

Temperatures and Their Impact on Tourism Activity in Dhi Qar Governorate: An Applied Climate Study

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Abstract

Temperatures significantly impact individuals, affecting their health and comfort. Extreme temperatures, whether high or low, can hinder a person's ability to work and engage in various activities. Consequently, people seek to minimize the negative effects of temperature on their comfort by finding places that alleviate thermal discomfort. Tourism is particularly sensitive to temperature variations, thriving during times and seasons with moderate temperatures and a comfortable atmosphere. Tourist activity tends to increase during these favorable periods, while it declines markedly during seasons with extreme temperatures. This research investigates the impact of three climatic elements on tourism activity in Dhi Qar Governorate. The study adopts Thom's temperature hypothesis and the wind cooling hypothesis by Sabul and Basel to determine the types of comfort influencing tourism in the area, utilizing climatic data from the Nasiriyah station. The analysis identifies general comfort levels, both day and night, to ascertain the optimal times and months for tourism. The findings reveal that March and November are the most comfortable and ideal months for tourism based on general temperature and humidity. April and November are considered relatively comfortable, with 10% of tourists experiencing some discomfort. When examining temperature and humidity during the day, December and February are identified as the best months for tourism, providing complete comfort. March, November, and January are found to be relatively comfortable. Additionally, the study evaluates the effect of wind on tourist comfort using general temperature and wind speed data. The wind cooling hypothesis shows that winds significantly cool the atmosphere in April and October (primary degree) and in February and November (secondary degree), making these months colder. In contrast, the negative impact of winds becomes evident during the extremely hot summer months, making the weather unsuitable for tourism.

Keywords: *Thom's Index, Complete Comfort, Relative Comfort, Wind Cooling Hypothesis, Tourist Activity"*

INTRODUCTION

Dhi Qar Governorate boasts a variety of tourist attractions, including natural sites like the marshlands, historical locations such as the ancient cities of Ur and Larasa, and religious sites like shrines and sanctuaries. These destinations attract numerous tourists from different parts of Iraq, as well as from Arab and foreign countries. In 2022, the governorate welcomed 280,000 tourists, and in 2023, the number of tourists reached 220,000. The organization of trips and the selection of appropriate tourist destinations heavily depend on temperature, highlighting the need for effective tourism strategies to mitigate the negative effects of temperature on tourism activity.

The Study Covered Several Key Topics, Including

The First Axis: The Problem of the Study

The study addressed the following questions:

Do temperatures affect tourism activity in Dhi Qar Governorate?

Are there ideal months and times for engaging in various tourist activities in Dhi Qar Governorate?

Are there months and times that are unsuitable for tourism activity in Dhi Qar Governorate?

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Significance of the Study

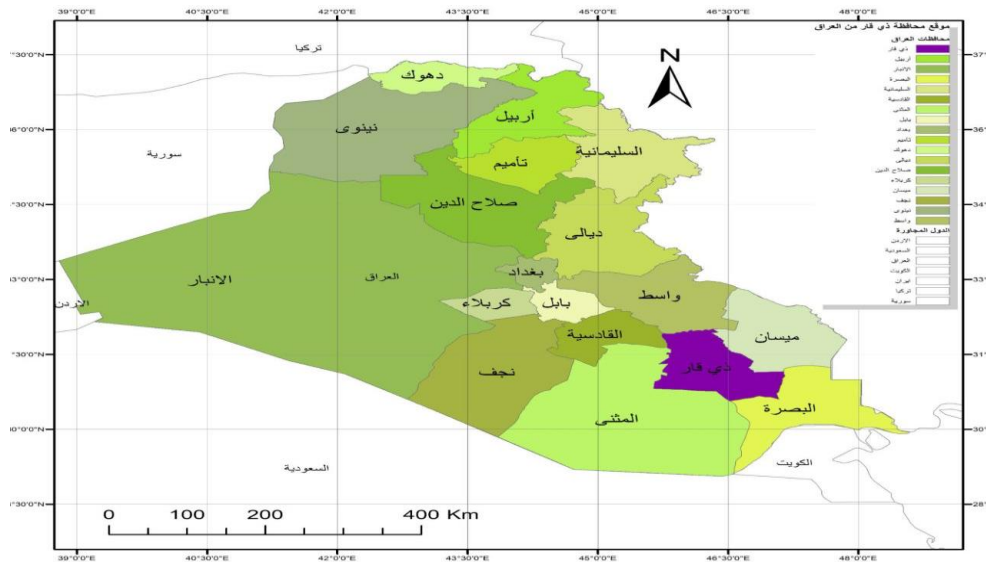
The study is important as it addresses the critical topic of how temperatures impact tourism activity. It also aims to assess the suitability of the study area for tourism, identifying whether it is conducive or not.

Objectives of the Study

- To elucidate the impact of temperature on tourism activity.
- To determine the best times and months for tourism activity.
- To propose solutions for mitigating the negative effects of temperatures on tourism.

Study Area Boundaries

Spatial Borders: Dhi Qar Governorate, located in southern Iraq between latitudes (30.33.31°) and (37.32.00°) north, and longitudes (45.36.12°) and (38.47.12°) east. It is bordered by Wasit Governorate to the north, Basra to the south, Maysan to the east, and Al-Qadisiyah and Al-Muthanna governorates to the west. The governorate covers an area of (12,900) km², accounting for 3.1% of Iraq's total area of (434320) km².



Map (1) Location of Dhi Qar Governorate in Iraq

Source: Based on Arc Gis 10.2

General Authority for Meteorology and Seismic Monitoring.

Temporal limits: Temporal limits Temporal limits are represented by the following: -

Time period for the number of tourists in the governorate: Data was collected related to the number of tourists (2022-2023), which concerns the number of tourists visiting the various tourist sites in the governorate.

Temporal period of climate data: represented by collecting climate data available from the Nasiriyah Meteorological Station for the period 1992-2022 AD.

The Second Axis: Climatic Elements Affecting Tourism Activity in Dhi Qar Governorate

Temperatures

The study area experiences high temperatures during the summer months. Data from Table (1) and Figure (1) show that normal temperatures peak in June, July, and August at 36.7°C, 36.8°C, and 36.4°C, respectively. In the fall, temperatures begin to decrease, with normal temperatures in September, October, and November

recorded at 26.4°C, 26.3°C, and 25.2°C, respectively. Winter sees a significant decrease in temperatures, with average normal temperatures for December, January, and February at 13.6°C, 12.3°C, and 16.0°C, respectively. Spring marks a gradual increase in temperatures, with March, April, and May recording 21.4°C, 26.4°C, and 31.8°C, respectively.

The average maximum temperatures at the Nasiriyah station exceed annual averages during the summer months, peaking in June, July, and August at 44.2°C, 45.4°C, and 45.5°C, respectively. In contrast, temperatures fall below annual averages during the winter months, with December, February, and January recording 8.3°C, 6.2°C, and 8.3°C, respectively. Neighboring stations report even lower temperatures during winter, with minimum temperatures in December, February, and January at 7.5°C, 5.8°C, and 7.2°C, respectively. Maximum temperatures reach their peak in June, July, and August at 42.5°C, 44.5°C, and 44.4°C, respectively.

Table (1) Temperatures at the Nasiriyah Meteorological Station for the period (1992-2022) AD

Temp.	Jan.	Feb.	March	April	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.	Annual rate
Ordinary	12,3	13,3	24,5	25,2	30,6	36,7	36,8	36,4	26,4	26,3	25,2	13,6	25,61
Maximum	18	20,5	31,5	32,5	32,1	44,2	45,4	45,5	33,4	33,2	23,4	19,5	32,35
Minimum	6,2	8,3	17,6	18,2	18,6	28,8	28,3	27,8	18,6	19,4	18,5	8,3	18,22

Source: Based on the Republic of Iraq, Ministry of Transport, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data.

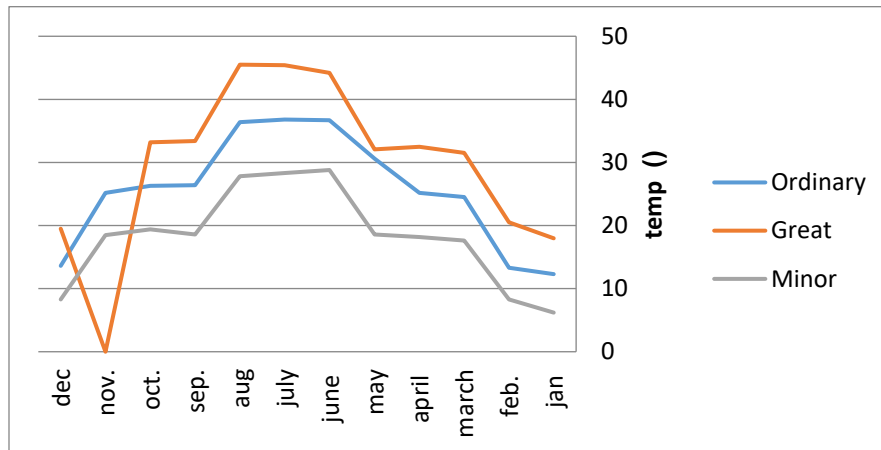


Figure (1) Temperatures for Nasiriyah station

Relative humidity: Relative humidity is considered to have an effective effect on a person’s comfort and activity. When the humidity rises, a person feels that the temperature is higher than what is recorded by the thermometer, because the process of evaporation from the body decreases or stops, which is responsible for lowering the body temperature.

It is clear from Table (2) and Figure (2) that the general relative humidity in Nasiriyah station recorded an annual average of (40%), as the percentage of humidity increases in the winter and decreases in the summer, as it is clear that the humidity in the winter season reached (56%). In January it was (59), while in February the humidity percentage reached (54). Then the humidity percentage gradually decreased to reach its lowest levels in the summer, where it reached for the months of June, July, and August (23%, 22%, 23%) respectively.

It is clear from Table (2) and Figure (2) that the maximum relative humidity reached its highest percentage in the winter, where it reached in the months of December, January, and February (91%, 94%, 84%) respectively, and the lowest percentage was recorded in the summer, when the humidity percentage reached The highest humidity is in the months of June, July, and August (38%, 37%, 39%), respectively. In the spring, the maximum

humidity is in the months of March, April, and May (81%, 65%, 52%), respectively. As for the fall months, September, October and November reached (46%, 68%, 84%) respectively.

As for the minimum relative humidity, it recorded the highest percentage in the months of February and November, reaching (24%) for both months, and the lowest percentage in the summer, where it reached in the months of June, July, and August (8%, 7%, 7%) respectively, as it is considered a hot dry season.

Table (2) Relative humidity % for Nasiriyah station for the period (1992-2022) AD

Month	General	Maximum	Minimum
Jan.	59	94	23
February	54	84	24
March	50	81	19
April	41	65	17
May	30	52	8
June	23	38	8
July	22	37	7
Aug.	23	39	7
September	27	46	8
Oct.	39	68	10
Nov.	54	84	24
Dec.	56	91	21
the average	40	65	15

Source: Based on the Republic of Iraq, Ministry of Transport, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data.

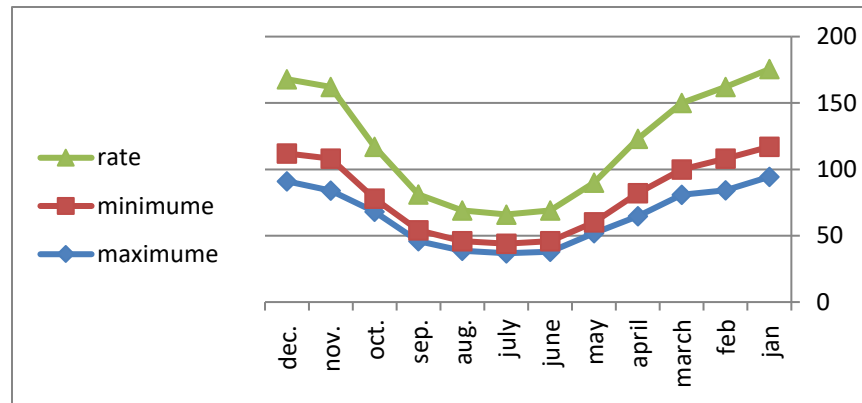


Figure (2) Relative humidity of Nasiriyah station

Source: Based on data from Table (3)

Wind

Winds play a crucial role in influencing air temperature, with varying speeds affecting the cooling or heating of the air. For instance, hot and dust-laden winds like the "Khamsin" in Egypt hinder tourist influx to certain areas. These winds, prevalent in spring, disrupt tourism and recreational activities. Similar effects are observed with the "fohn" winds in Europe and the "Santa Ana" winds in North America, impacting human health and behavior by increasing feelings of anxiety, sadness, distress, and insomnia. Conversely, very cold winds also restrict tourism activity.

Wind speeds typically increase during summer, with the highest average speeds recorded in June and July at 5.6 m/s and 5.6 m/s, respectively. August's average wind speed was 4.8 m/s. Wind speeds decrease in fall, with September averaging 3.9 m/s, October at 3.4 m/s, and November at 3.3 m/s. During winter, wind speeds further decrease, with December, January, and February averaging 2.9 m/s, 3.2 m/s, and 3.2 m/s, respectively. Wind speeds begin to rise in March, reaching 4.4 m/s, with April at 4.2 m/s, and May at 4.4 m/s.

Table (3) Wind speed at the Nasiriyah monitoring station for the years (1992-2022) AD

Month	Wind speed (m/s)
January	3,2
February	3,7
March	4,4
April	4,2
May	4,4
June	5,6
July	5,6
August	4,8
September	3,9
October	3,4
November	3,3
December	2,9

Source: Based on the Republic of Iraq, Ministry of Transport, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data.

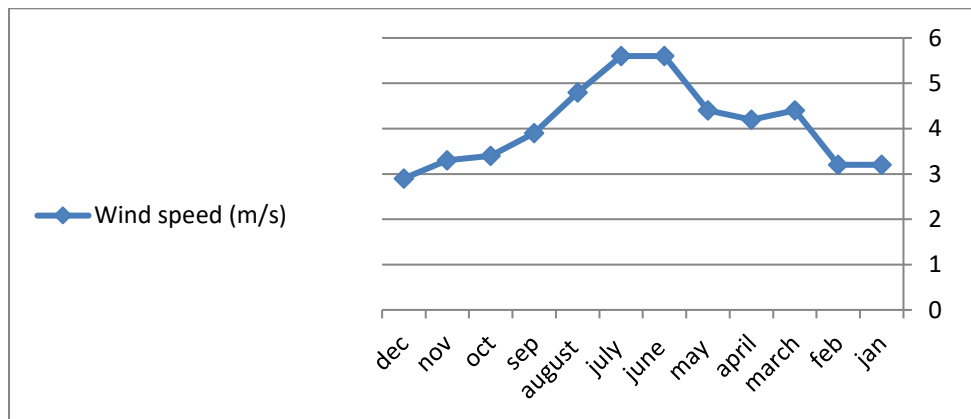


Figure (3) Wind speed m/s for the Nasiriyah monitoring station

Source: Based on data from Table (3)

The Third axis: The fourth axis: Analysis of climate data through climate clues used to measure comfort and discomfort for tourists in the study area:

Thom's Index (THI) (DI)

Thom's Temperature and Humidity Guide (THI) was developed in the United States in 1959 to measure human comfort under specific climatic conditions based on temperature, relative humidity, or dry temperature, as well as temperature, humidity, and dew point. This guide is used to express a person's sense of comfort by considering both heat and humidity. As humidity increases, a person feels the temperature is higher than the actual reading on the thermometer because the body's evaporation process decreases or stops entirely. Thom's index is used to determine the effect of heat and humidity on the human body, not the effect of cold, thus it has its limitations. It is specifically designed for hot areas and periods of the year where temperatures exceed 14.5°C (58°F). Thom's index is easy to apply and helps identify areas where a person feels comfortable, as well as distinguish between comfortable and uncomfortable periods for individuals. It has been adopted in the following context formula:

$$THI = T - (0.55 - 0.005 RH) (T - 14.5)$$

Since:-

THI- temperature and humidity standard.

T- Average temperature in Celsius.

RH- relative humidity.

The Thom Temperature-Humidity Index (THI) was used to measure the tourist’s feeling of comfort or discomfort and distress. Climatic data was adopted for all study stations, where the monthly averages of general temperatures were applied with the monthly rates of general relative humidity and the minimum temperature rates with the monthly averages. For maximum relative humidity to determine nighttime comfort, monthly averages of maximum temperatures were also applied with monthly averages of minimum humidity to extract daytime comfort. The results of Thom’s conjecture were as follows:

Temperature and humidity standard (THI) for the Nasiriyah station

First: The daily temperature and humidity standard: It is noted from Table (4) and Figure (,) that the THI value for the Nasiriyah station for the months of the year was as follows:

Winter season: The value of (THI) for the months of December, January, and February is (15.6, 12.9, 15) respectively. The tourist feels moderate discomfort.

Spring season: The month of March is considered one of the most comfortable months, as the value of (THI) reached (19). The month of April is considered relatively comfortable, with 10% of tourists feeling uncomfortable, as the value of (THI) in this month reached (22.5), while the month of May is considered a month of rest. It is annoying that the (THI) for this month reached (25).

Summer season: The summer months are months of great discomfort and great stress, as it is noted that the month of June reached the value of (THI) (26.6) and is considered a very annoying month for tourists. Likewise, the month of July is annoying and uncomfortable, as the THI reached (26.6), and also the month of August is annoying and uncomfortable. Comfortable with THI (25.8)

The autumn season is considered an uncomfortable and annoying month of September, as the THI in this month reached 25. Tourists feel relatively comfortable in the month of October, with the exception of 10% of them who feel uncomfortable, as the THI in this month reached 23.2. As for the month of November, the THI value reached (18.9), and it is considered a suitable month for tourism, as tourists feel completely comfortable.

Month	THI	Comfort type
January	12,9	Moderate discomfort
February	15,0	Moderate discomfort
March	19,0	Total comfort
April	22,5	Relative comfort (10% of people feel discomfort)
May	25,0	Moderate discomfort
June	26,9	discomfort (discomfort)
July	26,6	discomfort (discomfort)
August	25,8	Moderate discomfort
September	25,0	Moderate discomfort
October	23,2	Relative comfort (10% of people feel discomfort)
November	18,9	Total comfort
December	15,6	Moderate discomfort

Source: Based on data from Table (1) and Table (2)

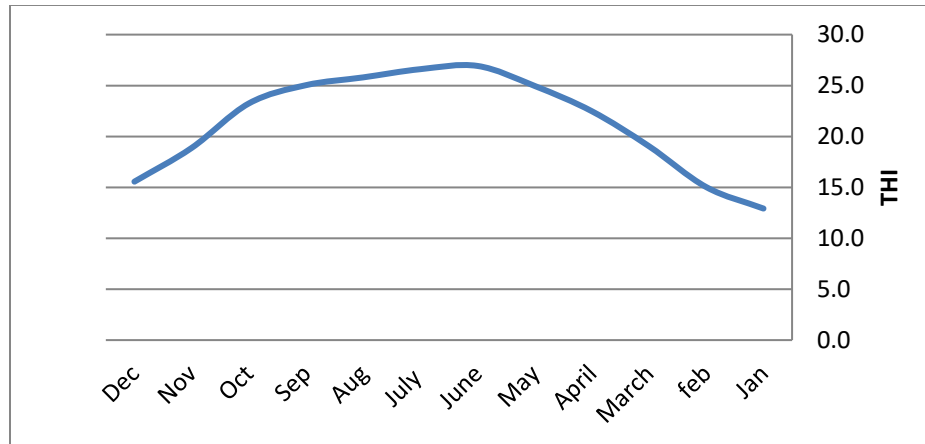


Figure (4) daily temperature and humidity standard for Nasiriyah station

The daily temperature and humidity standard for the Nasiriyah station: It is noted from Table (5) and Figure (5) that the daily THI value for the Nasiriyah station for the months of the year was as follows:

Winter season: The value of (THI) for the month of December is (19.6) and is considered a month of complete rest. The value of (THI) for the month of January is (16.5) and is considered a relatively comfortable month. The value of (THI) for the month of December is (16.5). As for the month of February, it is considered a comfortable month as the value of the THI reached (18.7) During this month, tourists feel completely comfortable.

Spring season: The month of March is among the months in which tourists feel completely comfortable, as the (THI) value for this month reached (21.4), and the month of April falls within the months of moderate discomfort, as the value (THI) for this month reached (24.7), while the month of May is considered a month of discomfort. Severe, as the THI for this month reached 27.1.

Summer season: The summer months are months of intense discomfort and great stress, as it is noted that the month of June reached the value of (THI) (30.1) and is considered a month of severe discomfort for tourists, and in the month of July the value of THI reached (29.9), and likewise the month of August is considered a month of extreme discomfort, as the value of THI reached (29.5) The summer months are very annoying due to the extremely high temperatures.

Autumn season: The month of September is considered uncomfortable and a month of great discomfort for tourists, as the THI value reached (28.7). Tourists also feel discomfort in the month of November, where the THI value reached (26.4). As for November, it is a month of relative rest for tourists, and 10% of them feel uncomfortable. The value of THI was (21.8).

Table (5) Standard daily temperature and humidity for Nasiriyah station

Month	THI	Comfort type
January	16,5	Relative comfort
February	18,7	Total comfort
March	21,4	Relative comfort (10% of people feel discomfort)
April	24,7	Moderate discomfort
May	27,1	Extreme discomfort
June	30,1	Extreme discomfort
July	29,9	Extreme discomfort
August	29,5	Extreme discomfort
September	28,7	Extreme discomfort
October	26,4	Extreme discomfort
November	21,8	Relative comfort (10% of people feel discomfort)
December	19,6	Total comfort

Source: Based on data from Table (1) and Table (2)

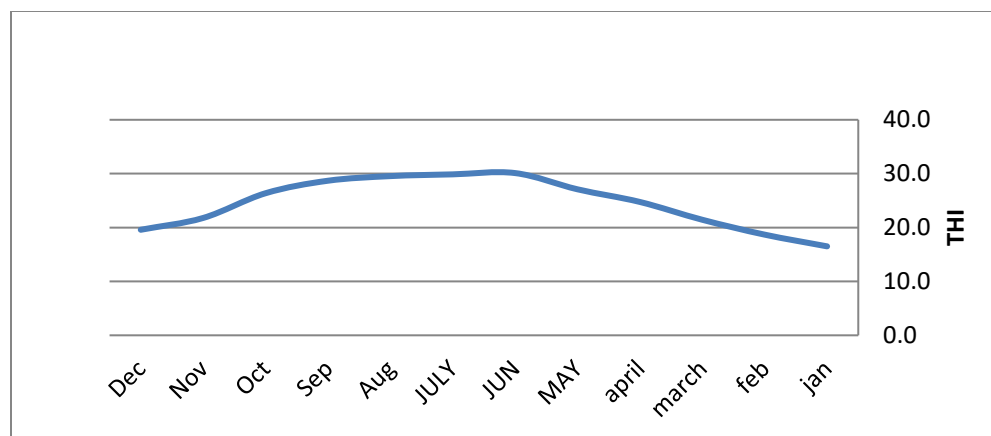


Figure (5) daily temperature and humidity standard for Nasiriyah station

Source: Based on data from Table (5)

Night temperature and humidity standard (for Nasiriyah station): - It is noted from Table (6) and Figure (6) that the night THI value for Nasiriyah station for the months of the year was as follows:

Winter: The winter months are extremely annoying and uncomfortable, as the THI value for the months of December, January, and February reached (8.6, 7.1, 9.2) respectively, and they are months that are not suitable for tourist activity.

Spring season: The month of March falls within the months of moderate discomfort, as the THI value reached (14.5), and the month of April falls within the months of complete rest, as the THI value reached (18.4), and likewise the month of May is considered a month of complete rest, as the THI value reached (20.8).

Summer season: The month of June, as well as the month of July, fall within the months of relative comfort, as tourists feel relatively comfortable, with the exception of 10%. They do not feel comfortable, as the THI value for the month of June reached (22.1) and reached (21.7) for the month of July, while the month of August falls within the months of complete comfort. The THI reached 20.1 and is considered suitable for tourism activity.

Autumn season: The month of September is considered a month of complete rest, as the THI reached (19.1). The month of October is considered a month of relative rest, as the THI reached (16.8). As for the month of November, it falls within the months of moderate discomfort, as the THI reached (13.8).

Table (7) Night temperature and humidity standard (THI) for Nasiriyah station

Month	THI	Comfort type
January	7,1	Annoying, severe discomfort (discomfort)
February	9,2	Annoying, severe discomfort (discomfort)
March	14,5	Moderate discomfort
April	18,4	Total comfort
May	20,8	Total comfort
June	22,1	Relative comfort (10% of tourists feel uncomfortable)
July	21,7	Relative comfort (10% of tourists feel uncomfortable)
August	20,1	Total comfort
September	19,1	Total comfort
October	16,8	Relative comfort
November	13,8	Moderate discomfort
December	8,6	Annoying, severe discomfort (discomfort)

Source: Based on data from Table (1) and Table (2)

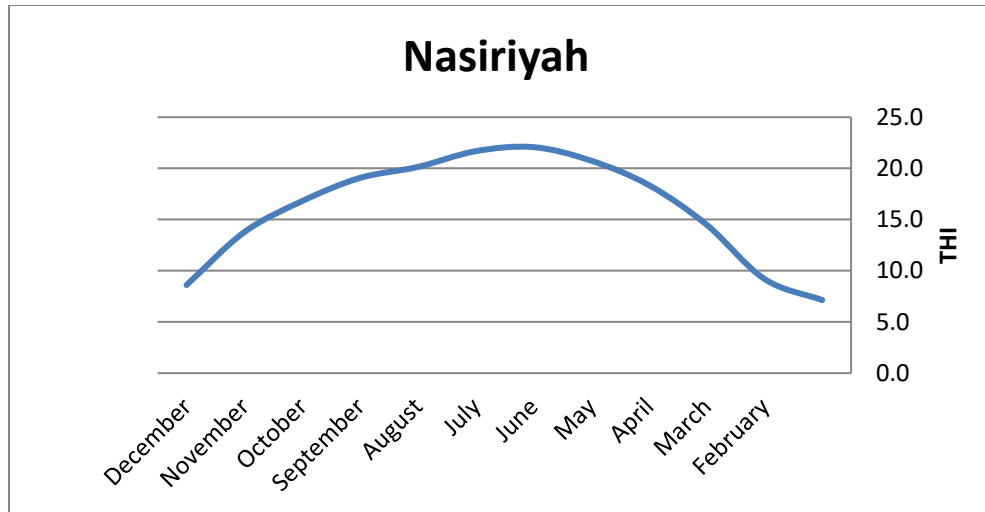


Figure (7) Night temperature and humidity standard for Nasiriyah station

Source: Based on data from Table (7)

Wind Chill Index (k)

This guide was developed by Spiel and Passel in 1954 AD and is based on wind speed and temperature. This guide takes the following mathematical formula:

$$K_0 = (100v + 10.45 - v)(33 - T_a)$$

whereas:

K_0 = Wind cooling coefficient (cal/m²/hour)

v = Temperature (°C).

T_a = wind speed (m/s)

The result of this evidence is compared to Table (7), which shows the wind cooling coefficient and the feeling that a person feels of the prevailing weather condition. If the wind cooling coefficient (K) is less than 50, the person feels the hotter atmosphere, and if the values of (K) are negative, the atmosphere is hotter than suitable for tourist activities. If the wind cooling factor is from (50-100), the weather will be warm and uncomfortable. If the wind cooling factor reaches (100-200), the weather will be pleasant and refreshing. If the wind cooling factor reaches (200-400), it will tend to be cold. If the wind cooling factor reaches (400-600), the weather tends to be cold and uncomfortable because of this. If the wind cooling factor reaches (600-800), the weather is cold. If it reaches (800-1000), the weather is very cold. If it reaches (1000-1200), The weather is extremely cold, and if it reaches (1200 - 2400), a person's exposed skin freezes, and if it reaches (1400 - 2000), a person's exposed skin freezes in a minute, but if it reaches more than (2000), then the weather becomes unbearable.

Table (7) The relationship between the wind cooling coefficient (K) and the weather condition felt by humans

Wind cooling coefficient K	Feeling the climate
Less than zero	Extreme heat (toxins)
Zero-49	hot (uncomfortable)
50-99	warm (uncomfortable)
100-199	Cute/comfortable
200-299	Cool (50% comfortable)
300-399	Tends to be cold (10% comfortable)
400-499	cold (uncomfortable)
500-599	Very cold (uncomfortable)
More than 600	very cold (uncomfortable)

The wind cooling assumption at the Nasiriyah monitoring station: It is noted from Table (8) and Figure (8) when applying the wind cooling assumption at the Nasiriyah station that:

Winter season: The month of December is cold and uncomfortable, as the (k) reached (420.3), and the month of January is very cold and uncomfortable, as the (k) reaches 516.6, and the month of February is also uncomfortable, as it falls within the cold category, as it reaches (k). (462.5) The winter months are considered unsuitable for tourist activity.

Spring season: The month of March is relatively comfortable, but it tends to be cold, with the value of (k) reaching 331.1. The month of April is pleasant and comfortable, with the value of (k) being 179.2, while the month of May is hot (uncomfortable), with the value of (k) being 40.5.

Summer season: All summer months are extremely hot and uncomfortable, as the value of (k) for the months of June, July, and August reached (-87.0, -77.0, -30.0), respectively, and they are months that are not suitable for tourist activity.

Autumn: The month of September falls within the uncomfortable, hot months, with the k value reaching (23.7), and the month of October is considered pleasant and comfortable, with the k value reaching 136.4, while the month of November is considered relatively comfortable, but tends to be cold, with the k value reaching 320.

Table (8): Results of the wind cooling (K) index for the Nasiriyah monitoring station

Month	K	Comfort type
January	516,6	Very cold (uncomfortable)
February	462,5	cold (uncomfortable)
March	331,1	Tends to cold (comfortable 10%)
April	179,2	Cute/comfortable
May	40,5	hot (uncomfortable)
June	-87,0	Extreme heat (toxins)
July	-77,0	Extreme heat (toxins)
August	-30,3	Extreme heat (toxins)
September	23,7	hot (uncomfortable)
October	136,4	Nice comfortable
November	320,2	Tends to be cold (comfortable (10%))
December	420,3	cold (uncomfortable)

Source: Based on Table (1) and Table (3) and applying the assumption of wind cooling

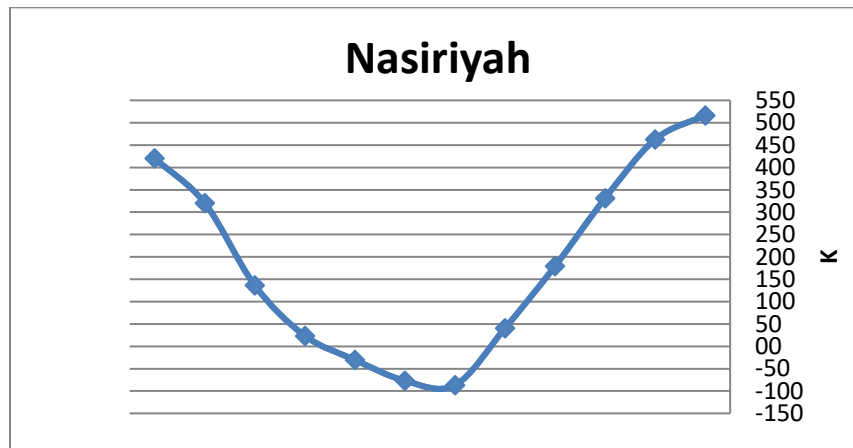


Figure (8) Wind cooling case (K)

Source: Based on data from Table (8)

Fourth Axis: Results and Recommendations / The study reached a set of results that can be summarized in the following points:

The climatic elements (temperature, wind, relative humidity) affect tourism activity in Dhi Qar Governorate. Suitability of the study area for tourism activity in some months.

It becomes clear when applying the general temperature and humidity assumption that there are two months that fall within the comfortable and ideal months for tourist activity, which are (March and November), and the months of relative comfort are represented by the months (April and October).

When applying the assumption of temperature and humidity during the day, there are two comfortable and ideal months suitable for tourist activity, which are (December, February), and the relatively comfortable months are (January, March, November).

When applying the nocturnal temperature assumption, it became clear that there are three months suitable for tourist activity during the night, which are (April, August, and September), while the months of relative rest are (June, July, and November).

When applying the presumption of daily and daytime temperature and humidity, it became clear that the summer months are annoying, uncomfortable, and unsuitable for tourist activity. It became clear when applying the presumption of nightly temperature and humidity that the summer months are comfortable, as the month of June and July fall within the months of relative comfort, while the month of August falls within the months of relative rest. Complete.

It is noted from the results of the wind cooling hypothesis that there is a clear effect of winds in cooling the atmosphere in the months (April and October in the first place) and February and November in the second degree, as these months tend to be cold.

It is noted from the results of the wind cooling hypothesis that the summer months are annoying and unsuitable for tourist activity, as the winds are extremely hot (poisonous).

It is clear from the results of the wind cooling hypothesis for the months of December and January that winds contribute to lowering temperatures, making the weather cold, uncomfortable, and unsuitable for tourist activity.

Recommendations

Planning tourism activities in the morning or evening by setting a tourism schedule In the morning or evening when temperatures are lower.

Creating a tourist guide to educate tourists about going to tourist sites, as well as promoting seasonal tourism to travel in the months and times that are pleasant and appropriate for tourism.

Educating tourists to avoid going to the study area in the summer.

Establishing tourist accommodation equipped with cooling facilities in the hot months to alleviate thermal discomfort.

Developing infrastructure by providing shaded and air-conditioned places for tourists in tourist areas.

Diversifying tourism activities to include indoor and air-conditioned activities, such as visiting the museum and holding art exhibitions, as these activities contribute to tourists enjoying the tourist destinations, even in the hot months.

Directing tourists to mitigate the effects of high temperatures by wearing appropriate clothing and drinking sufficient amounts of water to prevent dehydration.

Cooperating with local authorities to overcome the difficulties facing tourists.

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