesting to note that the people in the district who are predominantly agriculturalists rely mostly on the short rains from October to December. Droughts are common in the area and prolonged droughts cause significant decrease in vegetation which takes a long time to recover (Figure 16).



**Figure 16.** Means monthly average rainfall (mm) for Kalar district.

The system of the study areas rainfall is like the Mediterranean's one because it has winter rain and dry summer, i.e. most of the rainfalls in the winter and the summer is dry. In addition the rain of the study area is monsoon rain, which starts in October until the late march, i.e. It rains in the autumn, winter and spring this is at the sometime with that depression or low pressure which blows on the zone from the mid-October to march, and they include the Mediterranean depression as well as Atlantic Ocean depression. The highest average of rainfall is recorded in January and it amount is (780.4 millimeters), more than half of the rainfall is in winter because of blowing and coming a large amount the Mediterranean hurricane to the area in terms of sort and strength of the hurricanes the lowest average of rainfall is recorded in July and August which is (0mm) due to the stoppage hurricane of the Mediterranean sea from march until October. Division and equator of the rainfall average of the study area starts in the south and west of the study area with the amount of (300mm) until reaches (550mm) in the north of the area.

This division is because of the in the flounce of relief in a zone. Until we go from the south to the north, the area rises in terms of relief with the difference of around (1600m), therefore it causes a rise in the rainfall amount.

It is necessary to say that the average of rainfall is different in the area from one place to another as well from one year to another, during 14 years between 2000-2013. The highest average of rainfall is recorded with the mount of (434.8mm) in (2003, and

then the lowest average of rainfall was (301 mm), in 2008. Therefore, this is an evidence to show that the area is under influence of the arid –climate just like all the zones of the Mediterranean climate region (Khalaf, 1965; Table 12).

**Table 12.** Mean Monthly Annual and Season Total Rain Fall (mm) for Period (2000-2013) for Kalar Metrological.

Year	Spring			Summer			Autumn			Winter			Av.annual
	March	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2000	34.1	21.2	6.4	0	0	0	0.60	4.6	19.4	68.1	94	59	316
2001	64.8	5.5	0	0	0	0	0	2	12.5	99.3	56.2	40.3	281
2002	56.8	64.7	0	0	0	0	0	0	49	94.1	130	30.2	425
2003	37	32.3	0	0	0	0	0	1.2	48.3	40.9	62.8	29.8	252
2004	4.9	17.2	7.5	0	0	0	0	1.5	63.7	41.8	112	42.3	291
2005	1.4	26.5	4	0	0	0	0	0	28	44	69.1	36.9	313
2006	17.5	62.5	3	0	0	0	0	25.5	16.5	7	69	99	300
2007	6.5	61.5	2.5	0	0	0	0	0	0	10	85.5	67.5	234
2008	3	0	2	0	0	0	0	73.5	28	3	64	27.5	201
2009	25.9	0	0	0	0	0	0	3.4	68.3	23.3	22.5	24	167
2010	61.5	36.1	52	0	0	0	0	33	1.5	84.5	62	48.6	350
2011	7.6	41.4	17.4	0	0	0	0	3.5	7.5	5.4	157	11.1	250
2012	27.3	11.5	5.3	0	0	0	0	14.6	22.9	22.7	21.2	53.5	368
2013	1.9	2.8	20.1	0	0	0.03	0.04	0	146	61	93.1	20.2	345
Av. Monthly	33	27.4	8.5	0	0	0	0	9.5	51.3	43.2	78.4	42.1	4110
Average annual													293.5
T.Seosonal	68.9			0.0021			60.8			163.7			

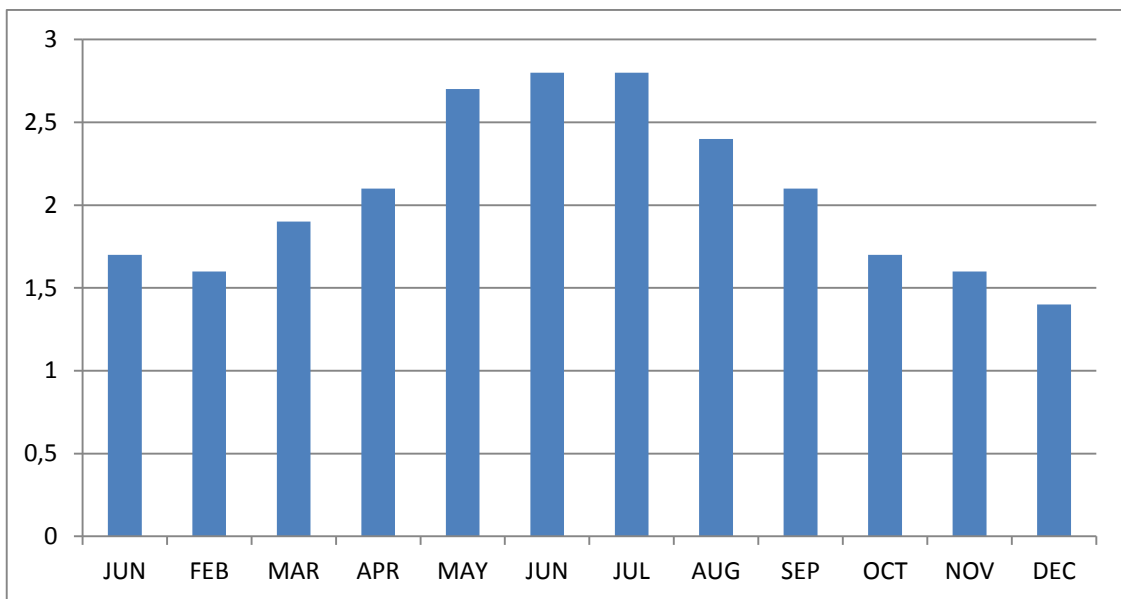
Researchers' work depending on (General directorate of agriculture in Gernyan and weathering of Kalar station, 2014, Technical Institute of Kalar 2014, Al- Palani, 2010).

### 3.5. Wind

Wind is the horizontal movement of air on the earth; air pressure has a main and direct role in the wind movement in terms of direction and speed. The wind blows from

the high-pressure area to the area of low pressure. In addition, to specify the real direction of the wind it is according to the place of high and low pressure (John, 1976).

Increasing of wind speed changes according to the winter and summer months. The highest average of wind speed is recorded in July with the magnitude of (3083m/s), but the lowest average of wind speed is recorded in December with the amount of (104m/s) division and equator of the annual average of wind speed is explained on the (Figure 17).



**Figure 17.** Means monthly wind speed (m/s) for study area for period (2000-2013), for Kalar metrological station.

The equator of the wind speeds annual average in the study area starts with (3m/s) from the south of the study area until it reaches (304m/s), in the northwest parts of the study area (Ali 2014). Apart from these, the zone owns a type of local wind which is known as the storm, which is quite quick and it is not in summer, but cold in winter (Ameen, 2008; Table 13).

**Table 13.** The Average of the Monthly and Annual Wind Speed (m/s) for Study Area for Period (2000-2013), of Kalar Metrological Station.

Year	Spring			Summer			Autumn			Winter			Av.annual
	March	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2000	1.9	2.3	3.2	3.4	2.8	2	2.1	1.3	1.2	0.9	1.7	1.5	20.3
2001	1.8	2.2	2.5	2.7	2.2	2.2	2	1.7	1.3	1.1	1.2	1.4	1.86
2002	2	1.8	3	2.9	3.2	3	2.9	2	2.1	1.9	1.4	1.6	2.32
2003	.2	1.9	2.2	2.8	2.9	3.1	2.4	2.2	2	1.7	1.9	1.9	2.28
2004	2.2	2.3	2.8	2.4	2.7	2.7	1.7	1.8	1.9	1.8	2.1	2	2.2
2005	2.4	2.5	3.1	2.7	2.9	2.2	2	1.9	1.7	1.5	2	1.8	2.23
2006	1.8	2	3	3.2	3.1	3	1.8	1.1	0.9	0.8	1.7	1.9	2.03
2007	1.9	2.2	2.4	2.8	3.3	2.8	2	0.8	1.5	1.2	2.4	1	2.03
2008	2.2	1.9	2.9	3	2.9	3	2.8	1.7	2	1.2	2.1	1.9	2.3
2009	1.9	2.4	2.8	3.2	3.4	2.4	1.3	1.7	1.8	1.7	1.7	1.5	2.15
2010	2	2.2	2.7	2.9	2.6	2	1.9	1.8	1.6	1.1	1.6	1.4	1.98
2011	2.1	2.3	2.8	3	2.7	2.3	2.5	1.9	1.5	1.7	2.1	1.9	2.23
2012	1.9	1.9	2.5	2.9	2.6	1.9	2.5	2.2	1.9	1.7	1.9	1.7	2.13
2013	1.8	1.8	2	2.5	2.3	2.1	2.2	1.9	1.8	1.5	1.8	1.6	1.94
Av.Mounthly	1.9	2.1	2.7	2.8	2.8	2.4	2.4	1.7	1.6	1.4	1.8	1.6	2.97
Average ,Annual							2.12						
Av.seasons	2.2			2.7			1.8			1.6			

Researcher's work depending on (General Directorate of Agriculture In Germyan and Weathering of Kalar Station, 2014, Technical Institute of Kalar 2014, Al-Palani, 2010)

### 3.6. Relative Humidity

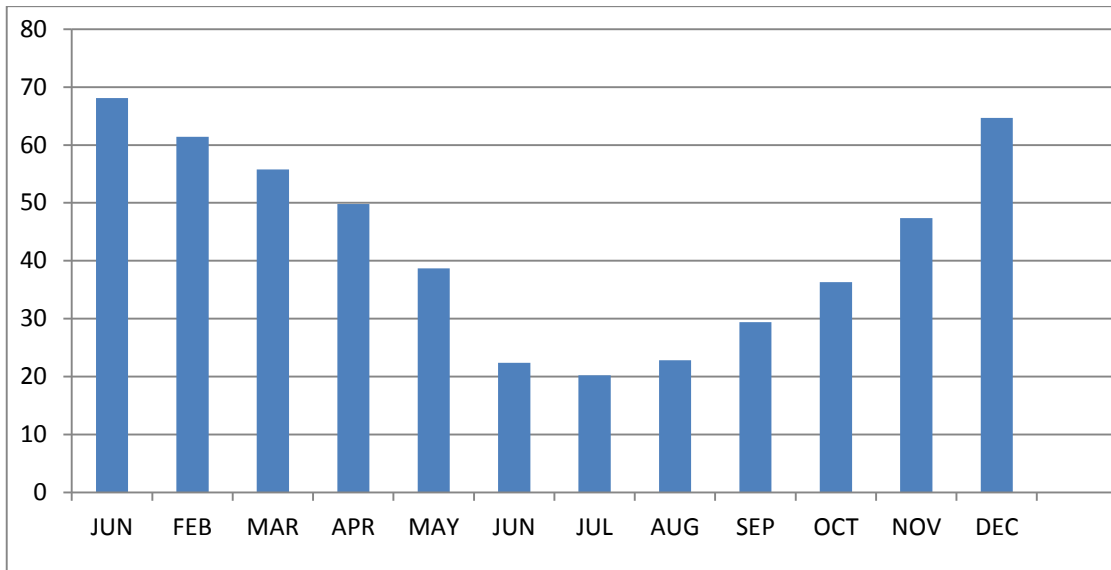
Relative humidity is the percentage of the amount of water vapor in the air in a specific degree, for the magnitude of the air in a water vapor in the air which can carry in some temperature (Haded and al-Husaini 1984 ). In the study area, the highest average oh relative humidity is recorded in January during winter and its amount is (68mm). But the lowest average of relative humidity is recorded in summer in July with the magnitude of (30.3mm), this is due to different temperature in those two seasons

(Table 14). Concerning the division and equator of the annual average of relative humidity starts from the south of the study area with the amount (41m) until it reaches (44mm)in the northwestern parts of the area (Sharif 1991; Figure 18).

**Table 14.** The Average of The Monthly and Annual Relative Humidity (mm), (%) for Kalar metrological station (2000-2013).

Year	Spring			Summer			Autumn			Winter			Av.annual
	March	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2000	61.2	58.1	44	32	19	26	28.1	38.3	39.4	65	65.1	64	44
2001	60.6	42.5	30.2	31.4	22.4	19.5	24.8	28.2	47.3	76	62	62.3	42.3
2002	51.2	65.3	36.4	28	28.9	17	34	40	65	74	76.9	62.5	49.1
2003	57.4	49.3	24.1	19	21.4	18.7	33	43	46.1	63	70.4	65	42.5
2004	54	51	34.3	21.3	22.4	23.3	34.1	35	36	57.3	72	66	42.1
2005	55.3	52.2	45.3	18	21.3	26.2	38.2	34.5	40.6	56.2	60	67	42.9
2006	51.2	50.7	47.2	23.9	24.6	27.2	35.2	34.8	43	61	71.3	70	45
2007	51	54	43	24	23.9	23.5	31.1	37	44.1	61	71	19	40.1
2008	54	45.4	41.3	26	25.3	23.3	29.3	41.9	44	63.3	71	66.2	44.3
2009	51	44.9	34.6	21.2	19.1	20.7	28.1	31.8	41	58	60	56.3	39
2010	66.1	44.7	45.3	22.1	18.7	21.7	27.7	33.1	41.2	73.3	64.5	66.6	43.8
2011	51.2	49.1	39.3	19.4	17.7	20.9	34.1	36.1	50.1	55.9	77.3	66.1	42.9
2012	62.4	48.8	38.7	13.1	17.9	19.7	20.6	35.4	64.1	70.7	65.1	64.9	43.5
2013	53.8	40.9	39.7	13.9	17.1	21.8	23.9	39	61.2	71.3	66.4	67.7	41.6
Av. Monthly	55.8	49.8	38.7	22.4	20.2	22.8	29.4	36.3	47.4	64.7	86.1	61.4	603
AVERAGE ANNUAL													43
Av. Seasonal	48.1			21.7			37.7			64.7			

Researchers work depending on (General directorate of agriculture in Gernyan and eathering of Kalar station, 2014, Technical institute of Kalar 2014, Al Palani, 2010).

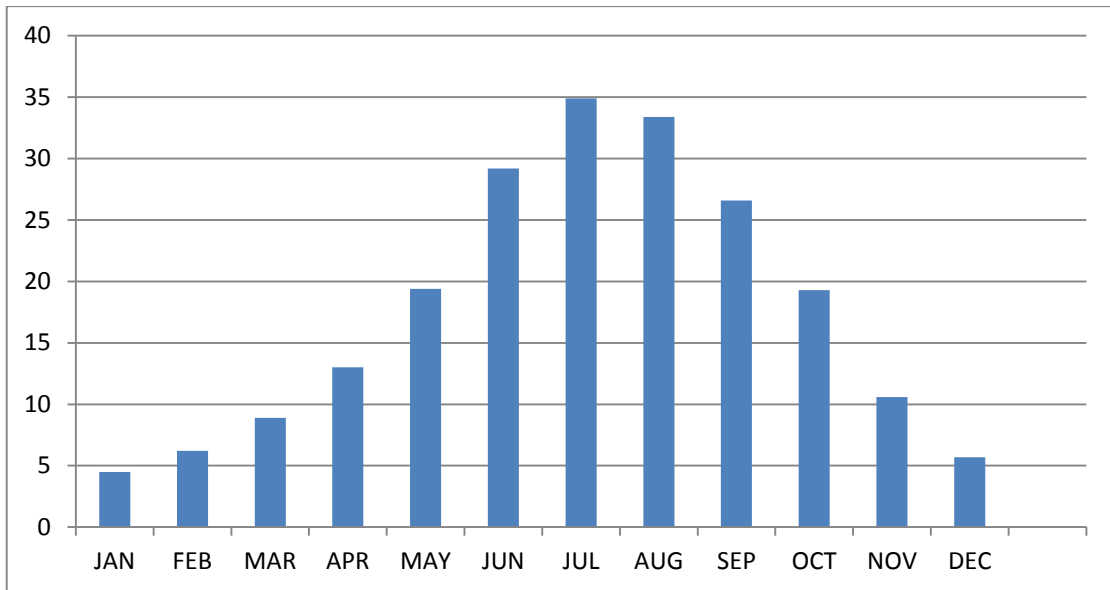


**Figure 18.** Mean monthly relative humidity % for study area kala for the period (2000-2013), for Kalar meteorological station.

### 3.7. Evaporation

Water vapors are an important element of the climate elements. Though its percentage doesn't reach (5.52%) of the gas cover. It has a big role in the creation of cloud fog., dew hurricane and other climate phenomena (Shehata 2009 ) and therefore. We can say that evaporation is the action of changing water from liquid state into gas state, this action happens when the air is not full of water a vapor (Xhanim, 2003).

Evaporation has a main role in indication of that amount of water which goes into the below ground, this is except the reduction of the ground water through activation of the capillary action as well as the type of its water.the amount of evaporation is effective because over, evaporation increases the density of some elements of water (Qadir, 2013; Fifure 19).



**Figure 19.** Monthly evaporation totals (mm) for the period (2000-2013).

The percentage of evaporation in the air depends on the each areas climate of the study area is cold in winter and it is hot and dry in summer and therefore, the highest average of evaporation is recorded in summer in July with the amount of (39.3mm). The lowest average of evaporation is recorded in December with the amount of (4.1mm), (Table 15). Because the magnitude of rainfall, relative humidity, wind speed and day time longevity have a medium level between winter and summer. The percentage of the annual evaporation is high in the study area in which the annual average reaches (3199.9mm) in Kalar station (Researchers analysis depending on Climate data.of kalar metrological, 2014).

**Table 15.** The Average of The Monthly and Annual Evaporation (mm), (%), for Kalar Metrological Station (2000-2013).

Year	Spring			Summer			Autumn			Winter			Av.annual
	March	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2000	109	145	227	360	518	439	350	237	172	73.2	66.7	96.5	237
2001	120	224	332	394	472	521	372	299	153	55.9	70.4	99	259
2002	139	117	259	372	456	425	427	256	96.3	54.4	42.2	80.8	227
2003	126	170	329	461	501	457	335	253	145	82	63.3	88.1	251
2004	141	188	290	470	476	448	347	261	165	100	55.5	93	253
2005	131	164	227	443	449	421	229	276	164	109	84.7	77.4	237
2006	128	189	246	386	485	427	220	286	146	80.1	57.6	82.9	236
2007	134	163	232	412	456	466	352	252	162	82.1	50.4	64.8	236
2008	123	178	234	404	555	453	385	238	169	78.1	53.1	75.3	238
2009	145	219	290	426	514	490	394	286	148	95.8	83.7	107	266
2010	145	219	290	426	514	490	394	286	148	95.8	83.7	107	266
2011	91.3	187	247	247	512	492	392	290	153	59.3	66.2	76.1	235
2012	124	192	255	420	515	494	395	258	150	95.5	43.6	90.1	253
2013	10.6	203	286	510	516	513	458	299	116	69.4	69.2	83.3	269
Av. Monthly	8.9	13	19.4	29.2	34.99	33.4	22.6	19.3	10.6	5.7	4.5	6.2	3462
AVERAGE ANNUAL							247.2						
Av. Seasonal	13.8			32.4			18.8			5.5			

Researchers work depending on (General directorate of agriculture in Gernyan and eathering of Kalar station, 2014, Technical institute of Kalar 2014, Al Palani, 2010).

### 3.8. Climate Type of The Area

The purpose of the climatic classification is to gather those places which are the some in terms of climate in one region. Introduction and classification of each areas climate has its own significance because, by knowing the type of each areas climate. We imagine a picture of the in environmental situation of those places, because each areas

prevailing climate reflects in the area in terms of soil water resource, natural vegetation and humanitarian activities such as agriculture, industry, settlement and planning.

As a result, to indicate or specify the type of the study areas climate, we have depended on a known equation which is (Dimarton) equation. While doing that equation, the result was (7.2) for Kalar station. Thus, the areas climate is the type of semi-arid climate and it has poor grass according to Dimartons classification.

$$Y = \frac{P}{T+10}$$

P= annual average of rainfall (mm)

T= annual average of temperature ( $^{\circ}$ C)

Y= it appears on this basis less than five (5) of arid desert climate (bwh), 5-10 of semi-arid, 10-20 semi-humid, 20-30 humid, more than 30 extremely humid (Palani 2000).

## CHAPTER FOUR

### 4. ANALAYSIS OF SOIL FEATURE AND NATURAL VEGETATION

#### 4.1. Soil Properties

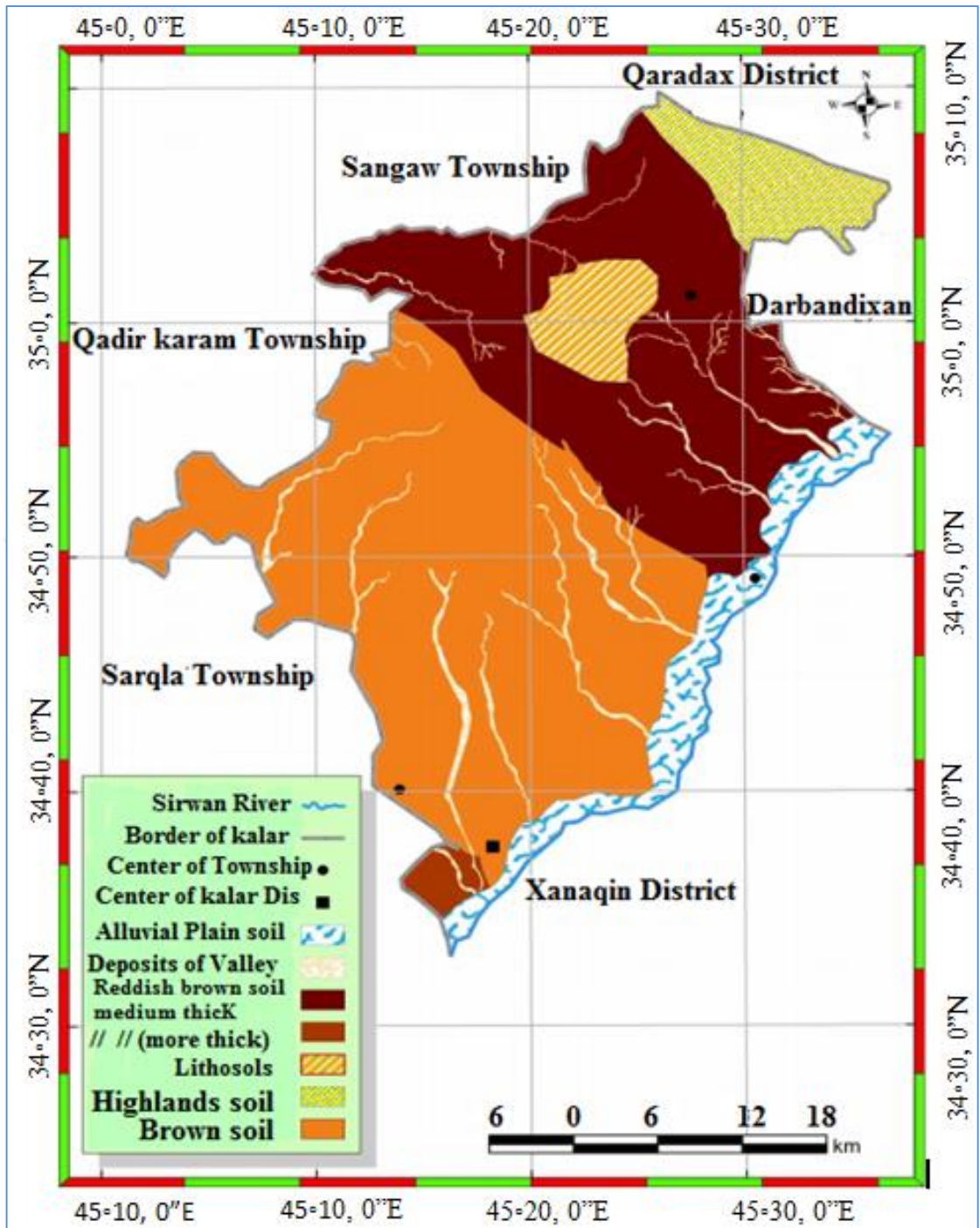
The object This Chapter is to analyses the natural features of soil and natural vegetation with the difference of their divisions from one place into another one in the study area. Each place has its own features and it is different from another place, this is because of having the environmental capacities in those areas. For this purpose, we analyses the features of soil and natural vegetation geographically in Kalar town. In the analysis, we use many different sources pictures from space and arc map 9.3.

Soil is a natural object which evolves continuously due to the weathering process and chemical and physical interaction (Salim, 2006). Soil is considered as one of the important natural elements and it has signification value which cannot be neglected. For instance in terms of natural vegetation, it is a centre for the extent of the plants root, absorption of organic matter and necessary minerals for their (Muhamed, 2015). Soil of Kalar town in terms of period and age dates back to Holocene period and the recent according to the classification of the Dutch scientist (Buringh, 1960).

This is a part from those areas which are formed from the old structure geologically dating back to Miocene period as well as they include (Fatha and injana) structures and the structures of the mountains soil such as Miqdady and Bay-Hassan formers which date back to Pliocene period (Buringh,1960).

##### 4.1.1. Soil Type of Kalar District

The soil of Kalar town is different according to the relief difference and the inclination of the earth's surface as well as the effect of erosion on the area and the type of its climate. According to the classification of the Dutch scientist (Buring, 1960). The soil of the area and the analysis of Kalar soil. It is divided into several types (Shakaly, 2016; Figure 20; Table 16)



**Figure 20.** Geographical classification of soil types in Kalar district according to Buringh classification (Buringh, 1960).

**Table 16.** Classification of Area and Percentage of Soil Types in Study Area

NO	Type of Soil	Area of study area Km <sup>2</sup>	Percentage of area (%) of study area
1	Alluvial plain soil	115.5	6.8
2	Valley soil	53.5	3.1
3	Reddish brown soil (medium thick)	539.6	31.9
4	Reddish brown soil (more thick)	21.1	1.2
5	Lithosols	62.6	3.7
6	Highlands soil	92.9	5.4
7	Brown soil	809.9	47.9
Total		1695	100%

Researcher's work depending on Buringh, 1960.

#### 4.1.1.1. Reddish –Brown Soil

This type of the soil of the area covers 33,1% of the study area and its area is (560,7 km<sup>2</sup>) which locates in the southern parts of brown soils. Its color is reddish-brown in the many parts of its soil. The amount of the organic matter in the soil is suitable for forming especially for winter crops. In addition, there are chalk and calcareous rocks below the soil. Because of the big texture of the soil, its run-off is good and this helps the collected water go. So, this soil is appropriate and easy for agriculture and it's good and easy for tillage, this soil is divided into two parts (Ali, 2014).

**The Thick and Medium Reddish-Brown Soil;** This soil can be seen in the southwest and southeast of the town as well as in the many parts of Kalar plains and Rizgary Township, what's more, this type of the soil covers a large area in Rizgary township and the centre of Kalar town with the amount of about (31,9 %) of the total area of Kalar town.

**The Deep Reddish- Brown Soil:** This type is seen in the part of the south of Kalar town in (Gizhakan) village that includes approximately (1, 3%) of the area of Kalar town (Mohammed, 2015)

#### **4.1.1.2. Brown Soil**

This type of soil covers about (47,9 %) of the study area, with the area of (809,9km<sup>2</sup>) it locates in the north of the thick layer reddish brown soil. Also it can be seen in the eminence plain, low lands, valleys and the hills. Its thickness is big in the ditches and valleys but the thickness is smaller and thinner in the eminence. In addition, its colure changes from brown to layer in the depth of (30-35 cm) but the up layer has organic matter with the amount of 1-2% ( Khasbak, 1973).

#### **4.1.1.3. Mountain Soil**

This type has an area of nearly (93,9km<sup>2</sup>) in the study area. In addition, this kind of soil is seen in bed-mountains, eminences and the slopes of the mountainous places in the northern and the northeastern parts such as the mountains of Zarda and Bara. In sheix Tawel township.

The area of this type of soil is not large, it is formed of calcareous rocks and gibbsite. This soil is considered as a fertile soil for agriculture especially for winter crops and summer vegetables (Table 16). What's more this soil can be divided into three parts.

1-Coarse Texture

2-Fine Texture

3-Moderate Texture (Hassan, 2006 and Soil Survey Staff, 1999).

The geographical division of soil types in Kalar district according to Buringhs Classification. This soil is not perfect and it has thin depth. It is formed of calcareous rock (Evan Guest, 1966). Because this soil is formed on gibbsite rock, limestone's, marl sandy stone and Eocene and Miocene period (Ameen 2008). Its amount of organic material is between 6,6 and 9,9 % (Mohammed, 2010). So it is inappropriate for growing those crops which depend on irrigation for their growth (Hassan, 2010).

#### **4.1.1.4. Valley Soil**

This type of soil covers approximately 1-3% of the total area of the studt district that its area is (53,5km<sup>2</sup>). This soil is formed through the water of the quarterly basins by the erosion of the valley floor and edges and then they settle at the bottom of the valleys. The granules of the soil are small in the up part, but the down part is mud and

sand, what's more, this soil is thin and shallow as well as it is suitable for agriculture (Palani, 2010).

#### **4.1.1.5. Alluvial Plain Soil**

This type of the soil of the study area extends from Sirwan River edge. It is created by the erosion. In addition this soil is friable and it is appropriate for agriculture because it has a good capacity for the absorption of water and the plants can easily produce roots. This soil also has organic matter; this soil has an area of about 115.4 km<sup>2</sup> of the area (Muhammad, 2015).

#### **4.1.2. Chemical Analysis of the Soil of Kalar District**

Soils are different on the earth's surface in terms of the chemical features. In a way from one field or region into another they are different from each other chemically. This difference happens because of those factors which affect their formation such as climate, relief, time, the plant cover, natural inclination of the earth's surface. Living creatures, ground water and sometimes human beings here. Briefly we discuss the most significant chemical and physical features of soil by using several samples of the soils randomly in the depth of 15-30 cm. In the soil of the study area and then by analyzing them chemically and physically (Table, 17).

**Table 17.** Chemical Feature of Soil in Kalar Town with Their Astronomical Place.

No	Location of the sample	Longitude	Latitude	Organismate %	EC	Potassium %	Phosphor %	Sodium %	Nitrogen %	PH
1	Bardasur	35:20:45°	38:38:34°	0,22	1	15	19	21	10,10	4,5
2	Tazade	0.8:25:45°	15:41:34°	0,23	2	14	17	17	10,10	5,6
3	Shahedan	24:38: 45°	37:19:34°	0,22	1	17	22	15	10,15	5,8
4	Said xalil	23:19: 45°	11:42:34°	0,21	1,9	15	19	18	10,22	7,5
5	Sherwana	11:19: 45°	26:36:34	0,22	1,5	19	19	21	10,23	7
6	Gazino	00:21: 45°	22:38:34	0,18	1,2	17	22	17	10,19	7,2
7	Shakal	11:13: 45°	11:40:34	0,22	1	21	18	18	10,24	7
8	Bastanaka	47:18:45	30:36:34	0,24	1,2	12	20	20	10,30	7
9	Shix tawel	34:27: 45°	4:1:34	0,28	1,3	13	18	14	10,17	6,5
10	Pebaz	9:30: 45°	14:49:34	0,22	1	18	23	21	10,13	7
11	Issay	47:27: 45°	5:46:34	0,27	1,5	17	21	22	10,20	7,9

Researcher's work depending on, General Directorate of Agriculture Garmiyan, 2014.

#### 4.1.2.1. Organic Matter of Soil

The percentage of the organic matter of the study areas soil is between 0,18-0,28% according to the result of the examples analysis and the highest one locates in the example number 33 in shix Tawel township. But the lowest one occurs in number 11 examples in the centre of Kalar district. In general, the density of this formation changes from one place to another in Kalar town soil. For instance, the highest density is in those areas which are at some time with the plant cover and rainfall such as in the north and mountainous places of the study area. However., the lowest density occurs in the southern parts due to the dry parts and lack of the plant cover of the area.

#### 4.1.2.2. Electrical conductivity

According to the result of the examples, analysis the degree of the electrical conductivity of the study area is between 1-2, 3. The highest degree is in the centre of Kalar district as it is shown in number 9 example. But the lowest one occurs in the examples 1, 5, 6, and 13 in Kalar town center. The examples 14,18,19 in Rizgary township, the examples 20, 25 in Shix tawel township as well as the example 36 in

Pebaz township. Moreover, the density of the structure in the soil of Kalar town occurs across the south of the study area with the northern parts of the area.

#### **4.1.2.3. Mineral Properties**

**Potassium;** The percentage of potassium in the soil of the study area between 11-33 % according to the result of the analysis of the examples. The highest rate is in the example 34 in Shex Tawel township whereas the lowest rate occurs in the example 4 in the center of Kalar town. However, generally, the density of these structures in the soil of Kalar town locates in the southeast and south of the study area.

**Phosphore;** The percentage of the phosphor in the soil of the study area according to the result of the analysis of the examples is between 14-24 %. The highest rate occurs in the example of number 9 in the centre of Kalar town and the example 13 in Pebaz township. But the lowest rate is in the examples 16 in Rizgary township. Number 24 in Shex Tawel township. However, in general the density of this structure in the soil of Kalar district occurs in the northeast and southeast of the study area (Al-Palani, 2010)

**Sodium:** The percentage of sodium in the soil of Kalar district according to the result of the analysis of the examples is between 13-23 %. The highest rate is in the example 21 in the Ahmed Qadir quarter whereas the lowest rate is in the example 25 in the centre of Shix Tawel township. However, the density of this structure in the soil of Kalar town generally occurs in the north and southeast of the study area.

**Nitrogen:** The percentage of nitrogen of the soil in Kalar is between 0,010-0,030 %. The highest rate is in the example 2 in the centre of Kalar town. But the lowest one occurs in the examples 1-3 in the centre of Kalar district and in the example 14 in Rizgary township. However generally the density of this structure in kalae soil occurs in the northeast and southeast of the study area (Mohammed, 2015).

**PH (Potential of Hydrogen):** The aim of PH of soil is the rate of the collection of the hydrogen ions in the mixture of water inside the soil. The scale of PH is used measure the degree of acidity of soil or the basicity of soil. The scale is between 1-14 degrees, and a PH of 7 is equilibrium. If a soil has a PH of less than 7, it is acid, but if a soil has a PH of more than 7, it will be a bas soil (Ahmed, 2013).

### 4.1.3. The Physical Analysis of Soil in Kalar district

To know and learn the physical features of soil in the study area and to show the map of those features, we could get several examples of the soil randomly in the depth of 15-30 cm in the various soils of the study area. After that, they area analysis physically according to the result of the laboratory by depending on the triangular of soil texture through the use of the program According to the result soil tests from (Muhammad .2015)

#### 4.1.3.1. Soil Texture and Structure

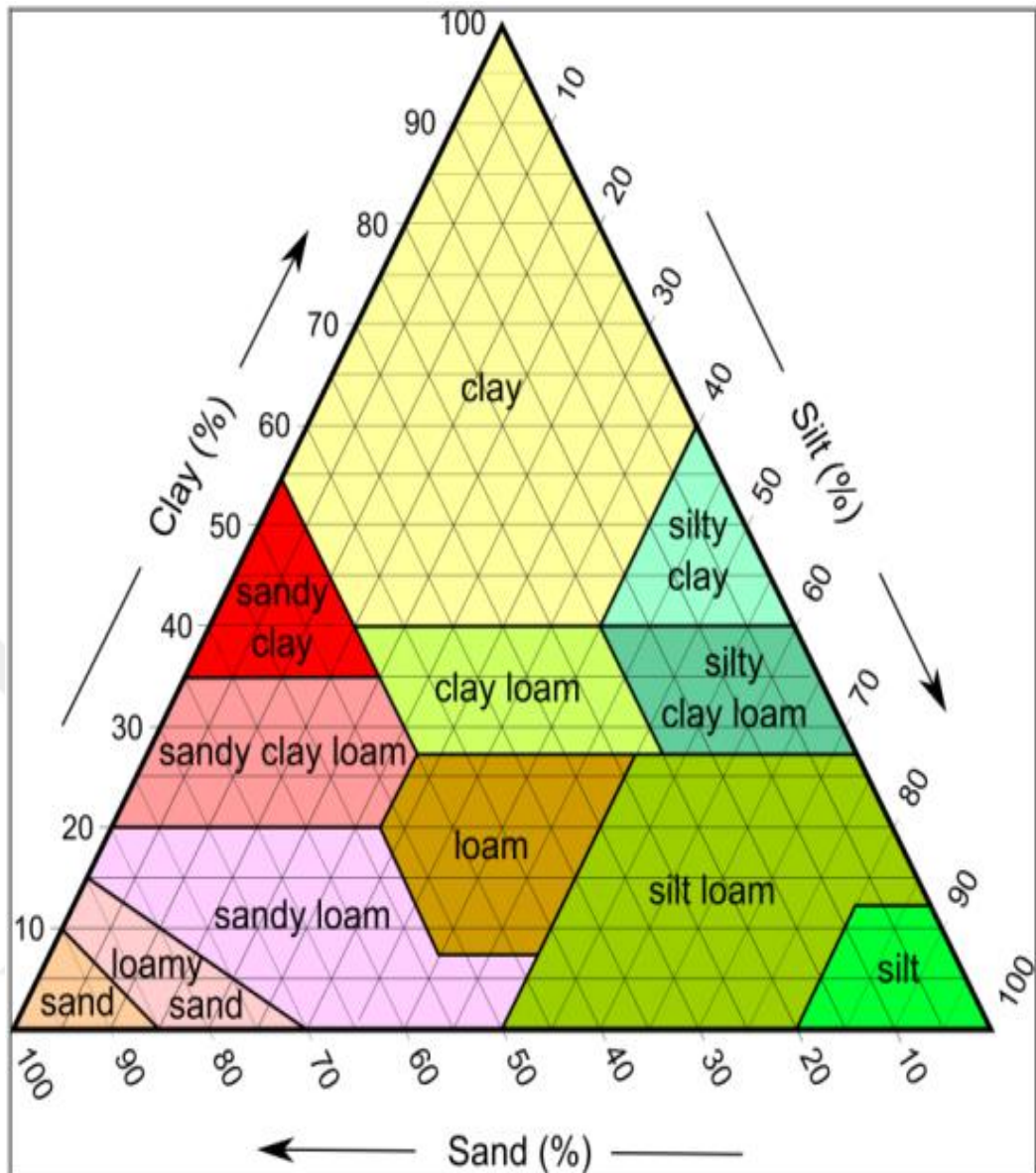
The term is used for the size of the soil granules and their organization, i.e. the collection of the soil granules (sand, clay, and salt). Soil texture means the shape or the method and organization of the soil as well as the way of matching of soil atoms as it is shown in (Figure 17). Soil texture is the division of the various size of soil granules. Because it is a clue about (coarse sand, moderate sand, small sand tiny sand) which their diameter is between 0,05-1 mm. They also participate in the soil texture largely which is 39,1 %.

The diameter of the size of silt granules is between 0,03-0,05 mm. Which they participate in the soil texture with the amount 44,8 %. In addition, the diameter of the size of clay granules is less than 0,003 mm and they participate in the amount 16,1 % (Qaraman, 2004; Figure 21 ,Tabe 18).

**Table 18.** Types of Soil Texture According to Granules Size and Percentage.

Type of comb	The size of grain	Percentage
Sand is too coarse	1-2	2,3
Sand course	1-0.5	6.7
Moderate sand	0.5-0.25	8.2
Tiny sand	0.25-0.10	9.4
Sand is too tiny	0.10-0.05	12.5
Silt	0.05-0,002	44.8
Clay	Less than 0.002	16.1

(Al-Mashhadani, 2006)



**Figure 21.** Diagram of comb soil (www.google.com).

#### 4.1.4. The Most Important Types of Soil Texture

**Clay:** The percentage of clay structure in the study area according to the result of the analysis of the examples is between 40-75 %. The highest amount occurs in the example 23 in the Shex Tawel. But the lowest amount in the example 28 in the Pebaz township. However, generally, the density of this structure in the soil of Kalar soil locates in the east and south of the study area.

**Sand:** The percentage of sand structure in the soil of the study area is between 34-50 %. The highest rate occurs in the examples 2-7 in the areas Bastana and Said-khalil of the centre of Kalar town. In the example 21 in Sheix Tawel township as well as

in the examples 28-33. In the villages Qula sutaw and Ahmed qadir in Pebaz township. But the lowest rate is in the example 34 in the centre of Shex Tawel township. However, the density of this structure in the soil of Kalar district occurs in the north, east and southeast of the study area.

**Silt:** The percentage of silt in the study area is between 5-12 % according to the result of the analysis of the examples. The highest rate is in the example 3 in the centre of Kalar town and the lowest rate occurs in the examples 2, 4 and 10. In the quarters (Bastana, Andaziaran, and Sherwana) of the centre of Kalar district. The lowest rate also locates in the example 14 in the center of Rizgary township. In the examples 21, 25 in the villages Gori Asp and Kela shen in Shix tawel townships as well as in the example 31-37 in Qula sutaw and Ahmed Qadir areas in Pebaz township. However, the density of these structures occurs across the north of the study area (Table 19).

**Table 19.** Physical Properties of Some Examples Soil of The Study Area

N0	Location of the Sample	Longitude	Latitude	Silt %	Sand %	Clay %	Soil Moisture %	Texture %
1	Bardasur	35:20:45°	38:38:34	7	43	50	2,1	Clay
2	Tazade	0.8:25:45°	15:41:34°	20	50	30	-	A mixture mud alluvial
3	Shahedan	24:38: 45°	37:19:34°	7	40	53	2,6	Sand
4	Said Xalil	23:19: 45°	11:42:34°	6	47	47	2,9	Mud alluvial
5	Sherwana	11:19: 45°	26:36:34	5	45	50	2,6	Mud alluvial
6	Gazino	00.21: 45°	22:38:34	12	43	45	2,6	Clay stone
7	Shakal	11:13: 45°	11:40:34	5	45	50	2,8	Mud alluvial
8	Tilako	00:12: 45°	35:50:34	10	45	45	2,4	Mud alluvial
9	Shix Tawel	34:27: 45°	4:1:34	10	38	52	2,5	Clay
10	Pebaz	9:30: 45°	14:49:34	10	35	55	2,7	Clay
11	Ahmed Qadir	11:31: 45°	0:50:34	5	50	45	2,4	Mud alluvial
12	Issay	47:27: 45°	5:46:34	8	40	52	1,9	Clay

Reference, researcher depending on, (Al- palani, 2010. and Muhamed, 2015).

**Soil Moisture:** Soil moisture in any area depends on the climate condition, temperature, air humidity. The speed of the wind and the plant cover, the soil moisture is also related to the soil capacity to preserve soil moisture due to the soil texture and the porous degree of the soil. Briefly, we can specify the degree of soil moisture for the

various textures of soil according to the percentage of the water in comparison to the gravity of the soil (Table 20).

The percentage of the soil moisture structure in the study area is between 1.9, 3.9 % according to the result of the analysis of the examples. The highest rate occurs in the examples 6 in Saidb Khalil in Kalar town whereas the lowest rate occurs in the example 29 in Essay village in Pebaz township. However, generally, the density of this structure in the soil of Kalar town locates across the northwest and in the middle of the study area.

**Table 20.** The Circumstance of Moisture in The Earth.

Rate of wetness	Percentage weight of the water in a different soil			
	Sand	Silt	Clay	Swampy
Soil moisture	5-10	15-22	20-30	30-50
Soil dry	2-5	8-15	12-20	20-30
Soil is too dry	0-2	2-4	20-12	12-20

(Ameen, 2014).

#### 4.2. The Natural Vegetation of the Study Area

The natural vegetation of the study area is under the effect of the natural factors especially the climate factors. Because climate is one of those reasons which has the main role in the division of the natural vegetation on earth's surface. Other natural factors which have effects on the natural vegetation are soil that participates in the growth of the plants. In addition, the rainfall as the main element has the role in the intensity and type of the vegetation in any place on the Earth's surface (Sharaf, 1961).

Due to the various shapes of the Earth's surface of the study area in terms of relief of the valleys, plains and mountains and the climate of these places as well as because of the humanitarian factors. The natural vegetation has been various in terms of the geographical division. The natural vegetation in the study area is divided into two main types.

#### 4.2.1. The Steppes

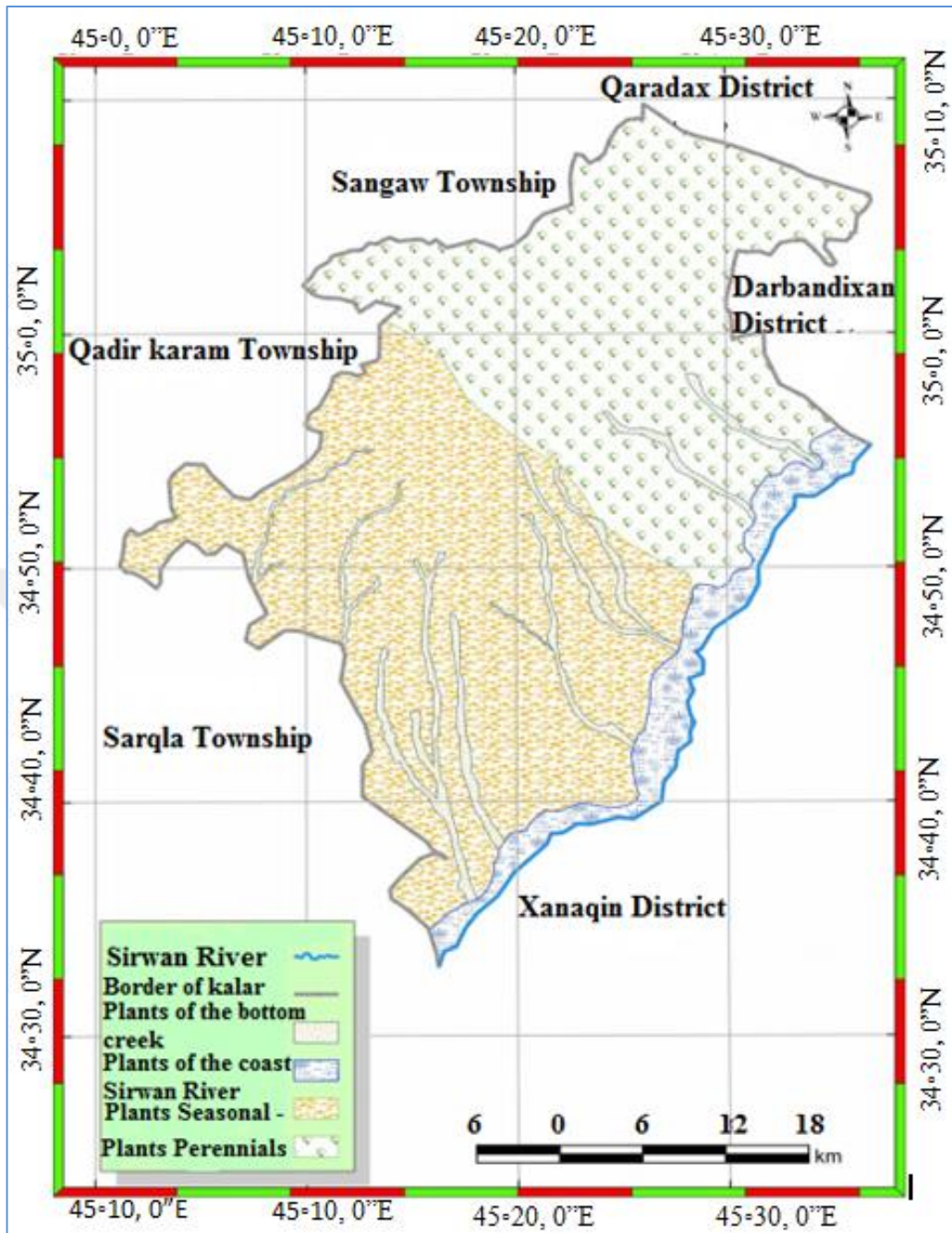
This types of the natural vegetation in the study area covers those places which their natural conditions and climate particular temperature. The luck of rainfall and relative humidity are not helpful in their growth. The plants of the study area are affected by these conditions because the study area locates between the humid region in the north and the semi-arid climate region. Moreover, if we go to northern parts, we can see that the vegetation grows intensively because of the high rainfall and the height of the area (Al- Palani, 2010).

In addition, the northern of the study area occur between the high lines of 300-500 m at sea level. However, the more we go towards the southern parts of the area, the thinner and shorter the natural plants appear due to the lack of rainfall and high temperature (figure 17). Therefore, these parts of the area have obtained the features of the desert particularly in those areas which locate between 200-300m high at sea level (Talib, 1998).

The steppes are very important as they form most of the study area. What's more, the plants of the steppe prevents the soil erosion. The steppe vegetation has economic advantages because some of the plants and weeds are beneficial for food and medicine. (Figure 22, 23).



**Figure 22.** The plants cane in the study area.



**Figure 23.** The Kinds of Plants Natural of Kalar district. Researchers work depending on (Muhammad, 1015)

**There are two types of steppe in the area of Kalar district. Seasonal Weeds and grass:** Seasonal weeds are those plants which do not live for a year but they live less than a year in a way they grow only in the spring or winter and then they go dry at the end of the some season (Abu-Samu, 2005).

The seasonal weeds and grass run dry because of the high temperature, the lack of rainfall and the increasing period of the solar radiation in Cadent. Which often causes the grass and plants to be dry and burnt such as the spring grass and weeds for example thorn, artichoke, spinal plant, etc ( Muhammad, 2015).

**The long –lived plants:** This type includes those weeds which can resist the high temperature. The dryness and the lack of the available water in the area. These plants preserve water in their leaves and their roots grow under the depth of the soil such as those plants which grow in the eminences of the area like pine and long plants.

In general, this type of vegetation loses their leaves at the beginning of the rainfall season in autumn, and then they grow again in the spring (Figure 19) (Al-Palani, 2010).

#### **4.2.2. The Plants Which Grow in the Edges of Sirwan River**

These plants grow in and near the edges of the basins, streams and Sirwan river. The plants in these areas are intensive because of the continuous source of water. The plants cover of this area as a narrow belt surrounds the edges of Sirwan River and the basins of the study area such as the basins of Qalla-Topzan and Quli-Jan) which they depend on the ground water in the summer. So, these plants do not need too much rain due to the continuous source of water (AL-Palani, 2010; Figure, 24, 25).



**Figure 24.** Plants of Acacia near the village of Qasim Aaga.



**Figure 25.** Plants River banks on the banks of study.

## CHAPTER FIVE

### 5. ANALYSIS OF HYDROLOGICAL FEATURES IN KALAR DISTRICT

#### 5.1. Kalars Hydrological Features

The object of this chapter is to analyze the hydrological features of Kalar town. In addition, another object of the chapter is to know and analysis the features of the depth and product of the springs and the channels as well as to analyses the chemical features of the well water and then to evaluate their use according to the Iraqi. Scale and world health organization scale for the purpose of finding out the type and density of the dirty matters inside the water and the extent of the usage of the well water.

Nowadays, water resource has more advantages this is due to those natural disasters which confront the environment such as climate change which causes the luck of rainfall and high temperature in some districts. As a result, it affects the water equilibrium and climate balance as well as it causes drought which is the continuous threat to the arid and semi-arid areas. Thus, the object of this chapter is to analyze the phase and hydrological features in Kalar district such as surface water and groundwater.

##### 5.1.1. Surface Run-Off

The surface run-off or the surface water in the study area generally includes those types of water which run off the Earth's surface either continuously such as the rivers Sirwan and Said-khalil or seasonally and intermittently like the basin (Al-Palani, 2009) as well as the bays as it is shown in the (Figure 21). The amount of the run-off which is expect to flow into the watershed or the river basins annually. Because there is no hydrological station in the study area. We have to depend on the mathematical estimation and we got to benefit from the weathering station of Kalar town and its surrounding areas as well as we used berkls equation which depends on the climate measuring the annual amount of the run-off of the river basin in the following ways (Ahmed, 2002, Figure 26).

$$R = (CIS)^{1/2} (W/L)^{0.45}$$

(R) Is the volume of the expect and annual run-off (billion/m<sup>3</sup>)

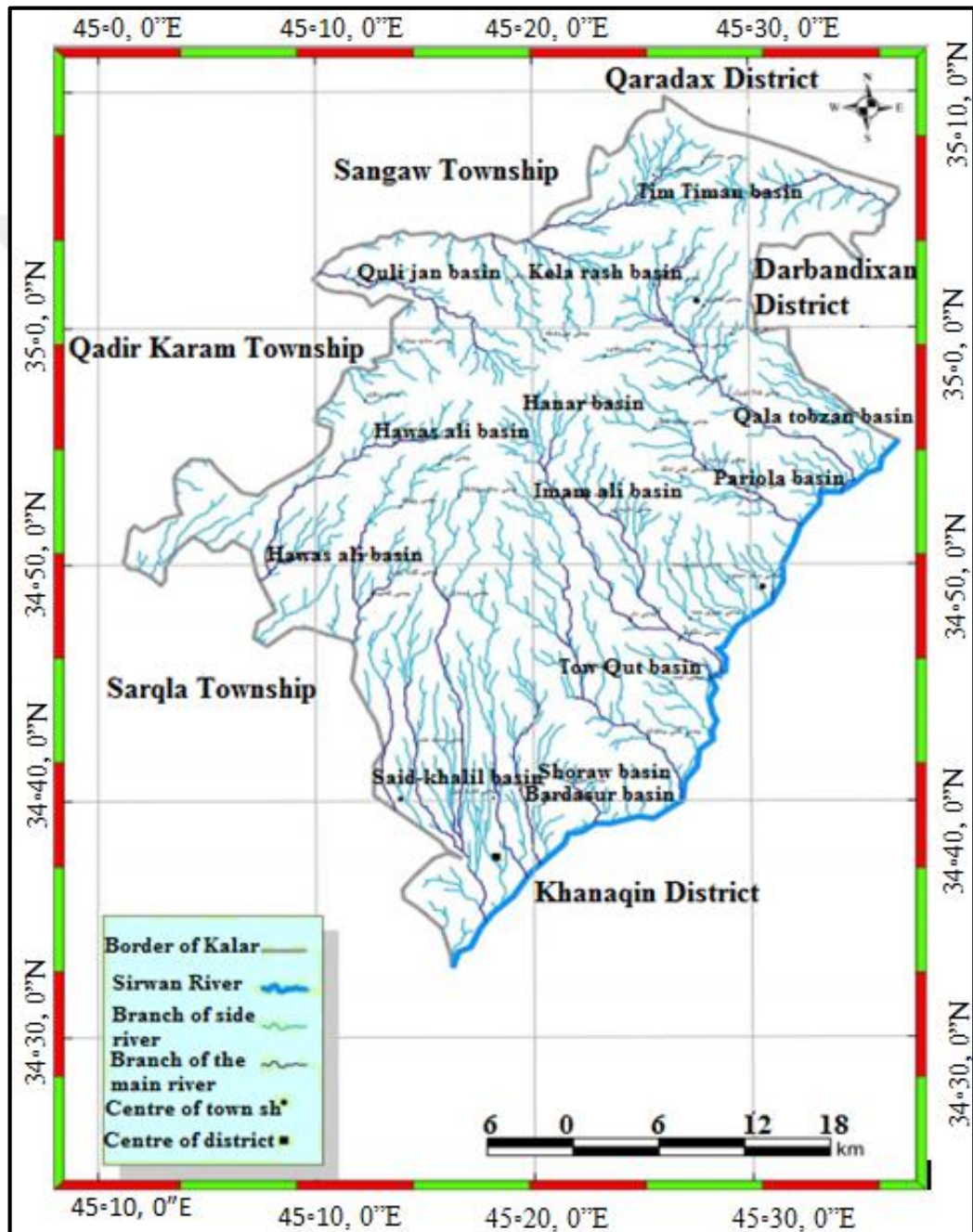
(C) 1/3 stable coefficient

$I$  = is the volume of the annual expected run-off (billion /m<sup>3</sup>), (multiplying the annual amount of the rainfall (mm) and the area of the basins and then dividing its result by 1000.000.

$(S)$  = The average of the inclination (m/km) the difference between its highest and lowest points then dividing it by the basins.

$W$  = The width of the basin

$L$  = The length of the basin from its source to its mouth (Mohammed, 2015).



**Figure 26.** The surface Runoff in Kalar district . Researchers work depending on (Al-palani.2010)

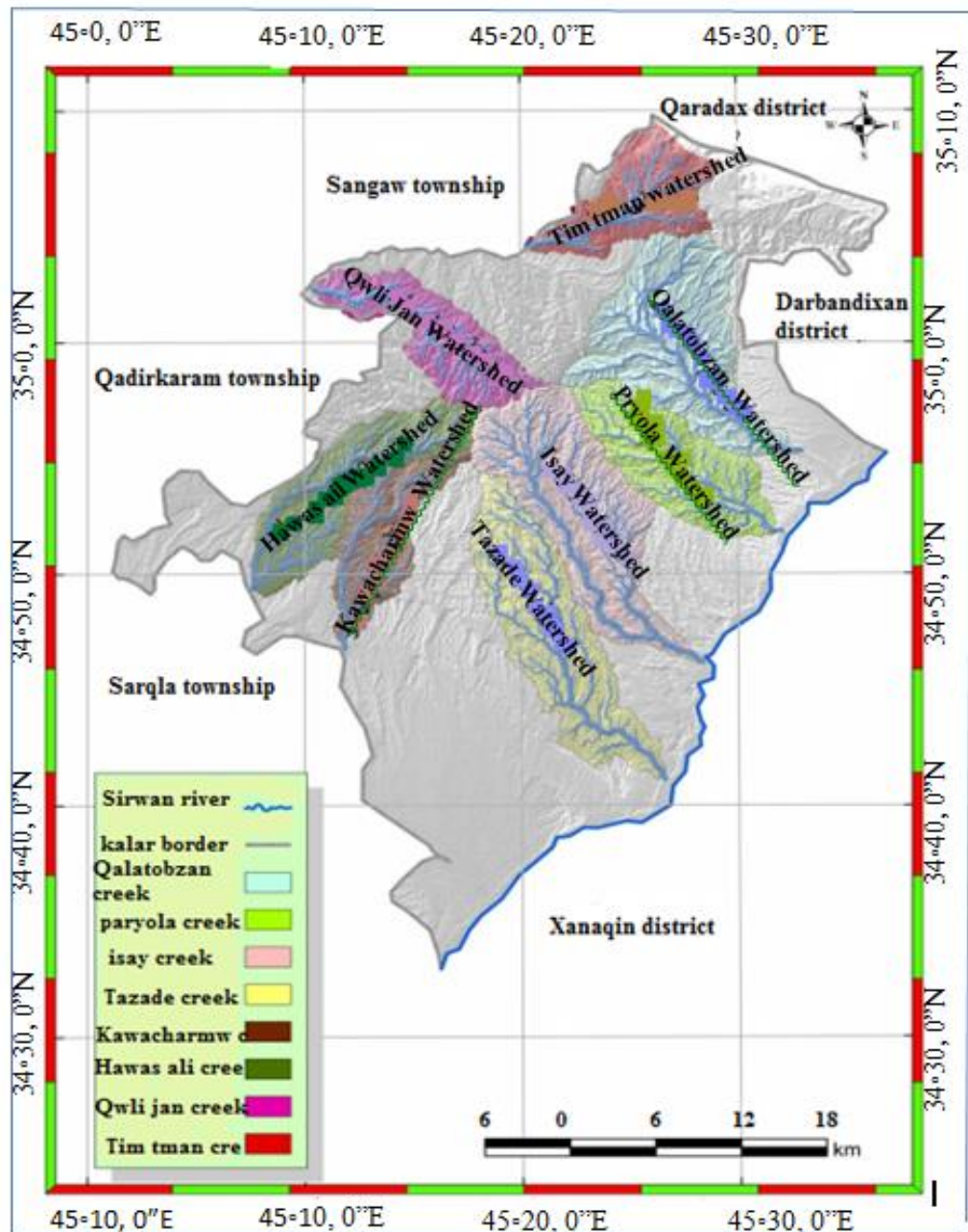
**The River Basins:** The basins are areas of land that are lower at the centre than at the edges and from them. Water runs down into a river. The basins are smaller and fewer than the rivers in terms of size, depth and the amount of water. As it was mentioned, the study area has some basins that some of them are seasonal and some are permanent. The reason for majority as a result, these basins have water in the middle and the end of autumn but they go dry in the summer.

What's more the volume and water of these basins change annually and seasonally according to the rainfall amount in Kalar district. There are the basins of Goban and Qara- Chil which comes from Sarqala village and then flow into the river Sirwan near Grda- Gozina village. There is also the essay basin which comes down from the Dari-Khla floor after passing Zhalay Haji Qadir. Village, it flows off the river Sirwan. What's more, there are other basins such as Chama bismila, Tazade and Shorawa (Ali, 2014). Tazde basin locates in the north-east of a study area and it is down Haji Abdul- Karim village. In addition, Tazade basin, which is more than 650 m above sea level, extends from near to the gut village, then it passes to gut basin. After that, it flows into the river Sirwan down Tazade village where it is 239 m above sea level (Table 21; Figure. 27).

**Table 21.** Area of The Length and Centre Breadth of Watershed of Kalar District.

Name of Creeck	Area (km <sup>2</sup> )	Rate of area %	Length (km <sup>2</sup> )	Central breadth (km <sup>2</sup> )
Tazade	128,94	7,593	28,23	5,9
Qala Tobzan	143,22	8,434	20,26	7,65
Paryola	86,51	5,0952	18,26	2,9
Kawa charmw	65,12	3,832	17,43	3,24
Hawas ali	89,75	5,275	21,21	4,53
Qwli jan	72,57	4,274	17,94	4,1
Tim tman	71,5	4,184	15,45	5,41
Isay	143,28	8,438	25,43	5,35

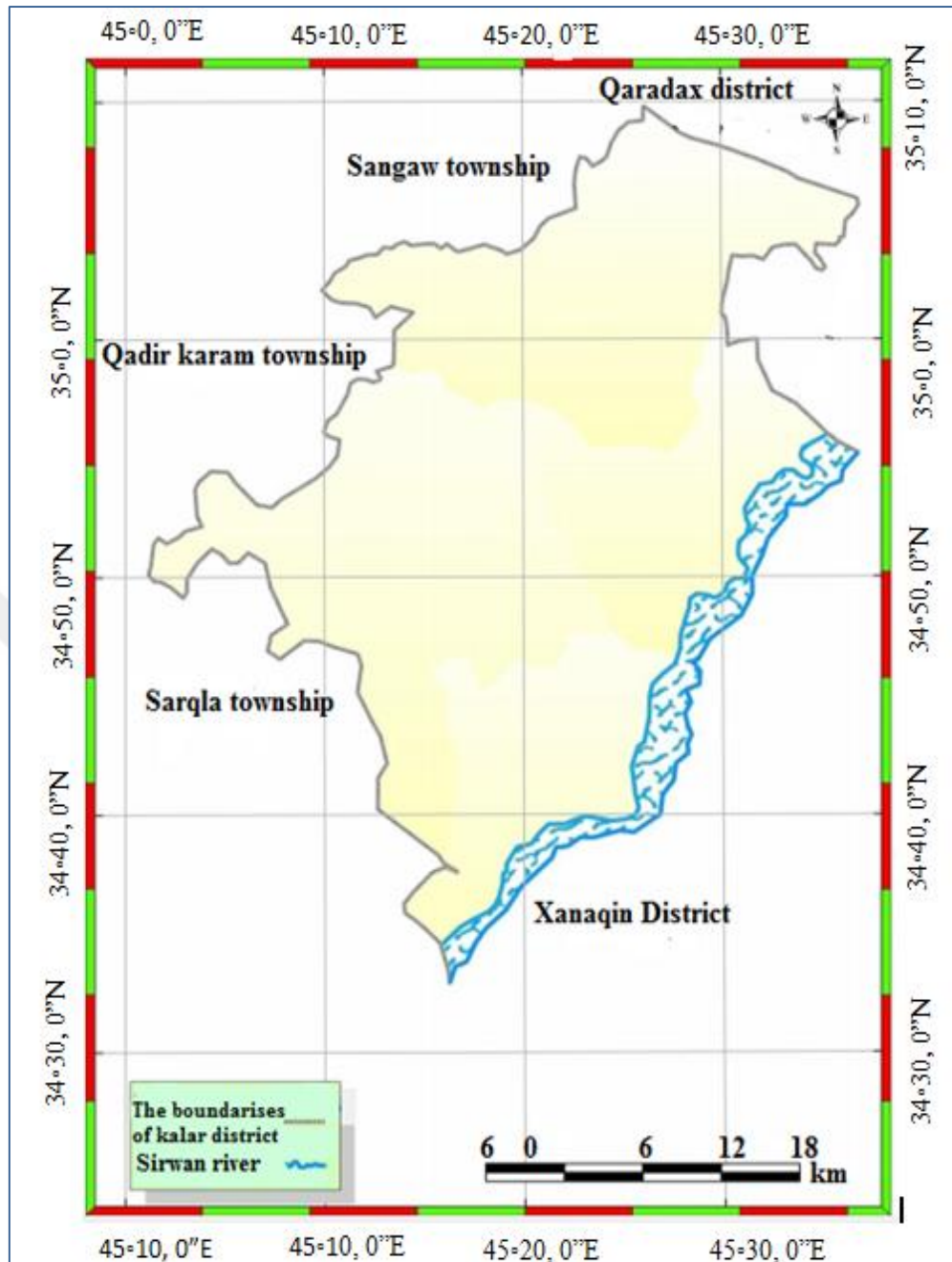
(Muhammed, 2015)



**Figure 27.** The basic watersheds in Kalar District (DEM-30 MT).

#### 5.1.1.1. The River Sirwan

This river is one of the main sources of the surface water in the area. This river passes through the east of Kalar town and it separates Kalar from Xanaqin district as a natural border. In addition, the river Sirwan flows from the eminences of the west of Iran and east of Iraq (Figure 28).



**Figure 28.** The location of the Sirwan River in Kalar .researchers work depending on (Muhammad ,2015).

(Palani, 2009). What's more, this river passes through the mountains of hawraman and kuhi- shunned, near Lawaran village in a suliymani province and then it flows into Iraq Kurdistan's land in the southeast (Al-Palani 2011).

The mountain is of listen and sulaimani province is the main source of providing water of this river. Moreover, the length of the river Sirwan is 386 km and the area of its basin is about 318 km<sup>2</sup> (Sharif, 1987). After that, the water of this river reaches the

Darbandixan town where the Barbadixan dam has been built on this river Figure 29.



**Figure 29.** Darbandixan dam in Darbandixan district.

After passing the town, it reaches the area and this river has brought considerable industrial and agriculture benefits particularly in the summer.

The amount of water which passes through this river is not stable; the highest amount was in 2010 that reached 237.55 million m<sup>3</sup>. And the lowest annual amount was in 2014 which reached 149.65 million m<sup>3</sup>. The amount of the water which passes through this river increases in October until it reaches the highest amount in March which is 396.54 million m<sup>3</sup> and this is due to the run-full and snow melting in this period. However, the amount of the passing water decrees in June until it reaches the lowest amount in September which is 51.78 million m<sup>3</sup>. Monthly, this is because of the lack of run-full and increasing evaporation as well as its usage in this period. (Water resource phase in Garmiyān Administration, 2014; Table 22; Figure 30).

**Table 22.** The Length of The Sirwan River and Proportion of The Kalar District

Name of River	Length in the Region/KM	The area of basin in region/Km <sup>2</sup>	Total annual water imports Billion(m <sup>3</sup> )	Length in the study area/km	The rate of length in the study area (%)
Sirwan	386	31896	5,36	90.34	23,4

(Saeed, 2013).



**Figure 30.** The location of sirwan River in the study area ([www.google.com](http://www.google.com))

**Table 23.** Average Monthly and Annual Water Flow of Sirwan River ( $\text{m}^3 / \text{s}$ ) of The Hydrological Measurement Station of Derbandikhan for The Period (1970-2006).

Total Annual	163,6
January	160,4
February	226,8
March	400,8
April	398
May	221,9
June	101,2
July	65,3
August	55,4
September	53,7
October	60
November	93
December	124,7

(Al-Palani, 2011; Muhammad, 2015).

#### 5.1.1.2. The River Said-Khalil

This river occurs in the southern part of the study area, 11 km off the Centre of Kalar town and it is more than 350 m high it sea level. What's more, this rivers source is the springs of the villages (Said- Khalil Khalifa, Said Khalili Faqe Mustafa) and Said Khalil Darwesh the amount of water which passes through the river changes from one

season into another. This change is due to the different amount of run-full in the area but generally the amount of the passing water through this river is 15 L/S<sup>3</sup> which is useful for agriculture, keeping pets and other needs. (Ministry of Agriculture, 2013).

### **5.1.1.3. The Valley Rivers**

In generally, valley is an area of lower land between two lines of hills or mountains, usually with a river flowing through it. Probably some valley floors are not near the sea level. There are some valleys which are thousands of meters higher than the sea level there as there are valleys which are lower than that level (Qadir, 2013).

In the study area, there are many valley rivers, and some of them are seasonal and some are permanent, which depending the amount of rainfall in the area. Moreover, the sum total of water which passes through these valleys changes from one season or year into another one. This is due to the different amount of rainfall in the district. In addition, the most important valley rivers of the study area are these (Qalla- Topzan, Parewla, Essay, Taza de, Kawacharmu, Qulijan, Tim Timan).

After the analysis of laboratory for the water of some of these valley rivers such as in Pungal and Said- Khalil, it appeared that this water of these valleys is beneficial for various usages. Because there is a standard rate of melted salt and ph in the water which is appropriate with the world standard as well as the Iraqi ones (Palani 2010).

### **5.1.2. Underground water**

Groundwater is the water percent beneath Earth's surface in soil pore spaces and in the fractures of rock formations (Kakay, 2003). Groundwater is one of the main water resources in the study area. Groundwater has brought great benefits for the population of the study area in their daily necessities during the four seasons of the year. Especially during the summer when the rain stops and the temperature rises and then some of the basins run dry. Sometimes in some years, the phenomenon of drought appears. Moreover, the water table of the study area is unstable and changes from one year and one season into another year and season due to the difference of rainfall amount from one year to another. What's more, there are two types of groundwater and one of them is called intercepted groundwater, which dates back to millions of years ago and it is also known as unrepeatable groundwater. There is no hydrological cycle effect on this type of groundwater. The second type of ground water is known as renewed ground

water which renews annually due to the rain water. Therefore, the amount of water of this type depends on the annual average of rainfall as well as on the topographical and geological soil of the area (Palani 2010).

#### 5.1.2.1. Wells

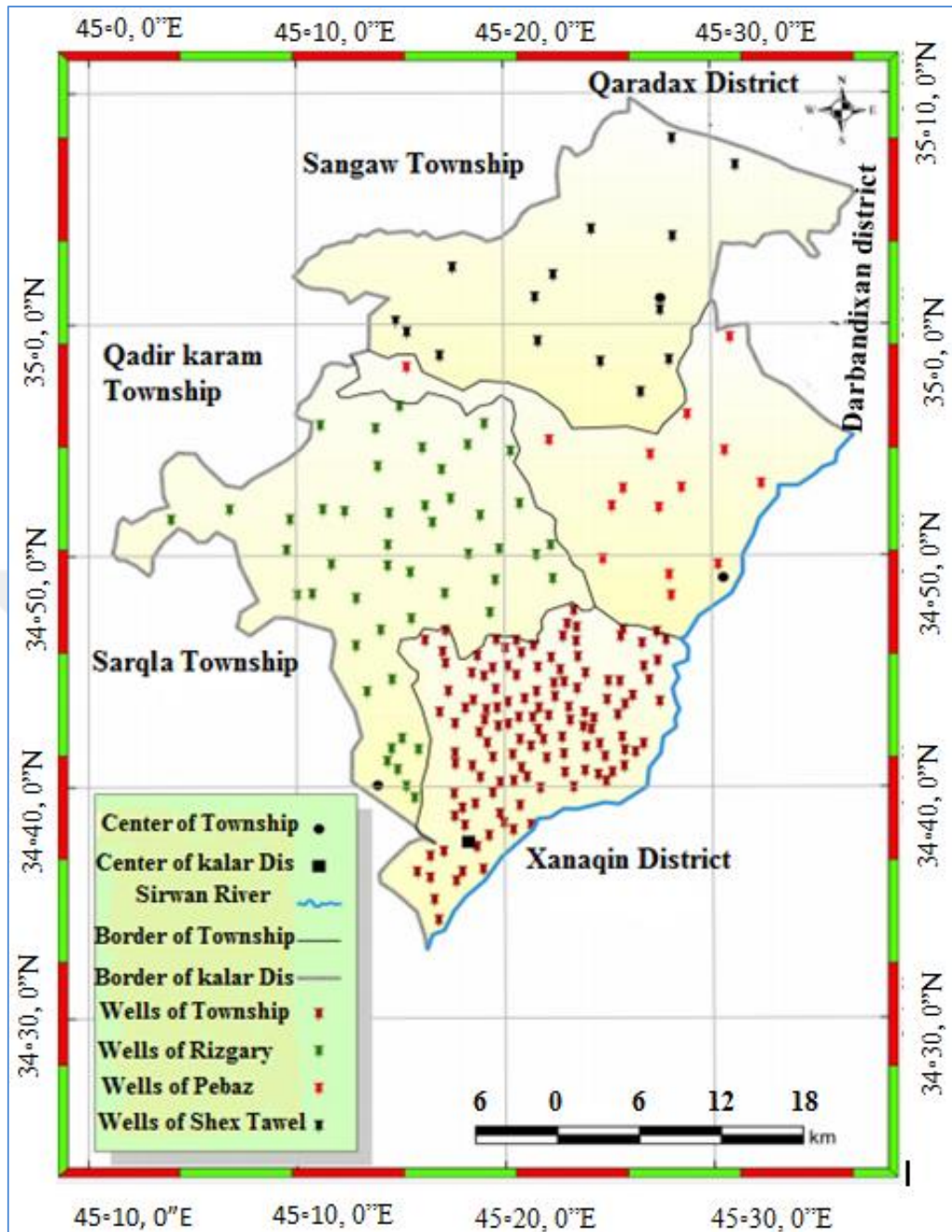
A well is an excavation or structure created in the ground by digging or other means such as drilling and driving. The depth of the wells starts from one meter until it reaches the water table (Talabani, 2008 ,Figure 31).

There are two main types of water wells, the first one is simple water well and its water is drawn by a device or by a pump or buckets, The second one is called artesian well which is a well from which the water is forced up out of the ground by natural pressure. In addition, the artesian wells are more common than other ways of drawing or extracting water in the study area. Apart from the various necessities, the summer agriculture of the area depends on the artesian well largely

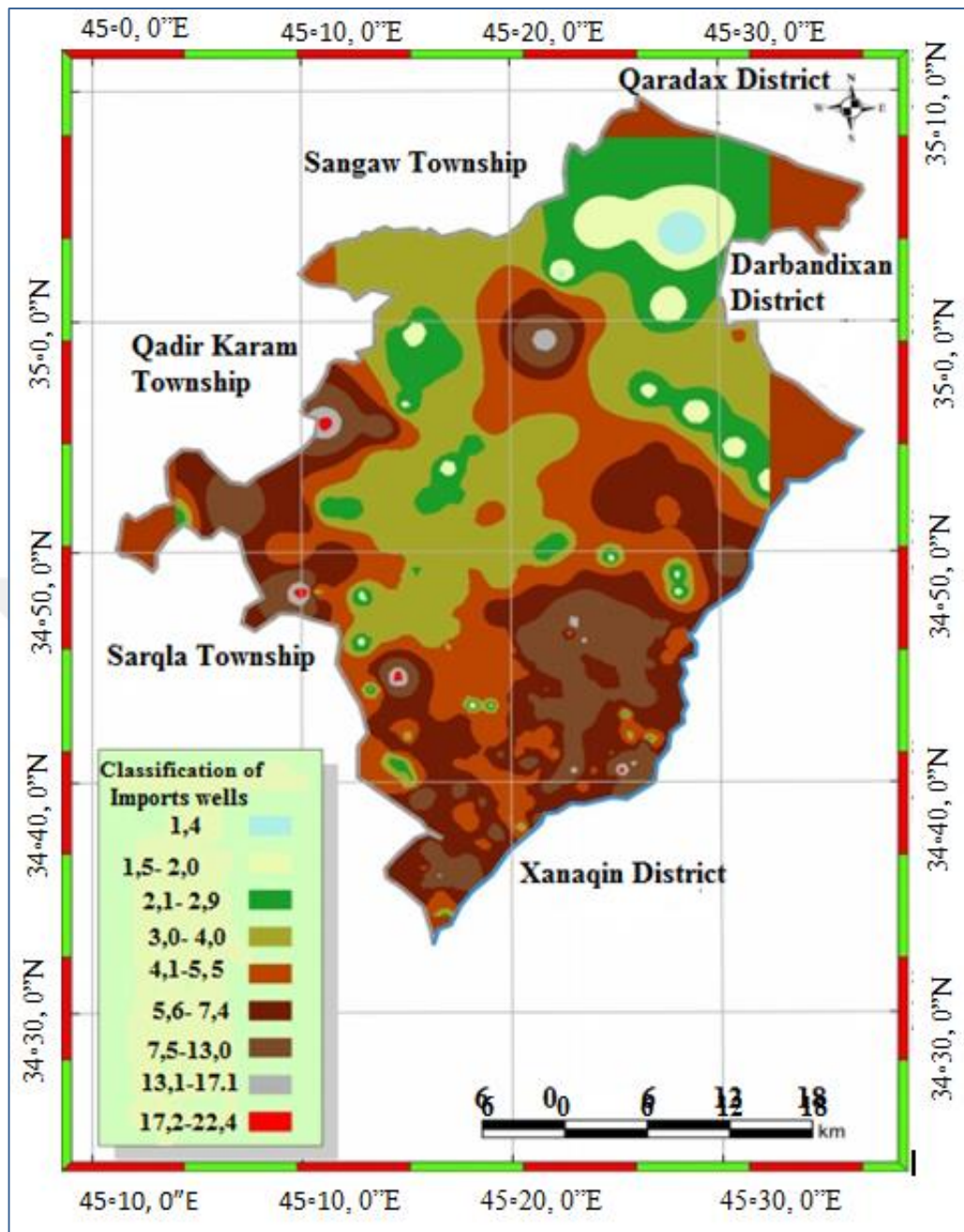


**Figure 31.** The wells (water wells) in the study area.

In the study area, there are 203 wells which their depth is between 12 metres and 310 metres. However, the deepest well occurs in Naze village between the longitude of 6:14:45 and the latitude of 36:38:34 and its depth is 310 m (Table 24; Mohammed, 2015). In generally, majority of the wells locates in the centre of Kalar town (Talib, 2005; Figure 32, 33).



**Figure 32.** Classification Geography of wells in Kalar district, researcher's work depending on Geological Map of Khanaqin Area, Scale 1:250.000 for the year 2003.



**Figure 33.** The amount of crops wells in Kalar district (Researcher's work depending on, Geological Map of Khanaqin Area, Scale 1:250000 for the year 2003).

**Table 24.** Properties of Wells in Kalar District.

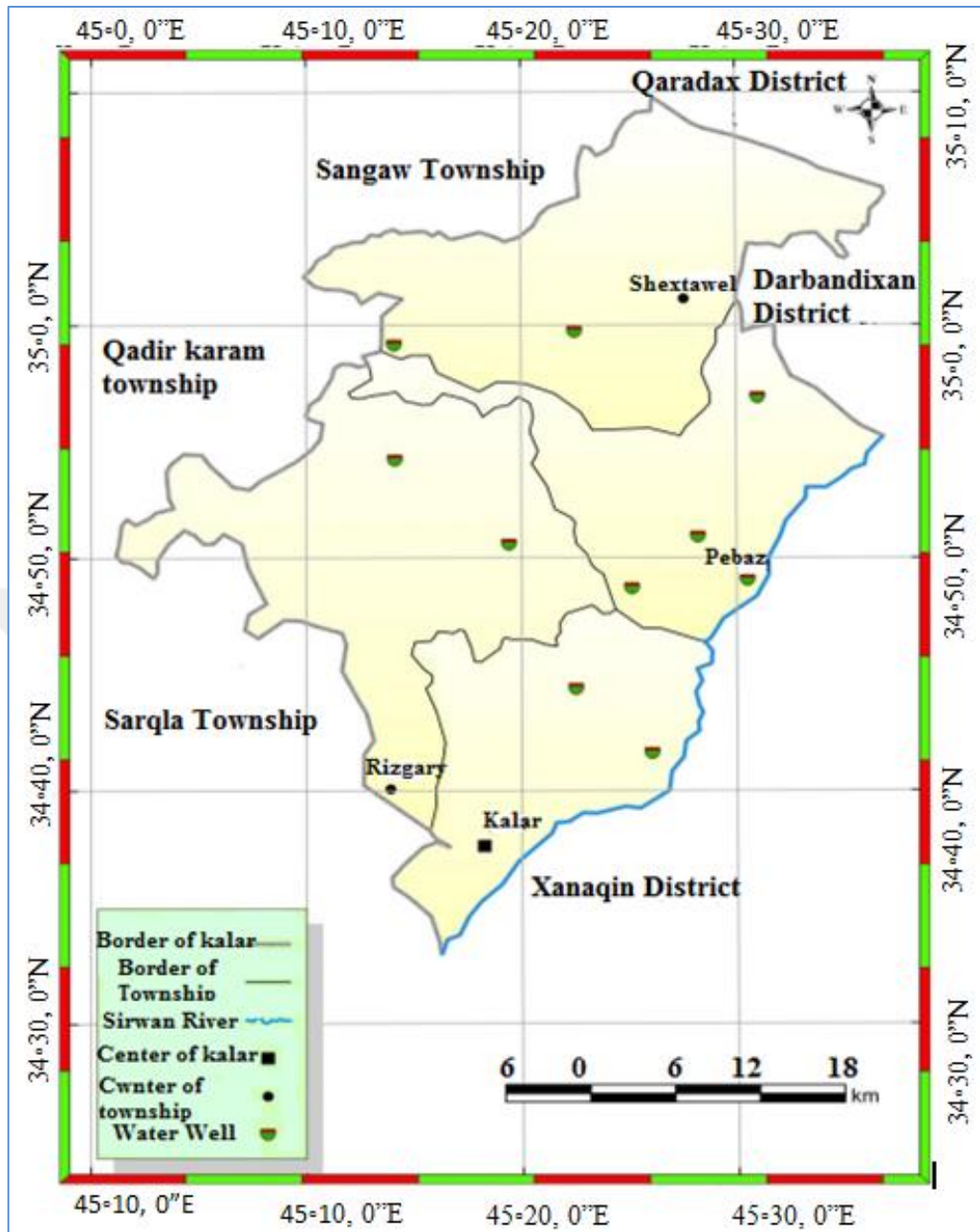
Unit Administrative	Area km <sup>2</sup>	Deep Wells (m)	Number of wells	Able to import (L /sec)
Center of District	323.4	12-182	124	0.5-25.8
Rizgary township	529.2	54-310	49	1.2-11.6
Shex Tawel Township	346.3	62-200	16	1.2-22.4
Pebaz Township	496.1	67-160	14	0.6-16.4

(Mohammed, 2015)

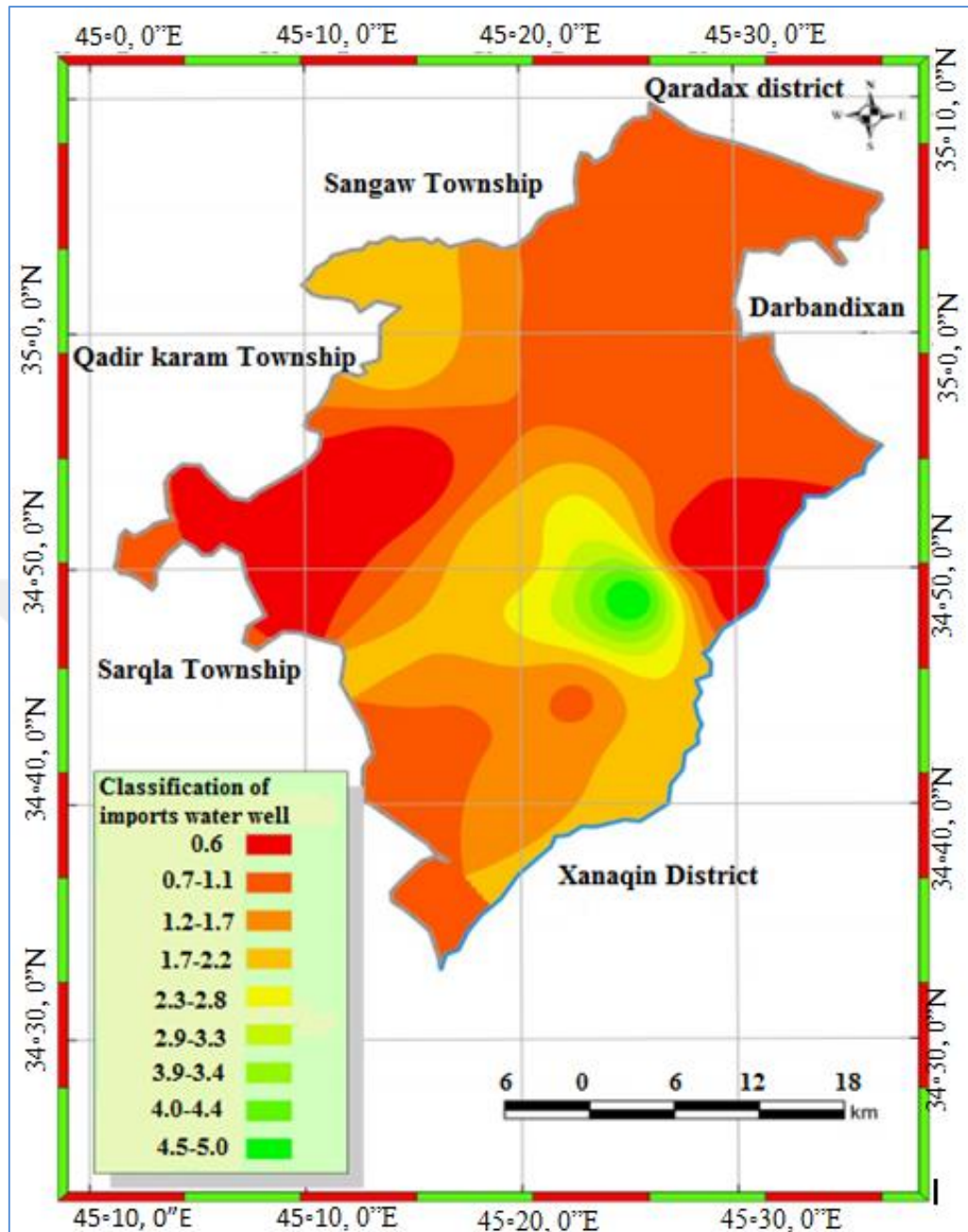
### 5.1.2.2. The Channels or Water Well

A channel is one of the ways to draw the ground water. The population of the study area has been using the channel since the past for the purpose of using it for different fields and necessities a channel is a group of sequential wells and, each of the wells is less than 20 m for from the other one. In addition, the depth of each well is less than the following one.

The wells are connected together by a shaft, and their length probably reaches several kilometers (Ghafoor, 2012; Figure 34). Probably the amount of water of some channels reaches 300-315 a thousand gallons in a day. (Khasbak, 1973). In general, the channels have reduced largely because some of them are filed up with soil or rocks and some of them ran dry. Some of the channels also need to be cleaned continuously and it costs too much money. The channel becomes dirty soon because the water of the channel is near the water table. There are nine channels in the study area and their length is between 50-3600 m and their depth is different according to the geological structure and relief of the area. Moreover, the amount of the channel water increases and decreases according to the seasons of the year particularly in winter and spring it increases and then it decreases in summer (Ministry of Agriculture and Water Resource, 2015; Figure 35).



**Figure 34.** Classification Geography of Water Well in Kalar district (Researcher's work depending on, Geological Map of Khanaqin Area, Scale 1:2500.00 for the year 2003).



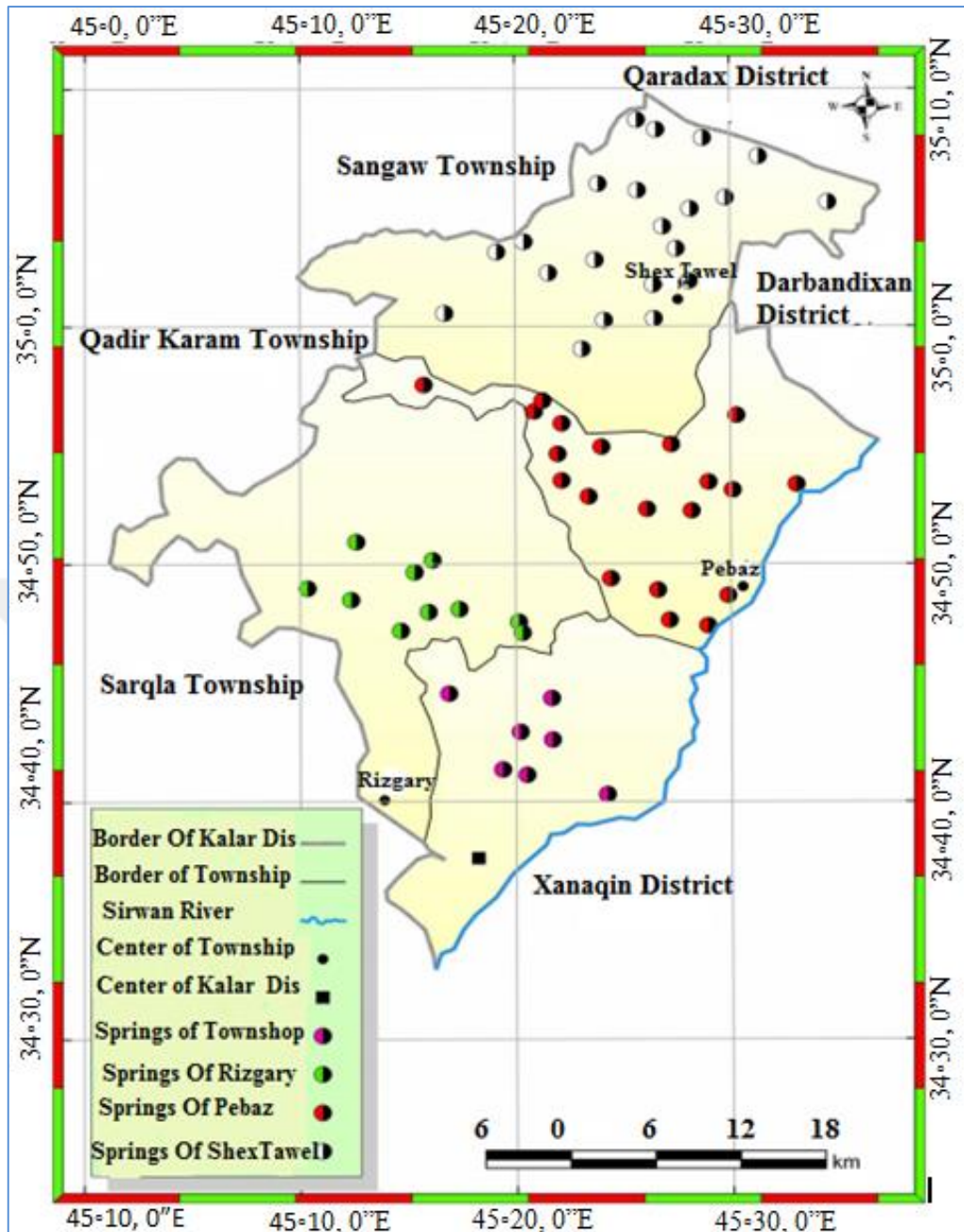
**Figure 35.** Quantity imports of Water Well in Kalar district (Researcher's work depending on, Geological Map of Khanaqin Area, Scale 1-250000 for the year 2003).

### 5.1.2.3. Springs

A spring is any natural situation where water flows from an aquifer to the Earth's surface. A spring may be the result of karst topography where surface water has infiltrated the Earth's surface, becoming part of the area groundwater. The groundwater then travels through a network of cracks. The water eventually emerges from below the surface (Ministry of Agriculture and Water Resource, 2015).

The springs have a significant role in the division and spread of the population and prosperity of the area. Moreover, the mineral water in the area is used as a treatment for many diseases due to the chemical elements of the water. Because the type of the water and spring sources are good and has less saltwater as well as it is beneficial and used for agriculture (Khalaf, 1961).

The springs can be separated due to their lack of chemical elements. Majority of the sources and springs are near the level of the Earth's surface and they are not very deep. As a result, they are affected by the climate such as high temperature, rainfall and evaporation (Mohammed, 2015). In general, the amount of the springs' product is located in the north of both Sheikh Tawel and Pebaz townships, and their amount is between 0.1-6 l/s. This amount is different annually and it relies on the annual rainfall, the inclination degree and the porous structure of the rocks. Generally, the average of the spring's product is 5 l/s (Figure 36).



**Figure 36.** Classification geography of springs in Kalar district (Researcher's work depending on, Geological Map of Khanaqin Area, Scale 1:250000 for the year 2003).

## 5.2. The Chemical Features of Ground Water in Kalar District

It is necessary to find out the importance of the analysis of the chemical features of ground water in the study area. So that we can be sure whether this water of the area is suitable for drinking, animals, irrigation, and industry; because there is no clean water on the Earth's surface but only too little.

Moreover, the water is mixed with the matters, salt and minerals which melt in the water and all these happen due to the continuous interaction of water, gases and rocks as well as water goes into the ground water through the rocks, and another reason for the interaction is due to the geological factor such as faults and porous structure.

Here, the important point is to indicate the amount of the melted salt and matters in the water because that amount indicates the limit of the various usages. If the amount of the melted salt and matters is high. It will be dangerous and harmful to agriculture and human beings health (Al- Palani, 2010). To find out the chemical features of groundwater in Kalar district, we got to benefit from some samples of the lab for the analysis and test of the well and springs water in the area (Table 24).

### **5.2.1. Potential of Hydrogen (PH)**

It is the hydrological features in terms of ph. i.e. the intensity of hydrogen ions in the water a ph of water is generally between 1-14. If water is with a ph of 7, it is balanced and it is considered acid. However, the base of water has two factors. One of them is high hydrogen ions in the water, the other one is the calcareous rocks in the area (Mohammed, 2015).

The hydrological features of the wells and springs in the study area are between acidity and basicity and they are balanced due to the influence of the ground water and geological formations of the study area which are important to refine water, to melt the various salt minerals and brimstones. After that, the minerals and brimstones settle at the bottom of the groundwater in the study area. Generally, the groundwater of the wells and springs is suitable for drinking and other usages according to the world and Iraqi standards. Because the waters ph are acceptable by world standard that is between 6.5-8.5 (Al- Palani, 2010).

### **5.2.2. Electrical Conductivity (EC)**

Electrical conductivity is the ability of  $1\text{cm}^3$  of water conduct an electrical current at the temperature  $35^{\circ}\text{C}$ . The highest value of this element in the study area locates in the village of Sufi-Rahim in Pebax township and it reaches  $675\text{ micro /cm}^3$ . However, the lost value locates in the village Qalla Qochan in Rizgary Township and it is  $334\text{ micro /cm}^3$ . This means the low amount of melted salt of the well and springs water, rock formations and geological formations. On the other hand, it means the

continuous renewal of the area's groundwater because rainfall causes all the salt to melt. In general, their value is between 300-350 micro.

### 5.2.3. Total Hardness (TH)

The existence of total hardness is due to the existence of the structure of calcium and magnesium in the form of bicarbonate, brimstones and chloride. Total hardness is a significant factor to find out the type of water and its usage for various purposes. (Namiq, 2008). When temperature increases, the ability of this type of salt reduces and it causes the change in the last and color of food (Abdul-Rahman, 2008). Total hardness has several types, but in general, total hardness can be divided into two types.

**Temperature Hardness:** It is that hardness which is formed by the salt of carbonates, bicarbonates, calcium and magnesium, so it is called temporary hardness.

**Permanent Hardness:** This type is created by the mixture of the ions of calcium, magnesium, brimstones, chlorides and nitrates and therefore it is known as permanent hardness (Muhammad,2008; Table 25).

**Table 25.** Classification of The Type Water According to The Degree of Hardness

Type of Water	TH J MM
Soft	0-75
Moderate hard	75-150
Hard	150-300
Very hard	More than 300

(Al- Hasnyani, 2013)

**Chloride (CI):** The amount of CI of the study area changes. For example, the amount of CI of the sampled water is between 9.3-70 mg /l. In the study area and it changes. The highest level occurs in Gallal village in Pebaz township. In addition, the lowest level locates in Mir-Qasim village Rizgary village in general, the total intensity CI in the area is (66.2 mg/l). Those, the groundwater of the study area is appropriate for drinking (Muhammed, 2013).

**Potassium (K):** Concerning the density of potassium ion in the study, area groundwater changes from one place into another according to the available result and it is between 0,96-5,9 mg /l. Moreover, the highest value occurs in Pebaz township and the wells in Rizgary township. In general, the total density of potassium in the area 2.14. Although the potassium of some wells is high it is generally low in the study area ground water (Muhammad, 2015).

**Calcium (Ca):** Calcium is considered one of the main substances in the groundwater and its source is from calcareous rocks, gypsum and hydrates due to their high amount of calcium (Ali, 2011). The amount of Ca, the sampled water in the study area is different from one place into another and it is between 34-100 mg/l.

The highest amount of (AC) occurs in (Kalla Shera ) village in Pebaz township. In general their total density of hydrogen is (7,5).it means that the hydrological features of the wells and springs of the area are suitable for usage due to the geological formations of Bai Hassan which contain low amount of calcareous rocks from Bamo breccia's which make the water purer and milt high level of the various salty minerals and then they settle in the ground water.

**Sodium (Na):** Concerning the level of sodium in the study area of Kalar town is different and changes from a place to another and it is between 6.4 -190 mg /l. The highest level occurs in the wells of Kawa Charmu village in Rizgary township. But the lowest level locates in the good number 4 in Said- Kali village of Kalar district; in general, the average of Na in Kalar town is(38.3 mg/l. As a result, the water of the wells and springs of the study area is suitable and good for drinking and usage ( Muhammad, 2015).

**Magnesium (Mg):** The sedimentary rocks are main sources of magnesium ion and they are available on the rocks with the rate 47.6 %. As well as in igneous rocks and clay stones. In addition, another source of magnesium is the waste of the factories (Amin, 2014). Concerning the magnesium level in Kalar town is between 8-57 mg /l and it changes from one place to another according to the samples of the study area water. Moreover, the highest value occurs in the wells of Kalar town centre. The lowest value is in the wells of Asuda quarter in Rizgary Township. Therefore, the total amount of magnesium in the area is 33.3 mg /l and it means the water of the areas wells and springs are drinkable and useful for other purposes ( Mohammed, 2008).

**Nitrate (NO<sub>3</sub>):** The amount of NO<sub>3</sub> of the sample of the area's water is different and change from one place to another and it is between (1-35 mg /L), The highest value occurs in kallasheray Khwarawa village in Pebaz township, but the lowest amount is in the mewakay khwarawa village in Rizgary town ship. In general, the average of No3 in the area is (13.3 mg /L) and it means the water and springs of the well are drinkable and useful (Mohammed, 2008).

**Sulphur or Sulfur (So<sub>4</sub>)**

The amount of sulfur in the study areas changing from one place to another according to the samples analysis it is between (9.13 – 369 mg /L). The highest level occurs in Qalla qochan village in Rizgary Township whereas the lowest amount is in (Yaramand) village in Pebaz Township. In general, the average of sulfur in the area is (59, 5 mg /L). As a result, the water of the study areas wells and springs is drinkable and useful for various purposes (Mohammed, 2015).

## CONCLUSION

Statistics and information on the characteristics of the natural elements in the Clare Closure in the form of maps, tables and statistical images of the study area. Moreover, Geologically, the components of the triangular and quadrilateral structure cover the region with several other components, such as (Injana formation, muqdadia formation, Bay Hassan formation.Fatha formation ), The sediments of the fourth era, which are new, such as the floodwaters, the deposits of various sources, the deposits of the valleys and the slopes of the slopes, the fossilized sediments, (Folds), under the influence of the cracks of the reverse, and consists of the layer (anticline) (cycling), which is covered with new deposits. In addition,

In terms of geomorphology, the study area is composed of several different topographic units such as the plain, hill and mountains. The study area is located in north and northeast of al-Menta. Its height is 1800 meters and the lowest level is located in the south of the study area. And the highest line of equator line (1800 m) and the lowest line of (200 m).Whats more, The climate of the study area with semi-dry climate (STEPS) is known to be average The annual rainfall (293 mm), the annual temperature rate (23 ° C), the highest temperature for July, and the lowest temperature for the month of January. The climate of the study area is continental.However, The soil of the study area is different in general. It consists of the red structure, the stony rock in the high areas of the region and a group of shallow soils, including the phytoplankton, such as the slope and valleys, which differ in their thickness, fertility, porosity and water permeability. In general, the area of the study is of the type of clay soil

And a number of physical substances and chemical composition of the soil in the region in terms of different chemical and physical properties. However, The natural vegetation cover of the area in the seasons of the year varies greatly in summer and winter and generally in the spring, the area of green area (22.2%) includes the total of the judiciary, but in the summer this ratio drops to (2.9%) and the presence of plant cover Natural in the region is important and helps to unify the soil of the region and deflect it from water deviations. And The natural vegetation cover of the area in the seasons of the year varies greatly in summer and winter and generally in the spring, the area of green area (22.2%) includes the total of the judiciary, but in the summer this ratio drops to (2.9%) and the presence of plant cover Natural in the region is important and helps to unify the soil of the region and deflect it from water deviation.

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## APENDIX

### Ap 1. Originality Report



SOSYAL BİLİMLER ENSTİTÜSÜ  
YÜKSEK LİSANS TEZ ÇALIŞMASI ORJİNALLİK RAPORU

ÖĞRENCİ BİLGİLERİ	
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Tez Başlığı (Türkçe)	Natural Environmental Features of Kalar City and Its Surrounding (Northeast Iraq) in Respect of The Establishing Site Kuruluş Yeri Bakımından Kalar Şehri ve Çevresinin (Kuzeydoğu Irak) Doğal Ortam Özellikleri

#### SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ'NE

Yukarıda başlığı belirtilen tez çalışmamın a) Kapak sayfası, b) Giriş, c) Ana bölümler ve d) Sonuç kısımlarımdan oluşan toplam 105 sayfalık kısmına ilişkin, 24/11/2017 tarihinde Sosyal Bilimler Enstitüsü tarafından Turnitin adlı intihal tespit programından aşağıda belirtilen filtrelemeler uygulanarak alınmış olan orijinallik raporuna göre, tezimin benzerlik oranı % 6 'dır.

Uygulanan filtrelemeler:

- 1- Kabul/Onay ve Bildirim sayfaları hariç,
- 2- Kaynakça hariç
- 3- Alıntılar hariç/dâhil
- 4- 5 kelimedenden daha az örtüşme içeren metin kısımları hariç

Yukarıda bilgileri verilen öğrencinin yüksek lisans tezi Sosyal Bilimler Enstitüsü Yönetim Kurulu tarafından belirlenen azami benzerlik oranlarını aşmadığını ve tez çalışmamın herhangi bir intihal içermediğini; aksinin tespit edileceği muhtemel durumda doğabilecek her türlü hukuki sorumluluğu kabul ettiğimi ve yukarıda vermiş olduğum bilgilerin doğru olduğunu beyan ederim. Gereğini saygılarımla arz ederim.

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