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Research Article

CALCULATING THE TOURISM CLIMATE INDEX FOR URBAN PLANNING: A CASE STUDY OF MERSIN PROVINCE

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Abstract

The tourism climate index for both local and international tourists, particularly during the summer months, has been determined using the thermal comfort relationship in the Mersin Province. The primary objective is to identify the most favorable timeframes and locations for tourism activities within Mersin Province. Various meteorological parameters, including maximum, minimum, and average temperatures, as well as minimum and average relative humidity and average wind speed, were analyzed and assessed. The collected data was organized and integrated into a Geographic Information Systems (GIS) environment. For estimating data at unknown points within the study area, the inverse weighted average method was employed as an interpolation technique, utilizing known data points. The tourism climate index was utilized to characterize the climatic comfort conditions of the province, specifically in relation to tourism activities. This assessment sheds light on how climatic conditions impact tourism. Based on average temperature, relative humidity, total rainfall, and wind data, a tourism-oriented climatic comfort map for Mersin Province was generated, classified into seven categories: unacceptable, marginal, acceptable, good, very good, excellent, and ideal. The diversity of potential tourism activities during these periods significantly enhances the importance of this climatic classification. The outcomes of this research hold considerable importance for shaping the tourism strategy of Mersin Province. Extending this approach to derive tourism-oriented climatic comfort assessments for other provinces of significance in terms of tourism will greatly contribute to the overall tourism strategy of the country.

Keywords: Tourism Climate Index, Urban Planning, Mersin

Introduction

Tourism constitutes one of the largest and fastest growing industries in the world (Smith, 1993; De Freitas, 2003; Hamilton and Tol, 2004; Scott and Lemieux, 2010). As the World Travel and Tourism Council (WTTC) stated in 2019, tourism contributed 10.4% of the world's GDP and employed 319 million people (Zhong and Chen, 2019). The USA, Spain and France are at the forefront of the countries where tourism activity is an important source of income. Although the tourism industry is among the important economic sectors of the world, it has a sensitive and fragile structure against war, terrorism, theft, social and political crises (Clements and Georgiou, 1998; Fletcher and Morakabati, 2008; Fielding and Shortland, 2011; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin, Adiguzel and Zeren Cetin 2023; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020). In addition to these human factors that affect tourism, geographical location, topography, landscape, flora and fauna, as well as weather and climate, constitute the main natural factors that affect recreation and tourism activities (De Freitas, 2003; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020). Among these, especially climatic conditions are considered very sensitive in terms of tourism activities (Bode, Hapke and Zisler, 2003). In addition to coastal tourism, which is based on the sea-sand-sun trio all over the world, which still attracts the most tourists, diversification efforts have begun to come to the fore in order to spread tourism throughout the year and to

different regions in order to provide more income from tourism. Studies have focused on tourism types such as rural tourism or village tourism, highland tourism, thermal tourism, faith tourism, eco-tourism (Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020).

Climate is significantly associated with the tourism industry (Matzarakis, 2006; Scott and Lemieux, 2010; Hernandez and Ryan, 2011; Hejazizadeh et al. 2019; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020). Climate conditions directly affect tourism activities (Scott and McBoyle, 2001; De Freitas, 2003; De Freitas, 2005; Berrittella et al. 2006; Lin and Matzarakis, 2008; Scott and Lemieux, 2010, Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020). Studies revealing the climate-tourism relations show that climate conditions are the first or second factor affecting the destination preferences of tourists (Lise and Tol, 2002; De Freitas, 2003; Lin and Matzarakis, 2008; Scott and Lemieux, 2010; Zhong and Chen, 2019; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020) . Tourists who prefer destinations that are not suitable for climate may encounter extreme weather events that may negatively affect their own comfort. This situation causes the holiday mentality to be replaced by thermal stress and the holiday to be inefficient. For this reason, it is understood that the climate affects the comfort of the tourists participating in these tourism activities as well as tourism (De Freitas, 2003). In order to provide thermal comfort, the climate components must be in the appropriate value range for humans (Çetin et al., 2010; Matzarakis and Endler, 2010; Topay, 2012; Çetin, 2015; Çetin, 2016; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b; Zeren Cetin et al 2023a,b; Zeren Cetin et al., 2020; Zeren Cetin and Sevik 2020).

The relations of climate with tourism and recreation are explained through certain indexes (Moreno et al, 2008). These indexes facilitate the interpretation of the degree of integration of various atmospheric elements with each other and make it possible to compare places (De Freitas, 2005; Matzarakis, 2007). Various studies have been conducted describing tourism climate relations with numerical measurements (Auliciems and Kalma, 1979; Mieczkowski, 1985; Harlfinger, 1991; Maddison, 2001; Matzarakis, 2002; Lin and Mieczkowski, 2008; Lei Xiangjie et al, 2013; Liu Shaojun et al., 2014; Mendez et al, 2014; Wang Yanfang et al, 2016). The most popular index frequently used in tourism climate research is the Tourism Climate Index (TCI) developed by Mieczkowski (1985) (Lin and Matzarakis, 2008; Hejazizadeh et al. 2019). Mieczkowski (1985) designed a broad-based tourism index (TCI) to assess tourism-climate relationships, but except for the Harlfinger study (1991), TCI indices were initially interpreted without field research. Later, it was deemed necessary to conduct field studies in practice, instead of the researcher's subjective value judgments that test the accuracy of TCI indices (De Freitas, 2005). Thus, the number of academic studies that use the TCI index and test the accuracy of the data with field studies has started to increase (Scott and McBoyle, 2001; Scott et al, 2004; Amelung and Viner, 2006; Amelung, Nicholls and Viner, 2007; Farajzadeh and Ahmetabadi, 2010; Ataei and Hasheminasab, 2012; Adıgüzel and Doğan 2021; Adiguzel et al., 2022; Bozdogan Sert et al., 2021; Abo Aisha and Cetin 2023; Alrabiti and Cetin 2023; Cetin et al., 2010; Cetin 2015; Cetin 2016a,b; Cetin 2019; Cetin et al., 2018; Cetin et al., 2019; Cetin 2020a,b,c; Cetin et al., 2023a,b; Cetin and Alrabiti 2022; Cevik Degerli and Cetin 2023; Cevik Degerli and Cetin 2022a,b).

The aim of this study is to determine the relationship of climate elements with tourism activities and thermal comfort in Mersin province, which is one of the important tourism centers of Turkey and where local and foreign tourists participate intensively in tourism activities, especially in summer, by using the Tourism

Climate Index (TCI). With the study, it is aimed to reveal the most suitable time and the most suitable area for tourism activities in Mersin province.

Materials and Methods

The study material is Mersin and the surrounding area; The Mersin region, located in the Mediterranean Sea coast, the southern Sea Region in Turkey (Figure 1). It is with coordinates of 36° 81' north latitude and 34° 64' east longitude and the values evaluated and processed using GIS maps, and the map obtained is shown in Figure 1. The surface area of the region of Mersin has natural, cultural, and recreational resources have a high value. In the region, the majority of the year is dominated by the Mediterranean climate. The climate type of the study area is defined as the Csa which is characterized by dry summers and mild, wet winters according to the Köppen-Geiger classification (Ozturk et al., 2017). Mersin has its highest rainfall in winter. The average annual temperature is 23 °C. The highest temperature is 28 °C to 29 °C, which usually occurs in July and August. January is the coldest month at -3 °C. The northern slopes of the area get more rain (Cetin 2019; Cetin 2020c; Gungor, Cetin and Adiguzel, 2021).

Figure 1. Mersin province location map
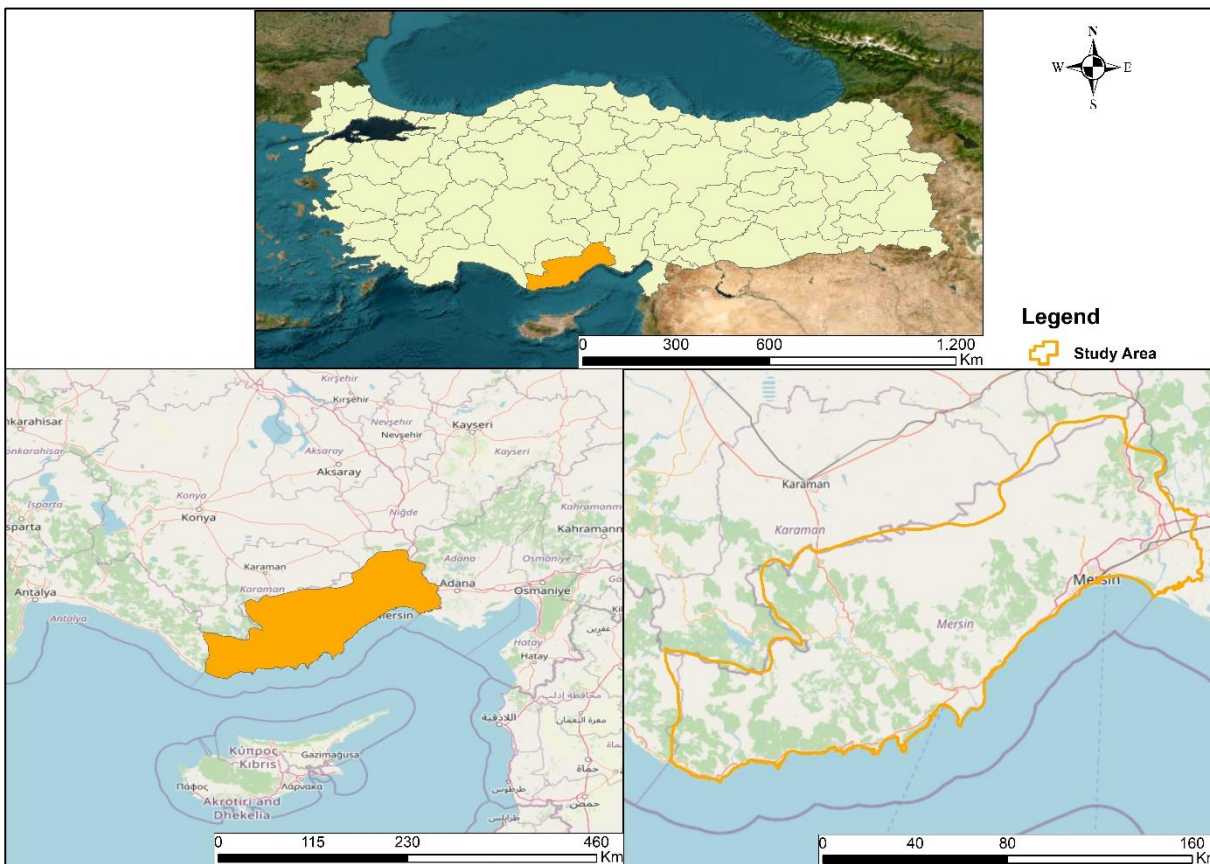
Temperature (maximum, minimum and average), relative humidity (minimum and average), precipitation (total and average), sunshine duration (total) and wind speed (average) data for Insolation variable (Mieczkowski 1985) are provided Table1, Table 2 and Table 3. The obtained data were arranged and transferred to the GIS environment. The Inverse Weighted Average Method (IDW), one of the interpolation methods, was used to make estimations about unknown points with the help of known points in the study area (Adiguzel et al., 2022; Cetin 2019; Cetin 2020c; Gungor et al. 2021). IDW;

$\hat{Z}(X_o) =$

It is expressed by the formula W (X_i) =. Here;

N = total number of known measuring points

W(X_i) = weight at i-th known position

$Z(X_i)$ = shows the amount of precipitation in the i-th position. The second formula is used to obtain the weights. It shows the sample point in the second formula and the distance between the estimation point (Adiguzel et al., 2022; Cetin 2019; Cetin 2020c; Gungor et al. 2021).

Table 1. The Precipitation Variable (Mieczkowski 1985)

Wind Speed (m/s)	Beaufort Scale
5.0	0.0–14.9 mm
4.5	15.0–29.9 mm
4.0	30.0–44.9 mm
3.5	45.0–59.9 mm
3.0	60.0–74.9 mm
2.5	75.0–89.9 mm
2.0	90.0–104.9 mm
1.5	105.0–119.9 mm
1.0	120.0–134.9 mm

Table 2. Wind Ratio Scale (Mieczkowski 1985)

Wind Speed (m/s)	Beaufort Scale	Normal System	Trade Wind System	Hot Climate System
< 0.79	1	5.0	2.0	2.0
0.80–1.59	2	4.5	2.5	1.5
1.60–2.50	2	4.0	3.0	1.0
2.51–3.39	2	3.5	4.0	0.5
3.40–5.49	3	3.0	5.0	0
5.50–6.74	4	2.5	4.0	0
6.75–7.99	4	2.0	3.0	0
8.00–10.70	5	1.0	2.0	0
> 10.7	6	0	0	0

Table 3. Insolation variable (Mieczkowski 1985)

Rates	10 h or more	Rates	10 h or more
5.0	19 h–9 h 59 min	2.5	4 h–4 h 59 min
4.5	8 h–8 h 59 min	2.0	3 h–3 h 59 min
4.0	7 h–7 h 59 min	1.5	2 h–2 h 59 min
3.5	6 h–6 h 59 min	1.0	1 h–1 h 59 min
3.0	5 h–5 h 59 min	0	less than 1 h

In order to determine the effect of the climatic conditions of Mersin on tourism, the Tourism Climate Index (TCI) prepared by Mieckowski was used to determine the climatic comfort conditions of the province in terms of tourism. This index;

TCI=2[4 * CID + CIA + (2*P) + (2*S) +W] I was calculated using the formula (Güçlü, 2010; Kovác and Unger, 2014; Adiguzel et al., 2022; Cetin 2019; Cetin 2020c; Gungor et al. 2021).

CID and CIA: CID is the daytime comfort index and is calculated according to the maximum temperature and minimum relative humidity values. CIA Represents the daily comfort index and uses average air temperature and average humidity. In order to reveal these values, the thermal comfort average system prepared by ASHREA was used. If the temperature is 20°C and the relative humidity is 30%, the scale equivalent is 5.0. If the relative humidity is 70% at 27°C, the scale equivalent is 3.5. Due to the nature of this study, no ethics committee is required.

Results

Tourism-based climatic comfort conditions of Mersin were determined according to TCI criteria. Average temperature, relative humidity, total precipitation and wind parameters were used for this index. In line with the data obtained, tourism-based climatic comfort maps of Mersin are shown in Figure 2, Figure 3, and Figure 4. Average monthly temperature values of Mersin vary between 2.2°C and 28°C. The temperature values, which reach the highest level in the summer season, reach the lowest level in the winter season. Due to the topographic structure of the city, the places where the temperature is high in the summer season are the areas close to the sea level, and the places where the temperature is the lowest in the winter season are the mountainous areas. The hottest months of the city are listed as August>July>June. During this period, the temperature is higher in areas under the influence of the sea; As the altitude increases, the temperature is lower in areas under the influence of mountains. Accordingly, the hottest months, July and August, can be considered as the months with the lowest climatic comfort level. On the contrary, the decrease in temperature starts in November; The coldest period is listed as January>February>December. March is experienced as a transition period. Relative humidity rates in the study area vary between 43.1% and 88.0%. Relative humidity in winter in December-January; In summer, it reaches the highest level in July-August. Areas with high relative humidity are especially mountainous areas around the province. The period when the city is the highest in terms of relative humidity starts from October and lasts until the end of March. Considering the total precipitation data, it is 0.08 mm. with 310mm. It is seen that the amount of precipitation varies between The least precipitation occurs in summer and the highest precipitation in winter. Precipitation, which tends to decrease in general in summer, increases in relatively mountainous areas in winter. There is almost no precipitation in July and August. On the contrary, January is the rainiest month; It is seen that precipitation continues in other winter months.

It is presented in 3 categories in the tourism-based climatic comfort map (TCI) of Mersin, which was obtained using average temperature, relative humidity, total precipitation and wind data. These are uncomfortable, marginal, acceptable, good, very good, excellent, and ideal. The tourism-based climatic comfort (Tourism Climatic Index: TCI) map of Mersin Province is given in Figure 5. When the tourism-based climatic comfort in Mersin is evaluated in terms of average temperature; It is seen that the spring (March-April-May) period is the most suitable period in terms of climatic comfort. In addition, the most suitable period is autumn (October-November). In winter, comfort is generally acceptable and at good levels in December; It was determined to be generally at a good level in February. However, there is a noticeable decrease in the good level and an acceptable increase in January. The low temperature values and high relative humidity values caused different conditions to be effective in different regions in the winter season. In the winter season (except for February), the northern, central and eastern parts of the province are seen to be at "acceptable" levels in terms of tourism comfort conditions. In addition, it is seen that tourism comfort conditions are "good" and "very good" in all months (except June and July) in the coastal band of the province. There is no ideal area in terms of tourism-based climatic comfort conditions. It is seen that there are excellent fields as the highest class. Excellent areas were detected in very small areas during the spring season. In the spring season, "good" and "very good" classifications come to the fore throughout the province, while "acceptable" classifications come to the fore in the summer season. In the autumn season, it is seen that the comfort conditions of tourism begin to improve.

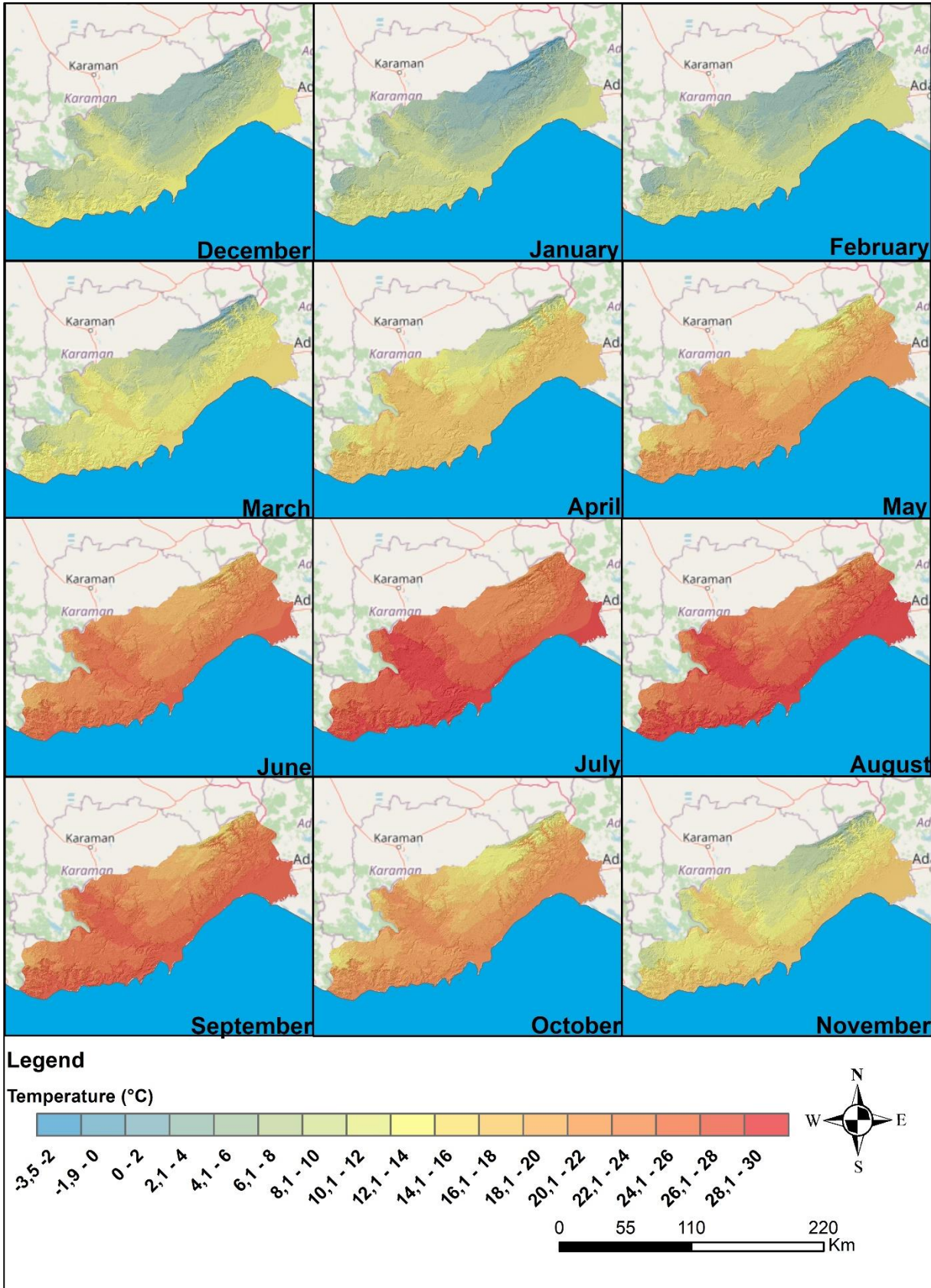**Figure 2. Evaluation of tourism-based climatic comfort in Mersin province in terms of average temperature**

Figure 3. Evaluation of tourism-based climatic comfort in Mersin province in terms of relative humidity
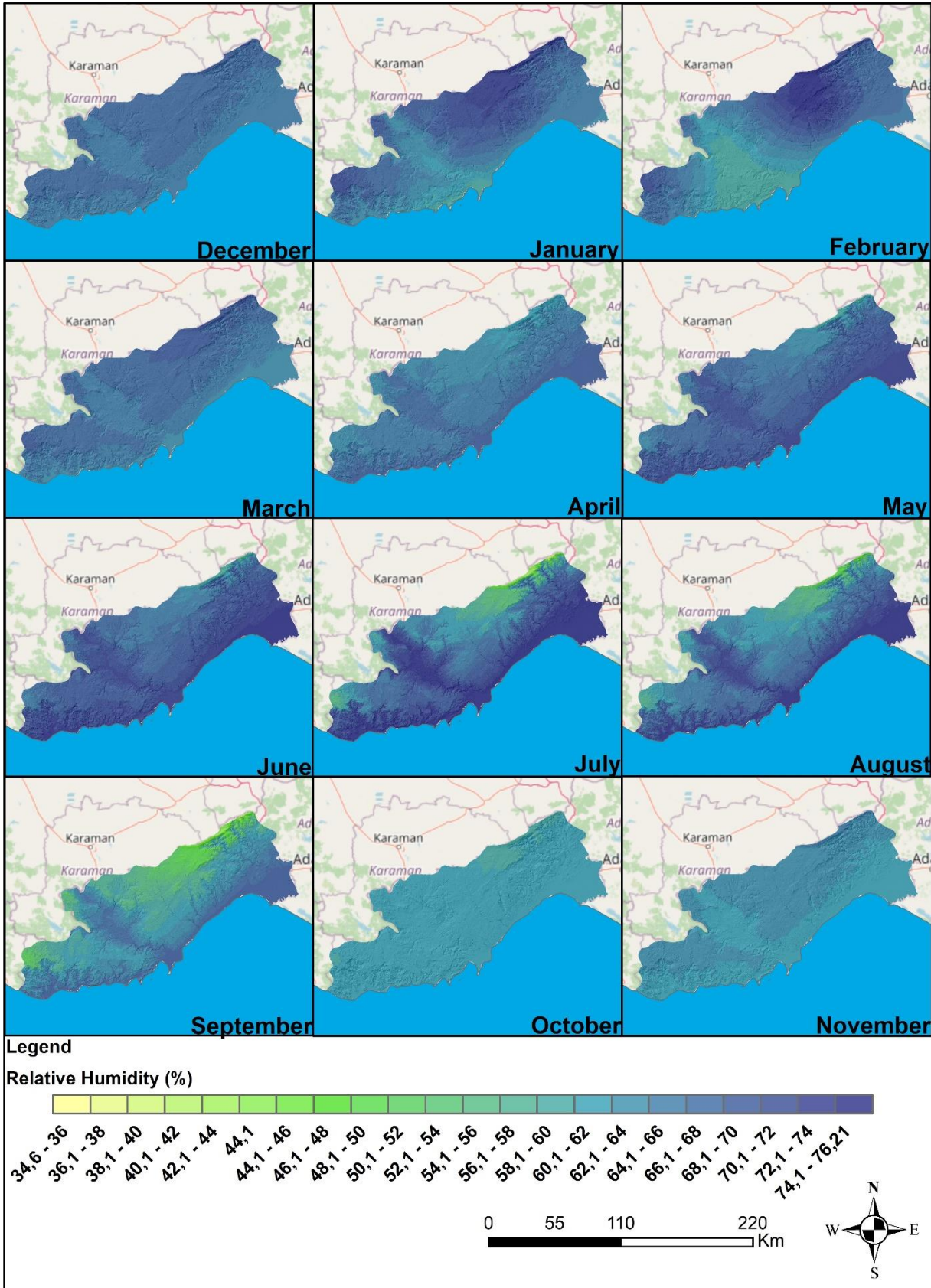
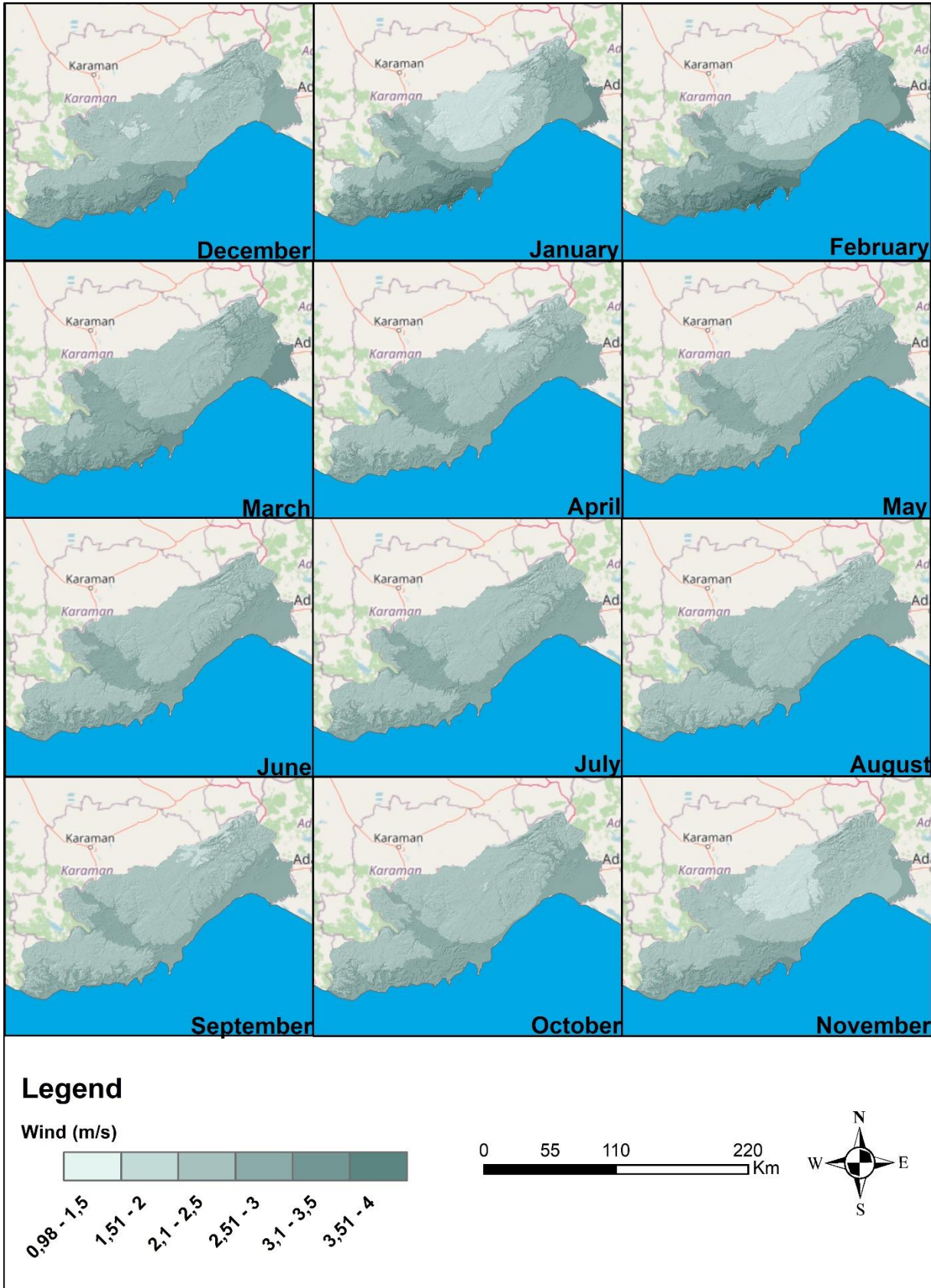**Figure 4. Evaluation of tourism-based climatic comfort in Mersin province in terms of wind**
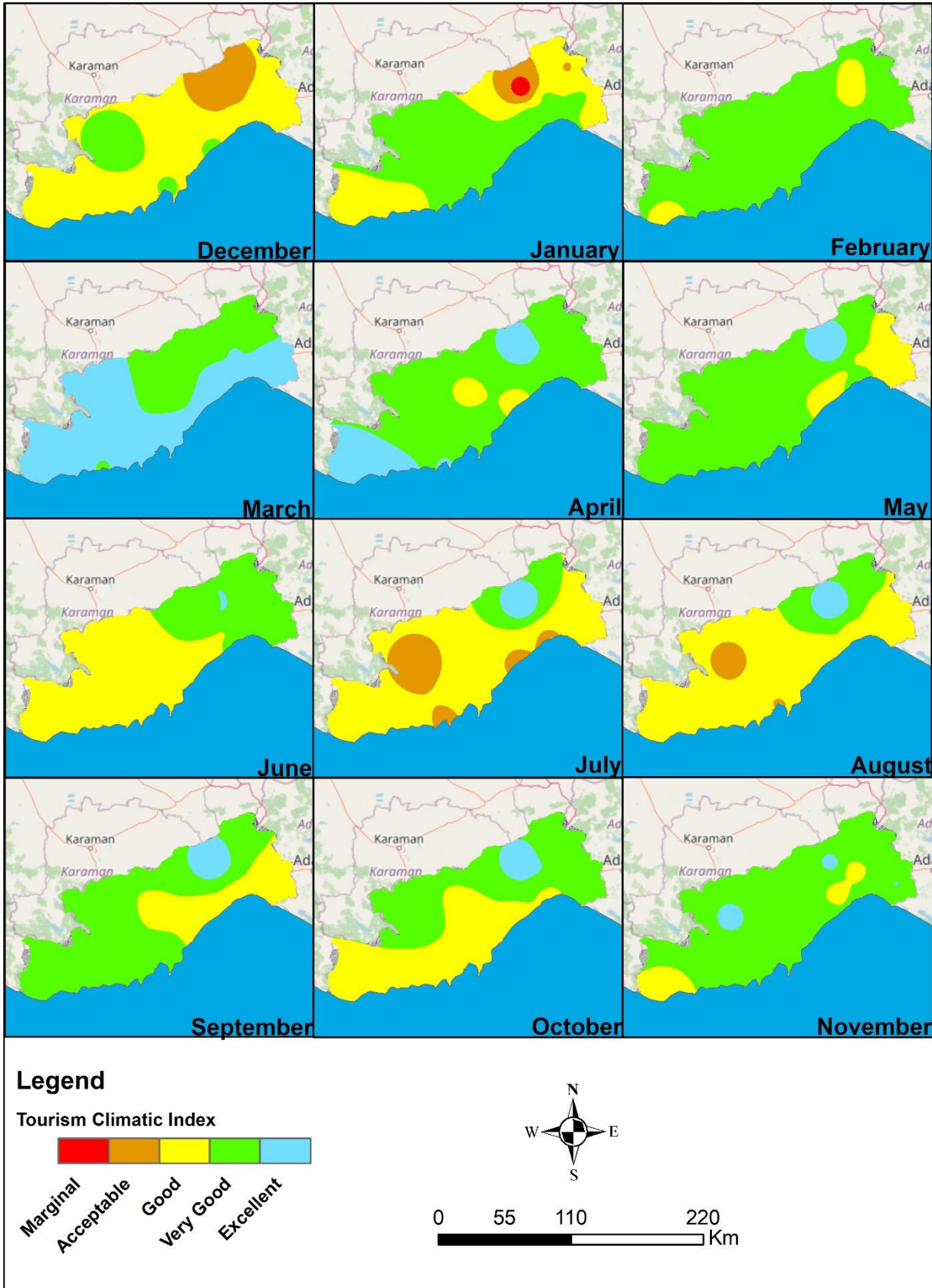
Figure 5. Tourism-based climatic comfort of Mersin Province (Tourism Climatic Index. TCI)

Discussions

The most frequently used index to reveal the effects of climate on tourism comfort worldwide is the Tourism Climate Index (TCI) developed by Mieckowski (1985) (Lin and Matzarakis, 2008; Scott et al, 2016; Hejazizadeh et al 2019; Adiguzel et al., 2022). For the index he developed, Mieckowski obtained monthly TCI

values using the data of 453 meteorological stations around the world and generalized the values he found on 12-month World maps. In addition, he divided the comfort levels into 10 categories, defined the most comfortable category as "Ideal" (TCI>90), and the category with no comfort as "Impossible" (TCI<9) for tourism activities (Mieckowski, 1985; Adiguzel et al., 2022). Although the comfort levels that Mieckowski categorizes are generally accepted throughout the world, regional differences in natural conditions cause the comfort categories to be different from each other. When the findings of the studies revealing the relationship between climate and tourism comfort by using the TCI index in Iran are evaluated together, it is noteworthy that there are areas with different categories from the comfort level that can be called "Unfavorable" to the comfort level that is considered "Ideal" (Farajzadeh and Ahmadabadi, 2010; Bakhtiari and Bakhtiari, 2013; Hejazizadeh et al. 2019; Adiguzel et al., 2022). In a study on Tbilisi, the capital city of Georgia, it was stated that TCI values are between the "Acceptable" and "Excellent" categories, and the climate of Tbilisi is suitable for tourism activities throughout the year (Amiranashvili, Matzarakis and Kartvelishvili, 2008). However, in studies on the cities of Kutaisi and Batumi, it has been revealed that the lowest level of comfort is "Unfavorable", while the highest level of comfort is "Excellent" for the city of Kutaisi and "Very Good" for the city of Batumi (Amiranashvili, Matzarakis and Kartvelishvili, 2010; Amiranashvili et al., 2018; Adiguzel et al., 2022). It has been observed that no area in the "Ideal" category has been identified in these three cities of Georgia.

By using the TCI index in Turkey, the effects of climate on tourism comfort have been revealed by studies on coastal settlements. It has been stated that the spring season in Canakkale, one of the important tourism destinations of Turkey, is the most favorable season in terms of tourism activities and TCI values are in the "Very Good" category in all months of this season. It was also revealed that summer months are in the "Very Good" category, November in the autumn is in the "Good" category, September and October are in the "Very Good" category, in the winter season December is in the "Acceptable" category, and January and February are in the "Good" category (Adiguzel et al. 2022; Gungor et al., 2021; Cetin 2020). In another study, in which TCI values were determined based on the climate data of Bodrum, Marmaris, Fethiye, Finike, Antalya and Alanya stations located in the south and southwest of Turkey, it was found that the TCI value did not fall below 40 or exceed 80 in any month in the mentioned cities (Excellent/ ideal) has been identified. It has been determined that TCI values are in the "Acceptable" category at all stations except Marmaris station during the summer season (Kum and Gönençgil, 2018).

In this article, which reveals the climate-tourism comfort relations in Mersin, which is located on the south coast of Turkey and one of the important tourism destinations of the country, using the TCI index, it is stated that "Ideal" conditions with a score between 90-100 in no month of the year in terms of climatic comfort throughout the province. It has been determined that the comfort level is in the "Good" and "Very Good" categories in March, April, May, October and November, while January, June and July have the lowest comfort level and are in the "Acceptable" category. It has been revealed that in the spring, a narrow field is in the "Excellent" category and the rest of the province has "Very Good" and "Good" comfort levels. It has been determined that the coastal areas of the province are included in the "Very Good" and "Good" categories in all other months except June and July.

In this study, the findings about Mersin were significantly consistent with the findings of studies dealing with Antalya and some settlements on the south/southeast coasts of Turkey. Spring has been the season with the highest level of comfort in all of these settlements. Amelung and Viner (2006) reached the same conclusion in a study in which they explained Mediterranean tourism using the TCI index (Amelung and Viner, 2006; Adiguzel et al., 2022). It is noteworthy that the comfort level in the "Ideal" category is not seen at any time of the year in Mersin, However, unlike the other settlements, it has been determined that "Excellent" comfort levels are seen in very narrow areas in the spring season in Mersin. Finally, the fact that the categories in which comfort levels prevail at all, including Mersin, are between the "Acceptable" and "Very Good/Excellent" categories, indicating that all of the mentioned settlements are suitable for tourism and recreational activities throughout the year.

Conclusions

Tourism, one of the fastest growing industries in the world, is affected by climatic conditions. Climatic conditions affect the thermal comfort of tourists participating in tourism activities. In providing thermal comfort, it is essential that the climate components are in the appropriate value range for humans. Turkey is in a luckier position than some other countries in this regard with its tourism diversity. In this context, the impact of the climate on the tourism development of Mersin, which is one of the most important tourism cities of the

country, is very high. In addition, its natural and cultural features allow the development of different tourism areas.

In this study, tourism-based climatic comfort conditions of Mersin province were determined according to TCI criteria. Average temperature, relative humidity, total precipitation and wind parameters were used for this index. According to the results obtained by evaluating all the parameters in the study, the climatic comfort classes in Mersin were determined as "unacceptable", "marginal", "acceptable", "good", "very good" and "excellent". There is no area in the "ideal" class in terms of tourism-based climatic comfort conditions within the scope of Mersin province. In the evaluations made for each month of the year, "acceptable" and "good" comfort classes are seen at the highest rate. When both coastal areas and mountainous areas are evaluated at the provincial scale, the most suitable months for thermal comfort coincide with the spring period. The diversity of tourism activities that can be done in these months also increases the importance of this period. Similarly, autumn (October-November) months are the months when thermal comfort is most appropriate. When the tourism-based climatic comfort conditions of Mersin are evaluated, the lowest comfort level is seen in January-June-July. These levels were determined as "acceptable" and "good" at the most.

The data obtained as a result of the study show that the province of Mersin can provide opportunities for tourism activities that can be done throughout the year. However, due to the fact that the comfort level is "good" and "very good" in the 5-month period (March, April, May, October, November), the fact that summer tourism activities can be carried out for these months will allow the tourism potential of the city to increase. For this purpose, it is necessary to support and diversify the activities to be carried out in the areas with "good" comfort level of the tourism activities in the summer period. It is thought that the results obtained in this study are important in terms of developing the Mersin Province Tourism Strategy. For this reason, making tourism-based climatic comfort conditions for all provinces important for tourism will make an important contribution to the direction of our country's Tourism Strategy.

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