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Remote sensing and GIS applications in historical research. Case of The establishment of the Tiaret city (Algeria) during the colonial era

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Abstract. The present research paper is a descriptive study of the most essential natural geographic factors that distinguish the location of the city of Tiaret and the surrounding lands, shedding light on the extent of their importance and impact on the emergence of the colonial city, and the relationship of the physical characteristics of the location to the pattern and shape of the urban growth of the city during the colonial era and to the rest of human activities in it, especially agriculture. Moreover, the study also aims to highlight the effectiveness of employing remote sensing techniques and geographic information systems (GIS) as a support and investigation tool for this historical research, which was used as a geographical method through which the researcher is assisted in scrutinizing some of the data and information contained in some previous research related to the geography of the city of Tiaret from the topography, the surface, climate, and hydrography.

Keywords. Tiaret**;** Algeria; colonial era; remote sensing; geographic information systems; topography

1. Introduction

The current city of Tiaret is one of the settlement centers that were constructed during French colonialism's expansionist settlement policy in Algeria as a way to increase its influence within its war plans, which were intended to put an end to any popular resistance or rebellion on the one hand and to create an environment of stability suitable for the Europeans who arrived there on the other. The military barracks, which were constructed in 1843 at the height of the crest line, and the settlement with a wholly European colonial origin [1] are considered the nucleus of the beginnings of the French settlement in it, and from them, this compound began to gradually expand until the end of the colonial period in 1962, where Tiaret became a city with an area of more than 180 hectares. It includes many neighbourhoods, equipment, and facilities built in a European architectural style.

1.1.Statement of the problem

Furthermore, the urban expansion of the city of Tiaret started at the barracks and its adjacent lands. This geographical area is considered the location in which the city was established because of its natural geographical characteristics, which we will try to highlight.

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The elements of the location include the study of the surface in terms of topography, type of terrain, and the network of waterways.

Consequently, the research issue was centered on the following questions:

- What are the most essential natural characteristics of the site on which the city of Tiaret was built during the beginning of the French settlement in the region?
- What is the extent of the influence of its elements - as natural geographical factors on the establishment of the city and on the human activities carried in it?

1.2. Objectives of the research:

The significance of this study lies in emphasizing the scientific value that may be given to historical research in general and to the topic at hand, which is the location-related characteristics of the city of Tiaret.

First: Employing satellite photographs instead of physically travelling to the area being investigated, we were able to collect digital data on this portion of the land to be studied by using remote sensing technology.

Second: Geographic information systems are used to study it. These systems are collections of digital data with geographic references that have been put together automatically and have functional components that enable building, modification, and cartographic display [2], in addition to spatial analysis of the raw data obtained, which is characterized by great strength in combining maps with a huge database of quantitative data. and descriptive at the same time. This is thus a system that enables the study of several phenomena at the same time to effectively contribute to the answer to the research problem [3] .

2. Methodology of the research:

As for the methods used, they are represented in the outputs of remote sensing techniques represented in (SRTM) [4] satellite images that were downloaded from a specialized US site (USGS Earth Explorer) and then processed by geographic information system software to extract analytical maps of the topography of the site from levels and slopes and the running water network, and then addressing other natural elements of importance to the establishment of the city, such as climate elements such as heat and precipitation, and trying to deduce the combined effect of these elements on the emergence of the city in this place and on human activities there.

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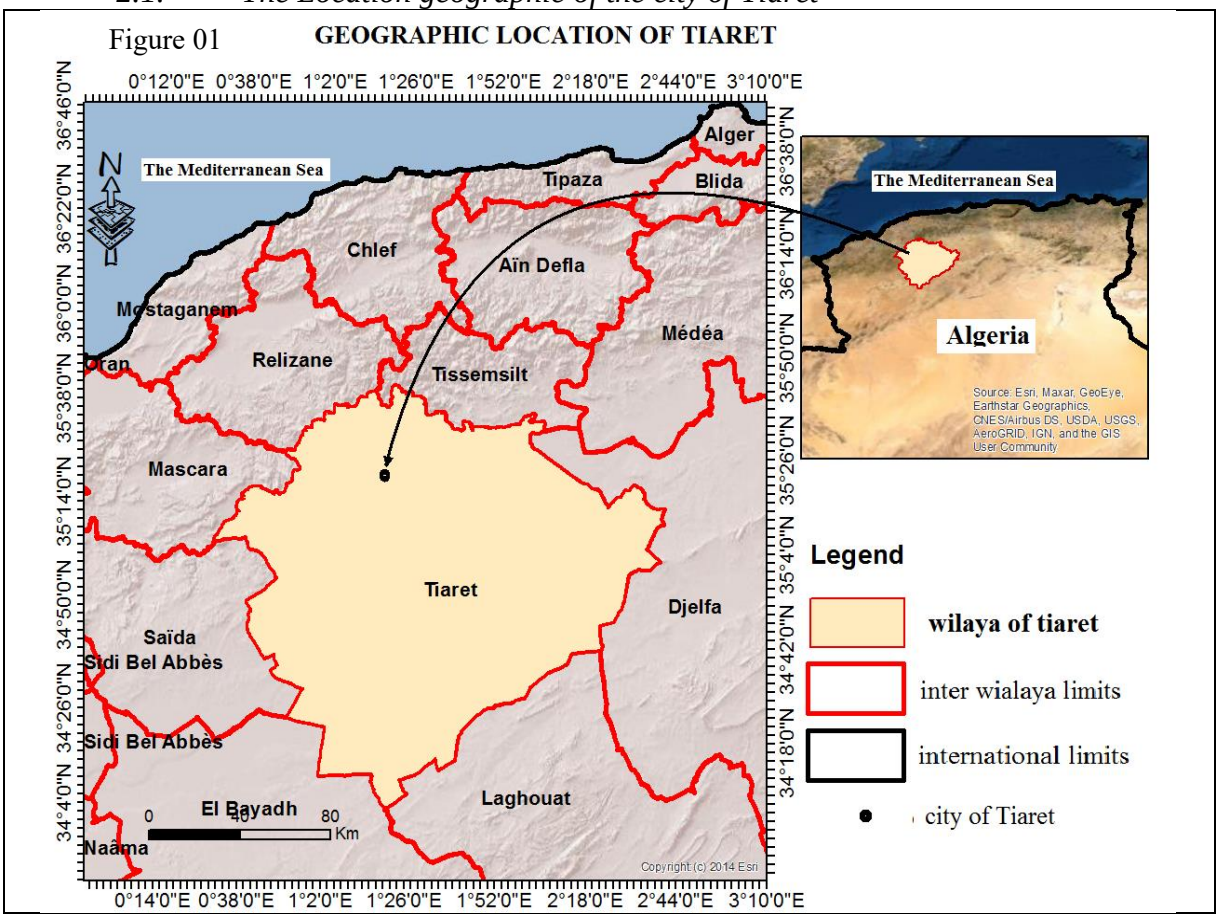
2.1. [5]The Location geographic of the city of Tiaret

Figure 01 GEOGRAPHIC LOCATION OF TIARET



Tiaret is located southwest of the capital Algiers in the western region of the high plains, in Tell Atlas, and about 150 km (93 mi) from the Mediterranean coast. Tiaret is located at latitude 35.3841 N and longitude 1,3361 E.

2.2. *The general topographic aspect of the Tiaret region*

According to figure 2, the topography of the entire Tiaret municipality's jurisdiction is between 879 and 1223 meters tall, with an average height of 1004 meters. Due to the area's height exceeding 600 meters, these heights suggest and initially create the impression that it belongs to the mountainous regions. We can determine the type of topography present in the municipality of Tiaret by carefully examining the three-dimensional image, as shown in figure 03, which allows us to identify:

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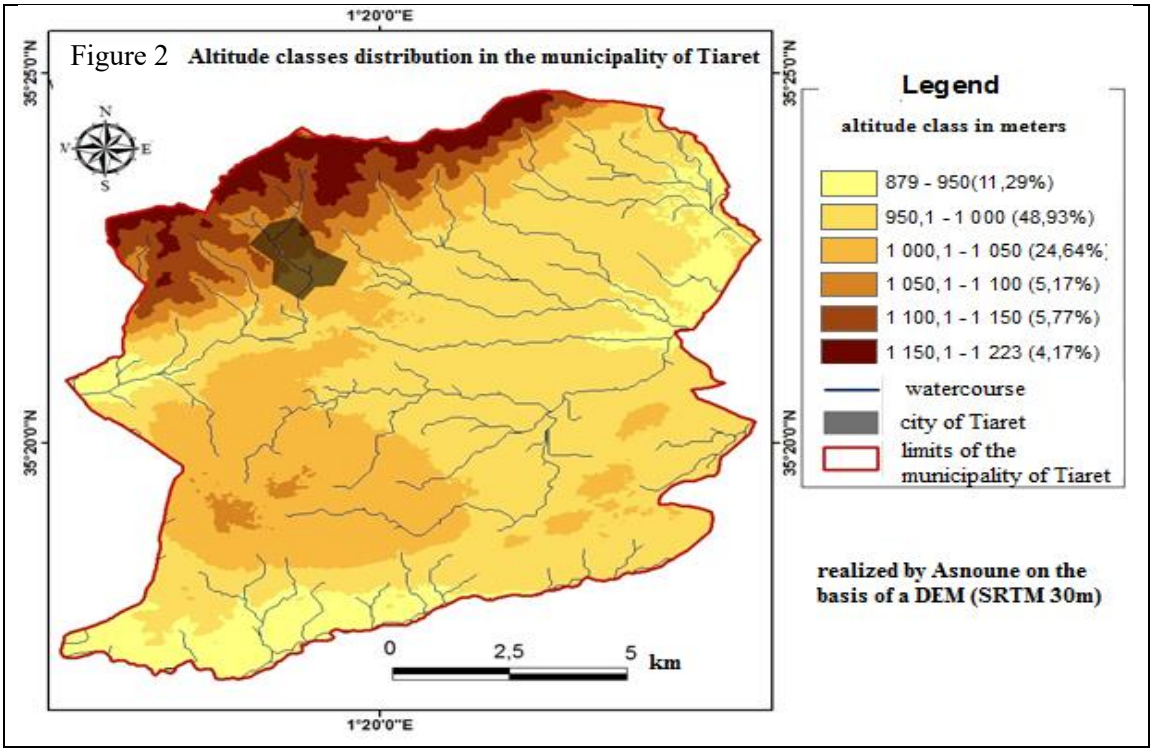

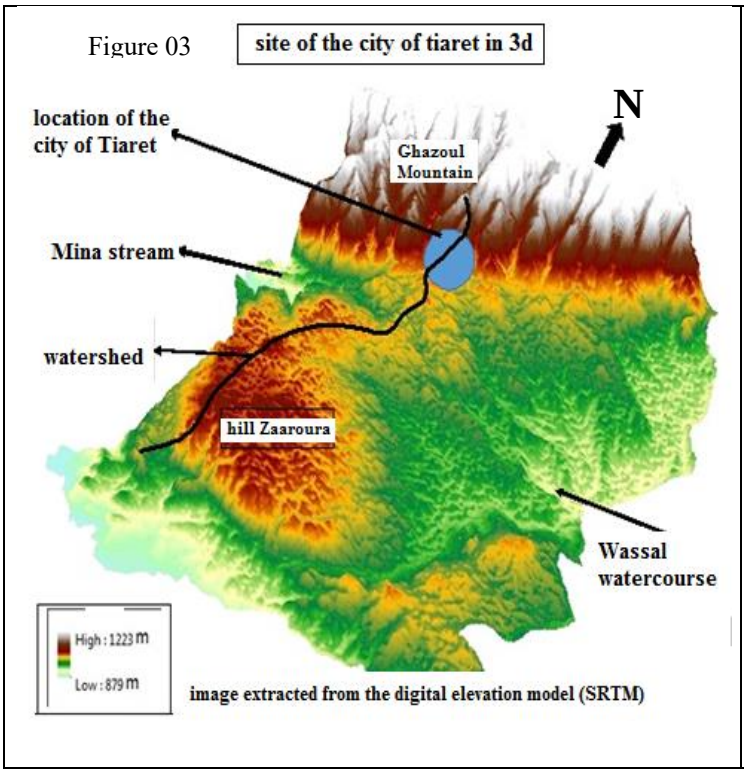

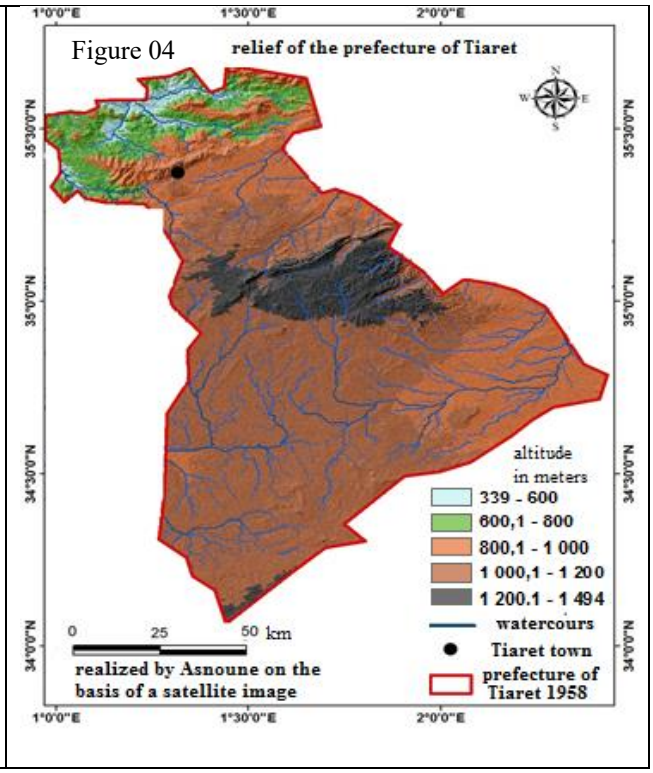

The more obtrusive mountain mass in the image's northernmost region, which takes the form of a short chain, is known as “Ghazul Mountain” extending longitudinally in a direction from east to west with a length of 10.34 km and transversely from north to south by about 2.6 km and reaching The highest peak is 1223 meters above sea level. As this height mentioned

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represents only 10% of the total area of the municipality, which is estimated at 123 km2, it is characterized by a steep slope that reaches 37°, as shown by the slopes map. 90% of the area is thought to be made up of lands with a height between 879 and 1100 meters. They are all lands with either a medium slope (from 3° to 12.5°) or flat lands with a slope not exceeding 3°, meaning that they are lands that are remarkably flattened, which made Biran mention, in his description of the terrain of the region, that travelers passing through its lands were amazed at its flatness [6] .

Despite the mountain's height, this flatness and the flatness that pervades the topography of the surface negate the mountain's character. Instead, it is thought to be a morphological property that relates to one of two separate terrain types: the plateau or the plain. Since it is shallow, we refer to this topography as the upper plains rather than the plateaus [7]. This topography (flatness) extends over most of the area of the Tiaret district to the south, as shown by the topography map of the Tiaret prefecture limit of 1958 as shown in figure 04.

3. Discussion and analysis of the results:

3.1. Analysis of The historical importance of the location of the city of Tiaret during the colonial era

- *Topographical terrain characteristics of the city of Tiaret*

Studies of the past have revealed that many criteria and elements have been used to determine where cities should be located throughout human history. due to defensive security concerns, the fact that it views the heights as an impregnable fortress against enemy attacks, or for other reasons.

The military barracks are considered the first colonial facility that was built in this place in 1843, and they are the nucleus of the city of Tiaret. However, the historical and archaeological research of this facility showed that it was built on the ruins of an old Roman fort, and it is known that the Romans used to build forts in their colonies on higher positions than around them for defensive purposes, which is confirmed by the height at which this Roman defensive fort was built, which was chosen by the French to build the military barracks, and it is also confirmed by the elevation map, which was also accomplished based on an SRTM satellite visualization with an accuracy of 30 meters, from which we extracted the following:

The height of the barracks is 1,100 meters, which is higher than the surrounding land towards the south and southeast

On the north side of the barracks location, there is "Mountain Ghazoul," which is higher than the height of the barracks site, but this does not affect the immunity of the barracks because it is considered a natural fort due to the steepness and steepness of its northern slope, which does not allow the arrival of any external threat through this foot.

To demonstrate the significance of the military barracks' height in relation to the surrounding buildings, we completed a topographic profile (from northeast to southwest) beginning at the military barracks and ending at the end of a hill in “Sidi Khaled”, which is part of Tiaret's city center, at a distance of 10 kilometers.

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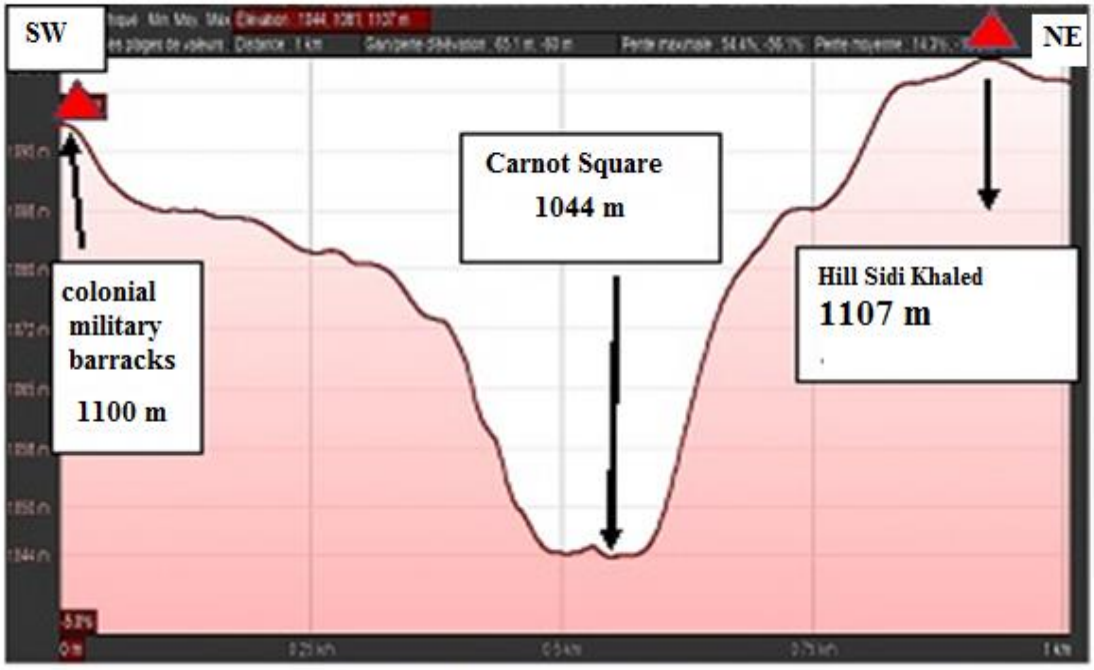
Figure 05 **Topographic profile in the city center of Tiaret**



The topographic profile clearly shows that the military barracks are located at a height from which everything that happens on the opposite side can be monitored at a distance of 1 km, where "Mountain Ghazoul" is located at an altitude of 1044 meters, meaning that it is 55 meters lower than the barracks, which gives the latter the ability to monitor all movements from above.

According to the elevation chart and topographic section, all of the neighbourhoods created in Tiaret after the completion date of the barracks had a height of less than 1100 meters (1100 meters is the height of the barracks).

However, this does not contradict the fact that this place may have other natural features, which makes us ask the question about the rest of the other natural characteristics that distinguish the place, such as the availability of the water element of watercourses and precipitation, as well as the nature of the surface in terms of slope in the lands adjacent to the city, which would encourage human activity represented mainly in agriculture, which we will try to highlight in the following.

3.2. The importance of hydrography and climate in the establishment of Tiaret

3.2.1.Surface watercourses:

Furthermore, satellite images (digital elevation model SRTM) of our study site allow us to extract the surface waterways network within it, providing us with clear information about the ranks and density of waterways, as well as the ability to draw the boundaries of hydrographic (water) basins and calculate their area.

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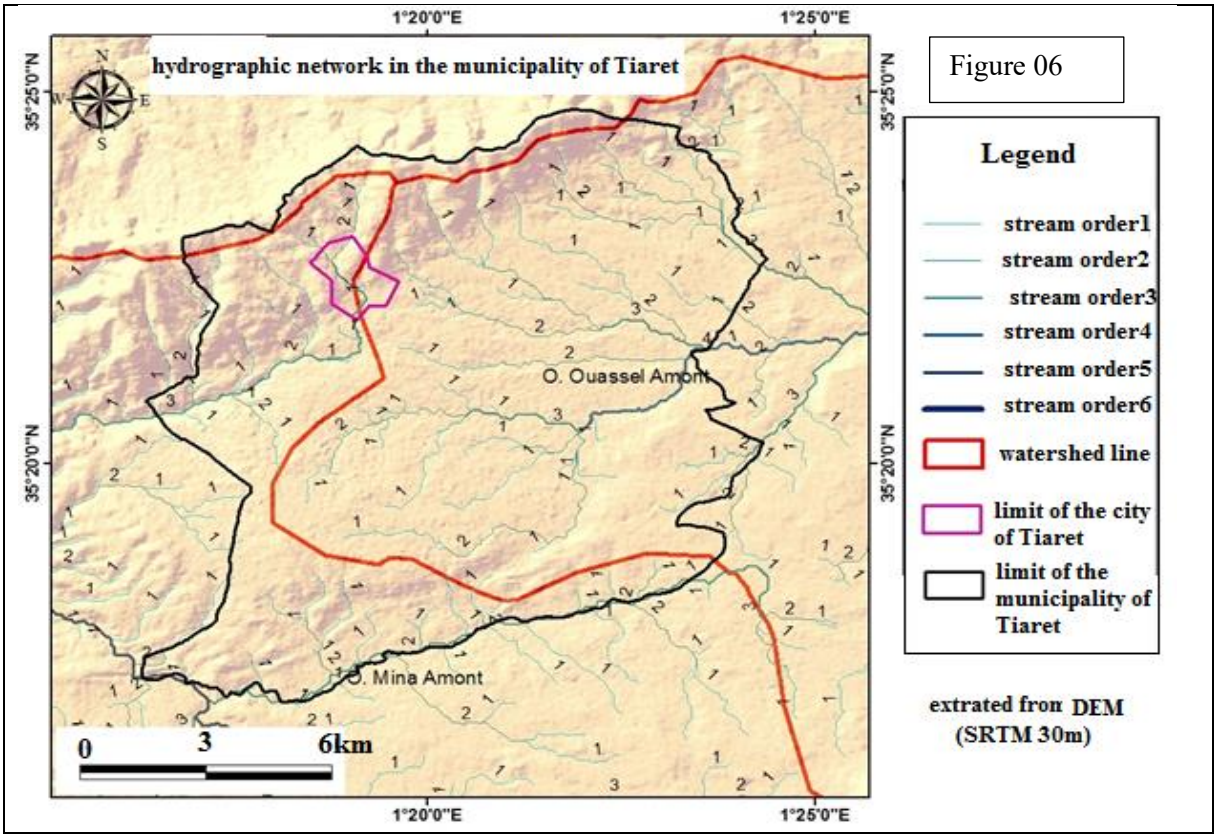

The location of the city of Tiaret was built on the same site as the water dividing line, which is depicted on the map as a red line that runs from north to south and splits the city of Tiaret into two pieces. This is shown by the hydrographic network map. The watershed line is a line that connects the highest points, and it is the first point on which rain falls, and then the rain is divided in different directions, and from it begins to form the first waterways and small reefs, which appear on the map at rank No. 1, part of which descends towards the western part, then unites with each other and forms watercourses of rank 2, which are more flowing than streams of rank 1, and so on with the rest of the successive river ranks that unite later to finally feed the main valley "Wadi Mina," forming the hydrographic basin “Wadi Mina” The same applies to the eastern side, where the small waterways descend due to gravity, starting from the water dividing line, where the city of Tiaret is located, and then unite with each other in the lower areas until reaching the main valley, which is "Wadi Wasal."

The municipality of Tiaret is devoid of essential watercourses of ranks 6, 7, and 8, as shown by the surface watercourse network map, but it is distinguished by the presence of small watercourses between ranks 1 and 2, which are temporary waterways with the weak flow and runoff due to their short length and lack of depth. The weak streams that encircle Tiaret's location are distinguished by:

- irrigated crops cannot be relied upon to receive their water needs from streams with short lengths and low flows, particularly during droughts.
- These waterways do not allow the completion of large dams due to their lack of flow, which explains why no large dam was built in this location.

The largest dam that was built is about 25 km away from the city of Tiaret; 50 million cubic meters on the mainstream of «Wadi Mina» [8] and at a height not exceeding 650 meters, where at this height the valley occupies the river rank 6 and becomes more flowing after all

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sewage water from the rank 5 or less coming from the heights gathers in it, which allowed the establishment of the dam in this place, in addition to the transfer of water from the Bakhada dam, for example, to the city of Tiaret.

This requires propelling energy that necessitates the construction of pumping stations, unlike many cities to which water is transported from distant dams, relying on the force of gravity, so that the height difference between them and The dam supplying it allows the water to be transported naturally, as is the case in the city of Oran, to which water was brought from the "Bani Bahdal" dam from the heights of the state of Tlemcen in 1952, where the water was transported over a distance of 180 km naturally due to the height difference between the dam area (1000 m) and the receiving area (400 m). [9] .

When compared to low-rise areas that are characterized by greater water harvesting, where the running water coming from the heights collects, the city of Tiaret's high position (1100 meters), which coincides with the water dividing line, makes it a place that lacks surface running water. But the rainfall factor is also considered an important factor in high places, as precipitation often increases with altitude, and thus it is an important factor in the growth of agricultural activity, especially rain-fed crops. What are the features of rain in Tiaret? Is it helpful to practice agricultural activity there?

3.2.2.Rainfall and temperature in Tiaret during the colonial era:

During the colonial era, climate studies in Algeria attracted the attention of many researchers. One of the first to attempt a study of the many climate factors that encompassed the geography of the entire Algerian soil was Seltzer, a climatology researcher. This culminated in the publication of his research at the University of Algiers in 1946 in the form of a book. Entitled ***"le climat d'Algérie"***, i.e. ***"the climate of Algeria",*** it includes a rainy map of Algeria on a scale of 1 in a million issued by the Institute of Meteorology at the University of Algiers. It was made based on the precipitation rate calculated for data taken during twenty-five consecutive agricultural years starting on September 1, 1913. Until August 31, 1938.

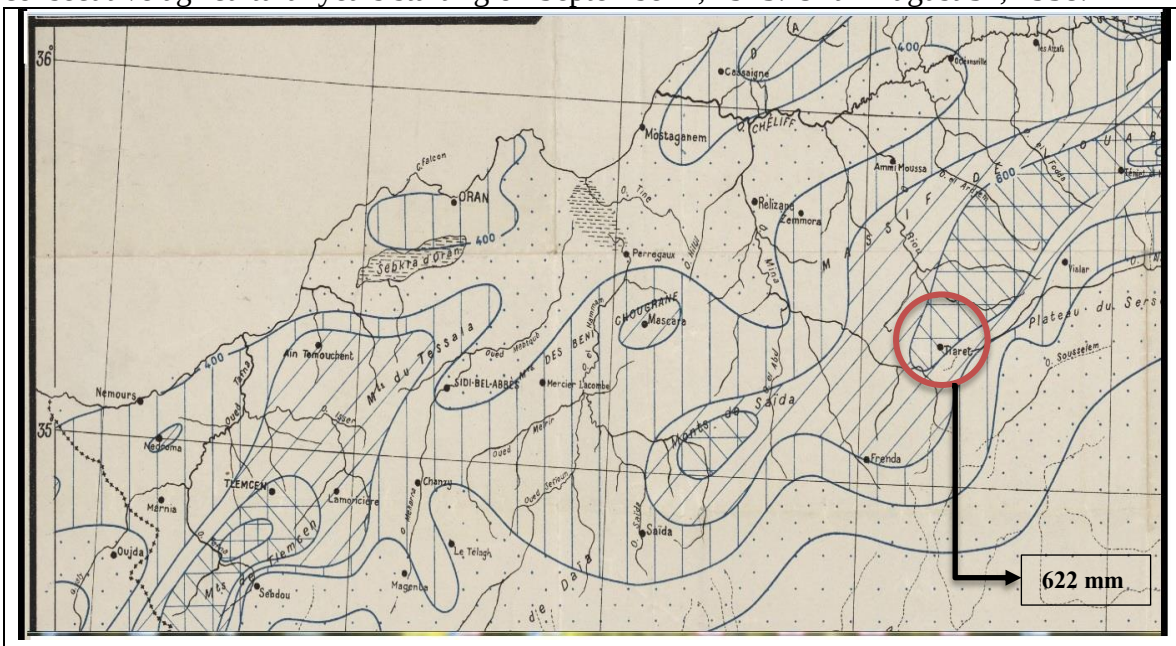

Figure 07: Taken from the rainfall map of (Paul Seltzer - 1918 to 1938)

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The isobaric lines indicate that the eastern regions receive more precipitation than the western regions, however, in the western regions, we find that the city of Tiaret experiences the highest annual rate of precipitation in all of western Algeria, at between 600 and 700 mm. Tlemcen, while the amount of precipitation ranges between 200 and 400 mm per year in all areas located in the south of the Oranian region [10], and even in the western coastal areas, where precipitation is less and is within the range of 400 mm in Oran and less than 400 mm in Mostaganem, although they are both coastal cities according to the Seltzer map.

Thus, the height factor above sea level is considered relative to the location of the city of Tiaret giving it the advantage of benefiting from greater relief, as the amount of precipitation increases with increasing height above sea level, which gave the location of Tiaret an added climatic value that encourages settlement in it so that precipitation is considered an important water resource that gives the opportunity to exploit it through the completion of some small water catches that are used as water reservoirs that benefit from the provision of drinking water, and this quantity also helps to encourage agricultural exploitation, especially non-irrigated agriculture, such as grain cultivation, which is indicated by the production figures of durum wheat, which was estimated at 29 quintals per hectare in 1857, and lean wheat, whose production reached 59 quintals per hectare in the same year [11].

The location of Tiaret was determined through an analysis of thermal data collected over a 20-year period (1918–1938) from the climatic station situated at an altitude of 1023 meters and situated at the level of the Boys' School, which revealed that the air temperature in the city of Tiaret during the colonial period. The average temperature of July, which was the hottest month, did not exceed 25.9 degrees Celsius in 20 years (1918–1938), while January was the coldest month, with an average temperature of 6 degrees Celsius in the same time frame[12].

Moreover, this type of special atmosphere for the Tiaret region was encouraging the arriving Europeans to settle there, given that its temperature is almost similar to the temperature of many French cities, and this was stated by "Bugeja", who is one of the frameworks for the colonial settlement in the Tiaret region, in a press statement over the years. The first is for colonialism, in which he asserted that the climate of the "Sersou" region is similar to that of the central plateau in France[13] .

We will attempt to analyze the Ombrothermic diagram in order to clearly demonstrate the significance of the type of climate present in the city of Tiaret, which is an innovative curve by “Bangol and Gussen” in 1953. It is a graph that combines temperatures and precipitation during the months of the year.

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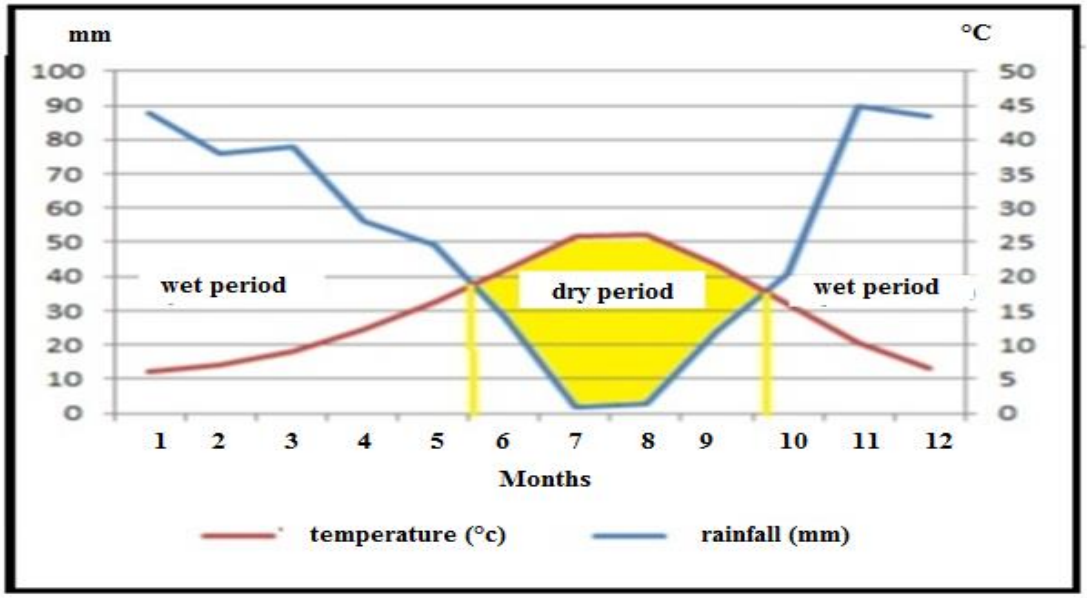

Figure 08: Ombrothermic diagram for the city of Tiaret during the period 1918-1938

Through the representation of the climatic data of the city of Tiaret over the period (1918-1938) according to the "Bagnol" and "Gaussen" models, the following figure was derived that will help us determine the dry period and the wet period in the location of the city of Tiaret.

A- The drought period in the city of Tiaret can be determined using the data of the time period 1918-1938, which is represented in the above curve in yellow and appears to extend over a period of 4 months, the driest of which are the months of July and August, during which the average temperature does not exceed 26 ° C.

B- The rainy period, which is expected to last 8 months and run from October to May, is twice as long as the dry period. Monthly precipitation varies from 40 mm in October to 90 mm in the months of October, December, and January.

We deduce the following from the previously displayed data:

- The climate in the city of Tiaret was extremely suited for human settlement and also promoted the practice of human activities, particularly in the agricultural sector. Precipitation is distributed over a period of 10 months, including the months of June and September, and the temperatures are pleasant even during the summer when summer temperatures do not exceed 26°C.

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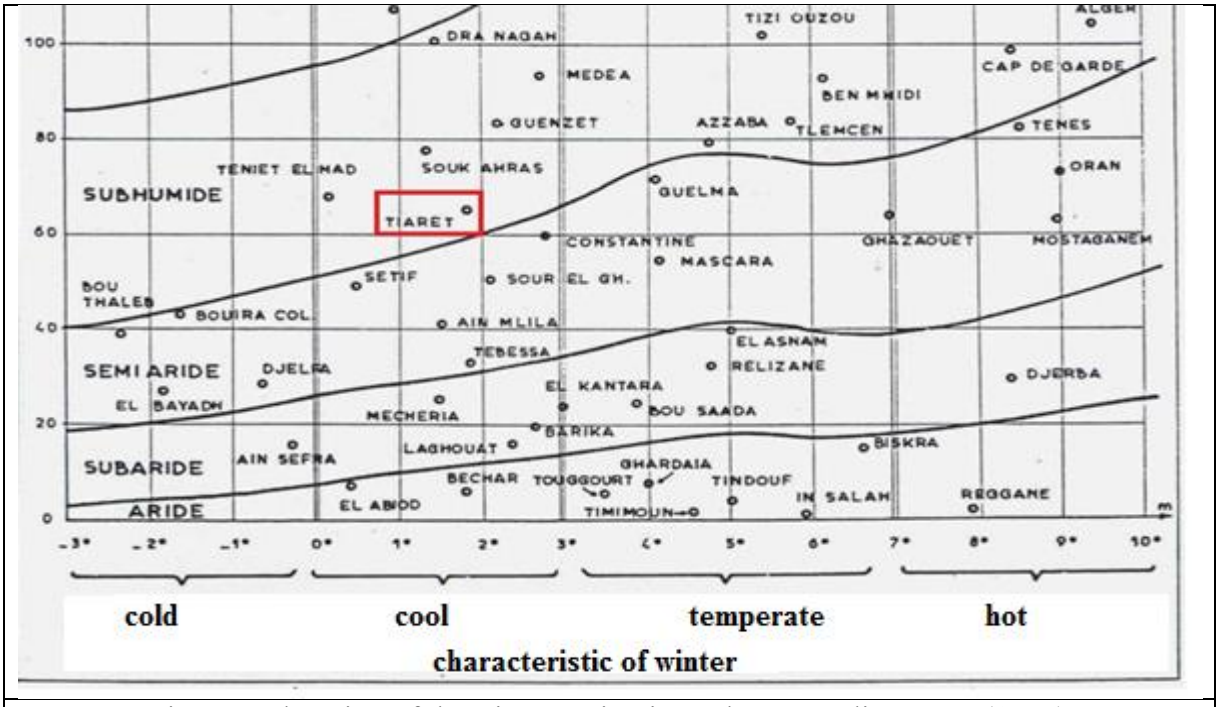

Figure 9: location of the Tiaret region in Emberger's climagram (1952)

- Figure 9 show that The climate of the city of Tiaret was better than the climate of the cities of Oran and Mostaganem, where the representation of the climatic data of the city of Tiaret according to the "emberger model" prepared in 1952 shows that the city of Tiaret is located within the moderate semi-humid bioclimatic zone, while the cities of Oran, Mostaganem and Tennis are located Within the hot semi-arid bioclimatic range, although they are all coastal cities, which have the advantage of being affected by wet sea currents.

4. The geography of the site and its importance for human activities during the colonial era:

4.1. The influence of the topography of the site on the urban appearance of the city between 1843-1962:

The topography of the city's site (the built framework) contrasts with the general appearance of the topography of the Tiaret municipality's surface, which is characterized by flatness and flatness. It reveals that its lands are predominately medium-sloping lands between (3° and 12.5°) with a rate of 70.44%, and it predominates in the northern part, the place of its origin. The city is located at the barracks, and the later-completed neighbourhoods are close by. In contrast, a tiny portion of the city's area is found in the south, where the ground is flat (less than 3°) and does not surpass 22%. Within the city, there are a few areas with steep slopes as well. 5 and 25°) by 8%.

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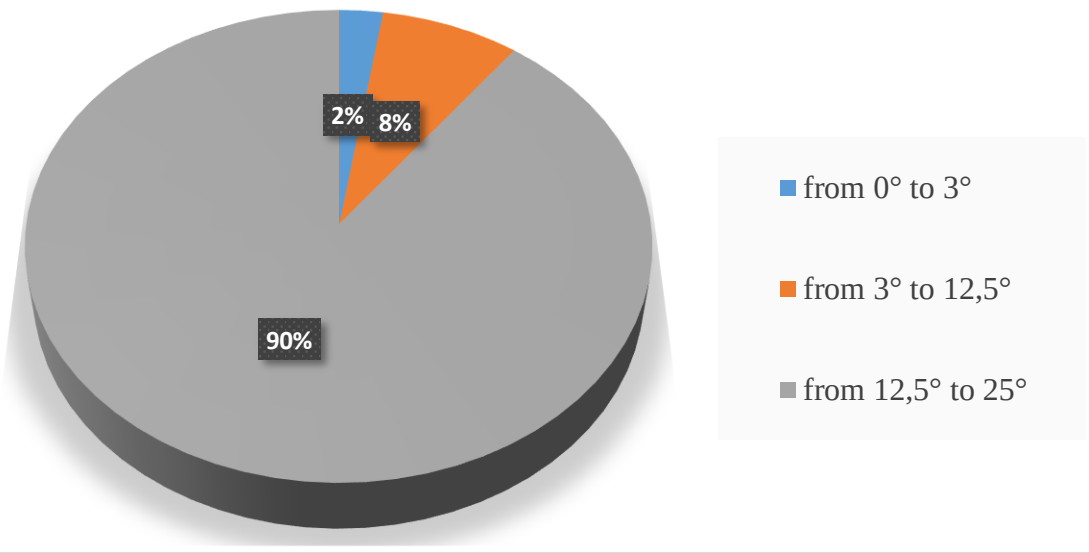
Figure 10 : Distribution of slops in the city of Tiaret



The nature of the sloping lands on which the city of Tiaret was built during the colonial era, from the beginning of its inception in 1843 until 1962, imposed a distinctive urban appearance produced by the urban plan used in it. The urban fabric consists of urban blocks [14] , as seen in city plans and while wandering through its neighbourhoods. Many of them are irregular geometric shapes, not squares, and this is in line with the topography of the place with varying slopes, where a person standing in a low area of the city, for example, at the place of the old covered market while observing east or west, can see a group of tall buildings stacked on top of each other. But in fact, they are nothing but buildings, the height of which does not exceed two floors, separated by streets, some of which are higher than others.

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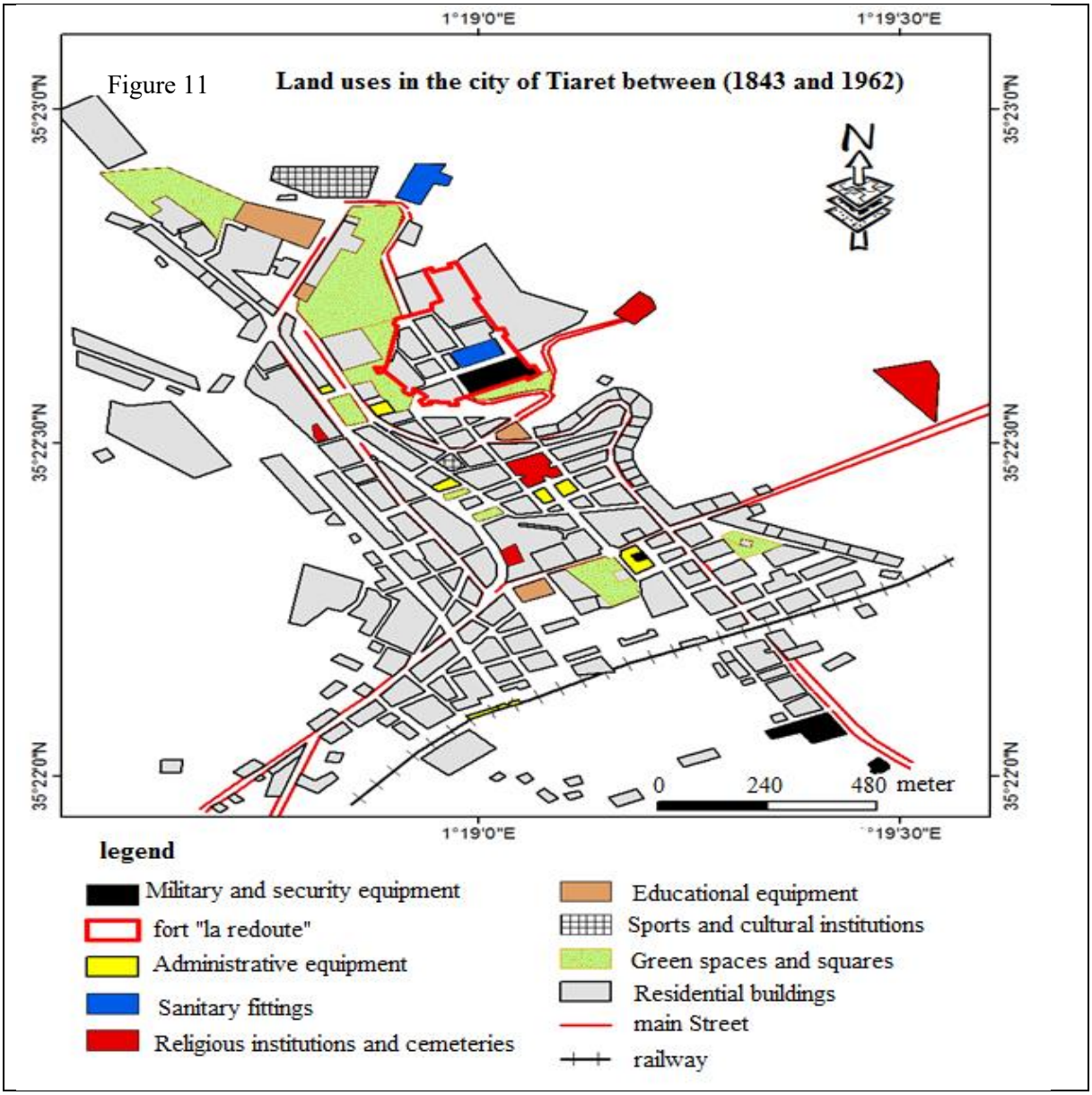

In order to mitigate the severity of slopes and tendencies within the urban fabric and to facilitate the construction process on the one hand and the movement of individuals and vehicles in the streets on the other, the city of Tiaret resorted to islands of irregular shapes surrounded by non-parallel streets when planning the neighbourhoods of Tiaret, which are located in a sloped area. This characteristic cannot be obtained by square-shaped islands since they are aligned with flat terrain.

Finally, the following plan was presented to the city of Tiaret:

- A distinct aesthetic feature, particularly in its northern parts, where the first European neighbourhood was built in a semi-circular shape, with all streets leading to the church next to you. Due to the beauty of this type of plan, some cities have adopted it even though their lands are flat.
- Another aesthetic feature imposed by the sloping nature of the site and rarely found in Algerian cities is the large number of stairs within the urban fabric, which exceed 10 in

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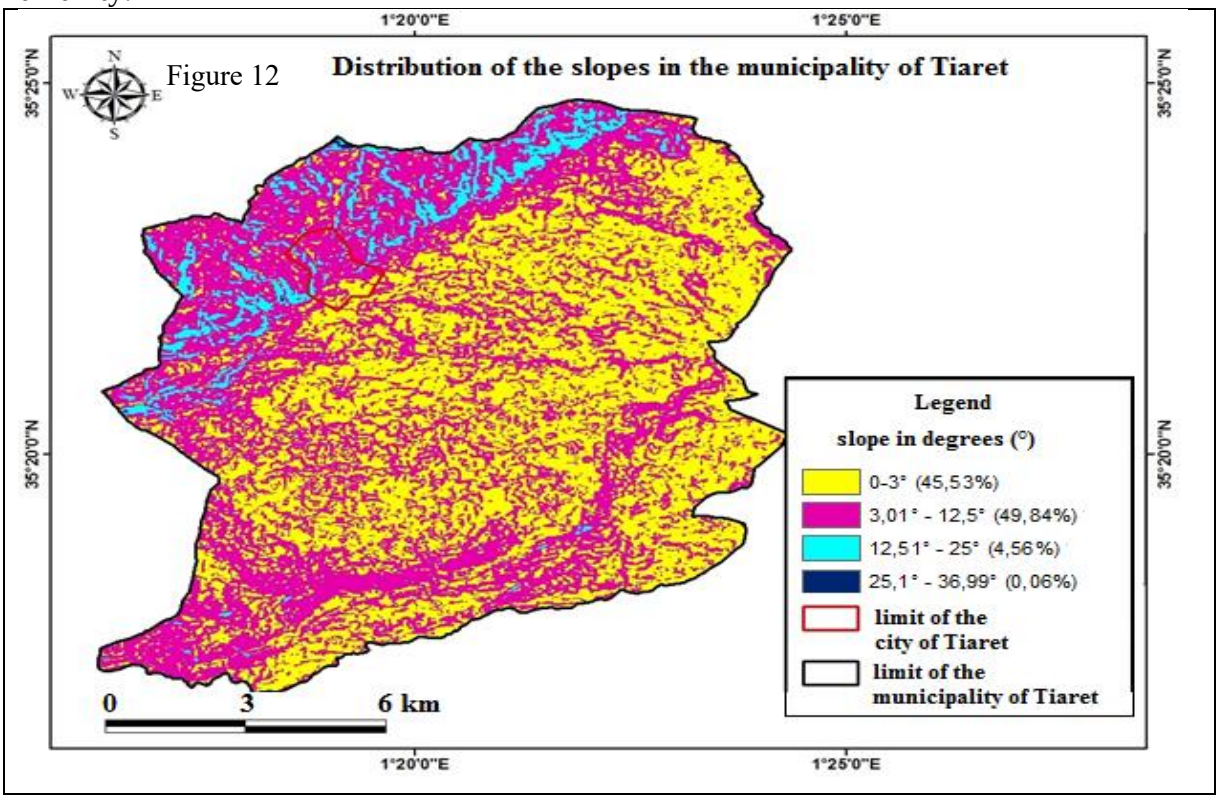
number and reach 30 meters in length, to facilitate the movement of people within the same urban blocks from one street to another, up or down.

The sloping location of the city of Tiaret helps to avoid problems associated with rainwater drainage networks as well as wastewater drainage, as the sloping lands contribute to its natural transfer in a quick and easy way and then disposal.

4.2. The nature of the surface and the practice of cultivation in the lands surrounding the site of the city :

Human activity varies; some of it is related to the urban environment and is practiced within the boundaries of the built framework, and some of it is practiced by the city's residents but outside the urban environment, such as farming. From this standpoint, we will analyze the nature of the surface topography within the city's borders as well as in the surrounding areas and try to find out the extent of the impact of the topography of the site on the activities of humanity.



Furthermore; the map of inclinations (regressions) extracted as well through the analysis of satellite visualization of the Tiaret region shows that the area of the municipality of Tiaret is estimated at 123 km^2, and despite its height above sea level at an average of 1004 meters, its topography is dominated by flat lands, especially in the lands surrounding the place of origin of the city to the south, where its percentage is estimated at 45.5%, which are lands that do not exceed the slope angle in most of them (3°).

There are 50% of the medium-slope lands with a slope less than (12.5°), they are all slopes that do not hinder human activity, and this means that these lands near Tiaret are not rugged, encouraging agricultural exploitation, as confirmed by the statistics of the year 1852, which show that through the cultivation of 52 hectares, 252 quintals of soft wheat and 772 of

barley were produced, with an estimated financial value of 4432 French francs[15] despite the use of traditional tools in this period, such as hand ploughs and cattle.

Conclusions

Tiaret city is located in Algeria's western high plains, around 220 kilometers from Oran. It was formed in 1843. The military barracks is regarded as the city's initial nucleus. according to the results of a spatial study of a satellite image of the region it was erected and built by the French colonialists on a hill at an altitude of 1099 meters, allowing it to monitor all movements from above, confirming the soundness of the premise of choosing this location to carry out security and defense responsibilities.

Based on the results of the study of the natural characteristics of the site using remote sensing data, the hydrographic network map showed that the high location of the city of Tiaret, which is located at a level identical to the watershed line, made it a place that lacks surface running water when compared to the low places that are characterized by greater water harvesting, where they accumulate. The running water comes from the heights, but this does not prevent the privilege of this place from having other positive elements. The factor of altitude above sea level in relation to the location of Tiaret characterized it as having a very suitable climate for human settlement, as it allowed it to benefit from greater relief, as it was more than 600 mm per year during the period 1913-1938, and the precipitation was distributed over 10 months of the year, including the months of June and September.

As for the temperatures, they were pleasant even during the summer, as summer temperatures did not exceed 26 ° C, which made the city of Tiaret classified within the semi-humid, moderate, encouraging bioclimatic range for human settlement. The significant amount of precipitation and the nature of the flat lands in the areas adjacent to the city - which most do not exceed the slope angle (3°) - helped encourage agricultural exploitation, especially rain-fed agriculture, such as the cultivation of all kinds of grain.

The topography of the land on which the neighbourhoods of the city of Tiaret were constructed in colonial era differs from the terrain in the area because it is characterized by sloping terrain that ranges between (3° and 12.5°) and predominates in the northern part, which is where the city's founding at the barracks and the neighbourhoods that were finished later near it took place. To lessen the severity of the slopes, engineers created triangle-shaped islands in the neighborhoods of the city of Tiaret that were situated on the hills. The sloping location of the city of Tiaret was also used to avoid problems associated with rainwater drainage networks as well as wastewater drainage, as the sloping lands contributed to its natural transport in a quick and easy way and then were disposed of far away.

List of references

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