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Original research

A Review of Bioclimatic Comfort Areas Determined by the New Summer Index in Terms of Tourism in Antalya

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Abstract: Many methods have been used to determine the comfort situation of an environment by using the parameters that make up the climate conditions. It is aimed to determine bioclimatic comfort areas by using climate parameters obtained from 31 meteorological stations in Antalya. In this study, which is based on Geographical Information Systems, raster data was produced from spatial interpolation techniques primarily from point data. From the data obtained, new Summer Index values were generated in the GIS environment. According to the New Summer Index classification scheme in June, July and August in Antalya province, there are 5 classes of 1st Generation, 2nd Generation, 3rd Generation, 4th Generation and 5th Generation. Along the coastline in Antalya Province; 3 generations, 4 generations and 5 generations dominated in the mentioned months; Elevation increases in Elmali, Korkuteli, Ibradi, Akseki and Gundogmus districts 1 Generation and 2 Generation climate conditions are dominant. Besides, SSI values around Alanya district, Serik district, Antalya city center and surroundings, Kemer district and surroundings have always been higher compared to other areas. On the other hand, it was observed that SSI values were lower among the settlements along the coastline of Kaş, Kalkan, Demre and Kumluca districts.

Keywords: Bioclimatic comfort; Antalya; New summer index; Geographic information systems

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Introduction

There are many factors that directly or indirectly affect people's lives. Among these factors, climate has been a major determinant of human needs throughout human history, such as nutrition, dressing and shelter. The effects of climate parameters (temperature, humidity, rainfall, wind, sunshine time) are very important. The overwhelming effect of moisture in a hot climate and the cooling effect of moisture in the cold climate conditions vary according to the wind speed, the combination of climate parameters separately or together, and the bioclimatic comfort character of the place. (Çınar, 2004; Toy, 2010).

The concept of bioclimatic comfort has emerged with the industrial revolution and the increasing need for labor and productivity. The deterioration or comfort of working conditions and the relationship between workers' complaints and work performances led to the start of bioclimatic comfort studies. (Toy, 2010) The first study on this subject was conducted in England in 1905, in order to determine the temperature stresses of mine workers. (Haldane, 1905). Bioclimatic comfort is important not only in terms of labor and productivity, but also in many aspects from activities in daily life to meeting the expected satisfaction from tourism activities or changing the duration and diversity of tourism activities.(Toy and

Yılmaz, 2010; Cetin 2019; Cetin et al., 2019). At the same time, climatic conditions bring many advantages and disadvantages in the areas where tourism activities are carried out. (Güçlü, 2009; Toy, 2010). These advantages and disadvantages affect the opinions of both tourists and investors. (Matzarakis et al., 2006; Güçlü, 2009; Cetin 2015; Cetin et al., 2019; Cetin et al., 2018; Cetin 2019).

There are mechanisms by which climate parameters affect individuals in different ways. These mechanisms are based on three different approaches. The first of these is defined as the bioclimatic comfort according to the psychological approach as the satisfaction of the brain from the ambient temperature where the individual is located". Additionally, it is emphasized that the bioclimatic comfort can change according to the mood of the person, the body cannot feel it directly and it shows itself as psychological pressure. The second approach is thermo-physiological approach. The direct effect of climate parameters on the human body is defined as thermo-physiological effect in bioclimatic comfort studies. (Lin and Matzarakis, 2008; Toy, 2010). In the thermo-physiological approach, there is an increase or decrease in thermal comfort according to the arousal state of the body nervous system against the temperature. Finally, in the body heat balance approach, the amount of heat entering the human body and the amount of heat exiting the body is in balance in the comfort range of the skin temperature and the amount of sweating. (ASHRAE, 2004; Höppe, 2002; Höppe, 1993; Adiguzel vd., 2019).

Many studies have been conducted by researchers to determine the bioclimatic comfort status of an environment. Body temperature should be 37 °C in order to feel comfortable in the environment. This value corresponds to the sensed temperature of 31 °C. In cases where the sensed temperature rises above 31 °C, there will be an increase in body temperature or a decrease in the temperature below 31 °C. Low and high temperature values at body temperature will cause various health problems.(Öngel and Mergen, 2009). According to Olgyay (1973), bioclimatic comfortable areas are defined as areas with a temperature of 21.0 °C to 27.5 °C, relative humidity of 30-65% and a wind speed of 5m/s. (Olgyay, 1973; Çetin et al., 2010; Kum, 2011; Çetin, 2016; Cetin 2015; Cetin 2019).

For approximately 80 years, different methods have been developed to assess the status of a site in terms of bioclimatic comfort. The ik Bioclimatic Comfort Chart developed by Olgyay in 1973 is the first of these methods (Figure 1). Olgyay (1973), the bioclimatic comfort diagram created by the coordinate system was aimed to determine the needs of people living in any area outside the Arctic and Equatorial Bioclimatic comfort. Different climatic necessity zones have been formed when the bioclimatic comfort needs of people change according to climatic conditions. These climatic requirement zones are separated from each other by the 'Shadow Line index' in the bioclimatic comfort chart. The area below the shadow line is defined as the region where the climatic conditions in which people need heat are dominant. This region is called the 'Least Hot Period. The area above the shadow line needs cooling. This region is defined as the 'Hottest Period'. Bioclimatic Comfort Zone is defined as the region where no climatic conditions are needed except for the need for very little shading and cooling of the people living in the hottest period.(Altunkasa, 1987; Çetin et al., 2010; Cetin 2015; Boz, 2017; Cetin 2019).

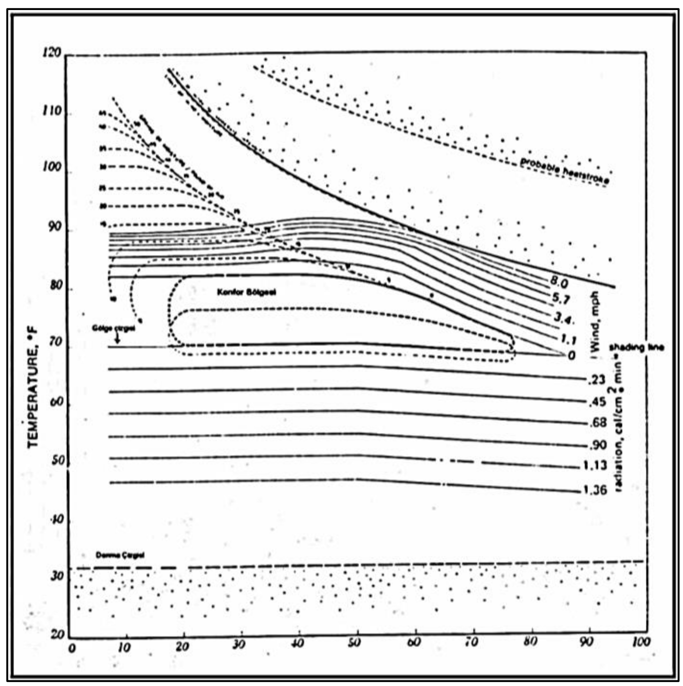

Figure 1. Bioclimatic comfort chart (Olgyay, 1973).

Furthermore, many indices have been developed by including climate parameters and additional factors. (Olgyay, 1973). Effective Temperature Index (ET), Wet Chamber Sphere Thermometer Temperature (WBGT), Tourism Climate Index (TCI), New Summer Index (SSI), Temperature Humidity Index (THI) and Physiological Equivalent Temperature Index (PET) are some of the indexes developed by researchers. (Thom, 1959;

Matzarakis, 2007; Budd, 2008; Mieczkowski, 1985; Tzenkova et al., 2007; Cetin 2015; Cetin et al., 2018; Cetin 2019). Each developed index has its own characteristics. For example; Temperature Humidity Index developed by Thom in 1959 only used temperature and humidity values, Matzarakis developed in 2007 by the Physiological Equivalent Temperature Index climate data (temperature, humidity, wind, rainfall), as well as changes in person to person, such as gender, age, height and weight personal characteristics are also included in the index (Matzarakis et al., 2007; Thom, 1959).

Bioclimatic comfortable destinations can become important tourism centers. Because one of the most important factors in marine tourism is climate. The seaside areas contain natural beauty and many attractions. Therefore, the seaside areas are the most popular tourist centers. For example, individuals participating in tourism activities on the coast can perform many activities such as swimming, diving, yachting, fishing, sunbathing and water sports. (Özgüç, 1998). In our country, the coasts are the areas where tourism activities are the most intense, receiving visitors nationally and internationally. The coastal tourism, which is realized by sea, sand and sun trio, cannot be carried out on all coasts due to its climate and landform features. For example; Cliffed of Turkey's eastern Black Sea coast waterfront property transport and climate character, it restricts the coastal tourism. (Doğaner, 2001). However, besides the restrictive features of the landforms, there are many features that allow coastal tourism. Located in the Mediterranean Region of Antalya province with the geographical characteristics, general climate character and sea water temperature and natural and cultural features, transportation activities and advanced facilities suitable for tourism activities attracts more and more attention of domestic and foreign tourists day by day. (Doğaner, 2001; Kervankiran and Bulut, 2015; Alkan et al., 2017). According to the records, 832,897 local and foreign tourists visited the Antalya province. In 2019, 50,344,818 domestic and foreign tourists visited Turkey. 16,615,775 of this number visited the province of Antalya. The average length of stay was 2.87 days in Turkey as a whole. In Antalya province, however, the duration was 4.43 days. As of 2018, there were 97 enterprises with tourism investment certificates and 791 enterprises with tourism operation certificates. According to TURKSTAT data, the total capacity of these facilities is 497,629. The occupancy rate of these facilities is 67.27%. Antalya is known for its maritime tourism. There are many national parks, karst caves, plateaus and archaeological sites. For example; Köprülü Canyon National Park, Manavgat Waterfall, Feslikan Plateau, Karain, Dim, Damlataş Caves are just a few of these places. Coastal tourism areas which are the main subject of this study are quite high. Lara, Konyaaltı, Cleopatra, Watermelon Lifts, Belek, Kundu, Side beaches are the main ones. Kemer, Tekirova, Kumluca, Finike, Demre, Kaş, which are located in the west of Antalya, have bays protected from anthropogenic effects with forests extending to the seashore (Kervankiran and Bulut, 2015). When the activities carried out in Turkey in terms of coastal tourism are examined, it is observed that tourism activities are intensified in June, July and August due to the limiting effect of climate conditions and personal reasons of individuals (Güçlü, 2010b). When TURKSTAT 2018 records are examined, it is seen that 40.9% of the tourists who visited during the year participated in tourism activities (Table 1).

In this study, the distribution of bioclimatic comfort areas in summer (June, July, and August), the characteristics of bioclimatic comfort conditions and the factors affecting bioclimatic comfort conditions, the relationship between tourism and climate comfort by using the New Summer Index (SSI) and interpolation methods.

Materials and Methods

Working Area

The selected working area is located in Antalya in the southwest of Turkey (Figure 2). Due to the geography of Antalya, which enables many tourism activities, tourism potential is increasing day by day. Therefore, it is very important to evaluate Antalya in terms of bioclimatic comfort for summer tourism.

In this study, monthly average temperature and relative humidity data obtained from 31 meteorological stations, covering the period between 1980-2019, were used to determine the bioclimatic comfortable areas of Antalya (Table 2) (Figure 2).

According to Köppen-Geiger climate classification, the general climate character of the study area is classified as hot-summer Mediterranean Climate with Csa letters (Öztürk et al., 2017). This climate type is also known as a "typical Mediterranean climate". According to Erinç climate classification, while the central part of the study area has perhumid and humid characteristics, especially the western part has a semiarid characteristic (Aydın et al., 2019).

Table 1. Turkey's number of tourists who arrival at the facility, overnight average length of stay, occupancy rates in 2018

Months	Number of Arrivals in Facilities	Overnight	Average Stay Duration	Occupancy Rate (%)
January	2 792 196	5 837 753	2,09	38,98
February	2 573 999	5 199 578	2,02	35,28
March	3 258 929	6 939 659	2,13	41,89
April	4 119 434	9 767 435	2,37	42,18
May	3 468 117	11 484 758	3,31	46,20
June	5 043 280	16 745 602	3,32	66,47
July	6 471 045	20 944 829	3,24	82,75
August	6 513 976	21 446 796	3,29	84,62
September	5 800 131	19 007 595	3,28	73,65
October	5 161 194	15 688 416	3,04	61,72
November	2 643 256	6 060 223	2,29	32,10
December	2 499 261	5 292 623	2,12	33,78
Total	50 344 818	144 415 267	2,87	56,43

Source: Ministry of Culture and Tourism Statistics, 2019.

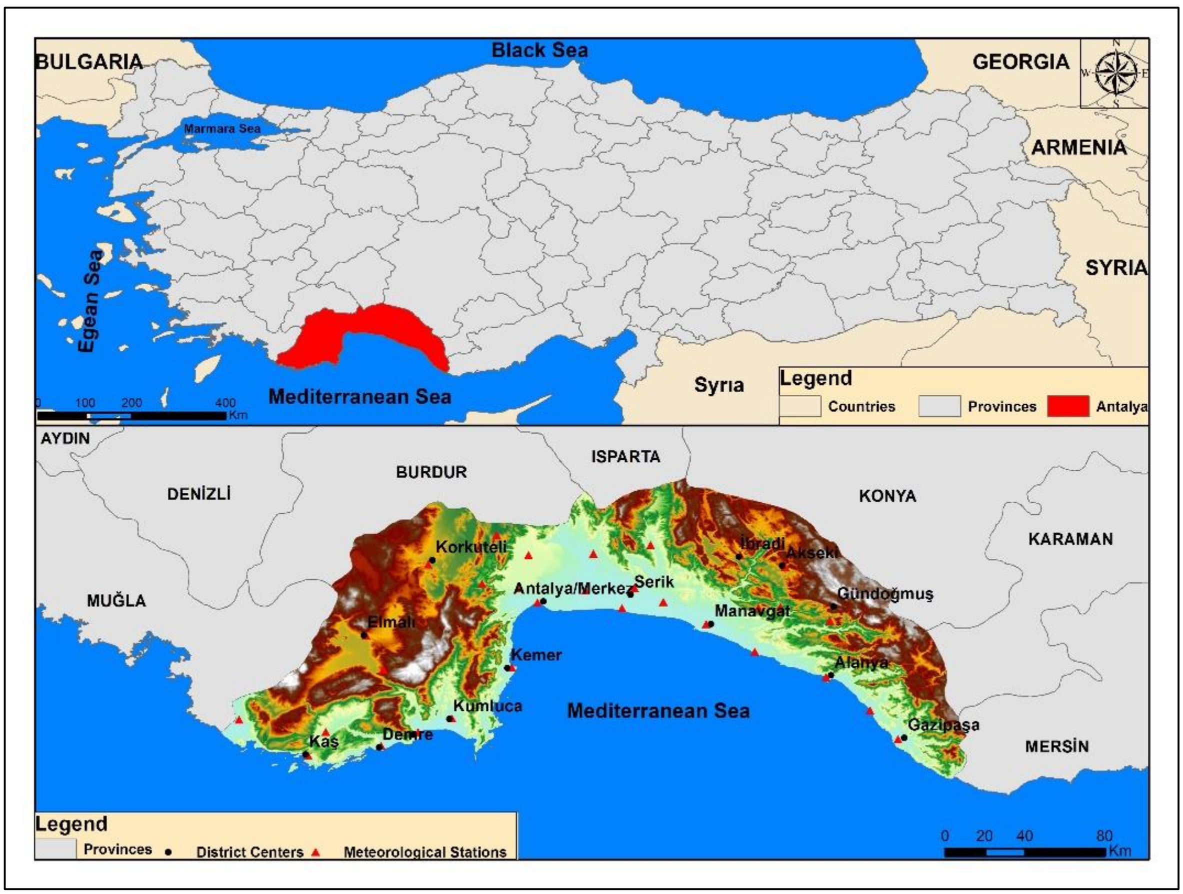

Figure 2. Location map of Antalya province

Table 2. Meteorological station information

Province	Town	Station Name	Station Code	Latitude	Longitude	Elevation (m)
Antalya	Akseki	Murtiçi Orman Sahası	18013	36,866	31,775	508
Antalya	Akseki	Akseki	18047	37,0468	31,7971	1063
Antalya	Aksu	Boztepe Tigem	17895	36,9393	30,898	10
Antalya	Alanya	Alanya	17310	36,5507	31,9803	6
Antalya	Alanya	Keçeli	18837	36,4003	32,1778	14
Antalya	Alanya	Okurcalar Beldesi	18838	36,6653	31,66	23
Antalya	Demre	Kale-Demre	17970	36,2421	29,979	25
Antalya	Döşemealtı	Dağbeli	18008	37,189	30,4995	789
Antalya	Döşemealtı	Nebiler Orman Sahası	18016	36,9501	30,6025	266
Antalya	Döşemealtı	Karain Havacılık	18307	37,0987	30,6425	308
Antalya	Elmalı	Elmalı	17952	36,7372	29,9121	1095
Antalya	Elmalı	Elmalı Orman Sahası	18305	36,5842	29,9892	1311
Antalya	Finike	Finike	17375	36,3024	30,1458	2
Antalya	Gazipaşa	Gazipaşa	17974	36,2715	32,3045	21
Antalya	Gündoğmuş	Gündoğmuş Orman Deposu	18012	36,8043	31,9979	898
Antalya	İbradı	İbradı	17927	37,0968	31,5952	1036
Antalya	Kaş	Kaş	17380	36,2002	29,6502	153
Antalya	Kaş	Çavdır Orman Sahası	18009	36,3592	29,3403	71
Antalya	Kaş	Kasaba Orman Sahası	18010	36,305	29,7306	211
Antalya	Kemer	Kemer/Antalya	17953	36,5942	30,5672	10
Antalya	Korkuteli	Korkuteli	17926	37,0565	30,191	1017
Antalya	Korkuteli	Bük Orman Sahası	18015	36,9703	30,4339	489
Antalya	Kumluca	Kumluca	17951	36,3646	30,2978	60
Antalya	Manavgat	Taşağıl Orman Sahası	17917	36,8886	31,2494	38
Antalya	Manavgat	Manavgat	17954	36,7895	31,441	38
Antalya	Manavgat	Beşkonak Orman Sahası	18011	37,1441	31,1909	142
Antalya	Manavgat	Manavgat Orman Sahası	18839	36,8614	31,6756	998
Antalya	Muratpaşa	Antalya Bölge	17302	36,8851	30,6828	47
Antalya	Serik	Belek	17915	36,8604	31,0627	6
Antalya	Serik	Gebiz Orman Sahası	18014	37,1046	30,9345	78
Antalya	Serik	Serik	18306	36,9517	31,1189	94

Interpolation techniques were applied to temperature and relative humidity data obtained from the meteorological stations in the study area. The spatial interpolation technique coordinates are algorithms that produce values between certain points. There are many interpolation techniques in GIS. Co-Kriging, Kriging, Inverse Distance Weighted (IDW), Radial Basis Functions, Kernel, Natural Neighbor are the most important of these algorithms (Cetin et al., 2018). Inverse Distance Weighted and Co-Kriging techniques were used for this study.

The most commonly used IDW technique among the interpolation methods is;

$F(x, y) = \sum_{i=1}^{n} W_i \; f_i$ is defined as.

Where n is the number of abutments at the surface,

f_i = shows known data values at the fulcrum.

W_i weights;

$W_i = \frac{\frac{1}{D^{p}ij}}{\sum_{i=1}^{n}\frac{1}{d^{p}ij}}$ is calculated as.

Here, p is known as 'power parameters', P is between 0 and 5. In the Shepard method, the p value is generally chosen as 2. If the p value is 2 according to Shaperd method, it is called Inverse Square Distance. (Tunçay et al., 2016).

Another technique used is Co-Kriging technique:

$Z_1(S) = \mu_1 + \varepsilon_1(S)$

$Z_2(S) = \mu_2 + \varepsilon_2(S)$ is calculated with the formula. μ_1 and μ_2 including unknown constants $\varepsilon_1(S)$ and $\varepsilon_2(S)$ shows two random errors. Co-Kriging $Z_1(S_0)_1$'i tries to guess, but in doing so it also deals with covariance information. (Tural et al., 2014; Cetin et al., 2019).

New Summer Index has been preferred for the determination of bioclimatic comfort conditions for summer tourism in Antalya. The fact that this index has a classification for coastal tourism and has been used in similar bioclimatic comfort studies has been decisive in its preference in this study.

Introduced for the first time in 2000, the New Summer Index (SSI) was introduced at the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHREA) meeting in California. and validated by tests conducted by Kansas State University (Güçlü, 2009; Tzenkova et al., 2007).

New Summer Index; SSI=1.98 [Ta-(055-0,0055Ur) (Ta-58)]-56,83 calculated using the formula. Ta in the formula, the air temperature (°F), Ur represents relative humidity (Güçlü, 2009, 2010a, 2010b; Pepi, 1987; Tzenkova et al., 2007). The SSI index is evaluated according to the classification given in Table 3.

Table 3. SSI classification scheme

SSI Value (F°)	Generation (zone)	Thermal Comfort Class for Human
70-77	1	Some individuals feel a little cool, many individuals feel comfortable,
77,1 - 82	2	Feels comfortable by many,
82,1-90	3	It is felt comfortable by many, some individuals feel a little warm.
90,1-99	4	Reduced comfort due to temperature increase,
99,1-111	5	It is an extremely hot environment. It is felt uncomfortable by individuals. Sunstroke, prolongation of activities, lack of comfort due to heat.
111,1-124	6	A high degree of discomfort is felt and the possibility of heat stroke is high. Everyone is uncomfortable in this generation.
124,1-149	7	There is a danger of heat stroke in this belt for the elderly or weak people. In this belt, the environment feels extremely warm and the comfort level is maximum.
149,1 more than	8	Individuals who have been exposed to these conditions for a long time are likely to collapse the circulatory system.

Source: http://summersimmer.com/ssi_page5.htm

Results and Discussions

Temperature

According to the temperature data applied to the interpolation analysis, the lowest temperature values (14 °C -16 °C) in June are observed in and around the high parts of Geyik Mountains, including İbradı, Akseki and Gündoğmuş districts in the east of Antalya city center. Other areas where low temperature values are observed are the high parts of the Bey Mountains located in the south of Elmalı district to the west of Antalya city center and north of Kumluca district. In June, Antalya city center and along the coastline to the east (Serik, Manavgat, Alanya, Gazipasa) and west (Kemer, Kumluca, Demre and Kas) temperature values vary between 24 °C and 26 °C. The temperature values around 20 °C and 22 °C in the western areas of the Elmali, Korkuteli districts are located in the east of the city center of Antalya and Akseki, İbradı and Gündoğmuş districts around (Figure 3).

The distribution of summer temperatures of Antalya, which has important destinations for summer tourism of our country, is as follows: The lowest temperature in July is 17.4 °C, while the highest temperature is 29.8 °C. The lowest temperature areas are Geyik Mountains in the east of Antalya city center and Bey Mountains in the west of the city and its surroundings. In July, the highest temperature values (29.8 °C) in the east of the Gulf of Antalya Serik District and the surrounding area (Figure 4.1).

The highest temperature in Antalya (30 C°) is August. The areas where the highest temperature value is seen according to the average temperature of August for many years are Kemer, Antalya city center, Serik, Manavgat and Alanya districts along the Mediterranean coast of Antalya province where the most intensive tourism activities of our country are carried out. The areas where the temperature values are lower than the other districts (17.5 °C) are the Bey Mountains and its environs located in the south of Elmalı district. Generally speaking, the temperatures in the city center and its vicinity are higher in June, July and August in Antalya compared to other settlements. Bey Mountains and Geyik Mountains where the high parts of June, July and August temperature values always show lower values compared to other settlements (Figure 3).

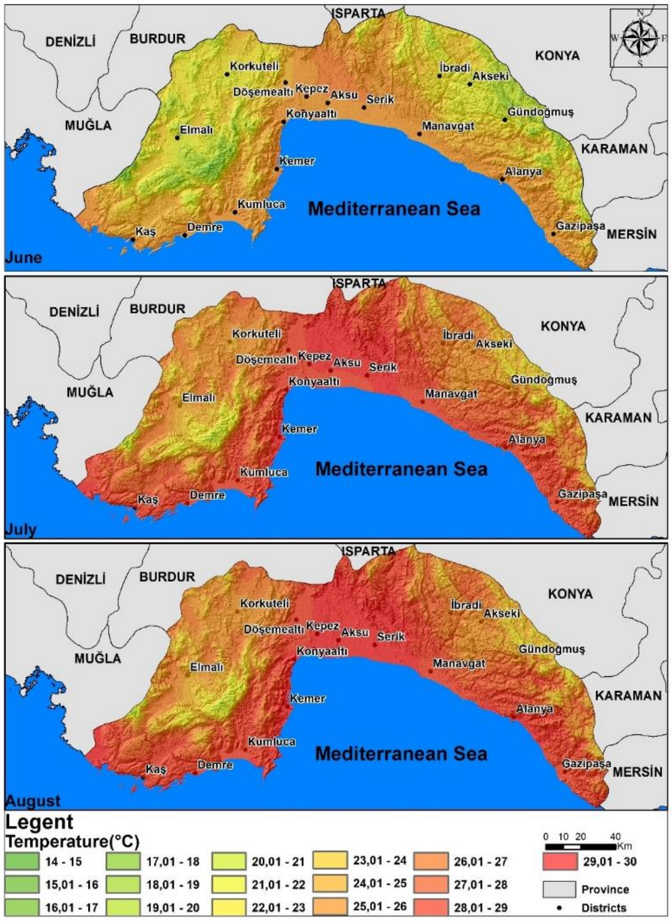

Figure 3. Monthly average temperature map of Antalya province

Relative humidity

When the relative humidity values of June are examined, it is observed that the minimum relative humidity values are around 45%. Relative humidity values around İbradı, Akseki, Gündoğmuş, Elmalı and Korkuteli are at the minimum level. The areas with the highest relative humidity values (75.6%) in June are Antalya city center and Gazipaşa, Alanya and Manavgat districts in the east. The relative humidity in Antalya varies between 39% and 69% in July. Compared to June, relative humidity decreased by 6% in Korkuteli, Elmalı, İbradı, Akseki and Gündoğmuş districts. Humidity is 9% higher in Gazipaşa, Alanya and Serik districts in Antalya city center and in the east compared to the districts in the west. While the contribution of this situation to the bioclimatic comfort perception of the tourists visiting the districts in the east is negative, it is positive in the western districts (Kemer, Kumluca, Finike, Demre and Kas) (Figure 4).

In the settlements along the coastline of Antalya province, relative humidity levels vary between 55% and 71% in August. On the other hand, the relative humidity is between 41% and 54%. The areas with the highest relative humidity (71%) are Serik, Alanya and Gazipaşa districts as in June and July. In the western districts relative humidity rates are between 54% and 60% (Figure 4). This situation made the districts in the west more comfortable for coastal tourism.

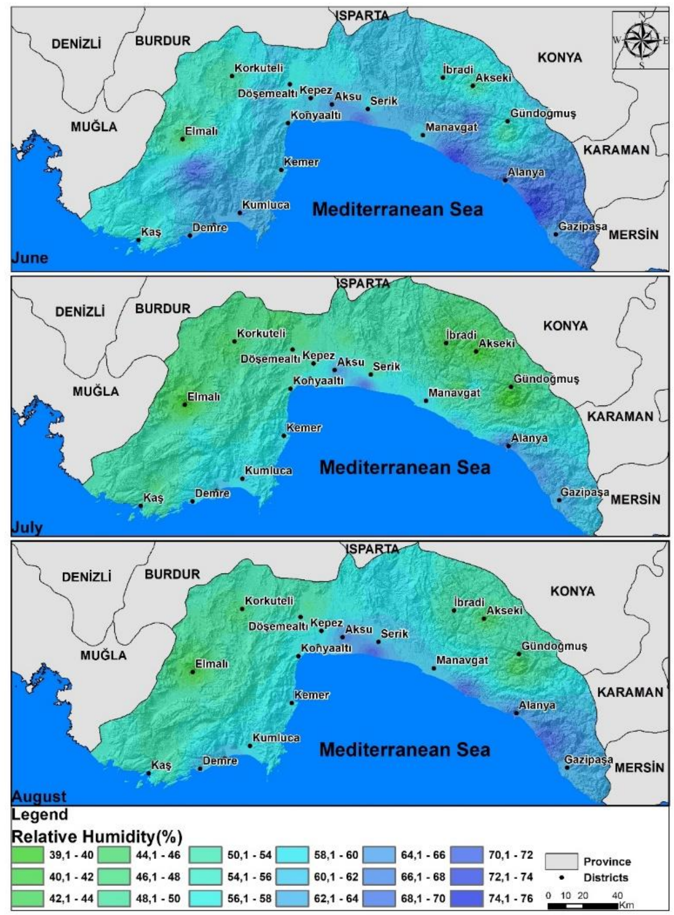

Figure 4. Monthly average relative humidity map of Antalya province

New Summer Index Results

The New Summer Index values, which were developed by the American Society of Heating-Refrigeration and Ventilation Engineers and proved authentic by many years of tests by Kansas State University, were calculated using the data of 31 meteorological stations in Antalya.

According to the SSI values produced for Antalya province, there are 4 classes in June, 1st Generation, 2nd Generation, 3rd Generation and 4th Generation. According to the SSI classification scheme, there are 3rd Generation and 4th Generation areas along the coastline. In the SSI classification scheme, the majority of the individuals in the 3rd Generation feel comfortable and some of them feel warm. This belt extends along the

Mediterranean coastline. In and around Alanya district, along the coastline in the south of Serik district and north of Kemer district, in the 4th Generation, it is seen that temperatures are around 20 °C and relative to 70% relative humidity values decrease bioclimatic comfort. The 2nd Generation class, which covers a range of 77 °F to 82 °F, is the area around the Elmali district in the west and İbradı, Akseki and Gündoğmuş districts in the east, where the elevation is higher than 1000 m for the people of Antalya. These areas, which are used as plateaus, are preferred by local tourists for recreational purposes in summer. (Sari, 2013). These areas were determined as bioclimatic according to SSI index for June. According to the SSI classification scheme, the 1st Generation, which contains values between 70 °F and 76 °F, is distributed around Bey Mountains and around Akseki, Gündoğmuş and Geyik Mountains, south of Elmalı district. Individuals living in this generation feel comfortable in terms of bioclimatic comfort. However, some of the individuals in Generation 1 feel bioclimatic. Air temperature varies between 14 °C and 15 °C. SSI classification scheme does not find, but for the month of June in the province of Antalya on the mountainous masses (Western Taurus) 56.8 °F to 70 °F shows the distribution of SSI values (Figure 5).

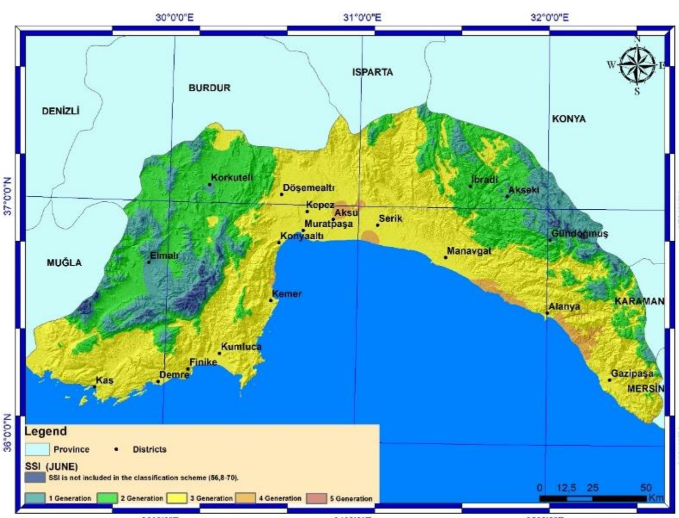

Figure 5. Antalya province new summer index results for june

According to SSI values, there are 5 classes of distribution for July: 1st Generation, 2nd Generation, 3rd Generation, 4th Generation and 5th Generation. The 4th Generation conditions, which range from 91.1 °F to 99 °F, are distributed along the coastline from east to west in Antalya. Under these belt conditions, individuals experience a reduction in comfort due to temperature rise up to 28 °C and relative humidity up to 65%. July is one of the most intense months of tourism activities for Antalya. The increase in temperature values was determined as the 4th Generation of the areas which were considered as comfortable in terms of bioclimatic comfort in June and it was observed that there was a decrease in comfort. The temperature values of 99.1 °F and 111 °F, which are determined as the 5th Generation in SSI classification scheme, are distributed around Kemer district, northeast of Antalya city center, north of Serik district and around Alanya district. Sunstrokes can occur to some individuals who have been living in these environments for a long time. In these environments, temperatures rise up to 30 °C and relative humidity rises up to 76% will cause individuals to feel warm and uncomfortable. It is observed that the 4th Generation conditions prevailed in İbradı, Akseki and Korkuteli districts where the 3rd Generation conditions were experienced in June due to the increase in temperature and relative humidity values in July. Therefore, many individuals will feel a decrease in comfort in comfortable and slightly cool environments. The 2nd Generation class, which covers temperatures between 77.1 °F and 83 °F, is observed around Elmalı district and north of Gündoğmuş district. In environments where these belt conditions are dominant, it is described as comfortable according to SSI classification scheme. According to the SSI classification scheme, the 1st Generation conditions are seen on the Bey Mountains (Figure 6).

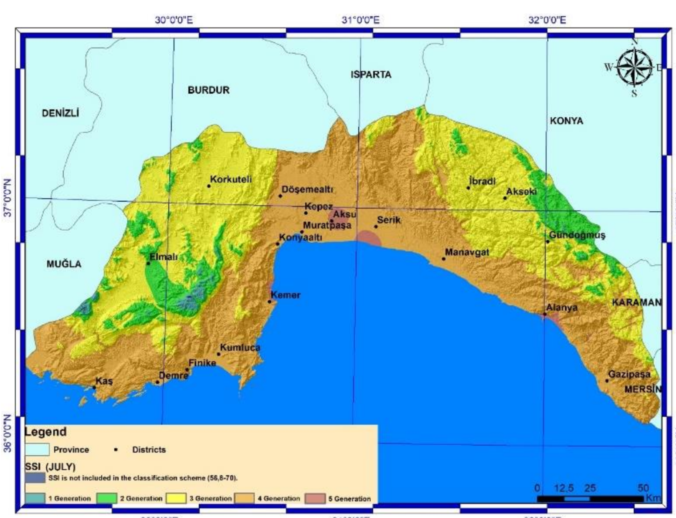

Figure 6. Antalya province new summer index results for july

According to the results of the New Summer Index of the province of Antalya in August, 5th Generation areas have expanded considerably compared to July. Around Alanya district, in the southeast-northwest direction, in Konyaaltı, Muratpaşa, Döşemealtı, Kepez districts and in the south-north direction along the coastline of Kemer district, the 5th Generation was enlarged. Increasing the relative humidity values up to 76% values in the areas where belt environment conditions are experienced and increasing the temperature values up to 30 °C provide extremely hot and uncomfortable environments according to SSI index. When SSI index and Gazipaşa and Manavgat surroundings, north of Kemer district, Kumluca, Finike, Demre and Kaş districts are evaluated in terms of bioclimatic, it is observed that 4th Generation conditions are dominant. The third generation environment conditions, which are described as being comfortable by many, are observed in Korkuteli, İbradı, Akseki districts and their environs. Due to the relative humidity conditions being around 40% and 20 °C temperature values, Elmali district is located in the 2nd Generation (Figure 7).

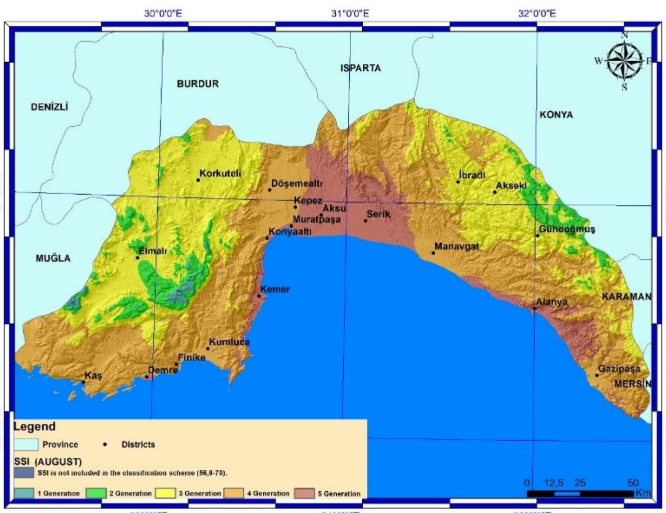

Figure 7. Antalya province august new summer index results

Results and Suggestions

In this study, in order to determine the bioclimatic comfort conditions of Antalya province in June, July, August, monthly average temperature and monthly average relative humidity data and interpolation analyzes were performed. SSI values were generated from the obtained data. The SSI values produced were examined according to the SSI classification scheme.

According to the SSI classification scheme, in June, July and August, there are 5 classes of 1st Generation, 2nd Generation, 3rd Generation, 4th Generation and 5th Generation. According to the SSI results, the conditions of the 3rd Generation prevail in the coastline of Antalya province in June. Apart from this, temperatures exceeding 25 °C in June and around Alanya affect the comfort negatively. Sea water temperatures and weather conditions in Alanya and Antalya city center and Kemer district in the 4th Generation according to SSI classification are suitable for coastal tourism activities in June.

The fourth generation conditions on the Mediterranean coast were effective in July. Along with the temperature increases in July, sea water temperatures also increased significantly. This situation caused the environment conditions not suitable for coastal tourism.

Due to the increase in air temperatures in August, 4th Generation bioclimatic comfort conditions prevailed on the coastline of Antalya province, from Gazipaşa district to Kaş district in the east. When the SSI values of August are compared between June and July, it is seen that there is a significant expansion in the areas where the 5th Generation environment conditions prevail. The south-east and northwest-wide expansion in and around Alanya district, the south, east and west expansion including Konyaaltı, Muratpaşa and Serik district and the north-south expansion in Kemer district reveal the changes in the environmental conditions. SSI values were always higher in Alanya, Serik and Kemer districts and around Konyaaltı, Muratpaşa, June, July and August compared to other settlements. According to TURKSTAT 2018 data, 4,227,248 to Alanya district, 3,038,291 to Serik district, 2,357,929 to Kemer district, local and foreign tourists visit for many tourism activities, especially marine tourism. According to SSI classification scheme, Manavgat district is more comfortable than the settlements where tourism activities are intense. Tourism facilities in the town of Manavgat with an occupancy rate of 64.28% host 4,222,981 domestic and foreign tourists each year. Besides, there is a comfortable environment when SSI values of Kaş, Kalkan, Demre and Kumluca districts are examined. However, when these districts' 2018 TURKSTAT data are examined (10,509 in Kaş district, 5,700 in Demre district, 21,172 in Kumluca district), it is seen that tourism activities are not as intensive as Alanya, Manavgat and Kemer districts (Ministry of Culture and Tourism Statistics, 2019). Based on these data, tourism should be gained by carrying out studies in these districts located on the coast.

Antalya provides many tourism activities with its natural and historical beauties. From this point of view, the potentials of Elmalı, Korkuteli, Akseki, İbradı and Gündoğmuş districts located in the north of Antalya should be mobilized for plateauing or recreational activities such as mountaineering and hiking.

It is recommended that the results of climate comfort studies be included in the planning processes in order to sustain the tourism activities carried out in Antalya and to continue without damaging the natural environment and during the establishment of tourism facilities.

References

ASHRAE. 2004. Thermal Environmental Conditions for Human Occupancy. ANSI/ASHRAE 55, American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, USA.

Adiguzel F., Cetin M., Kaya E., Simsek M., Gungor S., Bozdogan Sert E. 2019. Defining suitable areas for bioclimatic comfort for landscape planning and landscape management in Hatay, Turkey. Theoretical and Applied Climatology. https://doi.org/10.1007/s00704-019-03065-7

Alkan A., Adıgüzel F., Kaya E. 2017. Batman Kentinde Kentsel Isınmanın Azaltılmasında Yeşil Alanların Önemi. Coğrafya Dergisi, (34): 62-76.

Aydın S., Şimşek M., Çetinkaya G., Öztürk M.Z. 2019. Regime Characteristics of Turkey's Climatic Regions Determined Using the Erinç Precipitation Efficiency Index. 1st Istanbul International Geography Congress Proceedings Book, 752-760.

Boz A.Ö. 2017. Tekirdağ Kent Merkezinin Biyoklimatik Konfor Bakımından İncelenmesi. Namık Kemal Üniversitesi Fen Bilimleri Enstitüsü Peyzaj Mimarlığı Ana Bilim Dalı. Yüksek Lisans Tezi. 81 s.

Çetin M., Topay M., Kaya L.G., Yılmaz B. 2010. Biyoiklimsel Konforun Peyzaj Planlama Sürecindeki Etkinliği: Kütahya Örneği. Turkish Journal of Forestry, 1(1): 83-95. https://doi.org/10.18182/tjf.29063

Cetin M. 2016. Determination of bioclimatic comfort areas in landscape planning: A case study of Cide Coastline. Turkish Journal of Agriculture-Food Science and Technology, 4(9): 800-804.

Cetin M. 2015. Determining the bioclimatic comfort in Kastamonu City. Environmental Monitoring and Assessment, 187(10): 640, http://link.springer.com/article/10.1007%2Fs10661-015-4861-3.

Cetin M., Adiguzel F., Kaya O., Sahap A. 2018. Mapping of bioclimatic comfort for potential planning using GIS in Aydin. Environment, Development and Sustainability, 20(1): 361-375. https://doi.org/10.1007/s10668-016-9885-5

Cetin M. 2019. The effect of urban planning on urban formations determining bioclimatic comfort area's effect using satellitia imagines on air quality: a case study of Bursa city. Air Quality, Atmosphere & Health, (Air Qual Atmos Health). 12(10): 1237-1249. https://doi.org/10.1007/s11869-019-00742-4 https://rd.springer.com/article/10.1007/s11869-019-00742-4

Cetin M., Adiguzel F., Gungor S., Kaya E., Sancar M.C. 2019. Evaluation of thermal climatic region areas in terms of building density in urban management and planning for Burdur, Turkey. Air Quality, Atmosphere & Health, 12(9): 1103-1112. https://doi.org/10.1007/s11869-019-00727-3

Çınar İ. 2004. Biyokilimatik Açıdan Konfor Ölçütlerinin Planlama Sürecinde Etkinliği Üzerinde Muğla-Karabağlar Yaylası Örneği Araştırmalar. Ege Üniversitesi Fen Bilimleri Enstitüsü Peyzaj Mimarlığı ABD. Doktora Tezi. 246 s.

Güçlü Y. 2008. Climatic Conditions of Alanya-Samandag Coastal Zone With Respect to Human Comfort and Maritime Tourism Season. Turkish Geographical Review, (50): 1-20.

Güçlü Y. 2009. The Determination of Climate Comfortable and Sea Tourism Season According to the Climatical Conditions in the Western Black Sea Subregion Coastal Belt. Turkish Geographical Review, (53): 1-14.

Güçlü Y. 2010a. The Examination Of Climate Comfortable Conditions İn Terms Of Coastal Tourism On The Aegean Region Coastal Belt. Journal of Human Sciences, 7(1): 794-823.

Güçlü Y. 2010b. The Examination Of Climate Comfortable Conditions İn Terms Of Coastal Tourism On The Eastern Black Sea Subregion Coastal Belt. Turkish Geographical Review, 8(2): 111-136.

Haldane J.S. 1905. The Influence Of High Air Temperatures. Epidemiology & Infection, 65(I): 494-513. https://doi.org/10.1017/S0022172400006811

Höppe P. 2002. Different Aspects Of Assessing İndoor And Outdoor Thermal Comfort. Energy and Buildings, 34(6): 661-665.

Höppe P.R. 1993. Heat Balance Modelling. Experientia, 49(9): 741-746. https://doi.org/10.1007/BF01923542

Kaya E., Agca M., Adiguzel F., Cetin M. 2018. Spatial Data Analysis With R Programming For Environment. Human and Ecological Risk Assessment, 0(0): 1-10. https://doi.org/10.1080/10807039.2018.1470896

Kervankiran İ., Bulut E. 2015. How Do The Local People Evaluate The Development And The Effects Of Tourism İn Antalya Province? Turkish Geographical Review, 0(65): 35-45. https://doi.org/10.17211/tcd.29902

Kum G. 2011. İklim Değişikliğinin Türkiye'nin Güneybatı Kıyılarında Turizmin Konfor Koşullarına Etkileri. İstanbul Üniversitesi Sosyal Bilimler Enstitüsü, Doktora Tezi. 205 s.

Kum G., Gönençgil B. 2018. Tourism Climate Comfort of Turkey's Southwestern Seasides. Gaziantep University Journal of Social Sciences, 17: 70-87. https://doi.org/10.21547/jss.341541

Matzarakis A., Rutz F., Mayer H. 2006. Modelling the thermal bioclimate in urban areas with the RayMan model. PLEA 2006. 23rd International Conference on Passive and Low Energy Architecture, September, 6-8.

Olgyay V. 1973. Design With Climate: Bioclimatic Approach to Architectural Regionalism Princeton University Press. Princeton, New Jersey.

Öngel K., Mergen H. 2009. Review Of Literature About The Effects Of Thermal Comfort Parameters On Human Body. Medical Journal of Süleyman Demirel Universty, 16(1): 21-25.

Ozturk M.Z., Cetinkaya G., Aydin S. 2017. Climate Types of Turkey According to Klippen-Geiger Climate Classification. Journal of Geography-Cografya Dergısı, (35), 17-27.

Pepi J.W. 1987. The Summer Simmer Index. Weatherwise, 40(3): 143-145. https://doi.org/10.1080/00431672.1987.9933356

Samet R., Tural S., Ercan T. 2014. Two-Way Real-Time Meteorological Data Analysis And Mapping İnformation System. Applied and Computational Mathematics, 13(3): 350-365. https://doi.org/10.11648/j.acm.20140305

Sari C. 2013. Functıonal Change Processes of Plateaus and Festivals in West Taurus. nternational Journal of Geography and Geography Education, 27(1303-2429): 242-261.

Toy S., Yilmaz S. 2010. Evaluation of urban-rural bioclimatic comfort differences over a ten-year period in the sample of Erzincan city reconstructed after a heavy earthquake. Atmosfera, 23(4): 387-402.

Toy S. 2010. Biyoklimatik Konfor Değerleri Bakımından Doğu Anadolu Bölgesi Rekreasyonel Alanlarının İncelenmesi. Atatürk Üniversitesi Fen Bilimleri Enstitüsü Peyzaj Mimarlığı Ana Bilim Dalı. Doktora Tezi. 246 s.

Tunçay T., Bayramin İ., Atalay F., Ünver İ. 2016. Assessment Of Inverse Distance Weighting (Idw) Interpolation On Spatial Variability Of Selected Soil Properties İn The Cukurova Plain. Journal of Agricultural Sciences, 22(3): 377-384. https://doi.org/10.1501/tarimbil_0000001396

Tzenkova A., Ivancheva J., Koleva E., Videnov P. 2007. The human comfort conditions at Bulgarian Black Sea side. Içinde Developments in Tourism Climatology (Edited by: A. Matzarakis, CR de Freitas and D. Scott). https://www.researchgate.net/publication/233758996_Advances_in_Tourism_Climatology%5Cnhttps://www.researchgate.net/publication/233758650

https://yigm.ktb.gov.tr/TR-9851/turizm-istatistikleri.html: date of access: 03.01.2019

http://www.tuik.gov.tr/UstMenu.do?metod=temelist: date of access: 03.01.2019

http://summersimmer.com/ssi_page5.html: date of access: 03.01.2019