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Evaluation of bioclimatic comfort conditions in Hatay using the tourism climate index: a spatial analysis for sustainable tourism planning

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Introduction: The conditions of climatic elements such as temperature, precipitation, humidity, pressure, and wind in a given area directly affect bioclimatic comfort conditions. Climate parameters and weather variability affect the quality of urban life and influence the harmony of urban living areas with nature and energy consumption patterns. Therefore, bioclimatic comfort conditions must be identified to guide planning and design studies. The aim of this study is to reveal the bioclimatic comfort conditions of Hatay Province (Türkiye), located in the Eastern Mediterranean Region, on the basis of the Tourism Climate Index (TCI). Determining the most suitable periods and destination areas for sustainable tourism activities is particularly important for Hatay, where tourism represents an important potential in the post-earthquake reconstruction process.
Methods: Within the scope of the study, the climatic suitability of bioclimatic comfort was evaluated on the basis of the Tourism Climate Index (TCI). Climate data for Hatay Province covering the period 1960–2025 were used, including maximum, minimum, and mean temperature, relative humidity, precipitation, sunshine duration, cloudiness, and wind speed. These data were interpolated in ArcGIS Pro 3.4, and the bioclimatic comfort levels of the study area were subsequently determined using the TCI formula. Based on the interpolation results, tourism-oriented climatic comfort maps of Hatay Province were produced.
Results: The results revealed clear seasonal and spatial differences in tourism climatic comfort across Hatay Province. From March to November, the classifications "Marginal, Acceptable, Good, and Very Good" were identified, whereas December, January, and February were characterized by "Marginal, Unfavourable, Very Unfavourable, and Extremely Unfavourable" conditions. "Very Unfavourable" areas were predominant in December, while "Good" and "Very Good" areas were predominant in April, September, and October. March was the transition month in which the "Acceptable" class was most widespread across the study area. Neither the "Excellent" nor the "Ideal" class was observed during any month of the year.
Discussion: The findings indicate that December, January, and February represent the lowest levels of tourism comfort in Hatay, whereas the period from March to November provides relatively higher levels of climatic comfort. The nine-month period from March through November therefore represents an important potential for tourism activities in the province. These findings are important for

the development and diversification of tourism strategies in Hatay Province and for supporting sustainable tourism planning based on long-term climatic conditions.

KEYWORDS

bioclimatic comfort, geographic information systems (GIS), Hatay Province, sustainable tourism, tourism climate index (TCI)

1 Introduction

Tourism constitutes one of the largest and fastest-growing industries in the world (Smith, 1993; De Freitas, 2003; Scott and Lemieux, 2010; Adıgüzel et al., 2022; Guan et al., 2025). According to the 2024 data of the World Travel and Tourism Council (WTTC), tourism contributes USD 11 trillion to the global economy and accounts for 10% of global GDP, while the tourism sector provides employment for approximately 348 million people (WTTC, 2024). In this respect, tourism plays a critical role in supporting the development of global and national economies as well as leisure economies (Scott et al., 2011).

Although the tourism sector ranks among the world's major economic sectors, it has a vulnerable structure in the face of war, terrorism, theft, natural environmental conditions, and social and political crises (Clements and Georgiou, 1998; Adıgüzel, 2023). Tourism is considered particularly sensitive to the impacts of climate change (Dogru et al., 2019). This is because climate is highly influential in tourists' destination preferences (Maddison, 2001; Amelung and Viner, 2006; Rutty et al., 2020; Gössling et al., 2023; Barrutiabengua et al., 2025; Kovacs et al., 2025; Keleş Özgenç and Kiper, 2026). By using climate indices, tourists and tour operators can select the most suitable time and place for a particular holiday or plan activities that are compatible with expected weather conditions (Bakhtiari and Bakhtiari, 2013).

Academic studies examining the relationship between tourism and climate generally explain this relationship through specific indices (Mendez-Lazaro et al., 2014; Adıgüzel et al., 2022). In this context, numerous climate indices have been used for tourism in previous studies (Amiranahsvili et al., 2018). One of the most popular of these indices is the Tourism Climate Index (TCI), developed by Mieczkowski (1985) (Lin and Matzarakis, 2008; Hejazizadeh et al., 2019). The concept of the Tourism Climate Index evolved from more general knowledge regarding the effects of climatic conditions on human physical health (Amelung and Viner, 2006).

Following the introduction of the Tourism Climate Index, the number of academic studies applying this index in a wide variety of regions around the world and testing the accuracy of the data through field studies began to increase (Scott and McBoyle, 2001; Amelung and Viner, 2006; Amelung et al., 2007; Ataei and Hasheminasab, 2012). On the African continent, studies have been conducted at national and regional/local scales in Egypt, Algeria, Nigeria, and South Africa (Mahmoud et al., 2019; Hameidia and Medjerabe, 2025; Amrouche, 2025; Kganane and Fitchett, 2025; Enebeli et al., 2026). Among these publications, the study conducted by Enebeli et al. (2026) is particularly noteworthy. Unlike the prevalent literature that explains tourism–climate relationships solely through the TCI, this study focused on decision-ready metrics that translate meteorological conditions into comfort based on human perception. Similarly, Kganane and Fitchett (2025) drew attention to tourists' experiences in addition to TCI output scores.

On the Asian continent, empirical TCI studies focusing particularly on Iran have attracted greater attention (Table 1). In addition, various academic studies have been conducted in hot and arid regions such as Pakistan and Saudi Arabia, as well as in hot and humid regions such as Malaysia and Indonesia, and in Uzbekistan and China. Among these, Ali et al. (2025), in their study conducted in the "Hail Region" of Saudi Arabia, focused on the effects of TCI on health tourism, rather than solely on coastal tourism. Yuliarti et al. (2026), in their study conducted on the Belitung Islands of Indonesia, attempted to adapt the TCI to tropical geopark destinations. The significance of this study in terms of its originality lies in its integration of long-term historical climate data with future climate projections at the geosite scale through spatiotemporal climate comfort analysis. Other studies in Asia, consistent with the mainstream TCI literature, have focused directly on explaining the spatial distributions of index values.

Among the studies conducted in North America, Scott and Mcboyle (2001) calculated the existing TCI scores of 17 cities in North America and explained their spatial distributions. The scientific significance of the study lies in the fact that it is one of the few studies explaining how climate change and climate change scenarios may affect tourism climate resources. Ma et al. (2021) revealed the spatial distribution of TCI values across 11 national parks in the southern United States. Unlike coastal tourism regions, which have frequently been examined in the literature, this study is noteworthy for examining national parks in terms of the spatial scale of the study area. The study investigated the effects of climate on visitation and camping in national parks.

In Europe, studies conducted in Serbia, Hungary, and particularly in tourism destinations along the Mediterranean coast of Spain stand out. Barrutiabengua et al. (2025), in their study covering 50 provinces of Spain, investigated the potential impacts of climate change on tourism demand using scenarios extending to 2,100. One of the approaches that makes this study distinctive is its focus not only on the Tourism Climate Index but also on the statistical results of the Holiday Climate Index. Another study in which these two indices (HCI and TCI) were used together was conducted by Kovacs et al. (2025) in Hungary. In the study, multiple climate models (ALADIN5.2 and REMO 2015) and emission scenarios (RCP4.5 and RCP8.5) were used to determine the future development of the indices.

In Eurasia, TCI studies conducted in the Georgian cities of Tbilisi and Batumi, as well as particularly along the Aegean and Mediterranean coasts of Türkiye, are noteworthy. The location of these regions between the cooler and more humid summer climates of Europe on the one hand and the hot and dry summer climates of the Middle East on the other, together with their transitional climatic characteristics, makes TCI research particularly important. In studies conducted in Georgia and Türkiye,

TABLE 1 Some TCI studies according to their geographical origins.

Region/Continent	Study area (country)	References
Africa	Egypt (Hurghada)	Mahmoud et al., 2019
	Algeria (Algiers)	Hameidia and Medjerabe, 2025
	Algeria (M'Sila)	Amrouche, 2025
	Nigeria (36 states and Federal capital)	Enebeli et al., 2026
	South Africa (10 cities)	Kganane and Fitchett, 2025
Asia	Iranian (Kerman)	Bakhtiari and Bakhtiari, 2013
	Iranian (desert regions)	Hejazizadeh et al., 2019
	Iranian (Giran/Anzali Wetland)	Fadaee et al., 2013
	Iranian (Fars)	Masoudi, 2021
	Pakistan (Gilgit/Baltistan)	Ullah et al., 2024
	Saudi Arabia (Hail region)	Ali et al., 2025
	Saudi Arabia (12 destinations)	Faraj et al., 2023
	Malaysia	Jong et al., 2023
	Indonesia (Bangka, Belitung Islands)	Yuliarti et al. (2026)
	Uzbekistan (Jizzack)	Abdurakhmanov ve Umurzakova, 2025
	China (The belt and road)	Guan et al., 2025
America	USA (11 national parks)	Ma et al., 2021
	North America (USA and Canada)	Scott and Mcboyle, 2001
Europa	Serbia (Podrinje and Valjevo)	Milenkovic and Lukic, 2025
	Hungary	Kovacs et al., 2025
	Spain (50 province)	Barrutiabengua et al., 2025
	Spain (Balear Islands)	Amelung and Viner, 2006
Eurasia	Georgia (Batumi)	Amiranashvili et al., 2010
	Georgia (Tbilisi)	Amiranashvili et al., 2008
	Türkiye (south and west coasts)	Kum and Gönençgil, 2018
	Türkiye (The whole country)	Efe et al., 2022
	Türkiye (İzmir)	Adıgüzel et al., 2022
	Türkiye (Mersin)	Adıgüzel, 2023
	Türkiye (Tekirdağ)	Keleş Özgenç and Kiper, 2026

researchers have attempted to identify the most suitable times and regions for tourism activities based on the TCI, in line with the general research trend in the literature (Amiranashvili et al., 2008; Amiranashvili et al., 2010; Adıgüzel et al., 2022; Efe et al., 2022; Adıgüzel, 2023; Keleş Özgenç and Kiper, 2026).

When academic studies are evaluated as a whole, it can be observed that the TCI has generally been the subject of empirical research in mid-latitude regions, hot and dry climatic regions, and particularly in popular tourism destinations based on the sea-sand-sun tourism model. In fact, these regions represent suitable areas for the application of the TCI. However, only a very limited number of studies in the literature have focused on identifying suitable times and locations for tourism activities in areas exposed to natural disasters and on whether tourism can provide motivation, particularly in disaster-affected regions. For example, Guan et al. (2025) examined the spatial and temporal evolution of the tourism climate in the Belt and Road region, one of the most disaster-prone regions in the world. While drawing attention to the tourism potential of the region, the authors argued that changes occurring after natural disasters could profoundly affect tourism activities. At this point, it becomes evident that increasing the number of TCI studies in regions prone to natural disasters is critically important in terms of urban resilience and sustainability.

The aim of this study is to reveal the bioclimatic comfort conditions of Hatay Province, located in the Eastern Mediterranean Region in the southernmost part of Türkiye,

based on the Tourism Climate Index (TCI). Situated along a transition route between Europe and Middle Eastern countries, Hatay has hosted numerous civilizations throughout history and has been a setting for intercultural interaction. The presence of the Church of Saint Peter, one of the pilgrimage centers of Christianity in the world, and the Habibi Neccar Mosque, known as the first mosque in Anatolia, makes Hatay attractive in terms of religious tourism. Hatay also joined the UNESCO Creative Cities Network in the field of gastronomy in 2017 and has attracted attention as one of Türkiye's major gastronomy tourism centers. Hatay's status as one of Türkiye's border provinces makes the region important in terms of visitor profile and cultural diversity. The Mediterranean coastline in the western part of the province and the beaches developed along this coast (Arsuz, Samandağ) contribute to its tourism potential. In addition to all these characteristics, alternative forms of tourism, particularly thermal tourism, hunting tourism, botanical tourism, mountaineering tourism, and cave tourism, offer significant potential throughout the province.

Hatay, particularly Antakya and its surroundings in the central part of the province, is located in the southern part of the Antakya-Kahramanmaraş Graben, which developed under the influence of the Dead Sea and East Anatolian Faults and the Cyprus Arc (Korkmaz, 2006). This situation has resulted in numerous destructive earthquakes in the region throughout history. In particular, the earthquakes of magnitude 7.8 Mw and 7.6 Mw, centered in Kahramanmaraş and Hatay (Defne) on 6 and 20 February 2023, respectively, caused extensive destruction and significant loss of life and property in Hatay. Following this destruction and the substantial loss of life and property, the tourism potential of the province described above may serve as a driving force and an important source of motivation during the reconstruction process. Therefore, determining the most suitable periods and destination areas associated with its main tourism potential is of critical importance for sustainable tourism activities. The tourism potential and historical-cultural values of Hatay were influential in its selection as the study area. Other factors influencing the selection of the study area can be listed as follows.

- The presence of the Mediterranean coast and the Amanos Mountains in the western part of the province, the Amik Plain in its central parts, Habibi Neccar Mountain and the Kuseyr Plateau in the east, as well as the Orontes River Delta, creates microclimatic diversity.
- The different local geographical characteristics of the province's districts allow spatial comparisons of TCI values.
- The intention to develop planning recommendations concerning tourism–climate relationships within the planning framework of Hatay's post-February 2023 reconstruction process.
- Hatay's location along the transition route connecting Anatolia to the Middle East, its manifestation of transitional climatic influences, and particularly the fact that TCI indices have not previously been applied in Hatay.
- The greater attention given in the literature to Mediterranean countries and their coastal destinations (Hameidia and Medjerabe, 2025), the frequent emphasis on climatic factors affecting visitors travelling to Mediterranean countries, and the influence of the Mediterranean climate on the western coasts of Hatay, which is located in the Eastern Mediterranean.

2 Materials and methods

The location map of Hatay Province and the study stations are presented in Figure 1. The province is located between 35° 52′ and 37° 04′ north latitudes and 35° 40′ and 36° 35′ east longitudes. Geographically, Hatay is bordered by Osmaniye and Gaziantep to the north and northwest, Syria to the east and southeast, and the Mediterranean Sea to the south and west.

In this study, temperature (maximum, minimum, and mean), relative Figure 2 humidity (minimum and mean), precipitation (total and mean), total sunshine duration, and mean wind speed data for the period 1960–2025 obtained from the Turkish State Meteorological Service were used (Table 2). The meteorological data used in this study were obtained from the Turkish State Meteorological Service (TSMS) as monthly observational series covering the period 1960–2025. Long-term monthly climatological values were calculated separately for each meteorological station and parameter. Accordingly, the long-term mean for a given calendar month was determined by calculating the arithmetic mean of all available valid observations recorded for that month throughout the study period. For example, the long-term January value for each station was calculated using all valid January observations available between 1960 and 2025. Missing observations were excluded from the calculations and were not treated as zero values. Furthermore, no statistical estimation or imputation method was applied to replace missing observations. The resulting long-term monthly climatological values constituted the primary meteorological dataset used to calculate the components of the Tourism Climate Index. The obtained data were organized and transferred to a GIS environment. The data transferred to the GIS environment were prepared for spatial analysis. In order to reflect the microclimatic transitions between the rugged and mountainous topography of Hatay Province and its coastal areas, values at unknown locations within the study area were estimated from stations with known data using Inverse Distance Weighted (IDW) interpolation. Spatial interpolation was performed in ArcGIS using the Inverse Distance Weighted (IDW) method based on data obtained from 18 meteorological stations. A power parameter of two and a variable search radius incorporating the 12 nearest stations were used to estimate the value of each raster cell. The output raster cell size was set to 400 × 400 m. All spatial interpolation procedures were conducted in the WGS 1984 UTM Zone 36N projected coordinate system The mathematical model of the IDW method was formulated as follows.

$$\hat{Z}(X_0) = \frac{\sum_{i}^{N=2} W(X_i) Z(X_i)}{\sum_{i}^{N=1} W(X_i)}$$

$$W(X_i) = \|X_i - X_0\| - p$$

In this equation, N represents the total number of known measurement points, W(Xi) denotes the weighting function associated with the ith location, and Z (Xi) represents the measured value of the variable (temperature, precipitation, etc.) at the ith location. This interpolation algorithm was used with high

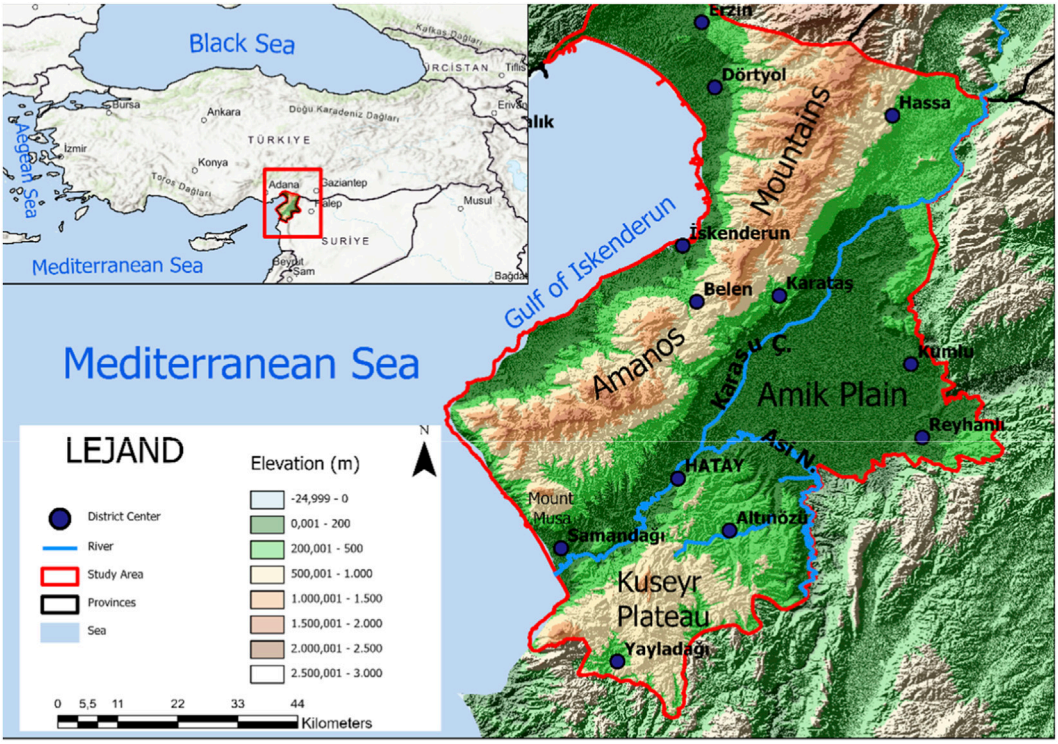


FIGURE 1
Study area.

accuracy in the production of spatial distribution maps by minimizing the local effects of Hatay Province's complex topographic structure on climatic parameters.

In this study, the Tourism Climate Index (TCI), developed by Mieczkowski in 1985, was used to determine the spatial distribution of areas suitable for human comfort in terms of climate–tourism relationships across Hatay Province. Following its introduction, the index received several criticisms. Its weighting methodology, subjectivity, low temporal resolution, and general application without considering the specific climatic requirements of different types of tourism are among these criticisms (Scott and McBoyle, 2001; Whittlesea and Amelung, 2010; Matzarakis et al., 2014; Demiroglu et al., 2020; Lukić et al., 2021; Hameidia and Medjerabe, 2025; Kovacs et al., 2025). Criticisms of the index have, over time, led to the development of various tourism climate indices, particularly the Holiday Climate Index (HCI), as alternative indices (Matzarakis, 2001; Hameidia and Medjerabe, 2025; Kganane and Fitchett, 2025). In some studies, these indices have frequently been compared with the TCI (Kovacs et al., 2025). Despite these issues and criticisms, the TCI continues to be widely used today and to inspire researchers due to several important advantages it offers.

Over time, the TCI has become the most popular index because of its simplicity, its reliance on readily available monthly meteorological data, and its ability to compare the climatic potential of different destinations (Scott et al., 2004; Perch-Nielsen et al., 2010; Adiguzel et al., 2022; Kovacs et al., 2025). Moreover, the Tourism Climate Index (TCI) continues to be widely applied in regional and spatial tourism studies due to its integrative structure, which combines key meteorological variables such as air temperature, relative humidity, precipitation, solar radiation, and wind speed into a single composite index and enables both spatial and temporal comparisons (Atasoy and Guneysu Atasoy, 2020; Yu et al., 2021). Its relatively simple data requirements also make it particularly suitable for long-term historical analyses and regional-scale climate projection studies (Yuliarti et al. (2026)). These advantages were decisive in the selection of the TCI in this study.

The TCI is based on the following formula:

$$TCI = 2[4 * CID + CIA + (2 * P) + (2 * S) + W]$$

In this algorithm.

2.1 CID and CIA

CID is the daytime comfort index and is calculated based on maximum temperature and minimum relative humidity values. CIA represents the daily comfort index and is calculated using mean air temperature and mean relative humidity values. To determine these values, the thermal comfort rating system developed by ASHRAE was used. If the temperature is 20 °C and the relative humidity is 30%, the corresponding value on the scale is 5.0. If the relative humidity ranges between 70% and 100% at temperatures of 27 °C–35 °C, the corresponding value on the scale is 1 (Figure 3).

2.2 Precipitation (P)

In the formula, precipitation is evaluated as the mean monthly precipitation amount in millimeters. The weight of precipitation

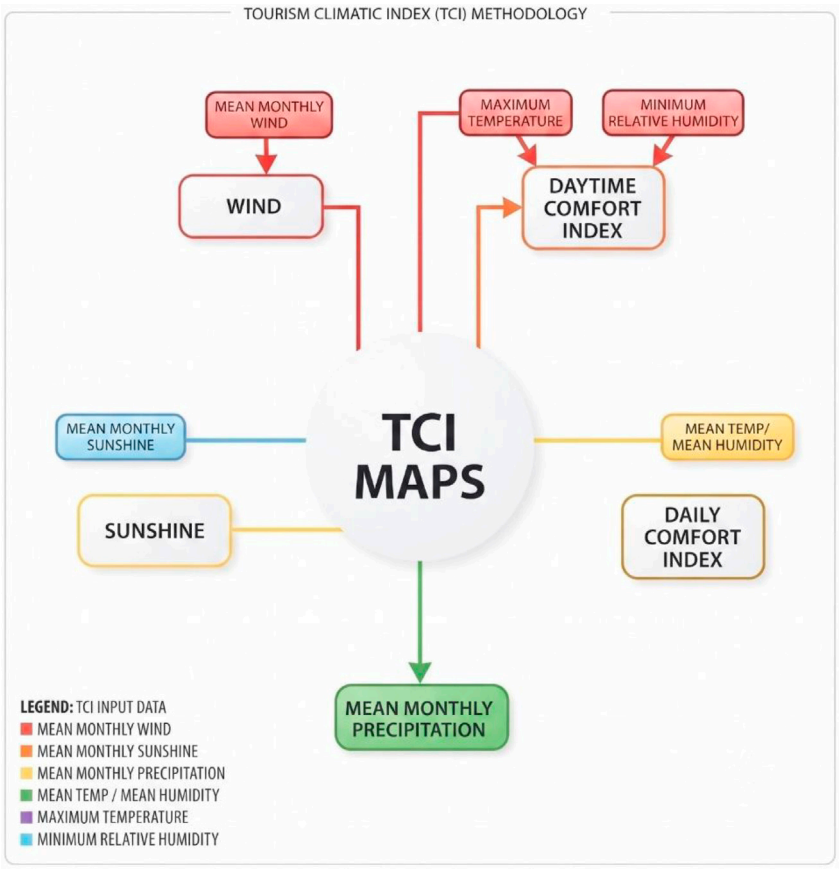


FIGURE 2
Flow chart of the methods.

in the TCI formula is 20%. Precipitation, particularly in coastal regions, has a considerably negative effect on tourism activities. If the amount of precipitation in the study area exceeds 150 mm, tourism activities are negatively affected in terms of comfort.

2.3 Sunshine duration (S)

Sunshine duration is one of the important climatic elements for tourism activities. Sunshine duration exceeding 10 h increases the attractiveness of tourism activities. The weight of sunshine duration in the TCI formula is 20%.

2.4 Wind (W)

The effect of wind varies between summer and winter periods. While wind during the summer months has a positive effect on tourism activities, wind during the winter months has a negative effect due to low temperatures. The weight of wind in the TCI formula is 10%.

To determine the effects of climate on tourism activities, according to the classification derived from the TCI formula, a value of −30 indicates unsuitable areas, values between 50 and 59 indicate acceptable areas, and values between 90 and 100 indicate ideal areas.

3 Results

The tourism-based climatic comfort conditions of Hatay Province were determined according to the TCI classification. Mean temperature, wind speed, relative humidity, precipitation, and sunshine duration were used for this classification. Based on the climatic data, the climatic comfort conditions of Hatay Province obtained from the TCI classification are presented in Figures 4–8.

The mean maximum temperature of Hatay Province varies between 6.4 °C and 29.38 °C during June, July, and August. During the summer months, temperature values are particularly high in the interior parts of Hatay Province, especially in areas close to the Syrian border. During the winter months, mean temperature levels decrease to their minimum values, with the lowest levels particularly observed in the mountainous areas of the province. There are considerable temperature differences between the coastal zone and the interior parts of Hatay Province during both summer and winter. The main reasons for these differences are maritime and continental influences and the presence of mountainous areas within the province. During the summer months, the variation in mean maximum temperatures follows the order of August, July, and June, whereas during the winter months, the mean minimum temperatures follow the order of December, January, and February. Considering the temperature values, August and July, which are the warmest months, and December and January, which

TABLE 2 Meteorological stations used in the study.

Station name	Station code	Latitude	Longitude	Elevation (m)
Altınözü	18058	36.11° N	36.24° E	365 m
Antakya	17372	36.20° N	36.15° E	85 m
Hatay Airport	17371	36.36° N	36.28° E	83 m
Arsuz	18858	36.41° N	35.88° E	10 m
Belen	18057	36.48° N	36.20° E	640 m
Defne	19363	36.14° N	36.14° E	120 m
Dörtyol	17962	36.84° N	36.22° E	35 m
Erzin	18274	36.95° N	36.20° E	165 m
Hassa	18275	36.79° N	36.53° E	420 m
İskenderun	17370	36.58° N	36.17° E	15 m
İskenderun Bay	17486	36.59° N	36.18° E	3 m
Kırıkhan	18276	36.50° N	36.35° E	145 m
Kumlu	18277	36.37° N	36.46° E	90 m
Payas	19378	36.76° N	36.19° E	25 m
Reyhanlı	17645	36.26° N	36.56° E	160 m
Samandağ	17986	36.08° N	35.97° E	20 m
Yayladağı	18278	35.90° N	36.06° E	450 m
Arsuz/Cape Akıncı Lighthouse	17481	36.32° N	35.78° E	109 m

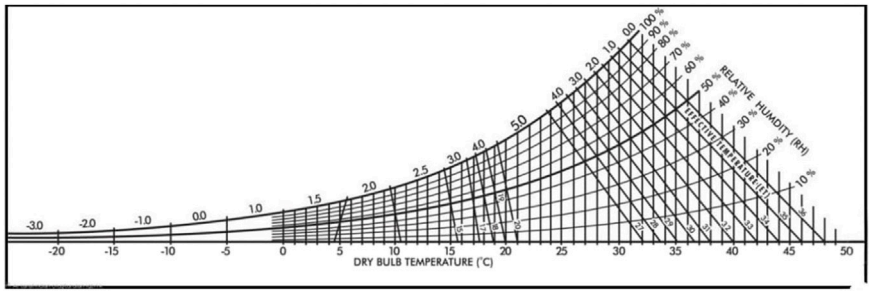


FIGURE 3
Thermal comfort proportioning system (Mieczkowski, 1985).

have the lowest temperatures, can be regarded as the months with the lowest levels of climatic comfort.

When the relative humidity values in the study area are examined, they are observed to vary between 49.1% and 79%. During the summer season, relative humidity increases along the coastal zone while decreasing toward the interior areas. During the winter season, however, areas of high relative humidity observed along the coastal zone extend toward the interior parts. The highest relative humidity values in the province occur in December and January, whereas the lowest values are observed in September, October, and November.

In terms of total precipitation, precipitation amounts in the study area vary between 0.002 and 310 mm. The province receives its lowest precipitation in July and August and its highest precipitation in December and January. In general, precipitation decreases during the summer months and increases during the winter months. Precipitation amounts are particularly high along the coastal zone of the study area, whereas they are relatively lower in the mountainous areas of the interior.

When the wind factor in the study area is evaluated, wind speed varies between 0.452 and 7.5 m/s. The highest wind speeds in the province are observed in mountainous areas and during March, April, May, July, August, and September. When wind speed is evaluated seasonally, it reaches its highest levels during the summer months and decreases to lower levels during the winter months.

When the climate-based tourism comfort of Hatay Province is evaluated, it is observed that, except for December, January, and

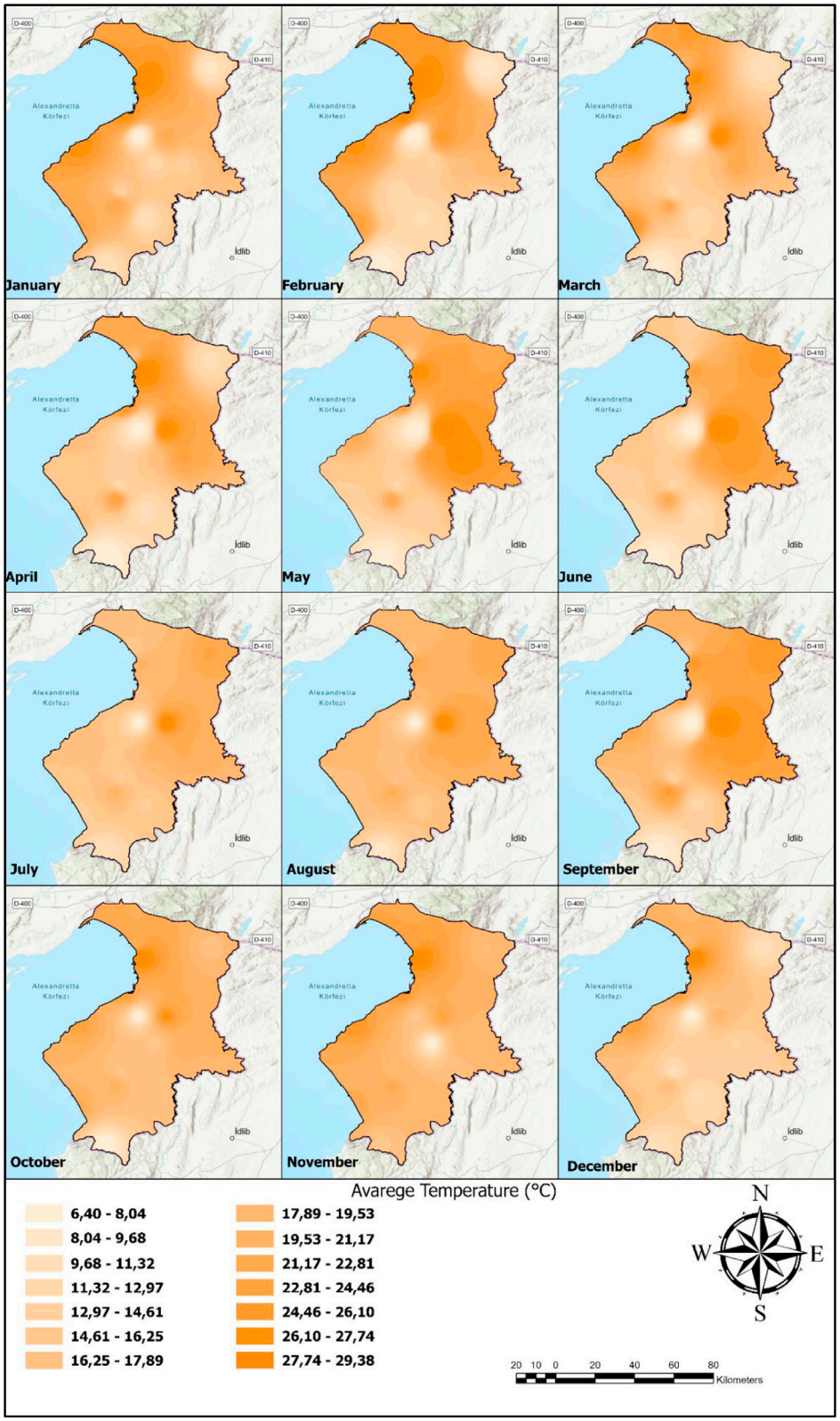


FIGURE 4
Long-term monthly mean air temperature (°C) in Hatay (1960–2025).

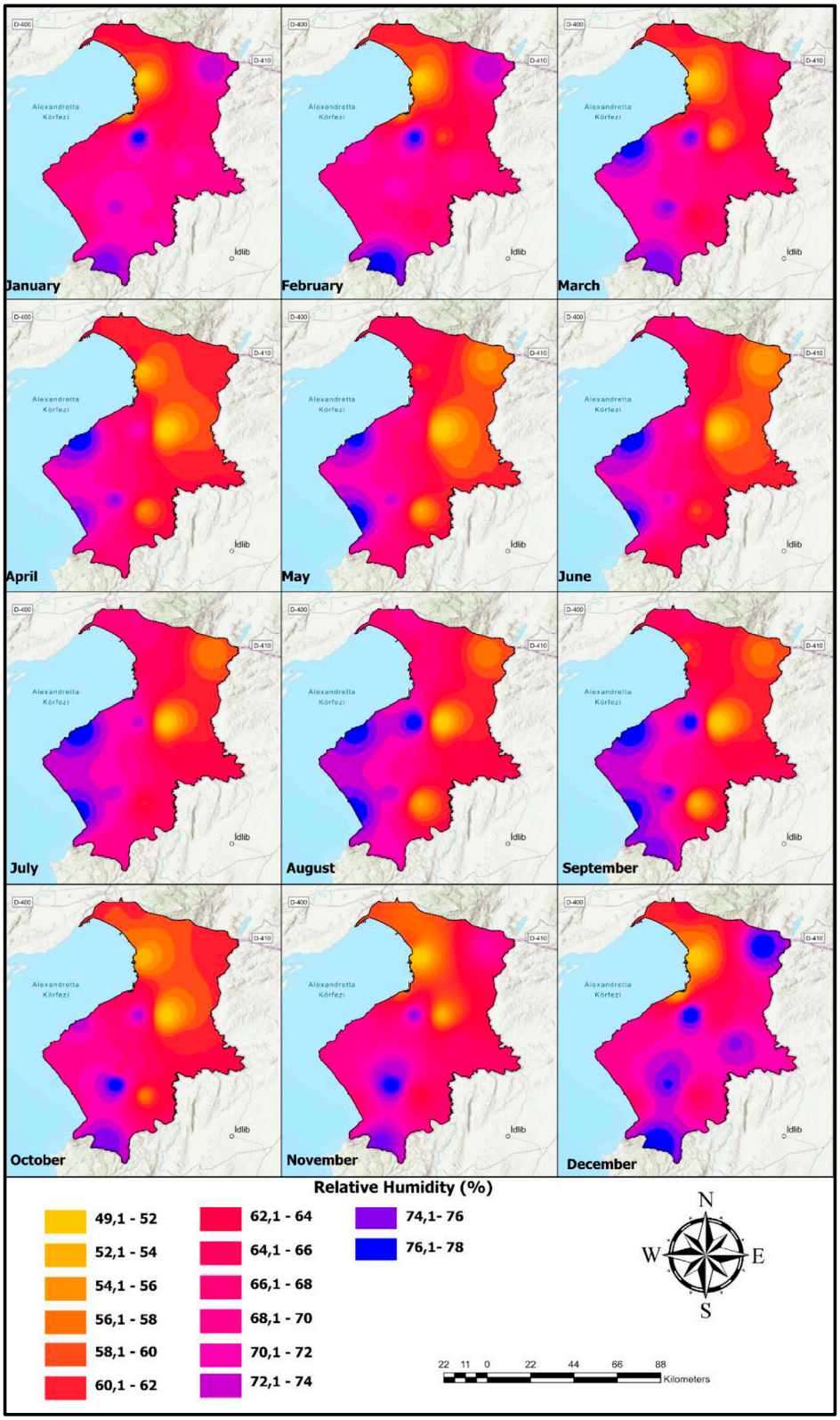


FIGURE 5
Long-term monthly mean relative humidity (%) in Hatay (1960–2025).

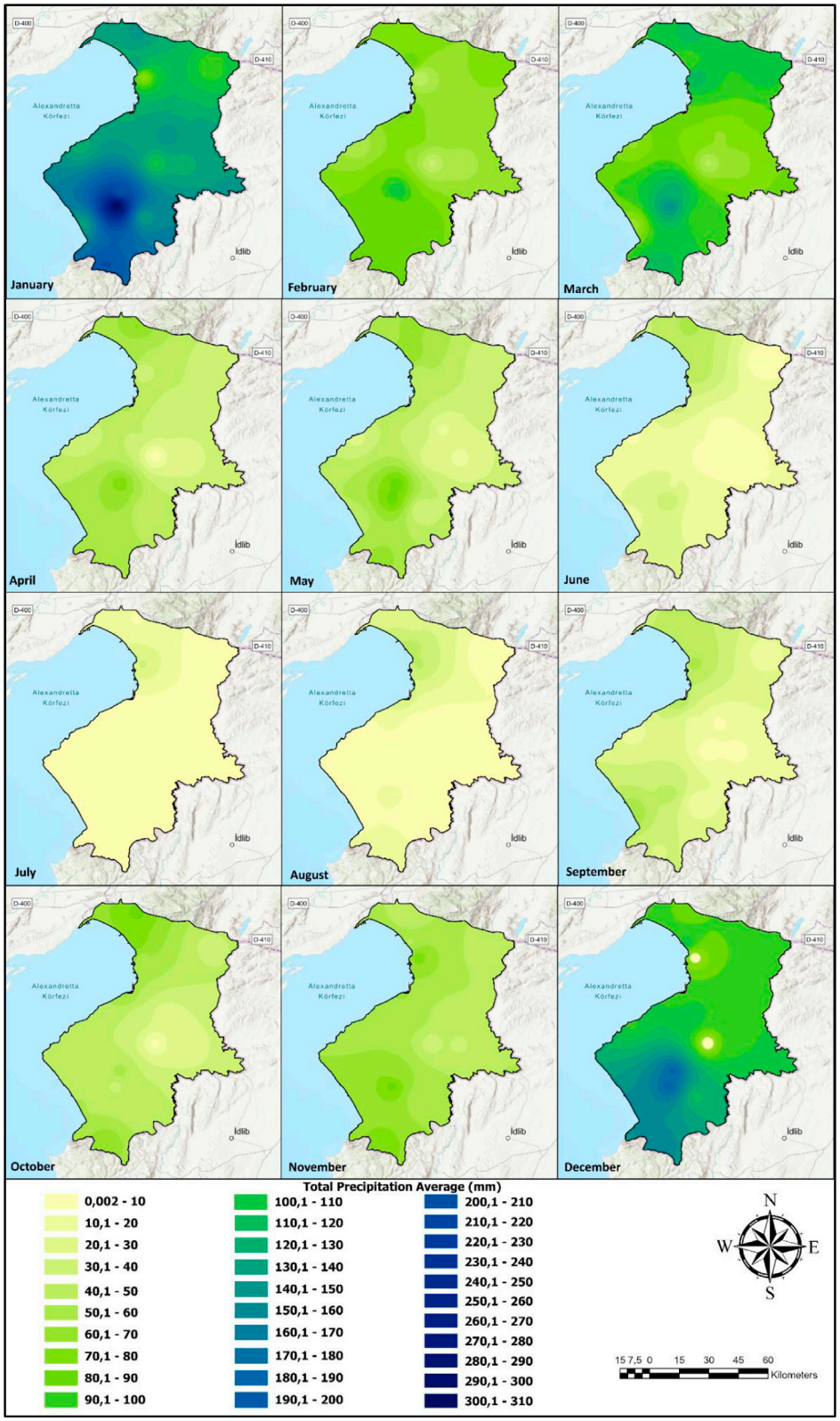


FIGURE 6
Long-term mean monthly total precipitation (mm) in Hatay (1960–2025).

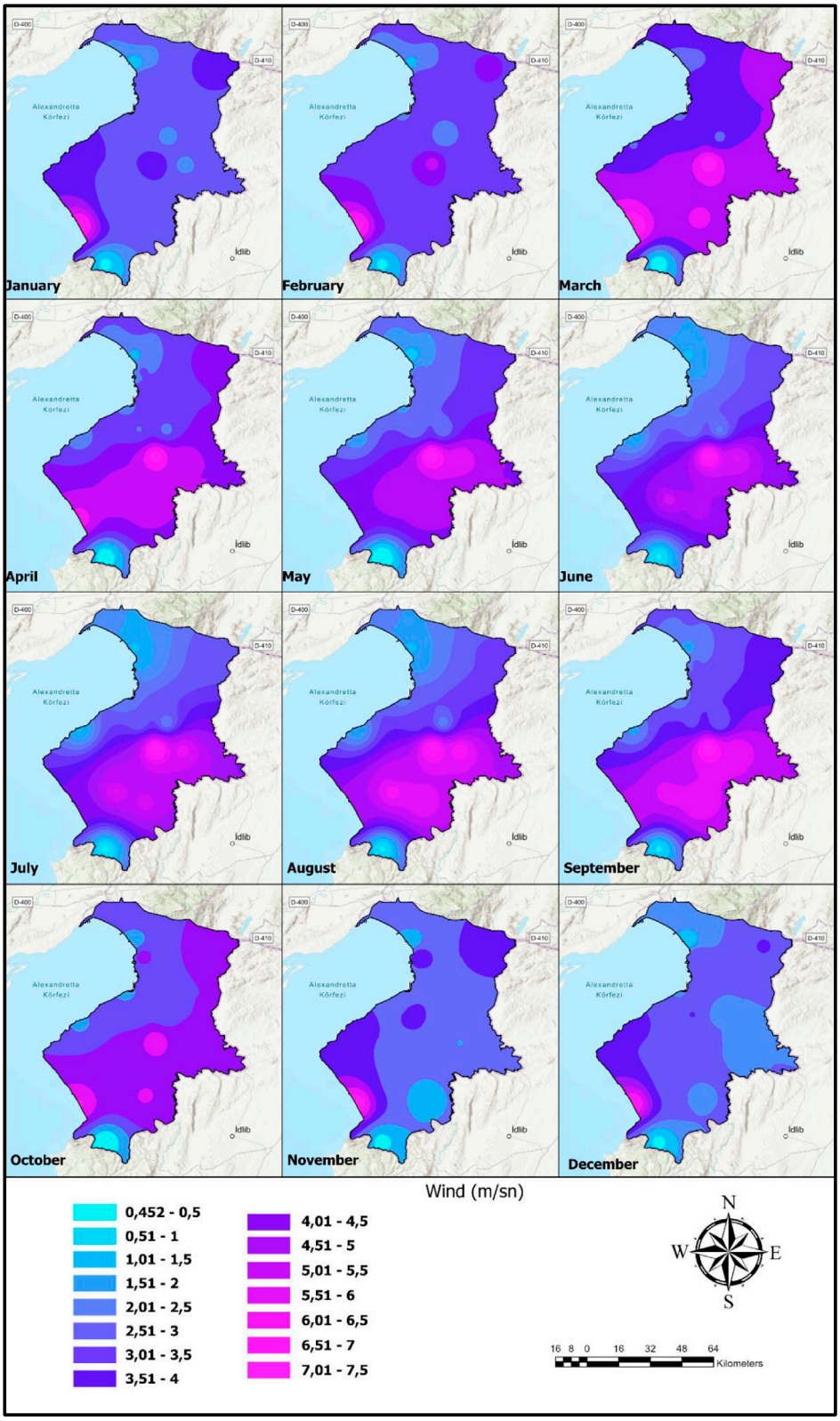


FIGURE 7
Long-term monthly mean wind speed (m/s) in Hatay (1960–2025).

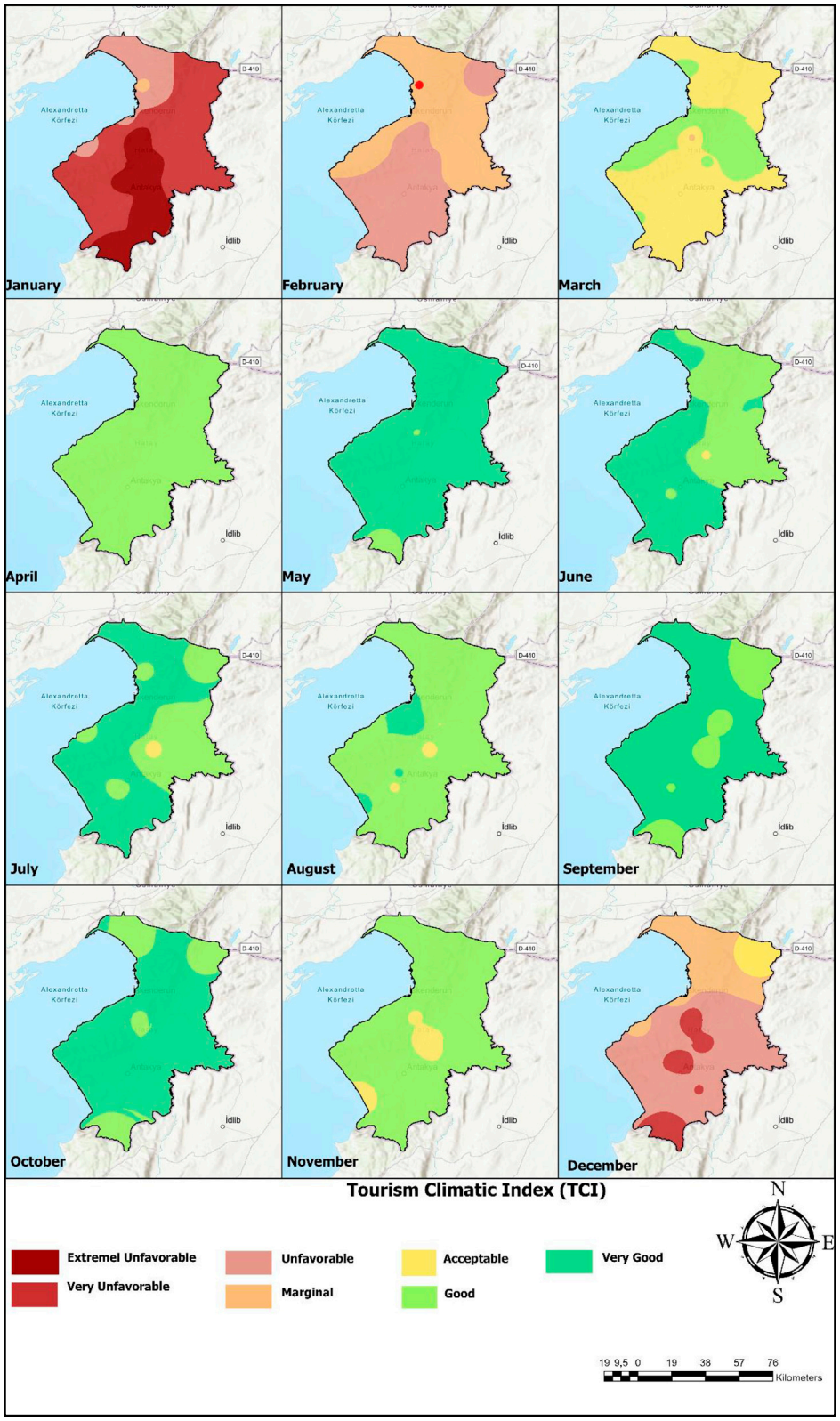


FIGURE 8
Tourism-based climatic comfort in Hatay Province (Tourism Climatic Index: TCI).

February, the climatic comfort conditions of the study area fall into three classes: "Acceptable, Good, and Very Good." However, during December, January, and February, four classes—"Marginal, Unfavourable, Very Unfavourable, and Extremely Unfavourable "—are observed in terms of climate-based tourism comfort. From March to November, the classifications "Marginal, Acceptable, Good, and Very Good" were identified. In contrast, from December to February, the classifications were "Marginal, Unfavourable, Very Unfavourable, and Extremely Unfavourable."

In December, areas classified as "Extremely Unfavourable" are observed particularly in the interior parts of the province, mountainous areas, and areas close to the Syrian border. The "Extremely Unfavourable" comfort class was not identified along the coastal zone and was observed only in mountainous and interior areas. While "Very Unfavourable" areas are predominant in December, "Good" and "Very Good" areas are predominant in April, September, and October. March represents the seasonal transition period in which the "Acceptable" class is most widespread throughout the study area.

4 Discussion

The Tourism Climate Index (TCI), developed by Mieczkowski (1985) and adapted to 12 monthly global maps using data from 453 meteorological stations, is one of the most frequently used indices worldwide for evaluating climatic conditions in terms of tourism comfort (Lin and Matzarakis, 2008; Scott et al., 2016; Hejazizadeh et al., 2019). Mieczkowski divided the TCI into 10 different classes. These classes range from scores of 0–9 and below to 90–100. The classification includes "Impossible, Extremely Unfavourable, Very Unfavourable, Unfavourable, Marginal, Acceptable, Good, Very Good, Ideal, and Excellent." Although the comfort levels categorized by Mieczkowski have gained general acceptance, it is evident that such a classification may yield different results in regions with different natural conditions, particularly different climatic characteristics. These differences cause different comfort categories to become prominent in each region. At this point, comparing the findings of empirical TCI studies conducted in various regions of the world with one another and with the results of this study is important in terms of the scientific contribution of the research. These findings are classified below according to climatic regions and their characteristics, and in the final section, the variation in TCI values in Hatay, located in the Eastern Mediterranean, is compared with that observed in other regions characterized by a Mediterranean climate.

Academic studies have shown that tourism comfort is low during spring and summer in regions of the Northern Hemisphere characterized by hot and dry climatic conditions because of high temperatures (Hejazizadeh et al., 2019; Faraj et al., 2023). Studies conducted in 12 destinations in Saudi Arabia and in areas covering the central, eastern, and southeastern deserts of Iran clearly demonstrate this pattern. In regions with such climatic characteristics, the winter season is more favourable in terms of tourism comfort. This creates a linear relationship between climatic conditions and tourist mobility. For example, it has been demonstrated that the regions surrounding Mecca and Medina, the two holy sites of Islam, provide excellent tourism comfort conditions from December to March, whereas very low comfort values are observed during the summer months (Faraj et al., 2023). In another study conducted in Kerman, Iran, Bakhtiari and Bakhtiari (2013) stated that hot climatic conditions during the summer season are uncomfortable for tourists, whereas the winter months provide cool and favourable environmental conditions.

In contrast to hot and dry climatic regions, various studies have determined that TCI values exhibit lower scores in areas characterized by hot, humid, and rainy climatic conditions. For example, Enebeli et al. (2026), in their study covering Nigeria's 36 states and the Federal Capital Territory, demonstrated that humid coastal states (Rivers, Bayelsa, Akwa Ibom, Delta, Abia, Lagos) exhibited lower scores because of persistent cloudiness, precipitation, and thermal discomfort associated with vapour pressure (Scott et al., 2016; de Freitas et al., 2017). Yuliarti et al. (2026), in their study conducted on the Belitung Islands of Indonesia, explained that the highest TCI values occurred during seasons with lower precipitation, whereas marked declines in comfort levels and an overall decrease in TCI values occurred during the rainy season, when precipitation and humidity increased in coastal areas.

Some recent empirical studies conducted in European countries have revealed that tourism comfort is particularly more favourable during spring and autumn. Kovacs et al. (2025), in their study conducted in Hungary, emphasized that climatic conditions were more favourable in spring and autumn than during summer. They also showed that climatic conditions in Hungary are expected to remain more favourable or unchanged from autumn to spring, whereas a general deterioration is expected during the summer months. Milenkovic and Lukic (2025), in their study covering the Podrinje and Valjevo regions of Serbia, demonstrated that spring and autumn are the most suitable seasons for outdoor tourism activities, with April, May, September, and October particularly standing out. Kovács and Unger (2014), in their study conducted in Central Europe, stated that the summer period is less favourable for tourism activities, particularly because of intense heat stress.

TCI studies conducted in regions characterized by transitional climatic conditions between the cooler and more humid summer climates of Europe and the hot and dry summer climates of the Middle East have reported several important findings. A study focusing on Tbilisi, the capital of Georgia, stated that TCI values ranged between the "Acceptable" and "Excellent" categories and that the climate of Tbilisi was suitable for tourism activities throughout the year. In that study, TCI values for June and September corresponded to the "Excellent" category (Amiranashvili et al., 2008). However, studies focusing on the cities of Kutaisi and Batumi revealed that the lowest comfort level was "Unfavourable," while the highest comfort level was "Excellent" for Kutaisi and "Very Good" for Batumi (Amiranashvili et al., 2010; Amiranashvili et al., 2018). No areas classified within the "Ideal" category were identified in any of these three Georgian cities.

TCI values in areas influenced by Mediterranean climatic conditions, characterized by hot and dry summers and mild and rainy winters, reveal several common findings. One of the most important of these is that TCI values are relatively low during summer along Mediterranean coastal areas as a natural consequence of high temperatures and high relative humidity. This situation has been clearly reported in numerous studies

(Amelung and Viner, 2006; Kum and Gönençgil, 2018; Adıgüzel et al., 2022; Efe et al., 2022; Barrutiabengua et al., 2025). For example, Barrutiabengua et al. (2025), in their study covering 50 provinces in Spain, demonstrated that the southern and eastern regions experience declines in tourism, particularly under higher warming scenarios. Hameidia and Medjerabe (2025), in their study conducted in Algiers, the capital of Algeria, showed that the most favourable months extended from March to June, whereas the least favourable months were from July to September. The findings of this study revealed that August and July, the hottest months in Hatay in the Eastern Mediterranean, and December and January, the months with the lowest temperatures, had the lowest levels of tourism climate comfort. Therefore, the findings obtained for Hatay are consistent with those of studies conducted along Mediterranean coasts or in regions characterized by a Mediterranean climate.

The relevant literature has indicated that, despite being located in different geographical regions, high relative humidity during summer in the coastal areas of both hot and humid and hot and dry regions negatively affects tourism comfort (Amelung and Viner, 2006; Scott et al., 2016; de Freitas et al., 2017; Kum and Gönençgil, 2018; Adıgüzel et al., 2022; Enebeli et al., 2026; Yuliarti et al. (2026). These findings are also applicable to the coastal areas of Hatay. Indeed, an examination of relative humidity values in the study area shows that they range between 49.1% and 79%. During the summer season, relative humidity increases along the coastal zone while decreasing toward the interior areas.

Another common finding identified in studies of areas influenced by the Mediterranean climate is that spring provides more favourable tourism comfort conditions than the other seasons. Amelung and Viner (2006) reached such a finding in their study explaining Mediterranean tourism using the TCI (Amelung and Viner, 2006). Kum and Gönençgil (2018), in their research covering the southern and southwestern coasts of Türkiye, identified the spring months as more favourable in terms of tourism comfort. Adıgüzel et al. (2022), in their study of İzmir in western Türkiye, determined that the coastal areas of the province fell within the "Very Good" and "Good" categories during all months except June and July and demonstrated that a limited area fell within the "Exellent" category during the spring months. The findings of the present study also showed that the "Marginal, Acceptable, Good, and Very Good" classifications were prominent in Hatay from March through November. This finding is also supported by Adiguzel et al. (2020), who reported that "At the beginning of summer season, June is the month in which suitable areas cover the largest area throughout the province."

Another finding reported by the majority of studies examining tourism destinations in climatic regions reflecting the characteristic features of the Mediterranean climate is that "Ideal" conditions, corresponding to TCI values between 90 and 100, do not occur during any month of the year (Cengiz et al., 2008; Kum and Gönençgil, 2018; Adıgüzel et al., 2022). For example, Kum and Gönençgil (2018), in their study of the southern and southwestern coasts of Türkiye, reported that none of the stations recorded TCI values of 90 or above and that no month fell within the "Excellent" category. The fact that neither the "Excellent" nor the "Ideal" class was observed during any month of the year in Hatay, which constitutes the study area of the present research, demonstrates that this finding is also consistent with the literature. This finding becomes even more remarkable considering that a significant proportion of global tourist flows are directed particularly toward these climatic regions characterized by the sea-sand-sun tourism model. Indeed, as Scott et al. (2016) also indicated, studies investigating the factors that motivate tourists, particularly those visiting Europe, have revealed that climate is a primary factor in travel to the Mediterranean region.

In Mediterranean climatic regions, the substantially greater precipitation received during December, January, and February compared with other months results in lower TCI scores during the winter season. This situation has been clearly documented in the literature. For example, Amelung and Viner (2006), who analysed the entire Mediterranean Basin using Mieczkowski's original TCI formula, demonstrated that the lowest scores on the TCI curve corresponded to the winter months. Cengiz et al. (2008), in their TCI analysis conducted in Çanakkale, reported that the winter months exhibited the lowest values in terms of daily maximum temperature, daily mean temperature, and TCI scores and clearly demonstrated this pattern in a graph showing the monthly variation in TCI scores. The study also determined that precipitation, one of the important climatic parameters, has a 20% weight in the TCI formula. In the study area, during the winter months when precipitation is abundant, the contribution of the precipitation parameter to the TCI score decreases. Abbasnia and Toros (2019), in their long-term (1961–2016) TCI analysis of Istanbul, which has a Mediterranean transitional climate, stated that the winter season had the lowest bioclimatic comfort for tourism activities. Efe et al. (2022), in their Türkiye-wide study that also included the Mediterranean region, demonstrated that the lowest TCI values occurred during the winter season. Adıgüzel et al. (2022), in their study conducted in İzmir, which reflects the characteristic features of the Mediterranean climate, determined that January had the lowest comfort level among all months and fell within the "Acceptable" category compared with the other categories. Consistent with the findings in the literature, areas classified as ", Impossible, Extremely Unfavourable and Very Unfavourable" were observed across a large part of Hatay during December, January, and February. One of the most important reasons for this is that winter precipitation along the Mediterranean coast is substantially greater than precipitation during the other seasons. This, in fact, explains why the winter season is less comfortable in terms of TCI values.

Although the broad consistency between the present findings and previous studies supports the applicability of the TCI framework to tourism climate assessments, several methodological limitations should be considered when interpreting the results. The monthly temporal resolution of the TCI may smooth short-term climatic variability and extreme weather conditions, while the fixed weights assigned to its components may not fully reflect the heterogeneous climatic preferences and thermal perceptions of different tourist groups. In this context, Adiguzel et al. (2026) emphasized that "SSI does not aim to replace comprehensive thermal comfort indices such as UTCI or PET. Furthermore, the index-based results were not empirically validated through field surveys or questionnaires addressing tourists' actual perceptions and experiences. Despite the use of data from 18 meteorological stations, the IDW-derived surfaces may also involve spatial uncertainty related to station density and distribution, topographic variability, and the assumptions inherent

in the interpolation method. Future studies could enhance the robustness of tourism climate assessments by incorporating higher-temporal-resolution meteorological data, locally calibrated weighting schemes, tourist perception surveys, and spatial cross-validation procedures. In addition, comparative analyses employing multiple bioclimatic indicators may improve the robustness and comparability of tourism climate assessments (Adiguzel et al., 2026a; Adiguzel et al., 2026b).

5 Conclusion

Climatic conditions undoubtedly directly affect tourism activities and the comfort conditions of tourists participating in tourism. In order to ensure tourism comfort, climatic conditions need to remain within the biological threshold values of humans. Türkiye, a mid-latitude country, is characterized by the distinct occurrence of four seasons within a year and by conditions in which all four seasons can be experienced simultaneously in different parts of the country. In this context, seasonal tourist comfort is of considerable importance for tourism activities in Hatay Province, which has a diverse topographic structure, a coastline, and climatic characteristics reflecting a combination of Mediterranean and, locally, continental influences. In addition, because the earthquakes of magnitude 7.8 Mw and 7.6 Mw, centered in Kahramanmaraş and Hatay (Defne) on 6 and 20 February 2023, respectively, caused extensive destruction and losses in Hatay, mobilizing the tourism potential of the province is of critical importance during the reconstruction process. In this respect, it is equally important to determine the months in which tourism activities provide more comfortable conditions, considering tourism as one of the potential sources of motivation that may contribute to the recovery of the region. Furthermore, developing sustainable tourism plans based on long-term climatic data is also important for regional stability.

By analysing all climatic data used in the study, tourism comfort conditions in Hatay Province were classified as "Impossible, Extremely Unfavourable, Very Unfavourable, Marginal, Acceptable, Good, and Very Good." The "Excellent" and "Ideal" classes were not observed in the study area. Seven classes were identified in the monthly evaluation of Hatay Province, with the "Good" and "Very Good" classes accounting for the largest proportions. The "Marginal" class was identified to the least extent. During December, January, and February, areas classified as, Impossible "Extremely Unfavourable and Very Unfavourable" covered a large part of the study area, whereas "Marginal" areas occupied relatively smaller areas. In terms of tourism comfort, the classifications "Acceptable, Good, and Very Good" were observed in the province between March and November. In this context, December, January, and February represented the lowest levels of tourism comfort, whereas March, April, May, June, July, August, September, October, and November exhibited relatively higher levels of comfort.

In conclusion, Hatay Province was evaluated as uncomfortable for tourism activities during December, January, and February, whereas the other months were found to offer opportunities for tourism activities. The level of comfort over 9 months (March, April, May, June, July, August, September, October, November) represents an important potential for carrying out tourism activities in the province following the earthquake. Therefore, tourism activities should be supported and diversified, particularly during spring, summer, and autumn, as these seasons have "Good" and "Very Good" comfort levels. In terms of its findings, this study is of considerable importance for the development and diversification of tourism strategies in Hatay Province.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EV: Formal Analysis, Software, Visualization, Writing – original draft, Writing – review and editing. YD: Data curation, Methodology, Writing – original draft, Writing – review and editing. MD: Conceptualization, Supervision, Writing – original draft, Writing – review and editing. EB: Investigation, Methodology, Writing – original draft, Writing – review and editing. FA: Project administration, Resources, Supervision, Writing – original draft, Writing – review and editing.

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The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declared that generative AI was not used in the creation of this manuscript.

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