

The Effect of Climate on Psychological Comfort in the

Historic area of Tolmitha in Libya

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Abstract:

This study is aiming to examine the effect of climate on psychological comfort in the historic area of Ptolemais, known as Tolmitha located in Cyrenaica, in Libya. The researcher focused on knowing the effect of climate on human comfort in the region, knowing the annual times that are comfortable and uncomfortable for humans in the region. Hence, descriptive approach was used as well as the quantitative approach, using the Temperature and Humidity Index, also collecting the necessary climate data from various sources, this study concluded that there are comfortable months and uncomfortable months for humans in the Ptolemais region, as the months of April, May, June, September, and October are comfortable for humans, while the months of January, February, March, November, and December are uncomfortable because of their coldness. The researchers also recommends exploiting times of climate improvement in tourist attractions in Tolmitha while preserving the environment and vegetation with establishing a meteorological station. In addition, the authors have noticed the need for more studies in this topic.

Keywords: Climate Element, Psychological Comfort, Seasonality, Environment Protection, the Province of Cyrenaica.

ملخص:

تهدف هذه الدراسة لمعرفة دور المناخ على الراحة النفسية في منطقة طلميثة التاريخية، ومعرفة الاوقات السنوية المريحة وغير المريحة للإنسان في المنطقة، ولقد تم استخدام المنهج الوصفي والكمي وجمعت البيانات من مصادر موثوقة، وقد توصلت هذه الدراسة إلى وجود أشهر مريحة واشهر غير مريحة نفسياً للإنسان في منطقة طلميثة، حيث إن أشهر إبريل ومايو ويوليو ويونيو وسبتمبر وأكتوبر مريحة للإنسان وأن أشهر نوفمبر وديسمبر ويناير وفبراير ومارس غير مريحة بسبب

برودتها، وفي المحصلة يوصي الباحثة بحماية البيئة والغطاء النباتي الطبيعي المحيط بالمنطقة لما لذلك من أهمية كبيرة في الحفاظ على الراحة النفسية كما يوصي الباحثان باستغلال اوقات تحسن المناخ في طلميته ومن ناحية أخرى العناية بالمزيد من الدراسات في هذا المجال مع إقامة محطة أرصاد جوية للاستفادة من دراسة العناصر المناخية على ساحل بالمنطقة لاستغلال جمال المناخ في موسم الجذب السياحي.

كلمات مفتاحية: العناصر المناخية، الراحة النفسية، الموسمية، حماية البيئة، إقليم برقة.

Introduction

According to previous literature, it is found that in most developed countries, there are many topics to analysis the relationship between climatic conditions and the feelings of psychological comfort have gained great importance to examine if that will lead to achieving happiness or lack of comfort for the visitors and the local community. Hence, the researcher believes that applied climate studies must place humans at the centre of their interests especially in geographical research and studies, and despite of the great technological progress that the world is witnessing, which has enhanced man's ability to control the conditions of his environment, the climate elements are still greatly affecting everybody's sense of comfort or his/her feeling of distress, discomfort, and psychological pressure.

In addition, during the last century, a large number of diverse academic studies have appeared in bioclimatology to address the role that climatic conditions play in a local community's sense of comfort or their feeling of distress and discomfort, however the main problem that these academic studies suffered from was the difficulty of defining an accurate or specific concept of comfort that all people agree upon and can be measured with expressing it in a quantitative and objective way. Perhaps the reason for this problem is the large number of variables that affect our comfort and psychological stability, as well as, the climatic variables, which have a direct impact on the feeling of comfort taking into account the challenges of measuring some of them. In addition to this, some of these variables are physiological, and some of them stem are related to cultural environment and are affected by the extent of the compatibility with the environment in which people are living and it is one of the most prominent non-climatic variables that affects the relationship between the feeling of comfort and weather conditions are gender, age, the health and psychological state of the person, the type and design of his/her clothing, the nature of the work he/she does, his/her eating habits, and the degree of their adaptation to the environment in which they live. For all of these reasons, the research methodology on this topic has developed greatly and successfully moved from the old deterministic school that was led by it to many advanced probabilistic models, such as the effective heat model that was developed by the American Society of Central Heating and Refrigeration Engineers and the simplified

model of the presumption of narrowness developed by Tom, the heat yield developed by Mezirand, the standard temperature of work, and the thermal acceptance factor developed by the Climatic Research Centre in the US Army during World War II. Hence, this study will study the impact of climate on human comfort in the Tolmitha region, using the temperature and humidity index.

2. Study Problem

The problem of the study is summed up in answering the following two questions:

- 1- What are the climate elements that most affect human comfort in the Tolmitha region?
- 3- How does the climate affect human comfort in the Tolmitha region?

3- Study Hypotheses

The hypotheses of this research are:

- 1- Prevails in the Tolmitha region, there is a moderate climate.
- 2- Temperature and relative humidity are among the climate elements that most affect human comfort in the Tolmitha region.
- 3- The cold months are considered less comfortable for humans in the Tolmitha region.

3. Study Objectives

This paper main objective is to examine the impact of climate on psychological comfort in the historic area of Tolmitha, which is located in Cyrenaica in the North East of Libya. In this study, the researcher focused on knowing the effect of climate on human comfort in the region with focusing on the following:

- 1- Knowing the effect of climate elements on human comfort in Tolmitha.
- 2- Knowing the prevailing climate pattern in the Tolmitha region.
- 3- Knowing which months are comfortable and uncomfortable for humans in the Tolmitha area.

4. Study Methodology

Literally speaking this study is looked at as qualitative rather than being a quantitative research based (Sugiono, 2017) and the authors carried out this scientific research on the principles of consistency where several approaches were used in this study, the most important of which were: the descriptive approach to determine the characteristics of the study area and to know its location and features. The quantitative approach was also used by using the temperature and humidity index to determine the comfortable and uncomfortable months for humans in the Tolmitha area.

5- The Importance of the Study

Some elements of the climate in the targeted area of Tolmitha, especially temperature and relative humidity, have a great influence on human comfort. When the weather is hot, the air conditioning is used, especially during the months of June, July and August. Therefore, the climate has a great role in increasing energy consumption. By knowing the climate elements of any region, it is possible to determine the expected amounts of electricity consumption during the various seasons of the year. In addition, by knowing the climate elements and their impact on human comfort, it is possible to know the times of the year that are comfortable and appropriate for all economic, social, and recreational activities, as this has not been done before to study the impact of climate on human comfort in the Tolmitha area.

6- Literature Review

6.1 Psychological Comfort

Physiological comfort is defined as an expression of the state of thermal balance between a body and its surrounding environment without the person and the surrounding environment, as he maintains his temperature at 37° without needing to increase his body temperature by shivering or increase cooling by evaporation (Sorour 2019). Physiological comfort has also been defined as the state in which the systems responsible for regulating body temperature are at the lowest level of effectiveness, such that the heat lost from the body to the external environment is equal to the amount generated from vital activities to maintain a stable body temperature Issa (2017).

In other words, physiological comfort is defined as the achievement of thermal equilibrium at normal body temperature with the minimum amount of bodily regulation. The body feels uncomfortable when it has to work too hard to maintain thermal equilibrium. Under the conditions of comfort, the production of heat is equal to the loss of heat without any action necessary by the heat control mechanisms. When the comfort condition exists, the mind is alert and the body operates at maximum efficiency. When the environmental temperature changes, the body tries to acclimatise by different temperature-regulating mechanisms clothing also helps in acclimatisation.

From another prospective.

6.2 The Geopolitical side of Ptolemais

Ptolemais, known today as (Tolmitha) located in Cyrenaica in the North East of Libya and city was founded by and named after one of the rulers of the [Ptolemaic Kingdom](#), probably [Ptolemy III Euergetes](#) (246–221 BC). What had been a small Greek settlement of unknown name that originated in the late 7th century BC and that acted as a port for the city of [Barca](#) know today as (Al-Marej) 24 kilometres (15 mi) inland, he transformed into a city that enclosed 280 hectares within its walls. Ptolemais probably served as the residence of the Ptolemaic governor of the region but, in spite of its large area, its population did not rival that of Cyrene, which under [Roman rule](#) became the capital of the region that, from then on, and still today, is called Cyrenaica. However, the term "Pentapolis" also continued to be used. Villa of Columns Ptolemais became a Roman possession in 96 BC. It was soon included in the [Roman province](#) of [Crete and Cyrenaica](#). With [Diocletian's](#) alteration of the administrative structure, Ptolemais became the capital of the province of [Libya Superior](#) or Libya Pentapolis. It later decayed and was replaced as capital of the province by Apollonia. The [365 Crete earthquake](#) struck the region and destroyed all the five major cities of the Pentapolis and it is important to specify the location of Tolmitha on the eastern Libyan coast is shown in the below Figure (1) GPS Map:



Figure (1): GPS location of Tolmitha on the eastern Libyan coast

Figure Source: <https://www.google.com/maps/search>

In relation to its remains, the city of Ptolemais survived the tragedy in relatively good condition. It served as capital of Cyrenaica until 428. The city was destroyed by the [Libyans](#) in 41. During the reign of [Justinian I](#), the city was rebuilt, but it never regained its powers and was again destroyed during the [Muslim conquest of the Maghreb](#) in the 7th century. Buried in the sands, the town's ruins have been remarkably well preserved. Excavation of the site began in the 1930s, revealing a planned city of rectangular shape, some 1650 by 1400 metres (about one square mile) and composed of blocks of about 180 by 36 metres. It held a [hippodrome](#), an [amphitheatre](#), and three theatres, the smallest of which, used as an [odeon](#), was adapted for water spectacles in the 4th or 5th century. A Roman aqueduct, probably of the time of [Hadrian](#), brought water from 20 km away, which was stored in two large open reservoirs in the east of the city, while further west a porticoes space, now called the Square of the Cisterns, stood above a set of seventeen vaulted cisterns, capable of holding 7,000 kilolitres.^[4] These were rediscovered during the Italian occupation, when they were found to be used as a hiding place for rebels, two or three hundred of whom could easily hide in them. West of the city stands a conspicuous and tower-like Hellenistic mausoleum, known as [Qasr Faraoun](#). There are many chamber tombs in the quarries east and west of the city, which have yielded a few tombstones and numerous inscriptions. Important sculptures and inscriptions have also been found within the city, including imperial edicts such as that by which Diocletian attempted to fix prices. In 2001 an archaeological mission from [Warsaw University](#) started excavations on the site.

In May 2011, a number of objects excavated from Ptolemais in 1937 and held in the vault of the National Commercial Bank in [Benghazi](#) were stolen. Looters tunnelled into the vault and broke into two safes that held the artefacts, which were part of the so-called Benghazi Treasure. The objects have not been traced and the remain of the city of Ptolemais is shown in Figure (2).



Figure (2): The remain of the city of Ptolemais

Figure Source: <https://www.britannica.com/place/Libya>

6.3 Previous Studies

6.3.1 Previous authors as if Dr. Yousef M Zekri (2005) has already written about climate and Physiological tranquillity, the study found that the physiological comfort zones in Libya differ from one season to another and from one place to another. In the winter season, the comfortable period appears in the southern region of Ghat only, while during the spring season, Libya enjoys a comfortable period with the exception of the mountainous areas and parts of the coastal region extending from Benghazi to the eastern border city of Amsaad and from for visitors to western border city of Ras Jdir, the comfortable period changes in the summer season, as the northern and inland areas become comfortable and the southern areas become completely uncomfortable. However, in the fall, the comfortable period shrinks to include the coastal areas and some parts of Libyan desert in Al- Kufra and Al-Hamada al-Hamra , and disappears in the rest of the other areas on the Libyan soil.

6.3.2 There's also another study by the same author Dr. Yousef M Zekri (2005) about measuring human physiological comfort in the city of Sabha in the levels of comfort inside buildings, where his study found that there is a difference in achieving complete comfort during daylight hours in the winter due to the warmth provided by solar rays, as the radiant balance in these areas works to heat the air, while comfort disappears during the night due to the extreme decrease in temperature levels. As for comfort levels outside buildings and in the shade, they disappear in the summer months and most of the fall months, while the weather is unpleasant during the day and night hours. The comfortable period during the day hours decreases in the spring months and is limited to the night hours.

6.3.3 The other Study by Suleiman Al-Subaie (2013) and he concluded that winter and spring constitute the optimal seasons of the year for human comfort in the coastal city of Sirte, according to the Oliver coefficient, where its value does not exceed 57 for the spring season, and the fall season comes in at 63 degrees in temperature and humidity for the winter season, and in terms of climatic comfort levels, this means that approximately An average of 70% of the city's population feel that there's a lack of climatic comfort and climatic discomfort during this season. Summer also represents the season of climatic discomfort and discomfort, as the temperature and humidity coefficient reach 75%. The study also concluded that the optimal month of the year for human comfort is 75%. January with average of 56 temperature and humidity.

6.3.4 There is also another research by Hafez Issa Khairallah 2017 on the spatial and temporal variation of comfortable and uncomfortable months in Libya using an index. The study concluded that the summer season indicates the presence of discomfort and discomfort in most regions of Libya with the exception of Derna and Shahat (Cyrene). The study also found, through the use of the temperature and humidity index, that 22, 2, 76, 14 The average annual temperature and humidity index at the study stations ranges

between night and day, respectively. This indicates that the climatic condition of the stations in the study area is climatically comfortable and that the winter months are considered the best months of the year for comfort during the day throughout the country, in addition to the month of March for the regions. Coastal months, April, and November for mountainous areas, while during the night the months of May and October are the best months of the year for rest during the night in all regions of the country.

6.3.5 Here is an additional study by Emily Muhammad Hamada and Jumaa Arhouma (2019) on the spatial variation in the impact of climate on human comfort in Libya. The study concluded that there is spatial variation in rates of temperature and relative humidity between the three regions of Libya that are geographically different, and this was followed by a difference in the degrees of a person's feeling of comfort or climatic discomfort, and then the ability and concentration at work, as it was found that the south of the country in general is more uncomfortable in the summer and the person feels hot and very discomfort, while in the north a feeling of complete comfort prevails.

6.3.6 There is also a study by Muhammad Sorour (2019) and study on the climate in the Libyan city of Sirte. The study concluded that heat loss predominates in the region, and the loss values increase with the winter months, exceeding 300 kilocalories/hour. The study also found that sweating stops in the winter, even when walking in the sun. The study also found that the comfortable months in the study area are March, April, and November.

6.3.7 There is another study by Hamad Sassi (2021) and the study has focused on the impact of climate on human comfort in the Jardas al-Abeed region. The study has primarily aimed to know the months that are comfortable and uncomfortable for humans in the region and by the end of his study he concluded that the months of May, June, July, August, September, and October are comfortable months for humans in the Jardas al-Abeed region, however, the months of November, December, and January February, March and April are uncomfortable months due to the extreme cold weather.

7. Area of Tolmitha Case Study

The Libyan ancient city of Ptolemais is situated along the Mediterranean coast about 100 km east of the modern city of Benghazi, It occupies a narrow space (about 2 km wide) between the sea and the lower spurs of the Jebel el-Akhdar (Green Mountain), it is situated between two valleys running from the hill of the Mountain to the sea, the valley of Ziwanah on the east and the valley Khambis on the west. As previously mentioned the city began as a Greek settlement founded in the 7th century BC and functioned as a port for the city of Barka known today as the city of Al-Marej (24 km inland). It is located on the eastern coast where an easy pass ascends the Al-Jabal al Akhdar (Green Mountain) towards Cyrene. The city later controlled the line of the Roman road to Cyrene. In the Hellenistic period (at least by the mid-3rd century BC)

the settlement was replaced by a new city called Ptolemais, founded by either Ptolemy I or Ptolemy III, Macedonian rulers of Egypt after the death of Alexander the Great in 323 BC. The early economic success of the city can be gauged by the fact it was invited to participate in the Panhellenic Games in Delphi in the late 3rd century BC. Ptolemais continued to flourish in the early Roman period and achieved a yet higher prominence in the early fourth century AD, when the city became the capital of the newly created province of Libya Superior/Pentapolis under Diocletian. At this time, Ptolemais surpassed Cyrene still suffering from the heavy damage incurred during the earthquake of 262 AD. Ptolemais was also the seat of an influential Christian bishopric in the Early Christian period. Subsequently the city decayed and Apollonia (Sozusa) supplanted it as capital. By the 18th and 19th centuries European explorers, visiting the area to catalogue the standing ruins, described the site as being abandoned. During the Italian occupation in the early 20th century, a colonial town was built next to the ancient harbour area and Italian fortifications and small forts in the area were constructed in the area.

7.1 Geographical location

The city of Tolmitha arose in the third century BC as a seaport for the city of Cyrenaica of Marej. When the Ptolemaic rulers of Alexandria extended their influence over the territory of the Five Cities in north-eastern Libya, they founded a city in place of the port. Furthermore, the figure 2 shows the exact location of the city of Tolmitha north of the city of Al-Marej on the map of Libya.



Figure (3): Tolmitha City north of the city of Al-Marj on the Libyan Map.

Figure Source: <https://ltc.highline.edu/teaching-excellence/assessing/assessmaa>

7.2 Climate Elements in Tolmitha

7.2.1 The Temperature Element in the Weather of Tolmitha

Temperatures in January is the coldest month of the year, reaches 12.15°C, and the minimum is 8.6°C. In summer, the average temperature reaches August is the warmest month of the year, reaching 28.4°C. The maximum temperature in August is 34.9°C, and the average annual temperature in the Tolmitha region is 21.19°C as shown next:

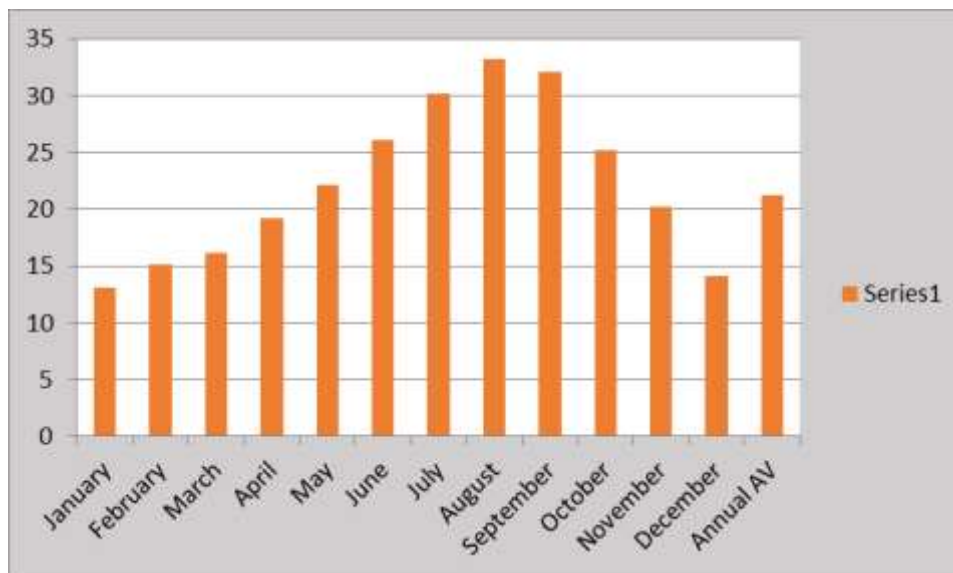
Table 1: The average monthly and annual temperature in Tolmitha

Month	Average monthly temperature
January	13.15
February	15.14
March	16.11
April	19.16
May	22.11
June	26.13
July	30.16
August	33.19
September	32.11
October	25.17
November	20.19
December	14;17
Annual Average	21.19

Source: Climate Data Org: 1982 – 2012

Furthermore, the below visual analysis of the average monthly and annual temperature in Tolmitha gives a deep look in human psychological comfort and stability as shown next:

Histogram (1): Visual analysis of the average monthly and annual temperature in Tolmitha



Source: Author's visual analysis work based on previous Climate Data

On the other hand, since the temperature and humidity index equation that we will use requires monthly temperatures in the Fahrenheit system, the monthly degrees Celsius have been converted to degrees Fahrenheit in the area of Tolmitha as shown in the following Table (2):

Table 2: The average monthly Fahrenheit degrees in the area of Tolmitha

Month	Average monthly temperature
January	23.67
February	27.25
March	16.11
April	29
May	39.77
June	47
July	54.28
August	59.19
September	57.79
October	45.30
November	36.43
December	25.50

Source: Climate Data Org: 1982 – 2012 converted to F Degrees ($^{\circ}\text{C} \times 9/5$)

7.2.2 The wind Element in the Weather of Tolmitha

Wind speed rates in the Talmitha area vary according to the seasons of the year, as their speed increases in the winter to be between 7.35-7.83 meters/second, while their speed decreases in the summer to be between 6.97-7.35 meters/second. The annual average wind speed in the Talmitha region is 18.7 meters/second. The following table shows the monthly and annual average wind speed in Talmitha as shown in Table (3).

Table 3: The monthly and annual average wind speed in Talmitha

Month	Average monthly temperature
January	7.32
February	7.80
March	7.52
April	7.51
May	6.97
June	6.95
July	7.32
August	7.21
September	6.83
October	6.49
November	6.83
December	7.35
Annual Average	7.19

Source: (NASA/POWER SRB/FLASH Flux/MERRA2/GEOS 5.12.4)

7.2.3 The Humidity Element in the Weather of Tolmitha

In winter, relative humidity rates are highest and recorded 75% in December. In summer times, relative humidity rates are lowest and recorded 55% in June. The annual average relative humidity in Tolmitha region is as follows 65% and the following Table (4) shows the average monthly and annual humidity in Tolmitha is shown:

Table 4: The monthly and annual average humidity in Talmitha

Month	Average monthly Humidity
January	67
February	74
March	68
April	60
May	54
June	53.5
July	66.2
August	68.5
September	64.9
October	70.5
November	72
December	78.8
Annual Average	66.4

Source: Climate Data Org: 1982 – 2012

7.2.4 Rainfall Element in the Weather of Tolmitha

Rainfall in the Tolmitha region comes in the winter with a rate of 60% and a total of 202 mm, as January is considered the rainiest month of the year, during which 84 mm falls, and the month of December, due to rain, 67 mm, and then the month of February, with a rate of 51 mm, and then March comes with success with 40 mm of rain. It is followed by November with 35 mm. The required amount of rain falls during the months of October and April and almost no rain during September and May. The risk of rain during the summer month in the Tolmitha region reaches 335 mm (Climate Data.Org).

7.2.5 Climatic classification of Tolmitha

According to the Köppen-Geiger climate classification, the Tolmitha region falls within the temperate steppes climate, which is symbolized by the symbol (BSK).

7.2.6 Applying heat and humidity guide to the Tolmitha area

By applying the temperature and humidity index equation to the months of the year in the Tolmitha area, the author obtained the following results as shown in Table (5):

Table 5: Results of applying the temperature and humidity equation to Tolmitha area

Month	Heat and humidity guide	Level of Comfort
January	52.18	Uncomfortably cold
February	52.99	Uncomfortably cold
March	56.07	Uncomfortably cold
April	60.80	Total comfort
May	64.91	Total comfort
June	68.08	Total comfort
July	71.46	Comfortable for 50% of the population
August	72.16	Comfortable for 50% of the population
September	70	Comfortable for 50% of the population
October	66.98	Total comfort
November	61.04	Total comfort
November	54.55	Uncomfortably cold

Source: Prepared by the researcher

From the previous table 5, it becomes clear to us that the cold months are the most uncomfortable months for humans in the Tolmitha area, while the uncomfortable period extends from December to March. As for the months, the comfortable period extends from April to June, as well as the months of October, November, July, August, and September. Partially comfortable for residents due to high temperatures

8. Study Findings and Conclusion

1- The climate elements that most affect human psychological comfort in the Tolmitha area are temperature and relative humidity.

2- The months of April, May, June, October, and November are considered comfortable months for humans in the Tolmitha region because of their warmth and the beauty of the sun, while the months of December, January, February, and March are uncomfortable months because of their coldness.

3- This research proved the importance of climate beauty for human psychological comfort and tranquillity.

4- The climate of Tolmitha and in Libya generally is one of the best in Mediterranean region and the entire world.

9. Study Recommendations

According to the results of this research, the authors strongly recommend that investing in human psychological comfort improvement in the area of Tolmitha is depending on the beauty and quality of the climate and local weather conditions taking into account the following advice:

1- Paying attention to the vegetation in Tolmitha is important for protecting the environment and having a nicer weather conditions.

2- The second advice is about establishing a comprehensive meteorological station in the Tolmitha area and the east coast of Benghazi to measure all climate elements.

3- The author also think that it is possible to benefit from the comfortable times for promoting tourism in Tolmitha.

4- The author recommends the local authorities to put in use non-polluting energy for heating during the cold months.

5- The researcher emphasizes the keenness to spread environmental awareness to reduce forest fires, throwing waste, and controlling animal grazing in the Tolmitha tourist area.

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