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Determining the right time for tourism using the Rayman method (Case study: Alangdareh Forest Park, Golestan Province)

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ABSTRACT

One of the most important parameters affecting the quality of tourism is the climate and weather conditions of the tourist destination. Most of the studies have focused on the seasons and months that are suitable for tourism. However, to determine the right time for tourism, this study has examined the differences in hours conditions during the whole of the year in Alangdareh Forest Park, Golestan province. To do this, meteorological data from the statistical period (2017-2022) was used to calculate the average value of the SET index (standard effective temperature). Then, this index was evaluated as an indicator of thermal comfort using Rayman software. Meteorological data, including temperature, relative humidity, wind speed, and cloudiness were entered into the software five times a day. Based on the results, the comfortable days were divided into two separate periods. The first period starts in the middle of April and continues until the middle of May, and the second period is in October. The results of the SET index in terms of hours showed the best time for tourists to visit the park during the winter season is between 12:30 PM and 3:30 PM and during the summer season at 6:30 AM. This information can help tourists choose the best travel time according to their personal preferences. Additionally, the results indicate a continuous increase in the SET index during the six years of the statistical period which indicates a warming climate and a decrease in thermal comfort.

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1. Introduction

With the growth of the population and urbanization, there has been an increased demand for tourism in natural environments (Tavakkolinia et al., 2018). A significant factor influencing the quality of tourism is the climate at the destination, as visitors often seek the best weather conditions for a satisfactory experience (Lecha and Shakelford, 1997). The choice of tourism destinations is affected by suitable and favorable seasons, and weather is a crucial factor in selecting natural tourism areas (Karimi and MahboobFar, 2018). Weather and tourism have a reciprocal relationship, with weather being a determining factor in the tourism industry (Lecha and Shakleford, 1997).

Weather can be considered a natural capital that impacts environmental resources, the duration and type of tourism, the health of tourists, and even their personal experiences (Scott et al., 2004; Bakhtiari et al., 2018). To choose a tourist destination, important information is needed regarding the destination's weather, including daily, monthly, and seasonal changes in temperature, precipitation, humidity, radiation, wind, and other weather parameters. This allows tourists to plan their travel time, clothing, activities, and required equipment accordingly (Abedi et al., 2022). A better understanding of the climate and comfort conditions of a region facilitates more principled and accurate planning

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in various aspects of society, such as public health, tourism, climate therapy, and the design of resort spaces. Therefore, determining the appropriate times for tourism is necessary for effective and optimal planning in a region. Numerous studies have been conducted worldwide, including in Iran, on this topic. For instance, Yahia et al. (2013) evaluated the thermal indices of PET and SET in different outdoor environments during the summer and winter seasons in Damascus City. Their findings revealed significant differences in thermal conditions across various outdoor locations. Zare et al. (2018) studied the relationship between the UTCI index and other thermal indices (PET, PMV, PPD, SET, and WBGT) in Kerman City over a 12-month period in 2016. The results demonstrated a significant correlation between the UTCI index and other thermal indices, as well as dry temperature in the city, with the highest correlation coefficient observed between the UTCI index and PET. Davoodi et al. (2019) investigated the comfort of tourism in 11 synoptic and climatology stations in Gilan province using indicators such as PMV-PET-SET-TCI. The results indicated that the weather conditions in the year's first half were suitable for tourist visits. Ghorbannia et al. (2022) determined the tourism calendar of Yasouj City by using indicators such as SET, PET, and PMV derived from the Rayman model over a 30-year period. They found that comfortable conditions accounted for 6 to 7 percent of the total days in a year, with the PMV index being a better indicator of comfort conditions than the other two indices. Hanafi et al. (2023) evaluated and zoned the ecotourism calendar in the northwestern region of Iran using the Rayman model. The results showed that the best time for tourism activities in cities like Tabriz, Urmia, and Zanjan was from mid-May to late June and from early September to mid-October. However, in mountainous areas like Ardabil, Khalkhal, Sarab, and Meshkinshahr, the period of climatic comfort extended from early June to mid-September. Reviewing the aforementioned sources emphasizes the importance of determining the optimal time for tourism in Alangdareh Forest Park. With its unique natural features, beautiful environment, and close proximity to Gorgan city, the Alangdareh region is considered one of the most significant tourist areas in Golestan province. Given the influence of climatic conditions on tourist experiences and the growing influx of visitors to this area, it is crucial to assess the comfort conditions of Alangdareh Forest Park using the Rayman method and determine appropriate times based on weather conditions. This information can assist managers in planning peak tourist seasons effectively and help tourists choose the best time and place for their outings. Traveling and visiting the park in the most suitable climatic conditions can positively impact satisfaction levels and increase the desire for future trips. Identifying suitable and unsuitable periods based on daily data can enable the creation of a tourism calendar for the region.

2. Material and Methods

2.1. Introduction to the study area

Alangdareh Forest Park is recognized as one of Iran's popular tourist destinations in Golestan province, situated 5 kilometers southwest of Gorgan city. The park is located at longitude 54 degrees 26 minutes 44 seconds and latitude 36 degrees 47 minutes 47 seconds, covering an area of 268 hectares (Fig. 1). Alangdareh Forest Park has been designated as one of the 7 exemplary tourism areas in the country and is renowned as a prominent forest park in the northern region. The forest air is noticeably cooler, with temperatures being at least 5 to 10 degrees lower compared to the urban areas of Gorgan (Alangdareh Forest Park Plan, 2018). The average rainfall in this area is 515.6 mm, with the majority occurring in spring and winter. The minimum temperature recorded is -12.6 degrees Celsius, while the maximum temperature reaches +45.7 degrees Celsius (General Meteorological Department of Golestan Province, year 2022). This area holds great importance due to its natural features and strategic location near Gorgan city, making it a desirable destination for tourism and recreation. The significant presence of tourists throughout the year highlights the significant role of this region in fulfilling the recreational needs of both local residents and visitors from other areas.

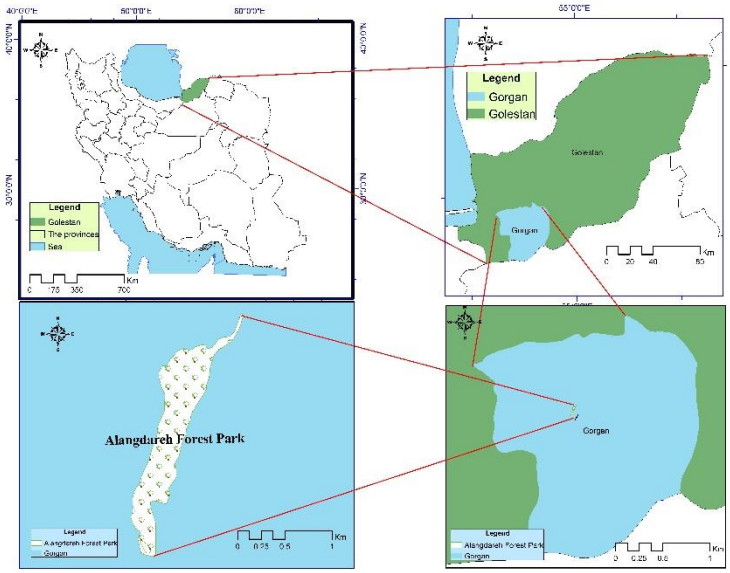


Fig. 1. Location the study area

2.2. Research Methodology

The evaluation of human thermal comfort is a well-established topic, as there has always been a need to assess the sensation of cold or heat. However, despite advancements in measuring indoor heat, there are still challenges in evaluating thermal comfort conditions in open environments. Researchers have proposed various indicators to evaluate thermal comfort in both indoor and outdoor spaces. One such index is the Standard Effective Temperature (SET) index (Zolfaghari, 2015). The effective temperature refers to the temperature of still air and saturated air that can have the same impact as the desired air without radiation (Halabian, 2008).

2.2.1. SET Index:

The effective temperature is calculated using Equation 1, known as the effective temperature formula. This index is expressed in degrees Celsius, and its threshold values are determined through Table 1. The Riemann model provides a more accurate calculation of this index.

Equation (1): (Baaghideh et al., 2013).

$$ET = T - 0.6(T - 10)(1 - RH/100) \quad (1)$$

T: Temperature in degrees Celsius

RH: Relative humidity in percent

Table (1) presents the threshold values of the SET Index for different degrees of human sensitivity (Matzarakis, 2001).

Table 1. Threshold values of SET Index in different degrees of human sensitivity (Matzarakis, 2001)

Thermal Sensitivity	Comfort factor
Super-hot	>30
Humid	27.5-30
Very hot	25.6-27/5
Hot	22.2-25.6
Comfort	**17.8-22.2**
Cool	15.5-17.8
Very cool	1.67-15.5
Cold	(-10) -(1.67)
Very cold	(-10) -(-20)
Extremely cold	< -20

In this research, our objective is to determine the right time for tourism in Alangdareh Forest Park using the Rayman model. This model has been utilized in previous studies to identify the appropriate timing for tourism (Davoodi et al., 2019). Since Alangdareh Forest lacks a meteorological station (thermometer, hygrometer, wind vane, etc.) and only has a rain gauge station, meteorological data including temperature in degrees Celsius, relative

humidity as a percentage, wind speed in meters per second, cloudiness in Oktas, etc., were collected from the nearby synoptic station in Hashemabad over a six-year period (2017-2022). These parameters were recorded five times a day at specific hours (03, 06, 09, 12, 15), which correspond to universal times (6:30 AM, 9:30 AM, 12:30 noon, 3:30 PM, and 6:30 PM) local time. Subsequently, the Rayman software (version 12) was employed to calculate the SET index by inputting the collected parameters. For using this software, the location, geographic coordinates, station height, and climatic parameters (temperature, humidity, wind speed, cloud cover) were entered as input data. The software defaults to the data regarding Table 2. Finally, after inputting the statistics for all 365 days of the year, the output was exported as a Notepad file and analyzed in the Excel software environment. Using the aforementioned indicators, the appropriate day and time for tourism in Alangdareh Forest Park were determined, specifying the year, month, day, and time.

Table 2. The conductivity value of different clothes (Razjooyan, 1988)

Clothing collection	Failure value in Kilo
naked	0
britches	0/1
Thin cotton underwear with short sleeves and cotton socks	0/35
Short sleeve thin cotton underwear with cotton socks and collared shirt sleeve shirt	0/5
Light pants, vest, long sleeve shirt and coat	1
Light pants, vest, long sleeve shirt and coat + cotton coat	1/5
Eskimo clothes	3/5

3. Results and discussion

Alangdareh Forest Park is widely recognized as one of the primary tourist attractions in Gorgan, owing to its stunning natural beauty. Optimal weather conditions greatly enhance the experience of visiting this park, increasing satisfaction and fostering a desire for future trips. Through the analysis of daily data, it is possible to identify both suitable and unsuitable periods, thereby permitting the creation of a tourism calendar for this region. The Rayman model was employed to calculate the Standard Temperature Index (SET) for the designated statistical period, including hourly, daily, and monthly averages. The resulting SET values were subsequently categorized based on thermal sensitivity. As depicted in Fig. 2, the highest SET index value was recorded in 2020 at 22.47 degrees Celsius, while the lowest value occurred in 2019 at 18.27 degrees Celsius. Generally, there is a gradual increase in the average SET index, apart from a noticeable decrease observed in 2019. This trend suggests that as the SET index rises, the region tends to become warmer and less thermally comfortable (Table 3).

Table 3. Monthly average SET (°C) for HashemAbad station 2017-22

Month Year	January	February	March	April	May	June	July	August	September	October	November	December	Average
2017	9/96	10/58	16/02	20/77	26/34	27/64	30/11	31/50	27/62	21/58	15/39	9/96	10/58
2018	5/89	12/33	17/85	18/14	25/80	26/78	32/41	28/23	26/22	21/72	14/03	5/89	12/33
2019	11/01	13/77	15/86	17/79	24/90	29/39	28/69	28/29	22/84	14/67	6/27	11/01	13/77
2020	7/77	14/48	18/27	20/56	29/45	31/92	33/13	29/50	30/54	24/55	17/13	7/77	14/48
2021	6/48	9/53	12/25	20/72	24/91	29/61	29/78	31/46	26/11	18/59	13/92	6/48	9/53
2022	8/25	13/91	16/68	23/07	24/18	28/53	28/98	30/52	27/39	23/72	15/98	8/25	13/91
Total Average	8.23	12/48	16/16	20/18	25/93	28/98	30/52	29/92	26/79	20/81	13/79	9/53	20/27

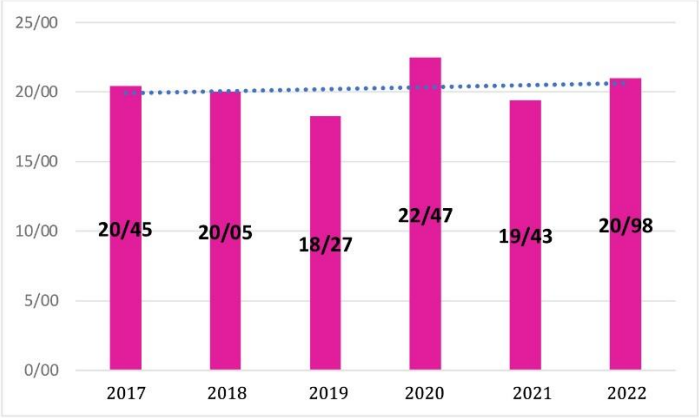


Fig. 2. Graph of average trend of SET index (°C) for Hashem-Abad station 2017-22

Fig. 3 presents the climatic conditions that offer comfort throughout the year. The vertical axis represents the months, while the horizontal axis represents the days of each month. The diagrams below illustrate the duration of comfort in terms of hours. The findings reflect the average SET index over a span of 6 years. As depicted in Fig. 3, 12% of the analyzed days exhibited thermal comfort conditions. These favorable conditions are most prominent in October and occur sporadically in April, May, and September, amounting to a total of 45 days in a year. Additionally, cold weather characterizes 49% of the year, which can be divided into two distinct periods: the first period starting from January and lasting until April, and the second period starting from the end of October and lasting until December. This cold weather persists for a total of 178 days in the statistical period. Furthermore, the results indicate that 39% of the year experiences hot to extremely hot weather. This period is concentrated in May, June, July, August, and September, totaling 142 days in a year.

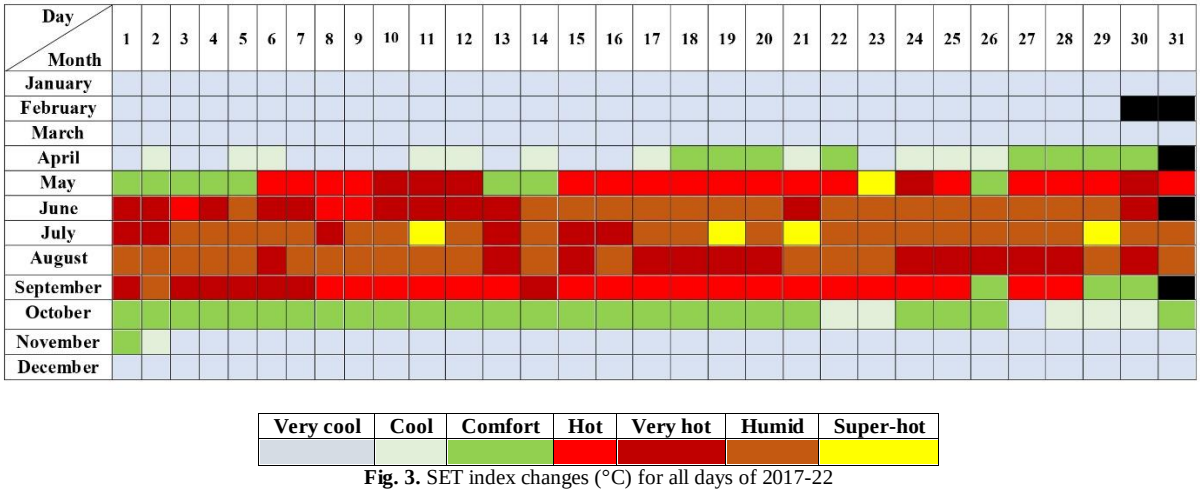


Fig. 3. SET index changes (°C) for all days of 2017-22

Fig. 4 depicts the weather conditions of the region in terms of percentages. Based on the SET index, the highest frequency percentages are observed for very cool, hot, comfortable, very hot, warm, and cool weather conditions, respectively. Extremely hot weather conditions exhibit the lowest frequency percentage, in line with meteorological data.

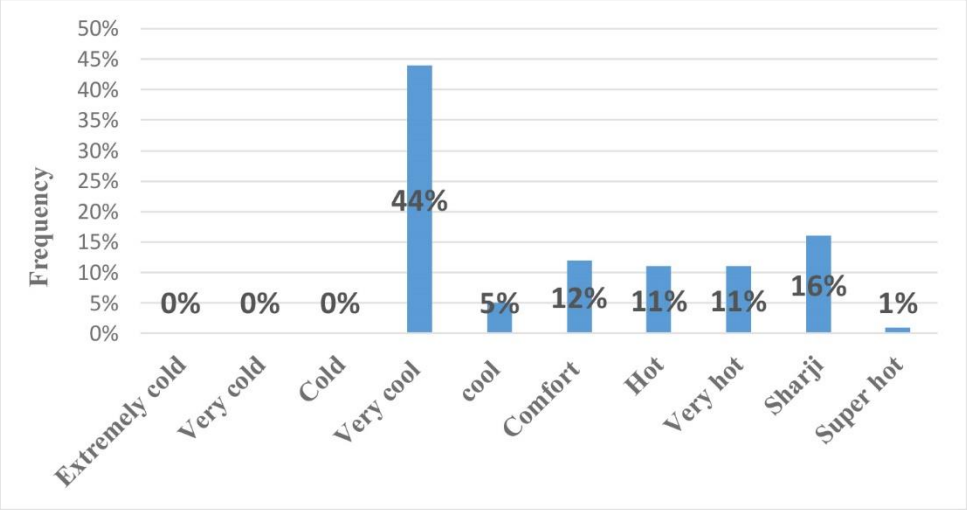


Fig. 4. Graph of climatic conditions in terms of SET index percentage

3.1. Determination of thermal comfort times

To visually represent the hourly comfort levels during specific months, a radar (spider) chart has been utilized, employing different colors to indicate varying comfort levels. Based on the analysis of Fig. 5:

• In January, comfortable conditions were observed only at 12 o'clock on a limited number of days (approximately 12%).

• During February, the most favorable conditions were found at 12 o'clock on a few days (around 18%).

• In March, comfortable conditions prevailed at 09:00, 12:00, and 15:00 on the majority of days (approximately 77%).

• April exhibited comfortable conditions at 09:00, 12:00, and 15:00 on most days (around 85%).

• May showcase the most comfortable conditions at 06:00 for the majority of days (about 90%).

• June exhibited the most favorable conditions at 06:00 on nearly all days (approximately 96%).

• For the entirety of July, comfortable conditions were recorded solely at 03:00.

• August displayed the most comfortable conditions at 03:00.

• In September, the majority of days (about 93%) fell within the range of comfortable conditions at 03:00.

• October witnessed the most comfortable conditions at 15:00 on most days (approximately 71%).

• November exhibited the most comfortable conditions at 12 o'clock on over half of the days (around 60%).

• December showcased the most comfortable conditions at 12 o'clock on a few days (about 13%).

In Fig. 5 AV.T.3 to 12 of these graphs describes:

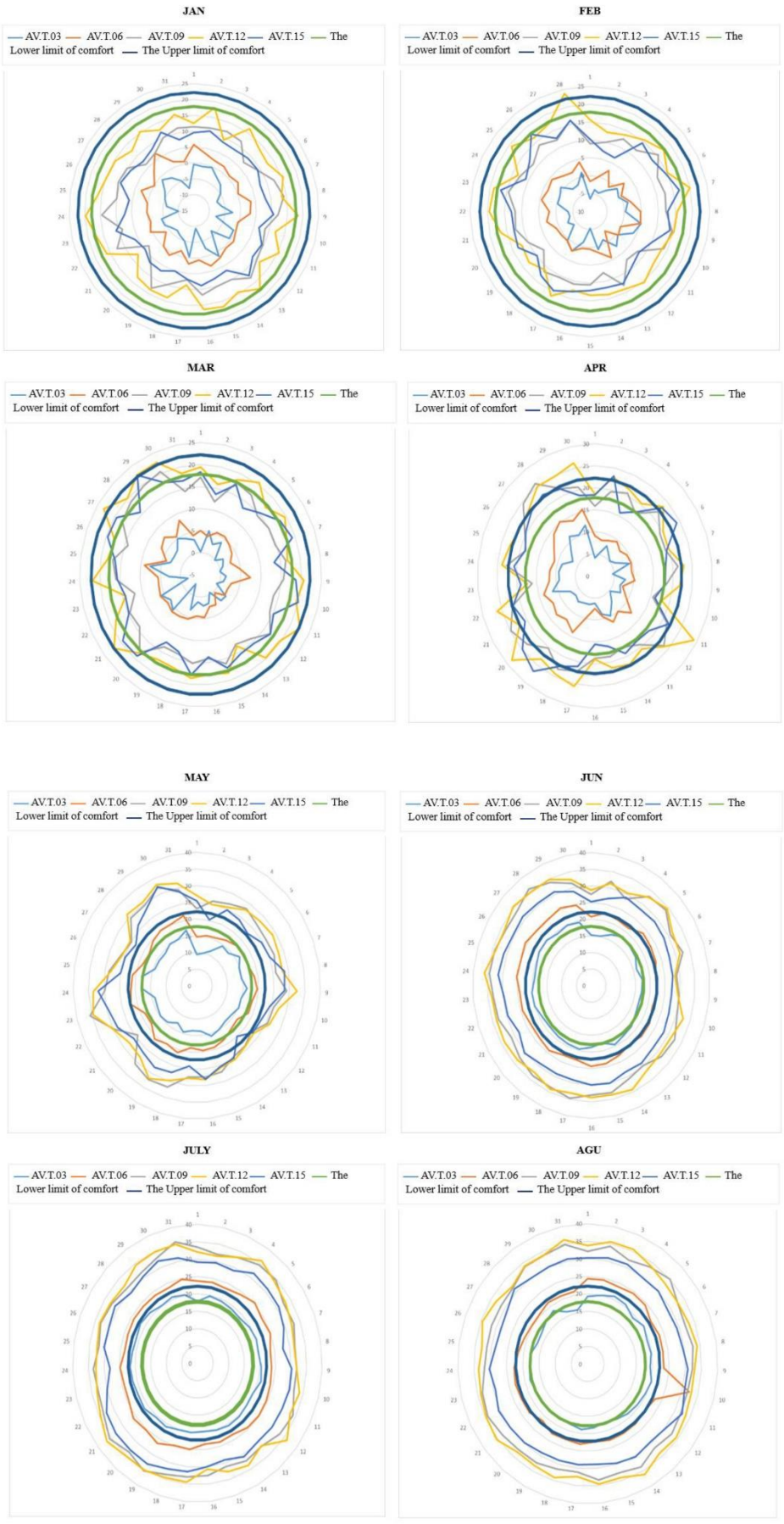
AV.T.03: The average 03 GMT in the years 2017 to 2022

AV.T.06: The average 06 GMT in the years 2017 to 2022

AV.T.09: The average 09 GMT in the years 2017 to 2022

AV.T.12: The average 12 GMT in the years 2017 to 2022

AV.T.15: The average 15 GMT in the years 2017 to 2022


JAN
AV.T.03 AV.T.06 AV.T.09 AV.T.12 AV.T.15 The Lower limit of comfort The Upper limit of comfort
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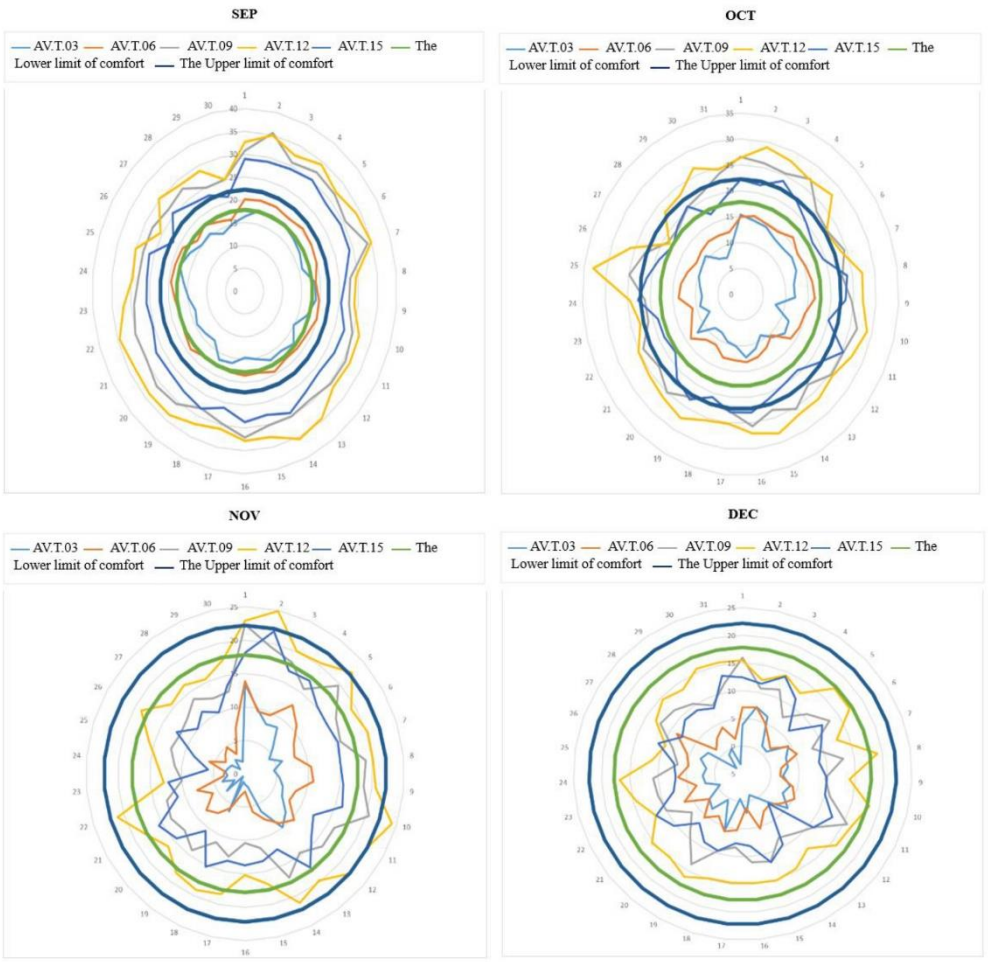

Fig. 5. Thermal comfort times of the statistical period (2017-2022)

Previous studies have also demonstrated that the use of Riemann's method in determining the appropriate time for tourism can yield satisfactory results in distinguishing the levels of thermal comfort throughout the day. However, none of these studies specifically focused on determining the optimal time for tourism in recreational areas. Shojaa et al. (2018) employed the SET index and the Riemann model to determine the best time for tourism in Urmia. Khorasani et al. (2015) conducted an hourly evaluation of climatic comfort conditions on Qeshm Island, using the SET index. Alijani et al. (2016) compared various comfort indices to assess the comfort level in Tehran and identified 9:30 am and 3:30 pm as times of thermal comfort. Ghorbannia et al. (2021) determined the thermal comfort calendar in Sabzevar City, demonstrating the climatic comfort during two periods in autumn and spring. Previous research has been conducted in the field of determining the appropriate time for tourism, but this study focuses on a tourist destination.

4. Conclusion

As mentioned in the research methods section, the Riemann tool was utilized in this study to calculate the SET index for evaluating the thermal comfort of Alangdareh Forest Park. The purpose of this study was to determine the most suitable time for tourists to visit the park. Based on the results obtained in this study, the highest SET index in the study area was recorded in 2020, reaching 22.47 degrees Celsius, while the lowest was observed in 2019, with 18.27 degrees Celsius. In accordance with the defined thresholds, thermal comfort conditions, based on the SET index, were experienced between 17.8 and 22.2 degrees Celsius. Overall, during the statistical period analyzed in this study, aside from 2019 when a noticeable decrease in the average SET index was observed, there was a gradual upward trend with a slight slope. Consequently, the period of thermal comfort decreased. According to the SET index, 12% of the year's total days were within the range of thermal comfort conditions. These comfortable conditions were most

prevalent in October and scattered throughout April, May, and September, totaling 45 days in a year. Around 49% of the year's days were subject to cold restrictions. This restriction was divided into two separate periods: the first spanned from January to the end of April, while the second extended from the end of October to the end of December, accounting for a total of 178 days within the entire statistical period. Heat limitations, ranging from hot to extremely hot, affected 39% of the year's total days. These limitations were most prominent in the months of May, June, July, August, and September, encompassing a total of 142 days. Furthermore, the SET index results revealed that the most favorable time for tourists to visit the park during the winter season was from 09:00 to 12:00 GMT, while during the summer season, the best time was at 03:00 GMT, aligning with the region's climatic conditions. The continuous increase in the SET index over the six-year period of study indicates climate warming and a decrease in thermal comfort. This information can assist tourists in planning their visits to the resort according to the appropriate time and weather conditions, enhancing their overall experience. Moreover, it not only aids in optimizing the tourist experience but also enables tourism managers to tailor their programs accordingly and contribute to the development and promotion of the tourism industry.

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