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Application of Holiday Climate Index (HCI): Urban to Potential Alternative Tourism Attractions

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Abstract

The climate is an important variable for the tourism sector since it influences the travel period, duration of stay, and the type of activities that can be engaged in. The global climate crisis will have inevitable impacts on the tourism sector as many others. One of the most extensively discussed impacts on tourism in the literature is heat stress and relatedly changing climatic comfort at tourism destinations. The change in comfortable and suitable climatic conditions is expected to shift tourism seasons and popular destinations from overheated locations and time periods to more preferable ones. These alterations are critical and might be devastating specifically for tourism-dependent economies. Therefore, it is vital to assess the variations in climatic conditions and take adaptation actions. Based on this necessity, this study aims to analyze the climate change impacts on tourism climate comfort by utilizing Holiday Climate Index (HCI): Urban and addressing the alternative tourism attractions for adaptation. Türkiye is one of the most popular and most vulnerable tourism destinations because of its exposure to heatwaves, especially in the summer period. This study focused on Denizli Province, an alternative tourism destination, to determine its potential to have a role in adaptation. The analysis (HCI: Urban) is conducted for 1971-2000/reference year, 2023-2050/medium-term projections, and 2070-2098/long-term projections for two different scenarios; RCP 4.5 (moderate impact) and RCP 8.5 (high impact). To compare the spatial distribution of comfort levels and evaluate the alteration, ArcGIS software is operated. The results present that there are potential alternative tourism attractions in different locations and different seasons in Denizli which can be beneficial for tourism adaptation strategies. This study is important to shed light on the emerging potential of alternative tourism attractions and provide a roadmap for strategic tourism planning.

Keywords

Climate Change, Tourism, HCI Urban, Adaptation, Türkiye

1. Introduction

The impacts of climate change are projected as high temperatures, rising sea levels, increasing the severity of extreme events, and decreasing precipitation (IPCC, 2022). Since climate has significant impact on destinations' attractiveness, tourism activities and tourist decisions such as travel period and duration, climate change is a major challenge of future of the tourism (Smith, 1993; Uysal et al., 2008; Chen et al., 2017). Moreover, climate change impacts are expected to cause serious threats to tourism infrastructure, assets, natural resources, and the health of tourists (Dube & Nhamo, 2018; Jarratt & Davies, 2020; Pathak et al., 2021). One of the most extensively discussed impacts on tourism in the literature is heat stress and relatedly changing climatic comfort at tourism destinations. The change in comfortable and suitable climatic conditions is expected to shift tourism seasons and popular destinations from overheated locations and time periods to more preferable ones. Consequently, the tourism demand and tourist preferences are likely to alter in terms of destinations, seasons, and tourism types. These alterations are critical and might be devastating specifically for tourism-dependent economies (Tranos & Davoudi, 2014). Furthermore, the severity of impacts depends on various factors such as geographical location, socio-economic vulnerability, exposure, and the adaptive capacity of the destination. In other words, the effects are projected to vary among destinations. Consequently, there is a high possibility that some destinations will gain more tourism demand and others will lose their leading position (Pang et al., 2013; Scott, 2021). In any case, it is critical for destinations to adapt to the new dynamics and trends in global tourism for sustainable responses. The infrastructure and tourism services need to be improved to manage increasing demand in different destinations and shifting seasons. Also, alternative tourism attractions and activities need to be promoted and enhanced to prevent demand loss (Aygün Oğur & Baycan, 2023). Therefore, it is vital to assess the variations in climatic conditions and develop adaptation strategies.

The prominent subject in tourism and climate change research is the change in comfort levels based on increasing temperatures. As a result of increasing temperatures and heatwaves already warmer destinations are expected to get higher temperatures that threaten tourists' health and create uncomfortable outdoor thermal conditions. On the other hand, cooler destinations would have more pleasant and warmer weather conditions which enhance the attractiveness (Carrillo et al., 2022; Faraj et al., 2023). The increasing temperature is also the main reason for seasonal shifts. The tourism season might be prolonged due to warmer winters and summers may lose their popularity. The shoulder seasons (spring and autumn) are expected to become the most suitable for tourism and outdoor activities in most of today's popular destinations (Bafaluy, 2014; Miszuk et al., 2016). The Mediterranean region which is the leading tourism destination in the world having more than 30% of international tourists is at the hotspot (UNWTO-UNEP-WMO, 2008; UNWTO, 2023). The region has the highest risk of increased temperature especially in the summer period. The projections show that the Mediterranean region may encounter significant impacts on tourism in terms of changes in tourism flows, periods, and the number of visitors (Hein et al., 2009; Demiroğlu et al., 2020; El-Masry et al., 2022; Aygün Oğur & Baycan, 2023). Moreover, IPCC addresses tourism as one of the most impacted sectors in Europe (Kovats et al., 2014).

Türkiye is located in the Mediterranean region and hosted more than 50 million tourists in 2019. The number of tourists decreased over the past 2 years due to Covid-19 measures, however, it increased in 2023 and reached 20 million in the first half of the year (TurkStat, 2023). Tourism is one of the most important sectors in the country's economy since it is a source of foreign currency earnings. Türkiye hosts the highest number of tourists in the summer season due to its well-known coastal destinations located on the Mediterranean and Aegean shores. Therefore, pointing out sea-sand-sun (3S) tourism and the pleasant weather as the main attractiveness of Türkiye tourism would be accurate. Climate change is a crucial phenomenon that threatens the strongest attribute of Türkiye's tourism in global competition. Studies focusing on tourism and climate change in Türkiye revealed that the coastal cities may lose their popularity in the future. The most mentioned impacts are a decrease in international tourism demand and altered seasonality. Besides extreme climate events and sea level rise, the main reason for that is overheating and more frequent and severe heatwaves. According to recent studies, the south and west coasts of Türkiye will experience a dramatic decrease in comfort levels in summer and an increase in shoulder seasons and winter. Moreover, the comfort levels of destinations in the inner land will not change as drastically as the coastal part in the popular tourism seasons. These studies have two perspectives; one defines critical risks for certain regions whereas the other highlights the opportunities in alternative destinations and seasons (Şenerol, 2010; Somoncu, 2018; Şensoy, 2020; Demiroğlu et al., 2020; Aygün, 2021). Most of the studies on the thermal comfort of tourism destinations in Türkiye either have an upper-scale perspective that covers multi-destinations/whole country or focus on the most popular coastal destinations (Demiroğlu et al., 2020; Adiguzel et al., 2022; Cinar et al., 2023; Aygün Oğur & Baycan, 2023). However, the alternative inner destinations are underestimated in tourism studies. The motivation for this study is derived from the need for a detailed assessment of these alternative destinations and to determine their potential for adaptation strategies.

The aim of the study is to analyze the climate change impacts on tourism climate comfort and address the opportunities in alternative tourism attractions for adaptation. Denizli province in Türkiye, an underestimated alternative tourism destination, is selected as a case study due to its geographic location and variety of tourist attractions. Holiday Climate Index (HCI): Urban which is a contemporary comfort index specifically provided for outdoor tourism activities is utilized for the study. The analysis (HCI: Urban) is conducted for 1971-2000/reference year, 2023-2050/medium-term projections, and 2070-2098/long-term projections for two different scenarios; RCP 4.5 (moderate impact) and RCP 8.5 (high impact). To compare the spatial distribution of comfort levels and evaluate the alteration, ArcGIS software is operated. The study focuses on micro-climatic zones, determines comfort level changes in different climate change scenarios, and reveals its potential to have a role in adaptation.

The first section after the introduction presents the climate comfort indices for tourism in the literature. The second part shows the characteristics and tourist attractions of the case study city, Denizli. The next section explains the methodology in detail and data sources. The following section reveals the results of the application of the HCI: Urban. The final section provides the conclusion and discussions.

2. Climate Comfort Indices for Tourism

Climate has always been an important variable in tourism research. It has a role in tourism motivation, destination choice, activities, the image of the destination, and the overall satisfaction of tourists (Kozak, 2002; Yiamjanya & Wongleedee 2014). As an early attempt, the impacts of various climatic variables on tourism activities were systematically assessed within a single index by Mieczkowski (1985). The Index called Tourism Climate Index (TCI) evaluated the cumulative impacts of temperature, humidity, precipitation, sunshine hour, and wind speed on general open-air tourism activities. It has become one of the most widely used indices in tourism discourse. In their studies, Scott and McBoyle (2001) integrated climate change projections into TCI and assessed the climate change impacts on comfort levels in North American cities. The results of this study revealed a decrease in TCI scores in the summer period, specifically in July and August of the projected year. Afterward, Scott et al. (2004) extended the study to Canada, Mexico, and the USA and clearly presented the difference between the Northern regions where climate suitability increases, and the Southern regions where comfort levels decrease.

TCI is also utilized for Europe in numerous studies. Ciscar et al. (2009) assessed the TCI score changes in Europe in their research project called PESETA. They concluded that TCI scores increased in Western and Northern and decreased in Southern countries by the end of the 21st Century. Similarly, Grillakis et al. (2016) conducted TCI for a 2˚C warming scenario in Europe and reached a conclusion that addresses the high risk for Mediterranean Basin including Türkiye for the summer period. Moreover, they projected increased TCI scores for Central and Northern Europe. TCI was also used in country-level studies such as Hein et al. (2009) in Spain or Aygün Oğur & Baycan (2023) in Türkiye. The results of these studies revealed a similar trend to previous continental studies. Moreover, there are city-specific TCI applications such as El-Almain in Egypt or İzmir in Türkiye (Adiguzel et al., 2022; El-Masry et al., 2022). These studies confirmed the findings of previous upper-scale studies on the shift of the peak tourism season. Although TCI is widely used in the literature, it is criticized in many aspects. First, its rating system and the weighting of variables are criticized for being subjective. Second, it generalizes tourism activities however, different tourism types require distinct evaluations. Finally, its resolution is low since it uses monthly data instead of daily or hourly data (Scott et al., 2016).

The Beach Comfort Index (BCI) was launched to assess the climatic comfort conditions of beach resorts in South Africa. In this index, the thermal conditions were calculated based on the human energy balance. Consequently, "beach day" and "beach hour" terms were introduced to tourism literature (Becker, 1998). Another beach tourism index; the User-Based Beach Climate Index was produced by modifying TCI. This index combined thermal sensation and bathing temperature with climatic variables defined in TCI. The index was based on questionnaires carried out world's most popular beach tourism destinations; Wales, Malta, and Türkiye. It also changed the weighting system of TCI by prioritizing climatic variables based on questionnaire outcomes (Morgan et al., 2000).

Another tourism-type-specific tool Climate Index for Tourism (CIT) was created by de Freitas et al. (2004) to analyze the thermal, esthetic, and physical characteristics of climate in terms of its suitability for 3S tourism. This index focused on coastal regions and was produced by the variables collected from the case areas. It defined thermal comfort as a function of thermal (ASHRAE thermal sensation scale), esthetic (cloud cover), and physical (wind and precipitation) attributes. This index was produced to overcome the deficiencies of previous indices and provide an empirically tested and theoretically accurate method (de Freitas et al., 2008). Following this, Yu et al. (2022) increased the resolution of CIT by using hourly climatic data and called this new index the Modified Climate Index for Tourism (MCIT). They conducted a comparative case study in Alaska and Florida and forecasted future trends based on the past 50 years' climate variables. The results showed increasingly favorable conditions for Alaska and a decreased climatic comfort in Florida due to increased temperatures. The index was presented as a quantitative tool to model climate change impacts. These indices are important for assessing the comfort level change for a specific tourism type and specific region in a certain time period.

The Physiologically Equivalent Temperature Index (PET) which focuses on outdoor thermal comfort for humans wasn't specifically developed for tourism assessment yet, used in tourism literature frequently. PET is a human climate comfort tool that has roots in thermal bioclimate literature. It focuses on the human physiological stress level as a function of radiation, temperature, wind, humidity, activity level, and clothing (Matzarakis et al., 1999). Matzarakis (2007) developed an integral approach to tourism climate comfort indices by utilizing PET as a thermal facet and integrating it with aesthetic and physical conditions. Lin and Matzarakis (2011) utilized PET with hourly climate data in their tourism study on temperate and (sub)tropical regions. The results of this analysis inform tourists about the bioclimatic conditions of destinations. This methodology has been conducted in case studies from different countries (e.g., Gulyas & Matzarakis, 2009; Farajzadeh & Matzarakis, 2009; Esmaili et al., 2011; Matzarakis & Nastos, 2011; Çalışkan et al., 2012; Khoshdel et al., 2021; Mazloom et al., 2023; Shevchenko et al., 2023).

2.1. Holiday Climate Index (HCI)

The Holiday Climate Index (HCI) is a prevailing and widely used index in climate change and tourism literature. Regarding the criticisms of the methodologies and outcomes of the previous climate change and tourism studies, HCI aims to develop a new approach to better understand the climatic preferences of tourists and thresholds. Specifically, the HCI was proposed to overcome four main deficiencies of TCI. First, TCI is criticized for having a subjective weighting and rating system. In HCI, the weightings of climate variables were derived from the tourism literature on tourists' preferences to reduce the subjectivity of TCI. Second, TCI doesn't regard the potential for an overriding impact of physical climate factors such as rain and wind. In this sense, HCI uses the conceptual frame designed by de Freitas et al. (2008) which is based on thermal, physical, and esthetic characteristics of the climate. The overriding impacts of physical characteristics (rain and wind) are accounted for with this conceptual frame. Third, TCI is criticized for using monthly climatic data because the decision-making of tourists is not overly affected by it. The monthly climatic data has a low resolution for tourism activities. Therefore, daily data was used to increase the resolution. Finally, TCI is a single index for all types of tourism activities and destinations. However, climatic requirements vary for different tourism destinations and activities. In order to overcome this disregard, two major segment of tourism is taken into consideration for HCI and two different formulas were defined for different tourism types. HCI: Beach was provided for climatic comfort assessment of 3S tourism destinations while HCI: Urban was for other open-air tourism activities (Scott et al., 2016).

HCI has been used extensively instead of TCI since HCI has more accurate results with tourist preferences. Yu et al. (2022) utilized multi-scale HCI to determine the future distribution of tourism climate resources in China. In line with previous studies, they determined certain advantages for today's climate-limited regions and high risks for popular city destinations. Samarasinghe et al. (2023) assessed the correlation between HCI scores and tourist arrivals in Sri Lanka. They concluded that the relationship between HCI and tourist demand changes depending on the origins of tourists. Hasanah et al. (2020) compared Temperature Humidity Index (THI), TCI and HCI and investigate their correlation with tourist preferences in Indonesia. They concluded that HCI is the most accurate method among these three in a tropical destination. Velea et al. (2022) confirmed the validity of HCI: Urban in rural areas by correlating tourist overnights and HCI: Urban scores. The case studies revealed that different indices give the same direction for the trend in climate comfort changes however, the intensity of change varies among them. Moreover, market-specific indices that are produced for specific types of tourism increase the accuracy of the assessment (Yu et al., 2022). The significance of micro-climatic assessments is also emphasized in the literature in terms of their contribution to local adaptation strategies (Rutty et al., 2020; Aygün, 2021).

2.2. Managing Impacts on Climate Comfort

Climate change inevitably causes destination and seasonal shifts as summarized in the previous sections. How to manage these changes and maintaining the tourism economy is a major challenge for tourism destinations. Therefore, it is frequently discussed in the literature and strategic recommendations are provided. As Tompkins et al. (2005) state, risk management plans have critical importance in climate change adaptation. These plans need to be linked with other strategic and action plans. At that point, climate comfort assessments become significant to reveal the regions under risk and the potential opportunities. A comprehensive planning perspective is beneficial to manage the adverse impacts and risks. Jopp et al. (2010) provide a framework for regional adaptation that defines the climate change adaptation process. According to this framework prior to implementing the adaptation options, vulnerabilities need to be carefully defined, risks and opportunities need to be revealed and strategies to increase resilience and decrease vulnerabilities should be determined. Such an adaptation process has a sustainability perspective in its focus (Njoroge, 2014).

Diversification of the market is one of the prominent strategies in adaptation to seasonal shifts and overheating (Becken, 2005). Marketing strategies need to be adjusted to the new conditions that occurred due to climate change. Alternative activities that are more resilient to climatic conditions can be an alternative to redirect the tourists. Also, tourists can be commutated to alternative locations and close by destinations that have more suitable climatic comfort Moreover, setting the opening and closing times of the activities and attractions according to the new conditions contributes to adaptation (Scott et al., 2009). In order to make an efficient adaptation plan, it is important to determine alternative opportunities for diversification both in terms of activities and destinations. In this sense, alternative destinations become prominent to assess their suitability for tourism activities and benefit for climate change adaptation.

3. Study Area: Denizli, Türkiye

Denizli is located in the southwest of Türkiye, close to the Mediterranean and

Aegean coastline. The most popular tourism destinations such as Antalya, İzmir, and Muğla are neighboring cities to Denizli (See **Figure 1**). It has always been an important settlement since the Hellenistic period due to its strategic location at the junction of trade routes. Therefore, it has cultural and historical importance. Denizli has a variety of tourist attractions and offers different tourism alternatives such as culture, history, belief, city, nature, and thermal tourism. Pamukkale, the most popular attraction in Denizli is a well-known natural and historical site that is on the UNESCO World Heritage List (Denizli Culture and Tourism Directorate, 2023).

Aygün Oğur and Baycan (2023) compared 30 tourism destinations in Türkiye regarding the climate change impacts on the number of international tourists. In their study, the coastal region where the most popular destinations are located was ranked as the most vulnerable. They claimed that the destinations in this area are expected to lose a critical number of tourists, especially in the summer period. However, some cities including Denizli are highlighted as gaining destination that is expected to experience an increase in tourism demand. For its strong connection and physical enclosure to major tourism areas and potential to have preferable climatic conditions in the future, Denizli can be accounted as an alternative destination. Moreover, Denizli has a diverse distribution of tourism activities within the city. In the city center, besides shopping areas, historical and religious buildings are densely located. There are more than 20 antique cities all around the city with different sizes. **Figure 2** shows 110 tourist attractions under 16 categories. The majority of tourist attractions are located on the west

Figure 1. Location of Denizli.

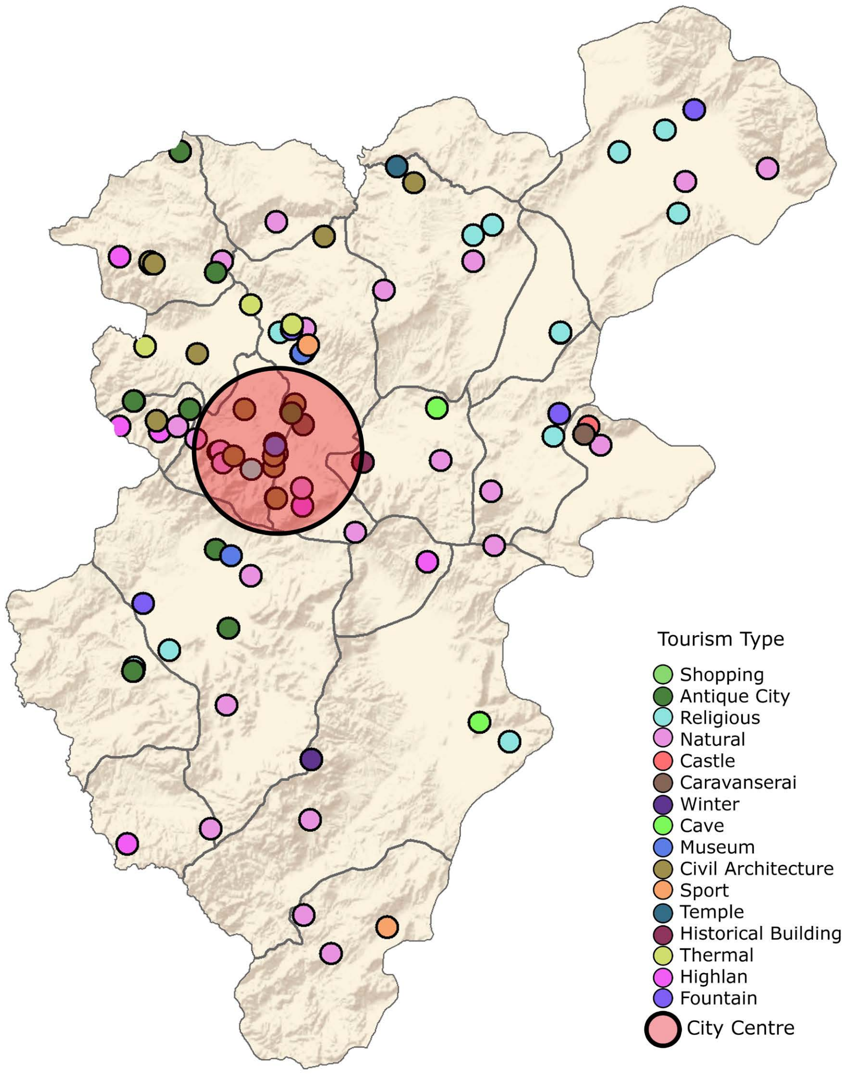

Figure 2. Distribution of tourism types in Denizli (Source: Pamukkale University, Faculty of Tourism).

side and around the city center. It is possible to find different tourism types at different altitudes and geographies. This provides diversity in micro-climatic conditions for tourism activities all around the city.

Although the valuable tourism inventory, Denizli is an underestimated destination that cannot compete with popular coastal destinations. It is clearly seen when the number of international, national, and total tourists are investigated in Denizli and Türkiye (see **Table 1**). Denizli receives more international tourists than domestic tourists. In 2016 and 2017 the number of international tourists decreased because of internal political problems in Türkiye. Excluding these years, there are no significant fluctuations in the number of tourists despite the increasing total number of tourists in Türkiye. Moreover, Denizli has a limited share in the total number of tourists coming to Türkiye and couldn't manage to increase its share in the tourism market. Only 1.09% of the total tourists visiting

Table 1. Comparison of the number of tourists arrivals to Türkiye and Denizli. (Source: Ministry of Culture and Tourism).

Year	International Tourist		Domestic Tourist		Total Tourist		% of Total
	Denizli	TR	Denizli	TR	Denizli	TR	
2019	538,522	38,853,764	345,696	42,012,998	884,218	80,866,762	1.09
2018	477,743	31,135,545	345,692	40,822,111	823,435	71,957,656	1.14
2017	258,914	22,927,768	378,569	39,024,237	637,483	61,952,005	1.02
2016	252,919	18,047,874	728,903	41,335,993	981,822	59,383,867	1,65
2015	588,465	27,614,421	679,391	40,314,135	1,267,856	67,928,556	1,86

Türkiye arrived in Denizli in 2019. There are two major factors that limit the potential of Denizli. First, the tourism assets except Pamukkale are not well-known for which tourists prefer day trips from surrounding destinations instead of overnight stays in Denizli. According to visitor statistics, more than 2.5 million tourists visited Pamukkale in 2019 (TurkStat, 2020). This significant difference between arrivals to the accommodation facilities and the heritage visitors clearly indicates that Denizli is perceived as a "stop-by" destination. Second, Denizli has limited tourism accommodation capacity. It only has 233 accommodation facilities with 8572 separated units and 18,308 bed capacity (Denizli Culture and Tourism Directorate, 2023). Denizli has great potential with its already popular attractions and alternative tourism types that haven't benefited effectively yet.

4. Data and Methodology

In this study, the first step of regional adaptation framework provided by Jopp et al. (2010) is assessed for the case study region. In this framework the initial stage is defining vulnerabilities, risks and opportunities. Therefore, this study focuses to reveal vulnerabilities, risks and opportunities in terms of thermal conditions of the alternative destination. To assess the suitability of climatic conditions for tourism activities in the future in Denizli, the Holiday Climate Index (HCI): Urban is deployed. There are two major factors in determining HCI: Urban as the analysis method of this study. The case study area has both urban and rural settlements. The accuracy of the HCI: Urban method is tested previously by different case studies both in urban (Scott et al., 2016) and rural areas (Velea et al., 2022). Moreover, it is practical to adapt future climate projections to the index to estimate and compare climatic comfort.

HCI: Urban defines the climatic conditions that affect tourism activities in three facets; Thermal Comfort (TC), Aesthetic (A), and Physical (P). Thermal comfort is calculated by evaluating the daily maximum temperature (˚C) and mean relative humidity (%). The most recent approach to calculating the cumulative impacts of temperature and humidity on thermal comfort is Humidex (Rutty et al., 2020). This approach is pursued in this study and TC is calculated with Equation (1). The aesthetic facet represents the percentage of cloud cover

(%). Finally, the Physical is a combination of wind speed (km/h) and precipitation (mm). Regarding their impacts on comfort level, the variables are weighted. Thermal comfort has the highest weight at 40%, aesthetic facet at 20 %, and precipitation at 30 %. The calculation of HCI: Urban is presented in Equation (2).

$$\text{Humidex} = T + 5/9 \times \left(\left(6.112 \times 10\left(\left(7.5 \times T\right)/\left(237.7 + T\right)\right) \times H/100\right) - 10\right) \quad (1)$$

$$\text{HCI: Urban} = 4\left(\text{TC}\right) + 2\left(\text{A}\right) + \left(3\left(\text{precipitation}\right) + \text{wind}\right) \quad (2)$$

The index defines a scale for each variable in the formula from 0 to 10. The overall rating of the destination is calculated with the equation and the results are scored from 0 to 100. The overall scores are categorized into 8; 100 - 90 Ideal, 89 - 80 Excellent, 79 - 70 Very Good, 69 - 60 Good, 59 - 50 Acceptable, 49 - 40 marginal, 39 - 10 Unacceptable, and 9 - 0 Dangerous (**Table 2**).

Initially, the tourism attractions, their geographical locations, and the tourism type information were mapped and the coordination of meteorological stations was added on ArcGIS. HCI: Urban ratings of Denizli is calculated for 3 time period. The reference year (1971-2000) represents the current climatic comfort conditions in Denizli. The projections are displayed for two different time periods; the medium-term (2023-2050) and the long-term (2070-2098). In projections, two different IPCC scenarios were adapted to the study. The first one represents the intermediate scenario RCP 4.5 that keeps global temperature increase below 2˚C as intended in the Paris Agreement. The second one represents the worst-case scenario RCP 8.5 which is a low effort to decrease global emissions and global temperature rising to almost 4˚C. The meteorological data (temperature, precipitation, wind speed, sunshine, and humidity) of each month, time period, and scenario were mapped by using spatial analysis tool and interpolation. The thermal comfort was calculated by utilizing Equation (1) by raster calculation. Finally, for each month of the year, HCI: Urban scores were evaluated and mapped in ArcGIS for 3 time periods and 2 scenarios by utilizing Equation (2) in the raster calculator. The results were compared and the opportunities and risks were defined at the regional scale for each season.

Table 2. HCI: Urban rating system.

Description	Score
Ideal	100 - 90
Excellent	89 - 80
Very good	79 - 70
Good	69 - 60
Acceptable	59 - 50
Marginal	49 - 40
Unacceptable	39 - 10
Dangerous	9 - 0

The meteorologic data and climate change projections were obtained from the Turkish General Directorate of Meteorology. The climate projection model data for 24 meteorological stations were used for the variables in **Table 3**. The climate projections were based on HadGEm2-ES Model, RCP 4.5 and RCP 8.5 scenario with a 20 km resolution, and downscales RegCM4.3.4 model (TGDM, 2015). Since the model didn't supply the cloud cover data, sunshine duration (hour) data was used instead of this variable.

5. Application of HCI: Urban on Denizli

The HCI: Urban applied first the reference year (1971-2000), then projection years medium-term (2023-2050) and long-term (2070-2098), respectively, for each scenario as explained in the previous section in detail. The results of each application are separately presented.

The comfort levels are calculated for the reference year (1971-2000) for each month to compare the ranges all around the year. The results of HCI: Urban has a positive distribution all over the year. In all months the scores are "good" and above. The lowest comfort levels are observed during the winter period. There is no spatial difference in December and January which means that the entire city has the same climatic comfort level labeled as "good". In February the comfort level increases in the west half of the city where the city center is located. There is an increasing trend in the spring season when the "ideal" category is dominant. It can be said that spring has the highest comfort levels, especially in May. In the summer period, the scores decrease from "ideal" to "excellent" and partially "very good" in July on the west side of the city. The summer period has the second-highest thermal comfort range.

Autumn has a diverse pattern from September to November. In September "ideal" and "excellent" scores can be observed. The high-elevated southern and northern regions have the highest scores in this month, yet the scores decrease in October. In November, an obvious decrease can be observed all around the city. As seen in **Figure 3**, the HCI: Urban scores range between "ideal" and "good" and the city has a long pleasant period, especially between April and October. Black dots on the maps show the locations of tourism attractions regardless of tourism type.

The second assessment is conducted for the medium-term projection year

Table 3. Meteorological variables used in the index.

Meteorological Variable	Unit
Daily maximum temperature	˚C
Daily total precipitation	mm
Daily maximum wind speed	Km/h
Daily sunshine duration	Hour
Daily average relative humidity	%

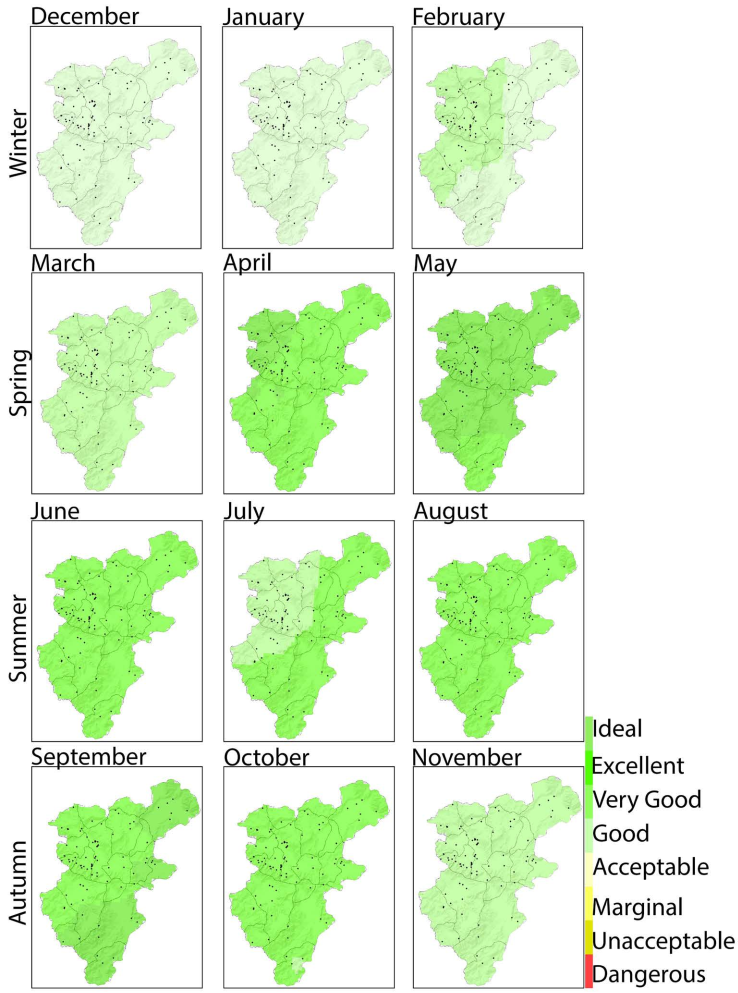

Figure 3. Distribution of HCI: Urban ratings for the reference year (1971-2000).

(2023-2050) for both RCP 4.5 and RCP 8.5 scenarios. In the projected period HCI: Urban scores range from "ideal" to "good" in 12 months of the year. Winter has the lowest scores in both scenarios whereas January and February have higher scores with the RCP 8.5 scenario. The southern part has a higher score in both scenarios in the winter, specifically In January. Spring has the highest scores in both scenarios. For the RCP 4.5 scenario, April has the most suitable conditions all around the city while the scores slightly decrease in the western part in May. However, in the RCP 8.5 scenario, there is a sudden peak from February to March that continues in April and partially in May. The scores slightly decrease in the northwestern part of the city in May. The summer season has the second-lowest scores in both scenarios. There is a decreasing trend in comfort levels from June to August in both scenarios while small spots at high altitudes in the north and south have increased scores in August. There is a fluctuating pattern in the autumn in the RCP 4.5 scenario. In September the comfort level is "very good" all around the city while it increases to "excellent" in the north and the south, "ideal" in the west in October. However, it decreases to "very good" again in November. The RCP 8.5 scenario shows higher comfort levels of "excellent" and "ideal" in September and October respectively all around the city. However, the scores drop to "very good" in November. According to medium-term projections, shoulder season comes forward with the highest scores. The difference between the two scenarios is not significant in the summer season, however, distinctions can be observed in other seasons in favor of the RCP 8.5 scenario. However, the increase in comfort levels in these seasons is highly related to increasing temperatures and decreasing precipitations which might be a reason for some other climate change related problems. Therefore, it is critical to have a comprehensive perspective while providing strategies for sustainable tourism development. To sum up, it can be said that the most suitable tourism period is spring and autumn while the whole year has high comfort levels. Figure 4 shows the spatial distribution of HCI: Urban scores for each month and both scenarios.

Finally, the HCI: Urban analysis is conducted for the long-term (2070-2098) period for both scenarios. In both scenarios winter and summer seasons have the

Figure 4. Distribution of HCI: Urban ratings for the medium-term projection year (2023-2050) with the RCP 4.5 and the RCP 8.5 scenarios.

lowest comfort levels of the year. In December the RCP 4.5 scenario has a "good" category all over the city, however, in the RCP 8.5 scenario as a result of increasing temperatures, the score rises to "very good" except for southern and northern parts. In January southern part has higher HCI: Urban scores than the northern part in both scenarios. In February comfort levels in the northern part increase to "very good" as in the southern part. Spring has the highest scores in both scenarios while the RCP 4.5 scenario has a lower comfort level in March. In the RCP 8.5 scenario, March has an "ideal" score in the western part and "excellent" in the other regions. The comfort levels reach the highest in April and slightly decrease in May in both scenarios. In the summer season, the scores are "very good" in the southwestern and the northwestern parts while "excellent" in the eastern and middle regions in June in the RCP 4.5 scenario. For the same scenario, July and August are at a "very good" level. On the other hand, the scores for the RCP 8.5 range between "good" and "very good" with the lowest scores in July in the western part of the city. In autumn the comfort levels yield "excellent", "ideal" and "very good" in September, October, and November respectively in the RCP 4.5 scenario. However, it has a diverse pattern in the RCP 8.5 scenario. The western part has the lowest "very good" score and the eastern part has the "excellent" score in September. The southern part has the highest score of "ideal" in October while the "excellent" score in the midland and northern parts. The "excellent" can be seen in the western part and "very good" in the eastern part in November. In the long-term projections, shoulder seasons provide the highest comfort levels for tourism while winter and summer seasons do the lowest. However, the HCI: scores are between "good" and "ideal". The most suitable climate is observed in April in both scenarios. The spatial distribution of scores slightly differs in the RCP 4.5 scenario yet, in the RCP 8.5 scenario there is a diverse pattern around the city. The impacts of differences in the assessed two climate scenarios can clearly be observed in increased autumn-winter (November and December) scores and decreased summer (June and July) scores. In other words, the RCP 4.5 has lower winter and autumn scores and higher summer scores than the RCP 8.5 scenario. **Figure 5** presents the HCI: Urban scores for both scenarios and each month of the year.

6. Results

Denizli has the opportunity to have good climatic conditions that are suitable for tourism activities in all projection years and scenarios. However, the scores change among seasons in each time period assessment which may have an impact on the preferences of tourists. The climate comfort levels increase in the winter season and decrease in the summer season in both projected years compared to the reference year. The comparison of the HCI: Urban scores in the reference year, medium-term and long-term projections reveals critical issues for tourism. The most significant impacts are observed in seasonality and spatial differences of impacts. Moreover, the impacts of the RCP 4.5 scenario can be

Figure 5. Distribution of HCI: Urban ratings for the long-term projection year (2070-2098) with the RCP 4.5 and the RCP 8.5 scenarios.

observed in the medium-term projections and these impacts slightly change in long-term projection. However, the impacts observed in the RCP 8.5 get more intense in the long-term projections.

The first important result can be observed in seasonality. Denizli has "good" and above HCI: Urban scores in all assessments. Although this is an opportunity to extend the tourism season to 12 months, there are outshining seasons and months that have higher suitability than other periods. In the reference year the summer season has higher comfort levels while in the medium-term projection, it significantly decreases. The lower scores become more dominant in the long-term projections. The decrease in HCI: Urban scores are more obvious in the RCP 8.5 projections for summer. Therefore, it is possible to express that the summer season will lose its high suitability for tourism activities in medium-term and the long-term periods. On the other hand, the spring season has high climate comfort conditions in all periods. The scores increase from the reference year toward the long-term projections. Therefore, the seasonality shift from summer to spring can be observed clearly. Spring provides a pleasant alternative for tourism activities. Autumn has a more diverse pattern over time, yet an overall increasing trend. The winter season has the lowest comfort levels throughout all assessments, however, a slightly increasing trend in scores especially in the RCP 8.5 scenario shouldn't be neglected.

The second critical result of the assessments is the spatial distribution of climatic comforts within the city. In warmer seasons like summer, the lower elevated areas, especially the western part of the city where the city center is located have disadvantages. On the contrary, the higher elevated regions like the northern and southern parts have higher suitability for tourism activities. The opposite is observed in the colder seasons, especially at the end of autumn and winter. In these times, the lower altitudes have a more pleasant climate and higher scores than the rest of the city. This separation is more distinct in the RCP 8.5 scenario and more spatial diversification of scores can be seen in maps. In the long term the spatial variations increase. Diversification of scores around the city increases the opportunity to offer different alternatives in different climatic conditions. Moreover, extending the tourism season to 12 months is possible when these spatial patterns are considered in tourism development strategies. Defining these geographical regions helps to develop adaptation strategies to climatic changes.

To sum up, Denizli is expected to experience a shift in suitable climate conditions for tourism. However, in the projection years, all seasons have "good" and above scores. This is an advantage for 12 months tourism period. It has spatial variations in terms of suitability to tourism activities which is an advantage for diversifying the activities and locations. Moreover, the changes are sharper in the long term especially in the RCP 8.5 scenario.

7. Discussion

The results of the analysis show that Denizli has suitable climatic comfort conditions in the reference year and maintain that feature in the future under climate change scenarios. However, there are significant seasonality changes due to the impacts of climate change. In the summer season, the comfort level scores are high in the reference year but decrease in both scenario and future projection periods. Moreover, the shoulder seasons, spring and autumn, have the highest HCI; Urban scores in the future projections for both scenarios. Although the summer season still has pleasant climatic conditions, the higher scores in spring and autumn lead to a seasonal shift. The other important issue is the variety of spatial distribution of scores within the city. In the warmer seasons, the higher altitude regions have higher comfort levels and in the colder seasons, the lower altitudes have more pleasant conditions. The western part of the city has higher HCI: Urban performance in winter and autumn. On the other hand, the southern and northern parts of the city have comparatively higher scores in the summer months. Determining the geographical differences in the distribution of

HCI: Urban gives insights into the spatial opportunities in tourism. Moreover, the results show that Denizli has high climatic comfort all around the year which creates an opportunity to extend the tourism season to 12 months. With this opportunity, Denizli can be promoted as an alternative destination to today's popular destinations which are expected to lose their pleasant climate conditions, especially in the summer. Therefore, it is important to promote these alternative destinations to attract the demand from unpleasant climate regions.

The results of the study are in line with previous studies. Aygün (2021) compared destinations in Türkiye by assessing the TCI change and revealed that the coastal line is more vulnerable and loses its pleasant climatic conditions. However, the inner cities including Denizli had better performance in all seasons compared to the coastal part. Therefore, the study suggests a detailed assessment of the inner cities to reveal their potential. In this study, a detailed assessment is conducted on Denizli and the results approved the previous one. The results of the study clearly show that Denizli has the potential to be an alternative destination. In the summer period, places that have comparatively better conditions can be promoted as an alternative to the other popular destinations. Moreover, Demiroğlu et al. (2020) used HCI: Urban to assess climatic comfort level change in the Mediterranean region and revealed a dramatic decrease in the coastal line compared to the higher altitude regions. Parallel to that, in Denizli, there is a difference between higher and lower altitudes in terms of climatic comfort change depending on the season. It can be said that higher altitude regions in Denizli have a higher potential in the summer period while the lowers have in the winter period. The results are also compatible with the global trends revealed in previous studies. Climate change and tourism studies assert a decrease in the summer period and address shoulder seasons as the new peak period (Scott et al., 2016). Results show the same seasonality change for Denizli in medium and long-term projections.

During the study, the major limitation has been the meteorological data. Since the cloud cover data has not been provided by the meteorological institute, the sunshine duration has been used for the aesthetic facet. This alteration has decreased the variety of regions and periods in terms of the aesthetic component since the sunshine hour is not as diverse as the cloud cover within the city. Moreover, this study only focuses on climate change impacts on thermal comfort levels and doesn't include any other future impacts of climate. In order to keep the scope of the study compact, the other impacts are not evaluated. Therefore, the results reflect a tourism development potential in the area. However, tourism development strategies should consider the climate change impacts on resources, people, natural areas, and disasters for sustainable and adaptive development. Research that brings different aspects of climate change together and conducts a comprehensive impact assessment is required for future tourism development. In this study, the importance of elevation in determining alternative tourism attractions has been addressed. For future studies, the elevation layer can be added to the analysis, and more detailed information regarding the morphologic characteristics of alternative regions can be provided. Moreover, this study only focused on the geographic locations of the attraction points regardless of their tourism type and infrastructure. In a future study, the tourist attractions should be compared considering the tourism type and the tourism infrastructure they have. Such an analysis would provide significant insights into the vulnerability and adaptive capacity of these regions to changing climatic conditions.

8. Conclusion

This study assessed the change in climatic comfort levels due to climate change compared to the reference year in Denizli. The case study is an alternative tourism destination in Türkiye that has significant potential with its attractive tourism assets. The results reveal the positive climate comfort conditions in Denizli in both the reference year and the projected years. In tourism planning, the high comfort levels are an advantage to address Denizli as an alternative. However, the most suitable season shifts from summer to shoulder seasons, and the comfort level distribution varies within the city. These insights are significant to have an effective adaptation plan. This study is unique for focusing on an alternative tourism destination instead of the most popular ones to reveal the options for sustainable tourism development. Moreover, it is important to address alternative regions within the city that have higher climatic comfort in specific seasons. This study provides a baseline for the strategic development of tourism in Türkiye to manage adaptation to climate change impacts. It also draws a roadmap for the future of Denizli's tourism and defines the critical regions that have opportunities for different time periods and seasons.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Adiguzel, F., Bozdogan Sert, E., Dinc, Y., Cetin, M., Gungor, S., Yuka, P., & Vural, E. (2022). Determining the Relationships between Climatic Elements and Thermal Comfort and Tourism Activities Using the Tourism Climate Index for Urban Planning: A Case Study of Izmir. *Province Theoretical and Applied Climatology, 147,* 1105-1120. https://doi.org/10.1007/s00704-021-03874-9

Aygün Oğur, A., & Baycan, T. (2023). Assessing Climate Change Impacts on Tourism

Demand in Turkey. *Environment, Development and Sustainability, 25,* 2905-2935. https://doi.org/10.1007/s10668-022-02135-7

Aygün, A. (2021). *Impacts of Climate Change on Tourism Sector in Turkey: Challenges and Future Prospects*. PhD Thesis, İstanbul Technical University.

Bafaluy, D., Amengual, A., Romero, R., & Homar, V. (2014). Present and Future Climate Resources for Various Types of Tourism in the Bay of Palma. *Spain Regional Environmental Change, 14,* 1995-2006. https://doi.org/10.1007/s10113-013-0450-6

Becken, S. (2005). Harmonising Climate Change Adaptation and Mitigation: The Case of Tourist Resorts in Fiji. *Global Environmental Change, 15,* 381-393. https://doi.org/10.1016/j.gloenvcha.2005.08.001

Becker, S. (1998). Beach Comfort Index—A New Approach to Evaluate the Thermal Conditions of Beach Holiday Resorts Using a South African Example. *GeoJournal, 44,* 297-307. https://doi.org/10.1023/A:1006871805262

Çalışkan, O., Çiçek, İ., & Matzarakis, A. (2012). The Climate and Bioclimate of Bursa (Turkey) from the Perspective of Tourism. *Theoretical and Applied Climatology, 107,* 417-425. https://doi.org/10.1007/s00704-011-0489-6

Carrillo, J., González, A., Pérez, J. C., Expósito, F. J., & Díaz, J. P. (2022). Projected Impacts of Climate Change on Tourism in the Canary Islands. *Regional Environmental Change, 22,* 61-70. https://doi.org/10.1007/s10113-022-01880-9

Chen, C. M., Lin, Y. C., Li, E. Y., & Liu, C. C. (2017). Weather Uncertainty Effect on Tourism Demand. *Tourism Economics, 23,* 469-474. https://doi.org/10.5367/te.2015.0513

Cinar, İ., Karakus, N., & Toy, S. (2023). Analysing Daytime Summer Thermal Comfort Conditions for Turkey's Third Largest Tourism Destination. *Environmental Science and Pollution Research, 30,* 50046-50056.

Ciscar, J. C., Soria, A., Goodess, C. M., Christensen, O. B., Iglesias, A., Garrote, L. et al. (2009). *Climate Change Impacts in Europe.* Final Report of the PESETA Research Project (No. JRC55391), Joint Research Centre (Seville Site).

de Freitas, C. R., Scott, D., & McBoyle, G. (2004). A New Generation Climate Index for Tourism and Recreation. In A. Matzarakis, C. R. de Freitas, & D. Scott (Eds.), *Advances in Tourism Climatology* (pp. 19-27). Berichte des Meteorologischen Institutes der Universitat Freiburg.

de Freitas, C. R., Scott, D., & McBoyle, G. (2008). A Second Generation Climate Index for Tourism (CIT): Specification and Verification. *International Journal of Biometeorology, 52,* 399-407. https://doi.org/10.1007/s00484-007-0134-3

Demiroğlu, O. C., Saygili-Araci, F. S., Pacal, A., Hall, C. M., & Kurnaz, M. L. (2020). Future Holiday Climate Index (HCI) Performance of Urban and Beach Destinations in the Mediterranean. *Atmosphere, 11,* Article 911. https://doi.org/10.3390/atmos11090911

Denizli Culture and Tourism Directorate (2023). *Denizli Turizmi.* https://denizli.ktb.gov.tr/Eklenti/68133,denizliturimpotansiyeliguncelpdf.pdf?0&_tag1=2CEAA3BF455DFA6698E7CE2EBEA8A5859F3E622E

Dube, K., & Nhamo, G. (2018). Climate Variability, Change and Potential Impacts on Tourism: Evidence from the Zambian Side of the Victoria Falls. *Environmental Science & Policy, 84,* 113-123. https://doi.org/10.1016/j.envsci.2018.03.009

El-Masry, E. A., El-Sayed, M. K., Awad, M. A., El-Sammak, A. A., & Sabarouti, M. A. E. (2022). Vulnerability of Tourism to Climate Change on the Mediterranean Coastal Area of El Hammam-EL Alamein Egypt. *Environment Development and Sustainabili-*

ty, 24, 1145-1165. https://doi.org/10.1007/s10668-021-01488-9

Esmaili, R., Gandomkar, A., & Habibi, N. M. (2011). Assessment of Comfortable Climate in Several Main Iranian Tourism Cities Using Physiologic Equivalence Temperature Index. *Physical Geography Research Quarterly, 75,* 8-10.

Faraj, T. K., Tarawneh, Q. Y., & Oroud, I. M. (2023). The Applicability of the Tourism Climate Index in a Hot Arid Environment: Saudi Arabia as a Case Study. *International Journal of Environmental Science and Technology, 20,* 3849-3860. https://doi.org/10.1007/s13762-022-04228-2

Farajzadeh, H., & Matzarakis, A. (2009). Quantification of Climate for Tourism in the Northwest of Iran. *Meteorological Applications, 16,* 545-555. https://doi.org/10.1002/met.155

Grillakis, M. G., Koutroulis, A. G., Seiradakis, K. D., & Tsanis, I. K. (2016). Implications of 20˚C Global Warming in European Summer Tourism. *Climate Services, 1,* 30-38. https://doi.org/10.1016/j.cliser.2016.01.002

Gulyas, A., & Matzarakis, A. (2009). Seasonal and Spatial Distribution of Physiologically Equivalent Temperature (PET) Index in Hungary. *Quarterly Journal of the Hungarian Meteorological Service, 113,* 221-231.

Hasanah, N. A. I., Maryetnowati, D., Edelweis, F. N., Indriyani, F., & Nugrahayu, Q. (2020). The Climate Comfort Assessment for Tourism Purposes in Borobudur Temple Indonesia. *Heliyon, 6,* e05828. https://doi.org/10.1016/j.heliyon.2020.e05828

Hein, L., Metzger, M. J., & Moren, A. (2009). Potential Impacts of Climate Change on Tourism; a Case Study for Spain. *Current Opinion in Environmental Sustainability, 1,* 170-178. https://doi.org/10.1016/j.cosust.2009.10.011

Intergovernmental Panel on Climate Change (IPCC) (2022). *Climate Change 2022: Impacts Adaptation and Vulnerability. Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://doi.org/10.1017/9781009325844

Jarratt, D., & Davies, N. J. (2020). Planning for Climate Change Impacts: Coastal Tourism Destination Resilience Policies. *Tourism Planning Development, 17,* 423-440. https://doi.org/10.1080/21568316.2019.1667861

Jopp, R., DeLacy, T., & Mair, J. (2010). Developing a Framework for Regional Destination Adaptation to Climate Change. *Current Issues in Tourism, 13,* 591-605. https://doi.org/10.1080/13683501003653379

Khoshdel, N., Rezaei, P., Sadraldin, S., & JanbazGhobadi, G. (2021). Explaining the Tourism Climate of the East of Guilan Province Using the Physiological Equivalent Temperature. *Journal of Studies of Human Settlements Planning, 15,* 1119-1136.

Kovats, R. S., Valentini, R., Bouwer, L., Georgopoulou, E., Jacob, D., Martin, E., & Soussana, J.-F. (2014). Europe. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1267-1326). Cambridge University Press.

Kozak, M. (2002). Comparative Analysis of Tourist Motivations by Nationality and Destinations. *Tourism Management, 23,* 207-220. https://doi.org/10.1016/S0261-5177(01)00090-5

Lin, T. P., & Matzarakis, A. (2011). Tourism Climate Information Based on Human Thermal Perception in Taiwan and Eastern China. *Tourism Management, 32,* 492-500.

https://doi.org/10.1016/j.tourman.2010.03.017

Matzarakis, A. (2007). Assessment Method for Climate and Tourism Based on Daily Data. In A. Matzarakis, C. R. de Freitas, & D. Scott (Eds.), *Developments in Tourism Climatology* (pp. 52-58). Commission on Climate, Tourism and Recreation International Society of Biometeorology.

Matzarakis, A., & Nastos, P. (2011). Analysis of Tourism Potential for Crete Island, Greece. *Global Nest Journal, 13,* 141-149.

Matzarakis, A., Mayer, H., & Iziomon, M. G. (1999). Applications of a Universal Thermal Index: Physiological Equivalent Temperature. *International Journal of Biometeorology, 43,* 76-84. https://doi.org/10.1007/s004840050119

Mazloom, K., Zolfaghari, H., Oji, R., & Matzarakis, A. (2023). A Comparison of Physiologically Equivalent Temperature Based on Model Simulation and Site Observation Data for Iran. *Air Quality, Atmosphere & Health, 16,* 1705-1720. https://doi.org/10.1007/s11869-023-01367-4

Mieczkowski, Z. (1985). The Tourism Climatic Index: A Method of Evaluating World Climates for Tourism. *Canadian Geographer, 29,* 220-233. https://doi.org/10.1111/j.1541-0064.1985.tb00365.x

Miszuk, B., Otop, I., Stronska, M., Schwarzak, S., & Surke, M. (2016). Tourism-Climate Conditions and Their Future Development in the Polish-Saxon Border Area. *Meteorologische Zeitschrift, 25,* 421-434. https://doi.org/10.1127/metz/2016/0700

Morgan, R., Gatell, E., Junyent, R., Micallef, A., Özhan, E., & Williams, A. T. (2000). An Improved User-Based Beach Climate Index. *Journal of Coastal Conservation, 6,* 41-50. https://doi.org/10.1007/BF02730466

Njoroge, J. M. (2014). An Enhanced Framework for Regional Tourism Sustainable Adaptation to Climate Change. *Tourism Management Perspectives, 12,* 23-30. https://doi.org/10.1016/j.tmp.2014.06.002

Pang, S. F., McKercher, B., & Prideaux, B. (2013). Climate Change and Tourism: An Overview. *Asia Pacific Journal of Tourism Research, 18,* 4-20. https://doi.org/10.1080/10941665.2012.688509

Pathak, A., van Beynen, P. E., Akiwumi, F. A., & Lindeman, K. C. (2021). Impacts of Climate Change on the Tourism Sector of a Small Island Developing State: A Case Study for the Bahamas. *Environmental Development, 37,* Article 100556. https://doi.org/10.1016/j.envdev.2020.100556

Rutty, M., Scott, D., Matthews, L., Burrowes, R., Trotman, A., Mahon, R., & Charles, A. (2020). An Inter-Comparison of the Holiday Climate Index (HCI: Beach) and the Tourism Climate Index (TCI) to Explain Canadian Tourism Arrivals to the Caribbean. *Atmosphere, 11,* Article 412. https://doi.org/10.3390/atmos11040412

Samarasinghe, J. T., Wickramarachchi, C. P., Makumbura, R. K., Meddage, P., Gunathilake, M. B., Muttil, N., & Rathnayake, U. (2023). Performances of Holiday Climate Index (HCI) for Urban and Beach Destinations in Sri Lanka under Changing Climate. *Climate, 11,* Article 48. https://doi.org/10.3390/cli11030048

Scott, D. (2021). Sustainable Tourism and the Grand Challenge of Climate Change. *Sustainability, 13,* Article 1966. https://doi.org/10.3390/su13041966

Scott, D., & McBoyle, G. (2001). Using a 'Tourism Climate Index' to Examine the Implications of Climate Change for Climate as a Natural Resource for Tourism. In A. Matzarakis, & C. de Frietas (Eds.), *Proc 1st International Workshop on Climate, Tourism and Recreation, 5-10 October* (pp. 69-88). International Society of Biometeorology, Commission on Climate, Tourism and Recreation, Halkidi.

Scott, D., de Freitas, C. R., & Matzarakis, A. (2009). Adaptation in the Tourism and Recreation Sector. In K. L. Ebi, I. Burton, & P. Hoeppe (Eds.), *Biometeorology for Adaptation to Climate Variability and Change* (pp. 171-194). Springer.

Scott, D., McBoyle, G., & Schwartzentruber, M. (2004). Climate Change and the Distribution of Climatic Resources for Tourism in North America. *Climate Research, 27,* 105-117. https://doi.org/10.3354/cr027105

Scott, D., Rutty, M., Amelung, B., & Tang, M. (2016). An Inter-Comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI) in Europe. *Atmosphere, 7,* Article 80. https://doi.org/10.3390/atmos7060080

Şenerol, H. (2010). *İklim değişikliği ve Türk turizmine etkisi*. PhD Thesis, Balıkesir University.

Şensoy, S. (2020). *Turizm sektörünün geleceği açısından sıcaklık indisleri ile termal biyoklimatik indisler arasındaki ilişkiler Antalya örneği*. PhD Thesis, Ankara University.

Shevchenko, O., Snizhko, S., Gryniuk, O., & Matzarakis, A. (2023). A Comparison of the Tourist Potential of the Climates of the Coastal Resort at Odesa and the Inland Resort by Lake Svityaz. *Atmosphere, 14,* Article 460. https://doi.org/10.3390/atmos14030460

Smith, K. (1993). The Influence of Weather and Climate on Recreation and Tourism. *Weather, 48,* 398-403. https://doi.org/10.1002/j.1477-8696.1993.tb05828.x

Somoncu, M. (2018). İklim Değşikliği Türkiye Turizmi için Bir Tehdit mi Bir Fırsat mı? In N. Türkoğlu, R. Bayar, K. Karabacak, C. Kurtar Anlı, H. Kılar, & E. Gökkaya (Eds.), *International Geography Symposium on the 30th Anniversary of TUCAUM* (pp. 748-771). Ankara University.

TGDM (Turkish General Directorate of Meteorology) (2015). *Yeni Senaryolar ile Türkiye İklim Projeksiyonları ve İklim Değişikliği TR2015-CC Ankara*.

Tompkins, E., Nicholson-Cole, S., Boyd, E., Hurlston, L.-A., Brooks Hodge, G., Clarke, J., Trotz, N., Gray, G., & Varlack, L. (2005). *Surviving Climate Change in Small Islands: A Guidebook*. Tyndall Centre for Climate Change Research, University of East Anglia, UK.

Tranos, E., & Davoudi, S. (2014). The Regional Impact of Climate Change on Winter Tourism in Europe. *Tourism Planning & Development, 11,* 163-178. https://doi.org/10.1080/21568316.2013.864992

TurkStat (2020). https://data.tuik.gov.tr/Bulten/Index?p=Cultural-Heritage-2019-33633

TurkStat (2023). *Tourism Statistics*. https://data.tuik.gov.tr/Bulten/Index?p=Turizm-Istatistikleri-I.-Ceyrek:-Ocak---Mart,-2023-49602

UNWTO (2023). *Statistics of Tourism*. https://www.unwto.org/tourism-statistics

UNWTO-UNEP-WMO (2008). *Climate Change and Tourism: Responding to Global Challenges Madrid*.

Uysal, M., Li, X., & Sirakaya-Turk, E. (2008). Push-Pull Dynamics in Travel Decisions. In H. Oh, & A. Pizam, *Handbook of Hospitality Marketing Management* (pp. 412-439). Butterworth-Heinemann. https://doi.org/10.1016/B978-0-08-045080-3.50018-4

Velea, L., Gallo, A., Bojariu, R., Irimescu, A., Craciunescu, V., & Puiu, S. (2022). Holiday Climate Index: Urban—Application for Urban and Rural Areas in Romania. *Atmosphere, 13,* Article 1519. https://doi.org/10.3390/atmos13091519

Yiamjanya, S., & Wongleedee, K. (2014). International Tourists' Travel Motivation by Push-Pull Factors and the Decision-Making for Selecting Thailand as a Destination

Choice. *International Journal of Social Education Economics and Management Engineering, 8,* 1326-1331.

Yu, D. D., Matthews, L., Scott, D., Li, S., & Guo, Z. Y. (2022). Climate Suitability for Tourism in China in an Era of Climate Change: A Multiscale Analysis Using Holiday Climate Index. *Current Issues in Tourism, 25,* 2269-2284. https://doi.org/10.1080/13683500.2021.1956442