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Evaluation of Climate Comfort for Tourism in Arasbaran Forest Region (Gharedagh), Northwest Iran

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Abstract
Forest visits are one of the most important ecotourism activities and Arasbaran Forest is renowned for being a unique destination for nature-based tourism in northwest Iran. This study was conducted to assess the tourism climate potential of Arasbaran Forest using Tourism Climate Index (TCI) and Holiday Climate Index (HCI). Analyses indicated that the most optimal climatic conditions occurred during the spring and summer seasons in the region. The TCI results classified the study area as falling within the "Excellent" to "Ideal" categories with values ranging from 86 to 92. The spring and summer seasons were the most pleasant for tourism activities between 2001 to 2018. HCI results indicated that the study area also falls within the "Excellent" to "Ideal" categories with values of 86 to 94 and the spring season was particularly pleasant for tourism activities between 2001 to 2018. These seasons were chosen mainly due to the moderate improvement in thermal comfort during the spring and summer compared to surrounding areas, a slight increase in sunny hours during the tourism season, as well as more frequent holidays in the summer months. These results provide valuable background information for decision-makers in the tourism industry.

Keywords: Climate Comfort, Forest, TCI, HCI, Tourism.

1. Introduction
Climate studies have shown that changes in the Earth's climate will occur at an unprecedented rate in the 21st century. As awareness grows regarding the risks and opportunities presented by climate change, the application of climate knowledge is becoming increasingly crucial for decision-making across various sectors, particularly in the tourism sector which is sensitive to climate. The spatial and temporal pattern of tourism demand are expected to be directly affected by rising temperatures or indirectly by factors such as rising sea levels, loss of snow cover, or changes to the landscape (Rossello-Nadal, 2014; Damm et al., 2020). On the other hand, tourism has become one of the most significant contributors to national and local economies worldwide with a close relationship to climate, and the influence of climate on destination attractiveness can impact where and when tourists choose to travel. Assessing climate suitability for tourism has become an important tool for decision-making within the tourism industry (Scott et al., 2016).

Climatic considerations and conditions of a destination are essential information in the tourism industry. Most nature tourists consider the climatic conditions of a region. Climate influences the environmental resources of tourist destinations, serves as a key resource, and significantly impacts the quality of both the region and tourist experience. Climatic indicators provide information about a destination's weather throughout the year, allowing tourists to choose the optimal time to travel based on desirable conditions. Thus, these indicators can serve as valuable guides

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for identifying areas with tourist potential. Expanding the tourism industry in the country is achievable through investment in these areas. Thermal comfort refers to psychological and physiological comfort of an individual which is influenced by specific temperature and humidity (Sarisaraf et al., 2010). Identifying indicators of greater tourism comfort is very important. The climate comfort of an area is an effective factor in attracting or deterring tourism and is a valuable tool for ecotourism planners who need information on conditions before, after, and while visits to nature. Comfort indices are indicators that reflect the combined effect of all factors influencing comfort (Yazdanpanah et al., 2013).

The effects of climate conditions have led to shifts seasonality opportunities for outdoor activities. It has altered the frequency and intensity of weather events such as droughts, floods, and windstorms, etc. Accordingly, there is a need for indices that are adaptable to both the tourism and climate sectors and adjust appropriately to the current conditions. Overall, providing an easy, quick, and objective view of the relationship between climate conditions and tourism attractiveness should be the main feature of these indices (Rossello-Nadal, 2014). The first work in tourism climatology was done by Mieczkowski (1985) who developed the Tourism Climate Index (TCI) to investigate the impact of climate on tourism activities. (Ma et al., 2020; Kovacs & Unger, 2014; Gandomkar & Mohseni, 2011). As mentioned, this indexing approach considers three climate resources as weather conditions that influence the demand for or satisfaction with nature-based outdoor activities. Accordingly, the "thermal" sources consider the perceived thermal comfort based on the atmospheric conditions including temperature and relative humidity. The "physical" resource considers special meteorological parameters such as precipitation and wind speed and the "aesthetical" resource considers the scenic comfort based on prevailing synoptic conditions such as sunshine hours (Ma et al., 2020). The TCI was designed to integrate the main climate variables related to general tourism activity into a single numerical index. It provides a composed measure capable of facilitating an interpretation of destination climate and has been applied to assess future climate sustainability (Scott et al., 2016). Therefore, TCI is particularly valuable because it allows the integrated effects of a range of climate variables to be quantified, facilitated, and interpreted at a rating of climate condition and objectively compare to the tourist destinations. This index relies on thresholds and classifications, which determine a range of qualitative and quantitative scales for each parameter (Dubois et al., 2016). TCI is also known as a useful index due to the widespread availability of climate data for its calculation at most locations. Climate-related changes in tourism are reflected in TCI scores and both negative and positive impacts have been estimated as an important element of nature-based tourism is vulnerable to climate change (Scott & McBoyl, 2001).

The Holiday Climate Index (HCI) is another tourism climate index that addresses the weakness of other indices and is designed to more accurately assess the climatic suitability of tourism destinations. HCI aims to better understand tourist climate preferences. This index incorporates three climate variables: thermal (thermal comfort), aesthetical (cloud coverage), and physical (precipitation and wind) components (Scott et al., 2016; Hejazizadeh et al., 2019; Rutty et al., 2020).

Previous studies have shown that the TCI is commonly used to describe the climate conditions suitable for tourism activities, development, and planning. Nemeth (2013) analyzed the long-term datasets from synoptic stations using the TCI to illustrate changes in the tourism climate potential over the past half-century of the Lake Balaton region of Hungary. The results showed that the best climatic conditions for tourism were observed in the summer months. Moreover, the tourism climate potential of the region changed over the past 50 years and significant changes can be detected in February. Kovacs & Unger (2014) characterized climatically unfavorable places and periods of the year in Hungary using a modified TCI. The results indicated that the most optimal climatic conditions are found in the shoulder seasons which are the travel period between the peak and off-peak seasons. The summer period is more unpleasant for outdoor tourism activities mainly due to the intense heat. Dubois et al. (2016) examined the reliability and

applicability of the TCI and assessed the impacts of different holidays on the definition of index thresholds, focusing on thermal comforts in France and the Mediterranean basin from the climate service perspective. Scott et al. (2016) compared the HCI and TCI to achieve a more accurate assessment of climate suitability for leisure tourism across Europe. Scott & McBoyl (2001) explored the impact of climate on tourism by using the TCI in 17 cities across North America. They demonstrated that all candidate cities had a summer-peak tourism distribution, while cities in the southern parts displayed a winter-peak or spring–autumn tourism peak distribution. Rutty et al. (2020) compared the HCI and TCI to explain the relationship between destination climate and tourist arrivals in the Caribbean and provided an overview of the evolution of climate indices.

The purpose of this research is to promote tourism in the region. Therefore, it is necessary to establish a timescale for tourism in this region. This study assesses the impact of climatic conditions on the tourism sector. We examined the potential of Arasbaran Forest area, the most visited region in northwestern Iran. This study identified the most favorable climatic conditions across seasons, including the length, quality of tourism seasons, and peak months of tourism activity, which had not been previously reported in this region, and emphasized the need to use the TCI and HCI indices to understand the relation between tourism and climate.

2. Materials and Methods

2.1. Study area and climate data

The study area was the Arasbaran Forest area, located at 38° 43’ 41” N – 39° 8’ 11” N latitude and 46° 39’ 50” E - 47° 1’ 48” E longitude. The forest protection policy was implemented in 1973, and this region was placed on the list of the international network of biosphere reserves by UNESCO in 1977 (Sagheb-Talebi et al., 2014; Sasanifar et al., 2019) (Figure 1).

Iran is one of the five countries with such significant climate variation, offering a rich biosphere that serves as an important criterion for tourism. The Arasbaran region is located in the northwest of Iran. It is one of the most mysterious places in Iran, known for its tourism potential. This region is one of the nine most valuable biosphere reserves in Iran, home to diverse and significant plant species and a unique wildlife reserve. Due to its diverse biosphere, valuable biological conditions, and rich flora and fauna; the Arasbaran region was designated as the most resourceful biosphere by the UNESCO. Therefore, this region possesses significant potential and features for the tourism industry (Mobaraki & Eslami, 2016).

The 18 years (2001-2018) of climate data, including minimum temperature, maximum temperature, mean temperature, precipitation, wind speed, relative humidity, and sunshine were obtained from the Kalibar meteorological station (38° 52′ N latitude and 47° 01′ E longitude). All data were averaged monthly for the observation period.

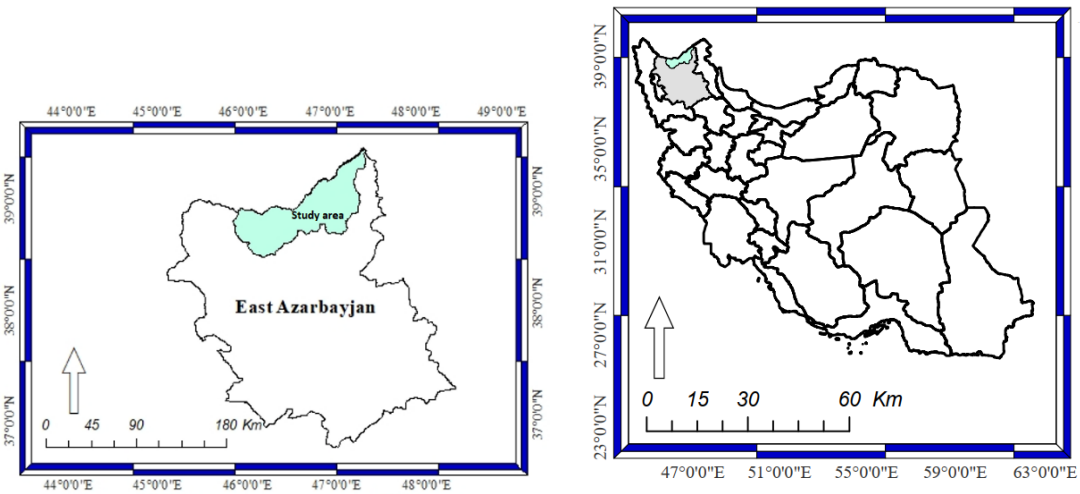

Figure 1. The geographic location of the study area in northwest of Iran

2.2. Methods

2.2.1. Mieczkowski's Tourism Climate Index (TCI)

TCI is one of the most common indicators for the study of climate-based tourism. It is used to present a quantitative and qualitative classification measurement for evaluating the effects of climate variables on tourism activities through a single index containing five weighted sub-indices:

CID: Daytime Comfort Index, which is a combination of daily maximum temperature (°C) and minimum daily relative humidity (%). The highest weight, 40%, is given to the CDI to reflect the period when maximum tourist activity occurs during the day (usually between 12 a.m. and 4 p.m.) (Table 1).

CIA: Daily Comfort Index, which is a combination of daily mean temperature (°C) and daily mean relative humidity (%). This index carries a 10% weight in the TCI formula over a full 24-hours period (Table 1).

Precipitation (mm): Total precipitation is given the second highest weight (20%) due to its negative impact on tourism activity (Table 2).

Sunshine (hours (h)): Sunshine duration is given the second highest weight (20%) due to its positive impact on tourism activity (Table 3).

Wind speed (km/h or m/s): Wind speed is given a 10% weight, with varying impacts depending on its value and maximum temperature (Table 4).

The TCI (Equation 1) uses a scale of 1 to 5 to rate each of its components (Tang, 2013). Each of the sub-indices is assigned a rating from a score of 5.0, contributing to the maximum score of 100 (ideal for tourism) and a minimum score of 30 (impossible for tourism) used to calculate the index in Equation 1 (Kovacs & Unger, 2014; Scott *et al*., 2016) (Table 7).

$$TCI = 2 \times [4(CID) + CIA + 2P + 2S + W] \quad (1)$$

Where TCI is the tourism climate index, CID is the daytime comfort index, CIA is the daily comfort index, P is the precipitation index, S is the sunshine index, and W is the wind index.

2.2.2. Holiday Climate Index (HCI)

The HCI (Equation 2) uses daily climatic data for calculation and was designed to use a ten-point scale for each of the climatic variables (a scale of 1 to 10 to rate each of its components) (Tang, 2013) (Table 7). To calculate this index, three components must be calculated and then combined in the final formula for computing HCI:

$$HCI = 4(TC) + 2A + 3P + W \quad (2)$$

Where TC: Thermal comfort (the combination of maximum temperature (°C) and average relative humidity (%), Table 1), A: Aesthetic (cloud coverage (%) (Table 3), P: precipitation (mm) (Table 5), W: wind speed (km/hour) (Table 6)

Table 1. Thermal Comfort (°C) of TCI (Tourism Climate Index) ratings scales (Tang, 2013; Scott et al., 2016)

TCI (Tourism Climate Index)		**HCI (Holiday Climate Index)**
Rating	**Thermal Comfort (°C)**	**Rating**
0	≥ 36	≥ 39
		37-39
1	34-35	35-36
2		
3	32-33	33-34
4		
5	30-31	31-32
6		
7	29	29-30
8	28	27-28
9	27	26
10	20-26	23-25
9	19	20-22
8	18	18-19
6	16-17	15-17
7		
5	10-15	11-14
4	5-9	7-10
3	0-4	0-6
2	-5- -6	-5- -1
0	-10 - -6	
-2	-15- -11	< -5
-1	-20 - -16	
-6	< -20	

0
0
2
4
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8
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10
9
7
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5
4
3
2
1

Table 2. Precipitation (mm) rating scales of TCI (Tourism Climate Index) (Mieczkowski, 1985)

Rating	Mean monthly precipitation (mm)
5	0.0 – 14.9
4.5	15.0-29.9
4	30.0-44.9
3.5	45.0-59.9
3	60.0-74.9
2.5	75.0-89.9
2	90.0-104.9
1.5	105.0-119.9
1	120.0-134.9
0.5	135.0-149.9
0	≥150.0 or more

Table 3. Aesthetic rating system: Mean monthly hours of Sunshine (h/day) (Mieczkowski, 1985) and cloud cover (%) rating scale (Scott *et al*., 2016)

TCI (Tourism Climate Index)		HCI (Holiday Climate Index)	
Rating	**Sunshine (h/day)**	**Cloud cover**	**Rating**
5	≥ 10 or more	11-20 1-10	10
4.5	9 – 9 hrs 59 min	21-30 0	9
4	8 – 8 hrs 59 min	31-40	8
3.5	7 – 7 hrs 59 min	41-50	7
3	6 – 6 hrs 59 min	51-60	6
2.5	5 – 5 hrs 59 min	61-70	5
2	4 – 4 hrs 59 min	71-80	4
1.5	3 – 3 hrs 59 min	81-90	3
1	2 – 2 hrs 59 min	90-99	2
0.5	1 – 1 hrs 59 min	100	1
0	< 1 hrs		0

Table 4. Wind speed (km/h) rating scale of TCI (Tourism Climate Index) (Mieczkowski, 1985)

Wind speed (km/h)	Normal (15-24°C)	Trade wind (24-33°C)	Hot climate (≥ 33°C)
< 2.88	5	2	2
2.88-5.75	4.5	2.5	1.5
5.76-9.03	4	3	1
9.04-12.23	3.5	4	0.5
12.24-19.79	3	5	0
19.8-24.29	2.5	4	0
24.30-28.79	2	3	0
28.8-38.52	1	2	0
> 38.52	0	0	0

Table 5. Daily precipitation (mm) rating scales of HCI (Holiday Climate Index) (Scott et al., 2016)

Rating	Daily precipitation (mm)
10	0
9	<3.0
8	3.0-5.99
5	6.0-8.99
2	9.0-12.0
0	>12.0
-1	>25.0

Table 6. Wind speed (km/h) rating scale of HCI (Holiday Climate Index) (Scott et al., 2016)

Rating	Wind speed (km/h)
10	1-9
9	10-19
8	20-29
7	
6	30-39
5	
4	
3	40-49
2	
1	
0.5	
0	50-70
-2	
-4	
-6	
-10	≥70

Table 7. Rating systems of TCI (Tourism Climate Index) (Mieczkowski, 1985) and HCI (Scott et al., 2016)

Score	TCI Descriptive rating	HCI Descriptive rating
90–100	Ideal	Ideal
80-89	Excellent	Excellent
70-79	Very good	Very good
60-69	Good	Good
50-59	Acceptable	Acceptable
40-49	Marginal	Marginal
30-39	Unfavorable	
20-29	Very unfavorable	Unacceptable
10-19	Extremely Unfavorable	
0-9	Impossible	Dangerous

3. Results

3.1. Tourism Climate Index

Analytical results indicated that TCI categories ranged from "Acceptable" to "Excellent". The seasonal and monthly distribution of TCI scores revealed that June had the highest spring TCI score (86) and was classified in the "Excellent" category. Summer months TCI scores ranged from "Excellent" to "Ideal" and July was classified in the "Ideal" category for recreation. In addition, August and September had similarly low differences in TCI, with values of 88 and 90, respectively. October, with a TCI score of 74, was classified in the "Very good" category as part of the autumn months. November and December showed similar values of 52 and 51, respectively, in the "Acceptable" category. March, with a TCI value of 70, was classified as "Very Good" for winter and had the highest TCI score in the study area. January and February were classified as "Acceptable" for tourism, with values of 53 and 51, respectively. According to the results, late spring and summer were the most suitable seasons for tourism in the Arasbaran Forest based on the TCI values. In addition, July was rated as "Ideal", followed by September, August, and June. Figure 2 shows the summer-peak shape of monthly and seasonal TCI sub-index ratings in the study area from 2001 to 2018 (Figure 2, Table 8).

We found out that 2017 was the "Optimal year" for the tourism climate during the study period, as it was categorized in the "Very good" class.

According to Figures 3 and 4, the climate parameters that influenced the TCI were the mean minimum temperature, mean temperature, mean monthly temperature, and mean monthly precipitation. The combined effects of a reduced precipitation and increased minimum and maximum temperatures in June, July, August, and September increased the TCI value.

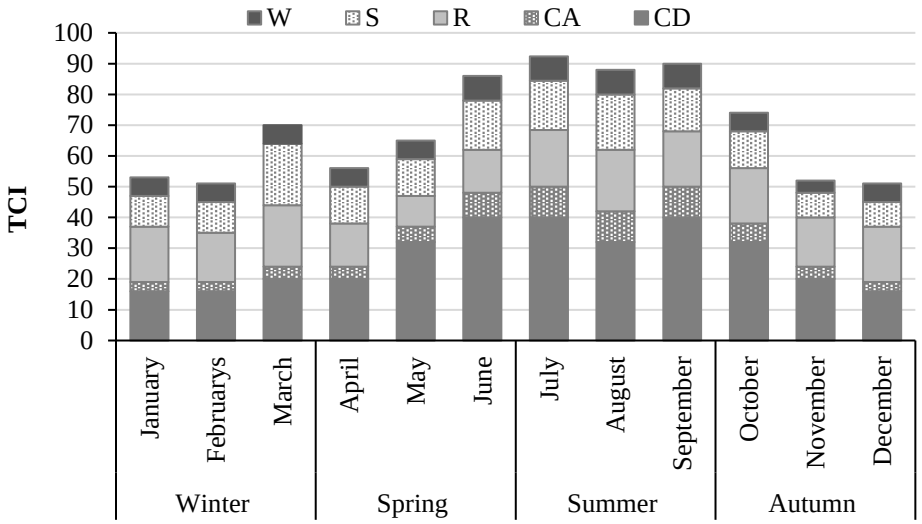

Figure 2. Monthly and seasonally TCI (Tourism Climate Index) sub-index ratings in the study area for the period from 2001to 2018

Table 8. Monthly TCI (Tourism Climate Index) scores and ratings in the study area for the period from 2001 to 2018

								TCI parameters						
Months	**T_{max}**	**T_{mean}**	**RH_{min}**	**RH_{mean}**	**p**	**s**	**w**	**CD**	**CA**	**P**	**S**	**W**	**TCI**	**Classification**
January	7.6	3.3	42.5	57.8	15.6	5.1	17.0	2	1.5	4.5	2.5	3	53	Acceptable
February	7.1	2.8	46.7	62.0	31.4	5.2	16.5	2	1.5	4	2.5	3	51	Acceptable
March	10.7	6.0	46.4	63.6	38.3	5.2	18.6	2.5	2	5	5	3	70	Very good
April	14.7	9.6	49.3	64.1	55.2	6.0	17.2	2.5	2	3.5	3	3	56	Acceptable
May	18.6	14.0	52.6	68.8	77.1	6.4	14.7	4	2.5	2.5	3	3	65	Good
June	24.1	18.9	47.6	63.0	53.0	8.7	12.2	5	4	3.5	4	4	86	Excellent
July	27.4	22.2	41.1	56.6	14.8	8.9	11.1	5	5	4.5	4	4	92	Ideal
August	29.4	23.5	37.2	53.1	11.6	9.5	11.1	4	5	5	4.5	4	88	Excellent
September	24.8	20.0	50.0	64.9	21.4	7.5	11.5	5	5	4.5	3.5	4	90	Excellent
October	19.4	14.9	52.1	68.4	26.8	6.4	14.3	4	3	4.5	3	3	74	Very good
November	13.2	9.1	52.4	68.3	38.2	4.8	12.9	2.5	2	4	2	2	52	Acceptable
December	8.6	4.6	46.9	62.0	27.4	4.7	15.0	2	1.5	4.5	2	3	51	Acceptable

Note: T_{max}: maximum temperature, T_{mean}; mean of temperature; RH_{min}: minimum of relative humidity; RH_{mean}: mean of relative humidity; p: the precipitation; s: sunshine; w: wind; CID: daytime comfort index, CIA: daily comfort index; P: precipitation index; S: sunshine index; W: wind index.

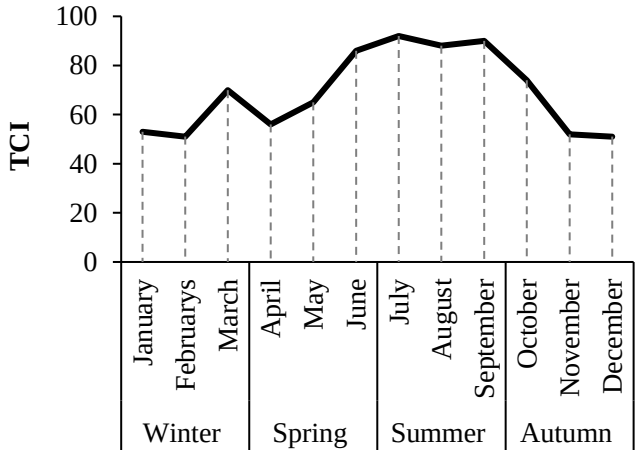

Figure 3. Mean monthly and seasonally TCI (Tourism Climate Index) values for the period from 2001 to 2018

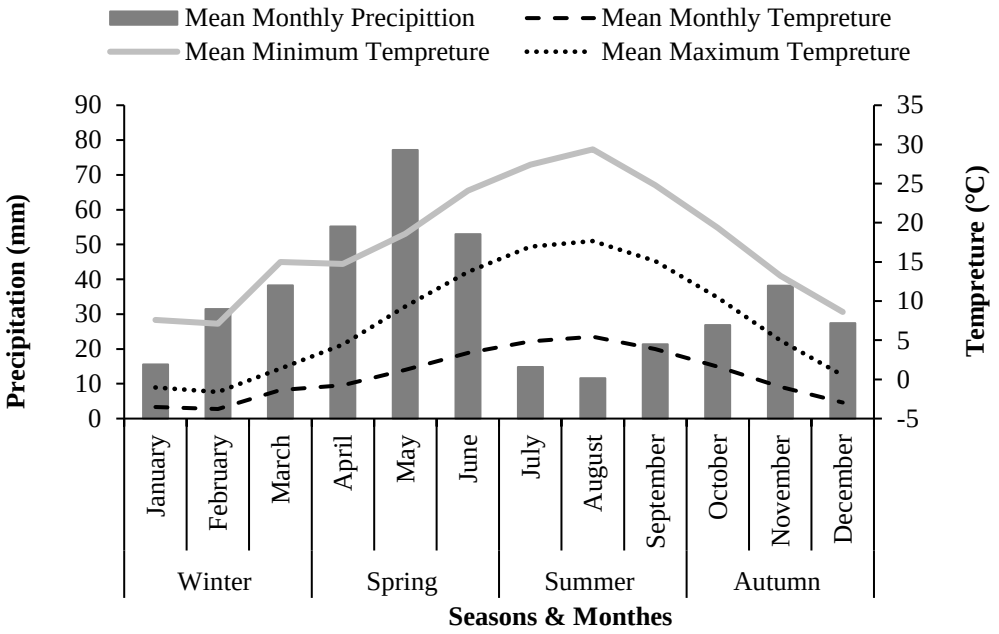

Figure 4. Mean monthly maximum, minimum temperature, mean temperature and mean total precipitation for the period from 2001 to 2018

3.2. Holiday Climate Index

Figure 5 shows the seasonal and monthly HCI values. March, April, May, and June indicated the highest HCI values, 88, 88, 94, and 86, respectively. HCI values were low in late summer, especially in September (Figure 5).

The categories and qualitative classification were shown in Table 9. From March to June, the values were classified into "Excellent" and "Ideal" categories. After that, the index value decreased, and the lowest value was recorded in September (60), placing this month into the "Acceptable" category. January, August, October, November, and December were placed in the "Good" category. February and July were also placed in the "Very good" category (Table 9).

The annual values of the HCI also showed that all years were in the "Good" and "Very good" categories.

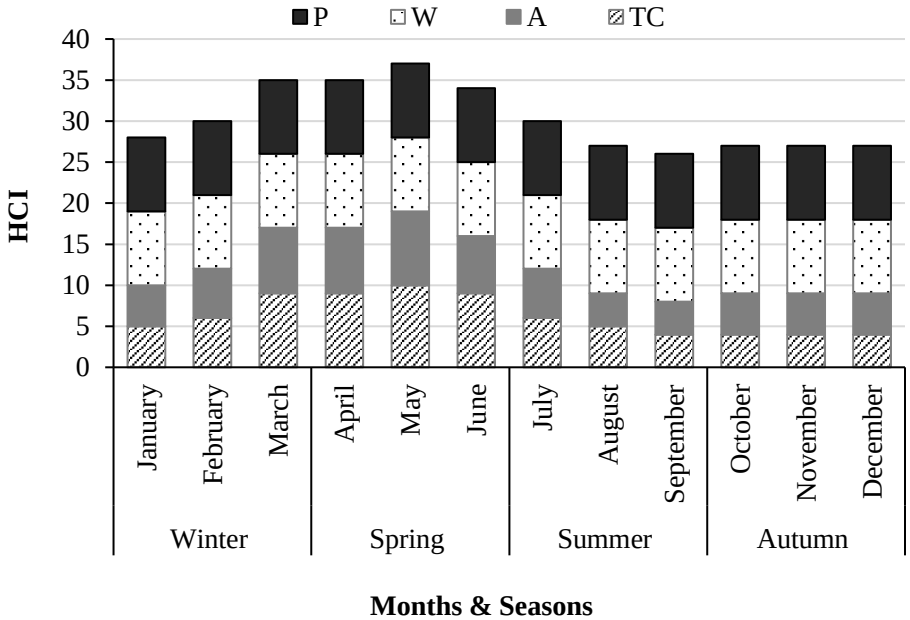

Figure 5. Monthly and seasonal values of HCI (Holiday climate index) in the study area for the period from 2001to 2018

Table 9. Monthly HCI scores and ratings in the study area for the period from 2001 to 2018

Months	T_{max}	Rh_{mean}	w	s	p	TC	A	W	P	HCI	Classification
January	14.7	64.1	9.3	6.0	1.8	5	5	9	9	66	Good
February	18.6	68.8	8.0	6.4	2.5	6	6	9	9	72	Very good
March	24.1	63.0	6.6	8.7	1.7	9	8	9	9	88	Excellent
April	27.4	56.6	6.0	8.9	0.5	9	8	9	9	88	Excellent
May	29.4	53.1	6.0	9.5	0.4	10	9	9	9	94	Ideal
June	24.8	64.9	6.2	7.5	0.7	9	7	9	9	86	Excellent
July	19.4	68.4	7.7	6.4	0.9	6	6	9	9	72	Very good
August	13.2	68.3	7.0	4.8	1.3	5	4	9	9	64	Good
September	8.6	62.0	8.1	4.7	0.9	4	4	9	9	60	Acceptable
October	7.6	57.8	9.2	5.1	0.5	4	5	9	9	62	Good
November	7.1	62.0	8.9	5.2	1.0	4	5	9	9	62	Good
December	10.7	63.6	10.1	5.2	1.3	4	5	9	9	62	Good

Note: T_{max}: maximum temperature, RH_{mean}: mean of relative humidity; p: precipitation; s: sunshine; w: wind speed; TC: temperature comfort index; A: aesthetic index (cloud cover); P: precipitation index; S: sunshine index; W: wind index.

4. Discussion

Climate information is the basic input for a range of climate services such as providing fundamental knowledge on changing climate impacts on tourism (Damm et al., 2020).

The TCI is the most widely used index for the assessment of climatic suitability for tourism which has been extensively used and has yielded varying results across different regions of the world (Scott & McBoyl, 2001; Nemeth, 2013; Yazdanpanah et al., 2013; Saligheh et al., 2013; Kovacs & Unger, 2014; Dubois et al. 2016; Scot et al., 2016). The TCI integrates several factors into a single index, demonstrating that climate plays an important role in tourism decision-making and variations in the climate patterns influence tourism demands (Ma et al., 2020).

Our results indicate that the late spring and summer were the most favorable seasons, with July being the most pleasant month for tourism activity during the study period. Autumn and winter were identified as unfavorable seasons for tourism activities in the Arasbaran Forest area. The Arasbaran region is mountainous, and local geographical conditions and latitude have created restrictions such as changes in the rainfall regime. Thus, rainfall is high in the highlands and low in the lowlands. Therefore, the cold seasons are wet, and the hot seasons are dry. This has resulted in late spring and late summer being the most favorable periods for tourism in Arasbaran (Saligheh et al., 2013). In addition, mitigating the Caspian Sea vapors, the humid currents of the Mediterranean Sea from the west and southwest, and the cold Siberian air masses from the north have affected the climate. As a result of diverse natural conditions across different areas, there are significant temperature variations throughout the year (Abdollahi, 2017). These results differ from those of Kovacs & Unger (2014), who reported that summer had slightly less favorable climatic conditions due to afternoon heat load in the cities they studied in Hungary. On the other hand, Scott et al. (2016) assessed the climate suitability of European cities and found that all had peak climatic conditions in summer, with June, July, and August being ideal, while January and February had the lowest TCI values. These results were similar to our results. In addition, Scott & McBoyl (2001) examined TCI values in Canada and found that all cities experienced "Excellent" conditions in the third quarter of summer. They confirmed that these results showed that warmer summer temperatures contribute to increasing tourism activity in Canada. A common finding across different methodologies is that while climate change has negative impacts, it may also lead to increased domestic tourism, particularly in colder regions.

TCI depends on sub-indices such as temperature and allocates half of its total weighting to the thermal comfort index making it the most important factor in determining the climate suitability of an ecosystem for tourism activities (Scott et al., 2016). A study on TCI by Mubarak Hassan et al. (2015) in Khuzestan province, located in southwest Iran, indicated that February was classified in the "Excellent" category for tourism due to low temperatures while June to September were the worst due to high temperatures. Khuzestan province is known for the low precipitation, abundant sunshine, and high temperatures, creating intolerable conditions for tourism. Therefore, it is expected that these results differ from our research, as the Arasbaran Forest area is

located in mountainous, cold-climate region in northwest Iran. The studies by Abdollahi (2017), Saligheh et al. (2013), Sarisaraf et al. (2010), and Yazdanpanah et al. (2013) in East Azerbaijan province support the findings of this study. They found that May, June, July, August, and September in the spring and summer seasons provided the best conditions for the tourists, while autumn and winter were the least favorable. Additionally, the spatial extension of the northwest and southwest parts of the study area contributed to better climate comfort conditions.

Finally, after computing the TCI for the study area as seen in Figure 2, relatively similar rankings and classifications were obtained from "Excellent" to "Ideal" in June (86), July (92), August (88), and September (90). Arasbaran forest reservoir is a mountainous region classified in the cold climate region. Therefore, these results align with Hejazizadeh et al. (2019) who showed mountainous regions had the highest TCI value in June. The present results supported the fact that winter and autumn have the lowest TCI values in mountainous areas, whereas coastal regions experience the highest rankings during these seasons (Hejazizadeh et al., 2019). In addition, school and university holidays are in late spring and summer in Iran, so promoting tourists to seek cooler, mountainous areas to escape the heat. Bakhtiari et al. (2018) used the TCI to investigate the climate change impacts on outdoor human comfort under past (1981-2015) and future (2016-2045) climate conditions. Their results showed that climate change led to improving climate comfort. Previous climatic studies by Abedi & Kazemi Rad (2020) reported that increasing minimum and maximum temperatures, along with global warming, will be inevitable in this forest region.

HCI is another bioclimatic index that assesses whether climate conditions are suitable for tourism activities. It was developed based on the limitations of the TCI and is able to accurately assess the climatic suitability of destinations for tourism (Javan, 2017). The results of the HCI index in this study showed that March (88), April (88), May (94), and June (86) showed the highest values of the index in the "Excellent" to the "Ideal" classes. Therefore, late spring and summer were selected as the best months for tourist activities based on this index.

HCI and TCI require the same climate variable to assess the suitability of the climate for tourism but the rating scale is different. TCI uses a scale of 1 to 5 for each component and HCI was scaled from 1 to 10. The comparison of TCI and HCI computing showed that June was found to be similar for both indices. Therefore, June can be considered the best month for tourism in the Arasbaran Forest. In addition, spring and summer were the best seasons for recreation based on both indices' results, Due to spring and summer holidays and weather conditions. Conversely, autumn and winter were identified as the least favorable seasons for tourism due to the region's extremely cold weather. With September being the least suitable month for tourism. However, the Arasbaran Forest region had no months classified as "unfavorable" since TCI and HCI values did not fall below 30 at any time.

Overall, the findings of this study have important implications for the response of tourism to climate change. The results of this study could serve as a valuable reference for other researchers and practitioners conducting similar studies on the effects of climate on tourism.

5. Conclusions

Arasbaran forest reservoir is a unique region for ecotourism activities having been included in UNESCO's international network of biosphere reserves since 1977. Forest visiting is one of the most important activities in nature-based tourism. This study concluded that TCI and HCI were useful indices for climate-based ecotourism in the Arasbaran Forest region. According to the results, the Arasbaran forest is a spring and summer peak tourism region. The forest was classified into five categories, "Acceptable", "Good", "Very good", "Excellent" and "Ideal"; on a seasonal and monthly basis, and three "Acceptable", "Good" and "Very good" classes on a yearly basis. Notably, no season or month was categorized as "unfavorable" or "impossible" during the study period.

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ارزیابی آسایش اقلیمی گردشگری در منطقه جنگلی ارسباران (قره‌داغ)، شمال غرب ایران

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چکیده

بازدید از جنگل یکی از مهم‌ترین فعالیت‌های بوم‌گردی است و جنگل ارسباران به‌عنوان منطقه‌ای منحصر به فرد برای طبیعت گردی در شمال غرب ایران شناخته می‌شود. به‌منظور بررسی پتانسیل اقلیمی گردشگری جنگل ارسباران، در مطالعه حاضر از شاخص‌های اقلیم گردشگری (TCI) و شاخص اقلیم تعطیلات (HCI) استفاده شد. نتایج نشان داد که بهینه‌ترین شرایط اقلیمی در فصول بهار و تابستان در منطقه مورد بررسی بود. نتایج شاخص TCI، منطقه را در رده‌های «عالی» تا «ایده‌آل» با امتیازهای ۸۶ تا ۹۲ طبقه‌بندی کرد و فصل‌های بهار و تابستان برای فعالیت‌های گردشگری در دوره زمانی ۲۰۰۱ تا ۲۰۱۸ خوشایندتر بود. نتایج شاخص HCI حاکی از آن است که منطقه مورد مطالعه دارای رده «عالی» تا «ایده‌آل» با امتیاز ۸۶ تا ۹۴ بوده و فصل بهار برای فعالیت‌های گردشگری در دوره زمانی مورد مطالعه خوشایندتر است. این فصول عمدتاً به‌دلیل بهبود متوسط آسایش حرارتی در بهار و تابستان در این منطقه نسبت به سایر مناطق اطراف، افزایش ساعات آفتابی در فصل گردشگری و همچنین تعطیلات بیشتر در ماه‌های تابستان در منطقه انتخاب شدند. این نتایج می‌تواند اطلاعات پایه‌ای و مفیدی را در اختیار تصمیم گیرندگان صنعت گردشگری در منطقه قرار دهد.

واژه‌های کلیدی: آسایش اقلیمی، جنگل، TCI، HCI، گردشگری.

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