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DETERMINATION OF THERMAL COMFORT CONDITIONS OF ZİGANA WINTER TOURISM CENTER ACCORDING TO SKIERS AND VISITORS*

Zigana Kış Turizm Merkezinin Termal Konfor Koşullarının Kayakçılara ve Ziyaretçilere Göre Belirlenmesi

Savaş ÇAĞLAK*

Öz

Turizm faaliyetlerinin yapılabilmesinde iklim koşullarının belirleyici bir rolü vardır. Bu çalışma Zigana Kış Turizmi Merkezi'nin (ZKTM) kayakçılar (aktif kayak yapan) ve ziyaretçiler (gezip-dolaşan) açısından termal konfor koşullarının belirlenmesini amaçlamaktadır. Çalışmada ZKTM'de bulunan meteoroloji istasyonunun saatlik ölçüm verileri kullanılmıştır. Termal konfor koşulları basit indislerden RSİ (Rüzgâr Soğuğu İndisi) ve karmaşık indislerden DFES (Düzenlenmiş Fizyolojik Eşdeğer Sıcaklık İndisi) indisleri ile belirlenmiştir. Çalışma sonucunda ZKTM'de kayakçılar için kasım ayından mart ayına kadar ki dönemde ocak ayının 10. gününden şubat ayının 10. gününe kadar ki dönem soğuk riskli koşullar etkili olurken diğer günler konforlu olarak ifade edilebilir. Gün içerisinde saat 10:00 ile 16:00 arasının uygun olduğu tespit edilmiştir. Herhangi bir aktivite yapmayan ziyaretçiler için ise tüm dönem boyunca soğuk riskler bulunmaktadır. ZKTM'deki turizm faaliyetleri için bu çalışmanın dikkate alınması önerilmektedir.

Anahtar Kelimeler: Kış Turizmi, Turizm İklimi, Termal Konfor, Rüzgâr Soğuğu İndisi (RSİ), Düzenlenmiş Fizyolojik Eşdeğer Sıcaklık İndisi (DFES), Zigana Kış Turizm Merkezi (ZKTM)

Abstract

Climatic conditions play a decisive role in the realization of tourism activities. This study aims to determine the thermal comfort conditions of the Zigana Winter Tourism Center (ZWTC) for skiers (active skiers) and visitors (wanderers). The study used hourly measurement data from the meteorology station at ZWTC. Thermal comfort conditions were determined with WCI (Wind Chill Index) from simple indices and MPET (Modified Physiologically Equivalent Temperature) indices from complex indices. As a result of the study, cold, risky conditions for skiers from November to March in the period from the 10th day of January to the 10th day of February are effective, while other days can be expressed as comfortable. It has been determined that the hours between 10:00 and 16:00 during the day are suitable. There are cold risks throughout the entire period for visitors who do not do any activity. It is recommended to consider this study for tourism activities in ZWTC.

Keywords: Winter Tourism, Tourism Climate, Thermal Comfort, Wind Chill Index (WCI), Modified Physiologically Equivalent Temperature (MPET), Zigana Winter Tourism Center (ZWTC)

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INTRODUCTION

Tourism is one of the largest economic sectors in the world. Tourism has an essential role in the economies of countries, in the development of regions, in employing people in rural areas, and in preventing the migration wave in rural areas. Today, tourism activities and diversity have gained more importance (Bulut & Yildirim, 2018). In particular, Turkey's natural beauties, such as mountains, plateaus, caves, streams, lakes, climate differences, and diversity of flora and fauna, ensure a high tourism potential. Winter tourism has a significant share among the developing and gaining importance of tourism activities. Winter tourism, hotels, etc., in areas where skiing can be done in snowy environments. It is a type of tourism carried out in the winter season, including entertainment and sports facilities, where accommodation opportunities are developed and visitors are hosted (Doğaner, 1997; Ülker, 2006). Skiing, previously used for transportation in cold climates, emerged as a sport in Norway but developed in Switzerland (Demiroğlu, 2013). The inclusion of skiing in the Olympics in 1928 and 1932 increased interest in ski sports. Ski sports became widespread worldwide after the increase in economic and welfare levels after the Second World War and the development of transportation opportunities (Özgüç, 2007).

Winter tourism has become a type of tourism with a high economic return, especially in recent years. Due to its high return, local administrators, planners, and investors have started to evaluate regions with ski potential and encourage investors. In Turkey, new centers have opened in recent years, and studies such as improving old centers are being carried out (Evren et al., 2020). The first skiers in Turkey were Turkish soldiers who learned from the Austrians during World War I. The first skiing activities started in Palandöken, and then in 1930, skiing activities became widespread in Uludağ. Skiing activities started as tourism in the 1960s. The first mechanical plant was established in Uludağ in the 1950s, followed by Elmadağ in 1956, Erciyes in 1963, and Bitlis, Palandöken, and Sarıkamış in 1969. With the development of communication and especially airlines, the number of winter tourism centers in Turkey has increased day by day. In the 2000s, the Ministry of Culture and Tourism, which tied the investments in winter tourism centers to a certain process, took action to prepare a winter tourism master plan in cooperation with the relevant local administrations to eliminate the deficiencies of the existing centers and areas, develop the domestic market, and organize national and international races. Today, there are around 50 ski centers in Turkey with incentives and studies (Demiroğlu, 2013).

The realization of winter tourism activities depends on natural resources such as climate and landforms. Especially favorable climatic conditions are attractive for tourism activities. The most essential condition for winter tourism is snowfall (Doğaner, 2001). The snow border decreases as you go from the equator to the poles. In Turkey, located in the middle belt, snowfall is mostly seen in high mountain areas. Therefore, ski resorts are generally developed in suitable mountain areas. Since winter tourism depends on snowfall, it is carried out between November and March, when cold conditions prevail throughout the year. The sustainability of tourism activities depends on the satisfaction of skiers and visitors. It has been stated that people between the ages of 15 and 40 and with a high level of education (college, etc.) participate in winter tourism centers (Yfantidou et al., 2018). In order for tourism activities to be sustainable, the unique perceptions and expectations of each generation must be taken into account (Hall, 2019; Seyfi et al., 2023). Among the natural factors, the satisfaction of the tourists is primarily determined by the climatic conditions. Climate change, which has been on the agenda of the whole world in recent years, affects many sectors directly and indirectly. The tourism sector is directly dependent on climatic conditions (Tranos & Davoudi, 2014).Therefore, tourism destinations need to adapt to the risks and opportunities presented by climate change (Scott et al., 2012). Climatic conditions such as extreme cold, low air temperature, high wind speed, and low radiation from the sun adversely affect skiers and visitors. Therefore, thermal comfort conditions should be determined in order for the activities in winter tourism centers to be of high quality and sustainable.

Thermal comfort can be defined as the state of people feeling happy, peaceful, and comfortable in their external environment (Olgyay, 1973; Sungur, 1980). Uncomfortable conditions increase people's health problems, decrease work efficiency, and cause such adverse effects. Especially cold, uncomfortable conditions; cause many health problems such as frostbite, frost burn, hypothermia, respiratory diseases such as asthma, pneumonia, bronchitis, and cardiovascular diseases (Blazejczyk et al., 2018; Donaldson & Keatinge, 2002; Liu et al., 2014; Noor et al., 2019; Singh et al., 2020). Many indices have been developed to concretely reveal the thermal comfort conditions, which are the situations people feel against atmospheric conditions in their environment. These developed indices can be evaluated in two groups: simple and complex indices. In the first group, simple indices are considered direct indices obtained by calculating only the measured climatic elements (air temperature, relative humidity, wind speed, etc.). In the second group, together with the climate elements, the heat exchange of the human body with the environment, metabolic heat according to the activities, clothing resistance, age, height, weight, etc. There are complex indices that also take into account personal parameters. Simple indices are easy to calculate and use. Complex indices are sensitive indices that are difficult to calculate and whose calculation inputs change according to the intended use (Çağlak, 2021; Jussila et al., 2017). In addition, bibliographic studies have been conducted explaining these indices' uses and purposes (de Freitas & Grigorieva, 2015; Epstein & Moran, 2006).

There are studies in the world and in Turkey on determining the thermal comfort conditions of tourism centers. Matzarakis (2001) explained the climatic conditions of Greece with informative guides for tourists, and Roshan et al. (2018) determined Iran's tourism potential in terms of climatic conditions. (Güçlü, 2010) examined the thermal comfort conditions in terms of coastal tourism in Turkey. Çalışkan & Matzarakis (2013) discussed the climatic conditions of Nevşehir in terms of tourism. Çağlak et al. (2017) determined the thermal comfort conditions suitable for tourism in Amasya. Lin & Matzarakis, (2008), Taiwan's Sun Moon Lake, and Nemeth (2013) determined the thermal comfort conditions of Lake Balaton in Hungary in terms of tourism. Studies examining the determination of the thermal comfort conditions of winter tourism centers and tourism thermal comfort conditions according to activity types have been limited in the literature.

This study aims to determine the thermal comfort conditions of winter tourism activities, a particular type of tourism according to skiers and visitors. Therefore, both simple indices and complex indices were used in the study. Daily and hourly thermal conditions of the meteorological station 17696 in the study area were determined using hourly measurement data between 2010 and 2021 (12 years). The WCI (Wind Chill Index), one of the simple indices suitable for the study, was used to determine the thermal comfort conditions. Among the complex indices, the MPET (Modified Physiologically Equivalent Temperature) index calculated with the Rayman model, which is widely used in the world, was used. In the calculations for the MPET index, the resistance of the clothes worn for winter tourism and the metabolic heat according to the activity are added as calculation inputs. In this study, it was aimed to determine the thermal comfort conditions for skiers and visitors of Zigana Winter Tourism Center (ZWTC), located in the borders of the Torul district of Gümüşhane province in the Eastern Black Sea Region of Turkey's Black Sea Region. Zigana Winter Tourism Center is located at the western end of the Kalkanlı Mountains between 2000 and 2500 meters (Figure 1). ZWTC was declared a tourism center in 1991 and officially entered operation in 1996. There are 850-meter-long ski tracks, a toboggan run, a 661-meter-long teleski with a carrying capacity of 843 people per hour, and two baby lifts in the winter tourism center. ZWTC is 3 km from Zigana Pass, 46 km from Gümüşhane, and 54 km from Trabzon. The tourism center, which welcomes visitors from surrounding cities such as Rize, Trabzon, Giresun, Ordu, and Samsun, offers accommodation facilities such as a 31-room hotel, four bungalows with five rooms, and services such as a restaurant (Evren et al., 2020). ZWTC welcomes visitors for winter tourism activities from the end of November to the end of March.

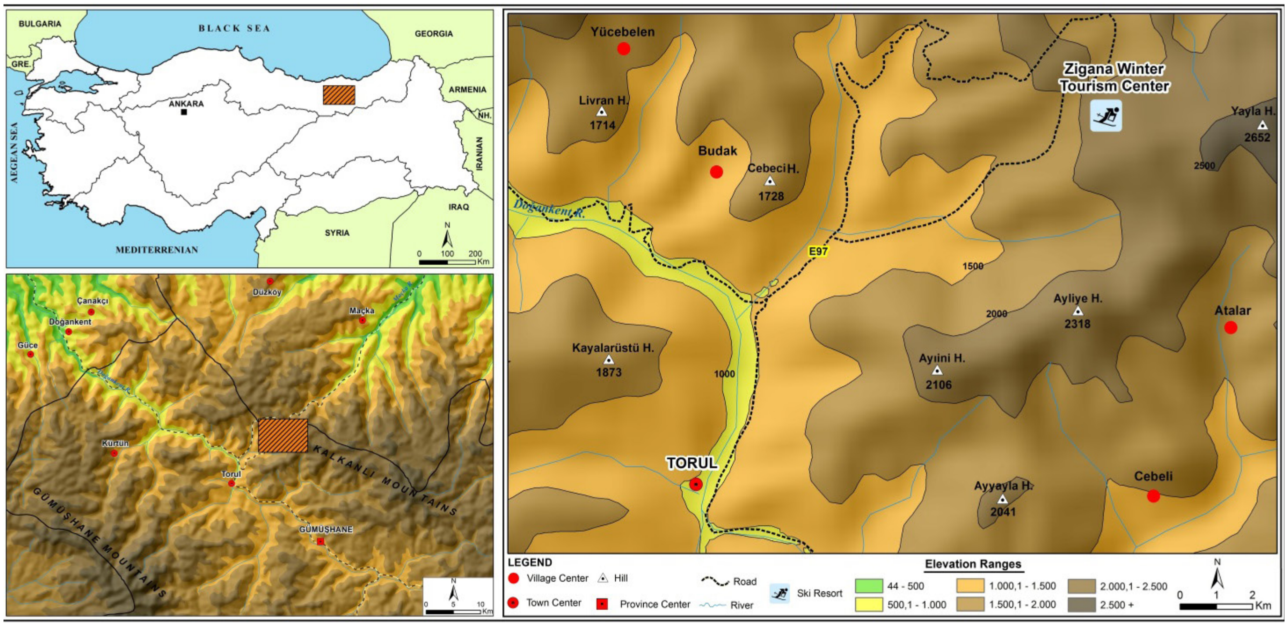


Figure 1. Location Map of Zigana Winter Tourism Center

The annual average temperature was 4.7 ˚C, the highest temperature was 29.9 ˚C, and the lowest temperature was – 16.9 ˚C in the ZWTC, where Black Sea climate features are experienced. The annual total precipitation amount is 549.1 mm, the number of rainy days is 165 days, and the number of snowy days is 68 days. The average relative humidity is 66.4%, and the average wind speed is 4.2 (m/s) (Table 1). The average and extreme meteorological parameters of the Zigana meteorological station are given in Table 1.

Table 1. Mean and Extreme Meteorological Values of Zigana Meteorological Station (2010 – 2021)

Parameters	Values	Date/Period
Mean temperature	4.7 ˚C	Annual
Mean maximum temperature	20.5 ˚C	Annual
Mean minimum temperature	-6.6 ˚C	Annual
Maximum temperature	29.9 ˚C	26.07.2012
Minimum temperature	-16.9 ˚C	28.01.2016
Mean relative humidity	% 66.4	Annual
Total precipitation	549.1 mm	Annual
Number of rainy days	165 days	Annual
Most precipitation in a day	48.8 mm	08.06.2012
Number of days with snow	68 days	Annual
Mean wind velocity	4.2 (m/s)	Annual
Fastest wind velocity	40.9 (m/s)	16.02.2012

METHODS

In the study, hourly measurement data from the meteorology station numbered 17696, established in the Zigana Winter Tourism Center between 2010 and 2021 (12 years), were used. The meteorological station was established in 2009, and full-year measurements started in 2010. Therefore, data from 2010 to 2021 were used in the study. Over the past century, many attempts have been made to determine thermal comfort conditions, and more than 200 indices have been developed. Bibliographic studies have also been conducted explaining these indices' similarities, differences, uses, and purposes (de Freitas & Grigorieva, 2015; Driscoll, 1992; Epstein & Moran, 2006).

As mentioned in the introduction, in the determination of thermal comfort conditions, the Wind Chill Index, which is one of the simple indices obtained by calculating the measured meteorological data, and the MPET (Modified Physiologically Equivalent Temperature) index through the Rayman model, which is one of the complex indices that also takes into account human thermophysiological conditions, were used.

The Wind Chill Index was established in 1945 using experiences and data from Antarctica (Siple & Passel, 1945). Later, the Canadian Meteorological Service made some improvements. Today, the Canadian Meteorological Service is used to prevent and warn the public about cold-related injuries (frostbite and hypothermia) (Osczevski & Bluestein, 2005; Roshan et al., 2010).

Wind Chill Index air temperature (°C) and wind speed (km/h) data are calculated directly, and thermal perceptions are determined. The index calculation takes the wind speed as km/h. The index is calculated using the formula in equation 1.

$$WCI = 13.12 + 0.6215 * T - 11.37.V^{0.16} + 0.3965 * T * V^{0.16} \quad (1)$$

*T in the equation: Air temperature (˚C), V: wind speed (km/hour)

The values obtained using Equation 1 are classified according to Table 2. According to the Wind Chill Index, there is no risk at values higher than 0 ˚C; there is a low risk at values between 0 ˚C and – 9 ˚C as long as you wear tight clothing and stay dry. It is classified as medium-risk between – 10 °C and – 27 °C, and winter tourism can be done by taking various precautions. However, at values less than – 28 ˚C, the risk of cold increases, and hazards may occur in hypothermia, frostbite, etc. (Osczevski & Bluestein, 2005).

Table 2. Wind Chill Index (WCI) classification, hazards and precautions (Osczevski & Bluestein, 2005)

Wind Chill Index (˚C)	Exposure Risk	Effects on Human Health	What to do
> 0	**No risk**	Rare discomfort	Stay dry
0 – -9	**Low risk**	Slight increase in discomfort	Stay dry Dress warmly
-10 – -27	**Moderate risk**	Uncomfortable Riskof hypothermia and frostbite if outside for long periods without adequate protection.	Dress in layers of warm clothing, with an outer layer that is wind-resistant. Wear a hat, mittens or insulated gloves, a scarf and insulated, waterproof footwear. Stay dry. Keep active
-28 – -39	**High risk:** exposed skin can freeze in 10 to 30 minutes	High risk of frostnip or frostbite: Check face and extremities for numbness or whiteness. High risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Dress in layers of warm clothing, with an outer layer that is wind-resistant Cover exposed skin Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear Stay dry Keep active
-40 – -47	**Very high risk**: exposed skin can freeze in 5 to 10 minutes.	Very high risk of frostbite: Check face and extremities for numbness or whiteness. Very high risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Dress in layers of warm clothing, with an outer layer that is wind-resistant. Cover all exposed skin. Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear. Stay dry Keep active.

-48 – -54	**Severe risk**: exposed skin can freeze in 2 to 5 minutes.	Severe risk of frostbite: Check face and extremities frequently for numbness or whiteness. Severe risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Be careful. Dress very warmly in layers of clothing, with an outer layer that is wind-resistant. Cover all exposed skin Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear. Be ready to cut short or cancel outdoor activities. Stay dry. Keep active.
≦ – 55	**Extreme risk**: exposed skin can freeze in less than 2 minutes	DANGER! Outdoor conditions are hazardous.	Stay indoors.

Another index used to determine thermal comfort conditions is MPET (Modified Physiologically Equivalent Temperature), among the complex indices. This index calculates the thermal comfort conditions according to the human body's heat energy balance. The index is calculated with the Rayman software, which is the radiation model. This model calculates the thermal comfort conditions by considering the meteorological parameters and the thermo-physiological conditions of the human body (type of clothing, activity, and metabolic processes) (Gulyás et al., 2006; Höppe, 1999; Matzarakis et al., 1999). Six types of thermal comfort indices are obtained from the model. Among these indices, the most widely used Physiological Equivalent Temperature (PET) index. With the development of the PET index, the MPET index was created (Chen & Matzarakis, 2018). The MPET index more precisely takes into account personal factors such as clothing, activity, and metabolic processes. This index was preferred in the study because it gives more consistent results in determining thermal comfort conditions according to sports activities and work.

In the calculation of the index, hourly air temperature (°C), relative humidity (%), wind speed (m/s), and cloudiness (octa) data are used. The index is calculated using the formula in Equation 2 developed by Höppe (1984).

$$M + W + Q * (Tmrt.v) + QH\ (Ta.v) + QL\ (e.v) + QSW\ (e.v) + QRe\ (Ta.e) + S = 0 \quad (2)$$

In the equation; M metabolic rate (activity), W mechanical power (type of activity), Q* radiation budget, QH change in perceived temperature, QL change in latent heat (evaporation), QSW distribution of latent heat through perspiration, QRe heat exchange through respiration (sensed and latent temperature), S is storage, Ta is air temperature, e is vapor pressure, v is wind speed, Tmrt is mean radiant temperature. In the MPET index, a healthy male individual who is 35 years old, 175 cm tall, weighs 75 kg, has a 0.9 clo clothing load and a workload of 80 W (Auliciems & Szokolay, 2007; Çağlak, 2021) is taken into account.

The date and time section is the area with the number 1 on the Rayman Pro software interface. The software calculates radiation values and sunshine durations according to the day of the year and the time of day. The latitude, longitude, altitude, and time zone of the meteorological station to be calculated are included in Part 2. The software evaluates this based on absolute position and elevation. Section 3 contains meteorological parameters. Field 4 contains personal information such as height, weight, age, and gender. In Section 5, clothing resistance (usually 0.9 clo), the amount of metabolic energy according to the activity (usually 80 W), and the position of the person are taken into account (Figure 2).

Since the calculations are hourly, there is a total of approximately 600 thousand pieces of data in 12 years. In order to calculate these data, first of all, meteorological parameters were prepared in file form according to the day and time of the year, and then 12 years of data were calculated automatically using the "input" tab of the program.

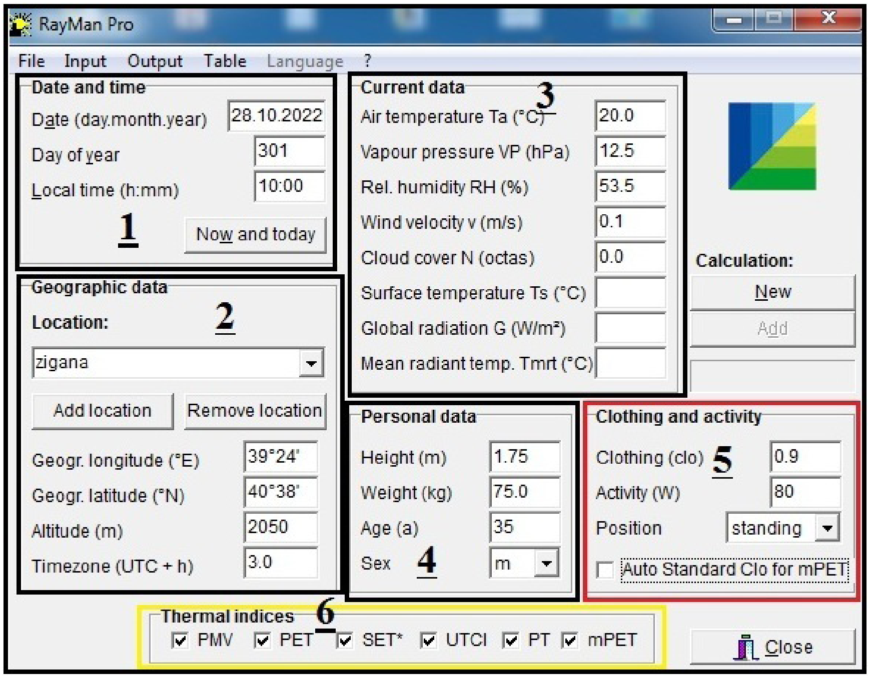


Figure 2. Rayman Software

In this study, the MPET index was calculated in two ways. In order to determine the thermal comfort levels, it was necessary to use 2.5 clo instead of 0.9 clo for visitors' clothing resistance, 2.5 clo for skiers' clothing resistance, and 405 W for the activity. The values in Table 3 are considered in determining the clothing resistance.

Table 3. Thermal resistance values of clothes (Clo) (Auliciems & Szokolay, 2007; Çağlak, 2021; ISO, 2005; Jussila et al., 2017; TTMD, 2021)

Clothing Type		Clo	Clothing Type		Clo
Underwear Bottom	Short underwear	0.04	Topcoat, Coat, Overcoat, Parka vb.	Topcoat	0.15
	Underpants (short)	0.06		Gaberdine	0.30
	Underpants (long)	0.10		Coat	0.60
Underwear Top	Undershirt	0.06		Parka	0.70
	T-shirt	0.09		Overcoat	0.55
	Singlet with long sleeves	0.12		Overalls	0.55
Pants and Skirt	Regular pants	0.28		Various overtops	0.52
	Summer pants	0.26	Footwear	Normal socks	0.02
	Winter pants	0.32		Ankle socks	0.05
	Light skirt	0.10		Thick stockings	0.1
	Regular skirt	0.18		Women's socks	0.03
	Heavy skirt	0.25		Summer shoes	0.02
Sweaters & Shirts	Regular sweater	0.28		Winter shoes	0.04
	Thin sweater	0.20		Boots	0.1
	Thick sweater	0.35	Small clothes	Glove	0.05
	Short-sleeved shirt	0.14		Wooly hat	0.01
	Long sleeve shirt	0.22		Scarf	0.01
	Long sleeve thick shirt	0.30			
Jacket and Vest	Summer light jacket	0.25	Heat-insulating outdoor clothes	Thermal overalls	0.9
	Jacket	0.35		Multi-component clothing	1.03
	Vest	0.13		Fibre-pelt overalls	1.13
	Cardigan	0.3			

Metabolic energy amounts according to the activities performed are included in the calculation according to the values in Table 4.

Table 4. Metabolic energy amounts produced by the body in different activities (Auliciems & Szokolay, 2007; TTMD, 2021)

Activity		W/m²		Activity	W/m²
Chores	House cleaning	170	Resting	Sleeping	40
	Cooking	100		Reclining	46
	Standing dishwashing	145		Seated, quiet	58
	İroning	170		Standing, relaxed	70
	Shaving , washing, dressing, etc.	100	Hobby and Sports Activities	Volleyball	232
	Shopping	93		Basketball	348
Driving	Automobile (Light Traffic)	50		Football	464
	Automobile (Heavy Traffic)	100		Handball	464
	Heavy vehicle	160		Hockey	464
	Night flight	60		Golf	290
	Autopilot landing	90		Tennis	405
	Combat flight	120		Swimming	348
Some Occupations	Teacher	95		Gymnastics	319
	Construction work	275		aerobic dance	348
	Agricultural business	380		Cycling	290
	Forestry – mowing trees with a chainsaw	205		Traveling with a backpack	405
	Forestry – working with an ax	500		Ice skating (18 km/h)	360
	Shoemaker	100		Running (15 km/h)	550
	Graphic design print typesetting	85		Skiing (9 km/h on smooth snow)	405
	Sitting desk work	70		fencing	350

The MPET values obtained from the calculation according to the day and time of the year are evaluated according to the classification in Table 5.

Table 5. Thermal sensation and stress levels of MPET index (Höppe, 1999; Matzarakis et al., 1999)

MPET(°C)	Thermal Sensation	Level of Thermal Stress
< 4.0	Very cold	Extreme cold stress
4.1–8.0	Cold	Strong cold stress
8.1–13.0	Cool	Moderate cold stress
13.1–18.0	Slightly cool	Slightly cold stress
18.1–23.0	**Comfortable**	**No thermal stress**
23.1–29.0	Slightly warm	Slightly warm stress
29.1–35.0	Warm	Moderate heat stress
35.1–41.0	Hot	Strong heat stress
>41.0	Very hot	Extreme heat stress

RESULTS

In the study, thermal comfort conditions were examined both daily and hourly. Since the Wind Chill Index calculates the meteorological parameters directly, no personal data has been entered. The MPET index was calculated by entering the amount of clothing and metabolic energy. In addition, the MPET index has been calculated separately for visitors and skiers.

Thermal Comfort Conditions According to Wind Chill Index

Winter tourism has been calculated daily with the average air temperature (°C) and wind speed (km/hour) data for each day from November to the end of March. The values obtained from the calculation are explained as a percentage at 10-day intervals. According to this index, it was observed that there was no risk of cold in the first 20 days of November, and "low risk" conditions were experienced from the 20th day of November to the 10th day of January and from the 20th day of February to the end of March. It was determined that "moderate risk" conditions were effective from the 10th day of January to the 10th day of February (Figure 3). In this case, there is a thermal risk for tourism activities to be carried out in ZWTC only in January and February. Thick clothes should be preferred for winter tourism activities in these months, such as hats, gloves, etc. Personal protective equipment should be worn and used.

According to hourly evaluations, "low risk" and "moderate risk" conditions are experienced from 18:00 to 09:00. In contrast, comfortable conditions are experienced with "low risk" conditions between 10:00 and 17:00. Especially between 12:00 and 14:00, this is the ideal interval of the day (Figure 4).

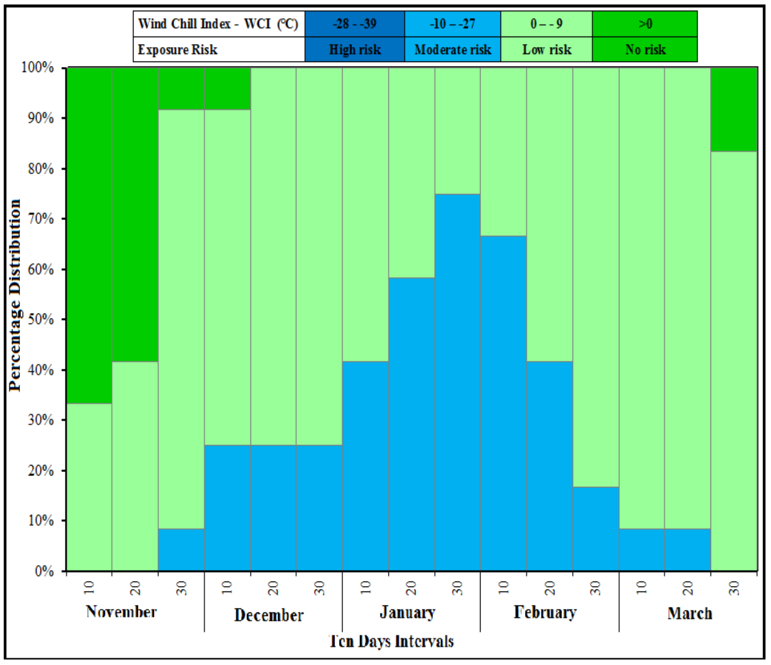


Figure 3. Distribution of Thermal Comfort Conditions in Ten-Day Intervals According to Wind Chill Index

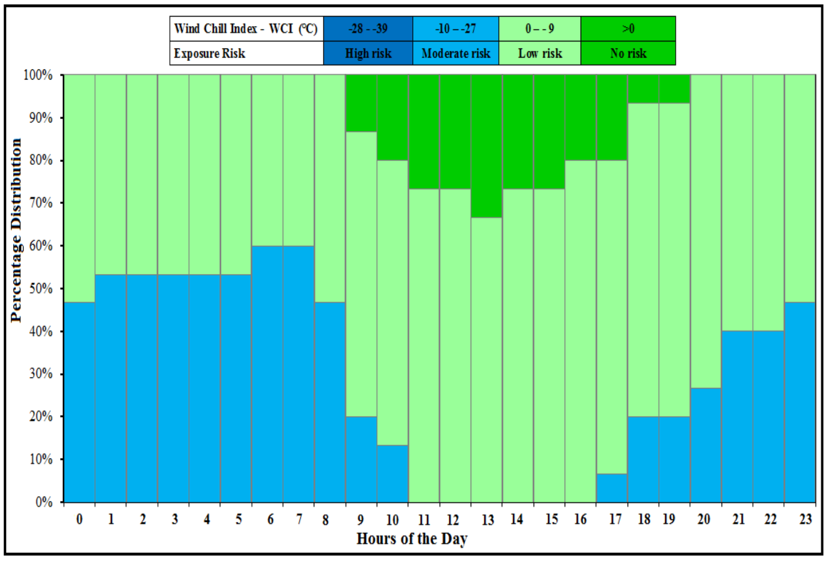


Figure 4. Hourly Distribution of Thermal Comfort Conditions According to The Wind Chill Index

According to the monthly hourly evaluations, in November, “low risk” is perceived between 19:00 and 08:00 in the morning and in comfortable conditions where there is no risk between 09:00 and 18:00 in the morning. In December and February, “moderate risk” conditions are effective between 21:00 and 08:00 in the morning, and “low risk” conditions are effective between 09:00 and 20:00 in the morning. In January, “moderate risk” conditions are experienced from 6:00 p.m. to 9:00 a.m., and “low risk” conditions are experienced for 7 hours between 10:00 and 17:00 p.m. In March, between 10:00 and 16:00, comfortable perceptions are perceived for 6 hours, while “low risk” conditions are perceived at other times of the day (Figure 5).

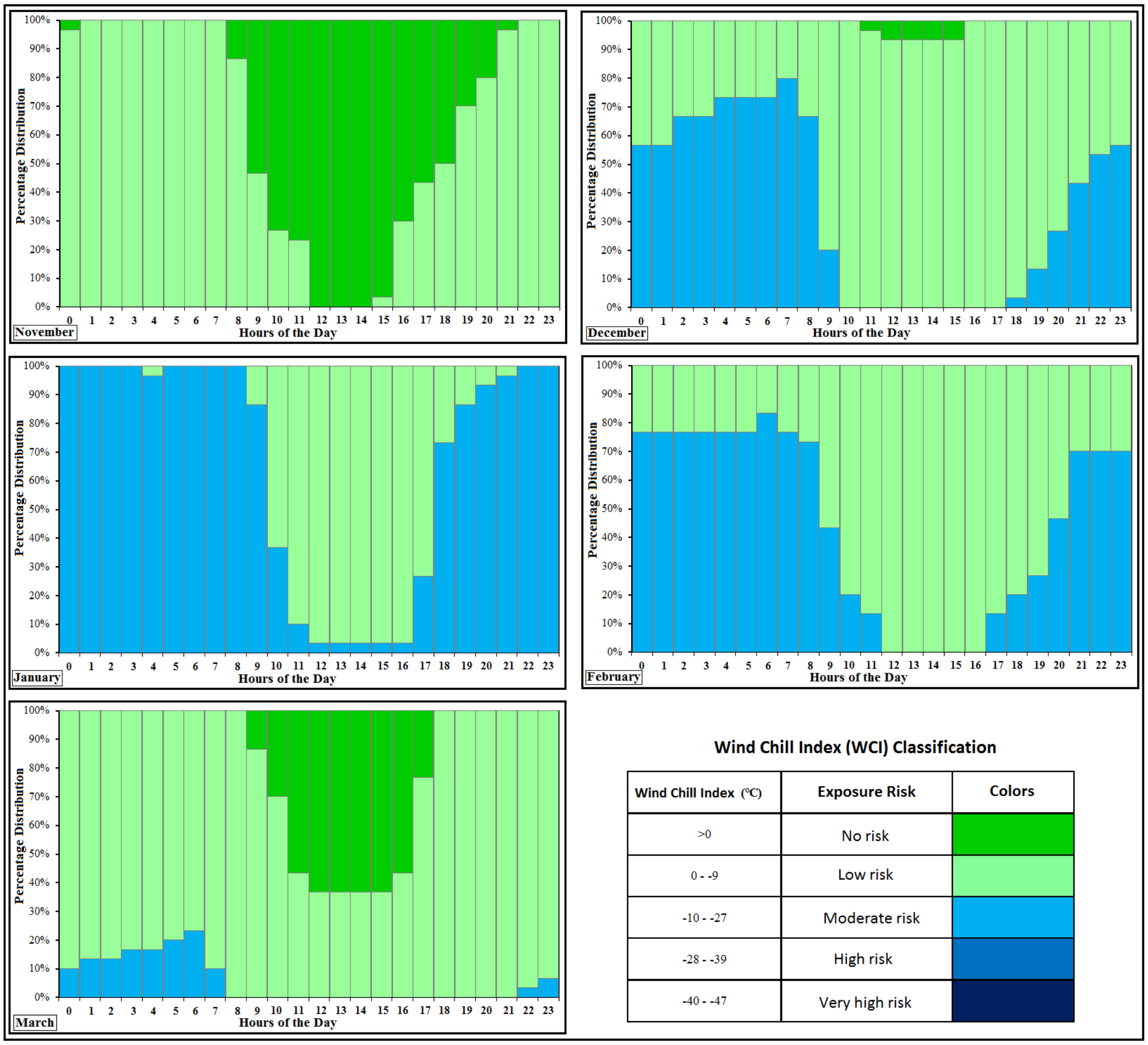


Figure 5. The Hourly Distribution Oof Thermal Comfort Conditions by Months According to The Wind Chill Index

Examination of Thermal Comfort Conditions for Visitors According to the MPET (Modified Physiologically Equivalent Temperature) Index

According to the MPET index, which is among the complex indices that take into account the thermophysiological conditions, the clothing resistance of the visitors to ZWTC was evaluated as 2.5 clo, and the metabolic energy amount was evaluated as 80 W as a daily activity. As a result of the analysis, “cool” and “cold” stresses are perceived only in the first 20 days of November, while “very cold” stress is perceived on other days (Figure 6).

According to hourly evaluations, "very cold" stress is effective from 16:00 to 10:00 in the morning, and "cool" and "cold" stress are effective during the hottest times of the day between 11:00 and 15:00 (Figure 7).

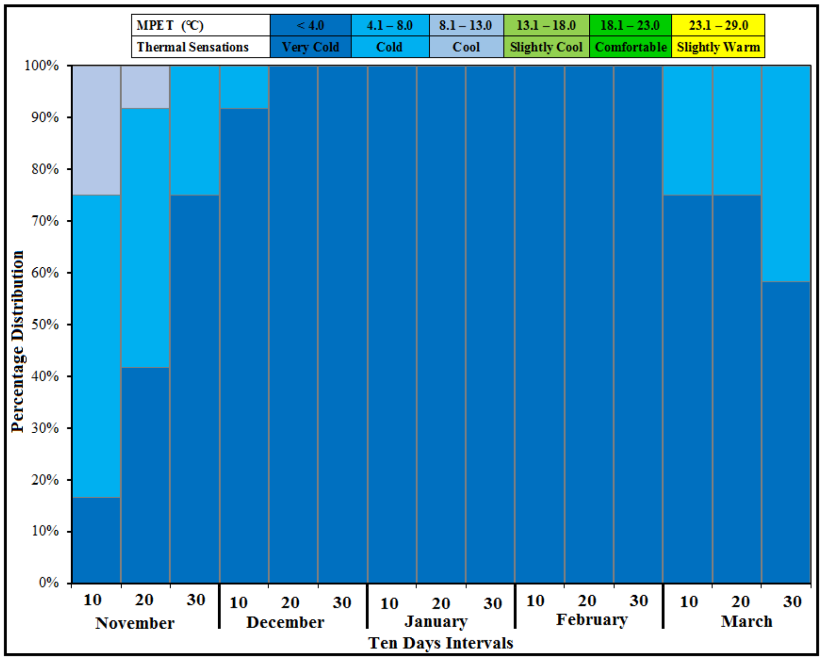


Figure 6. Daily Distribution of Thermal Comfort Conditions for Visitors According to The MPET Index

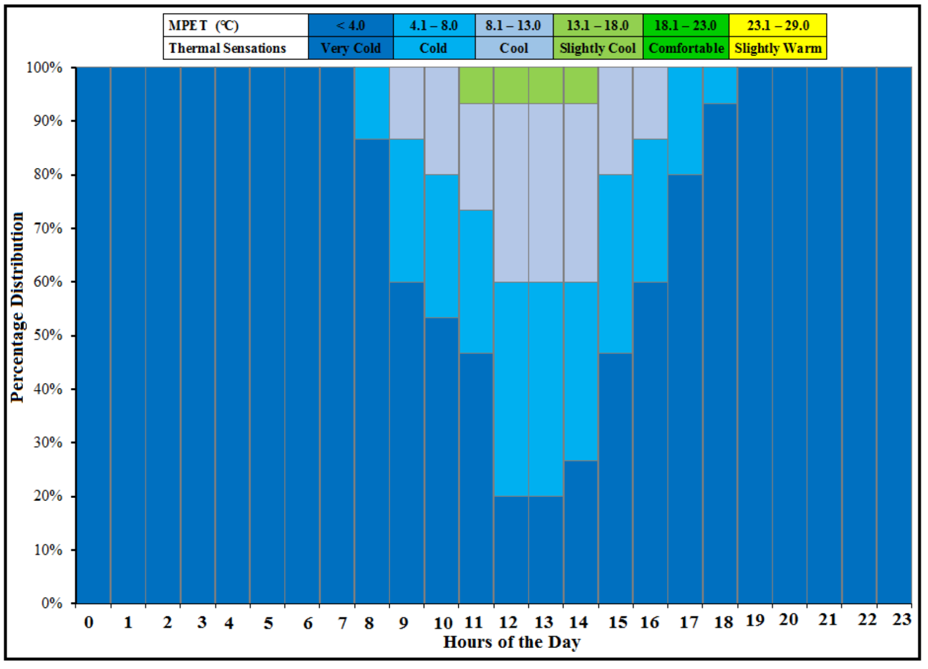
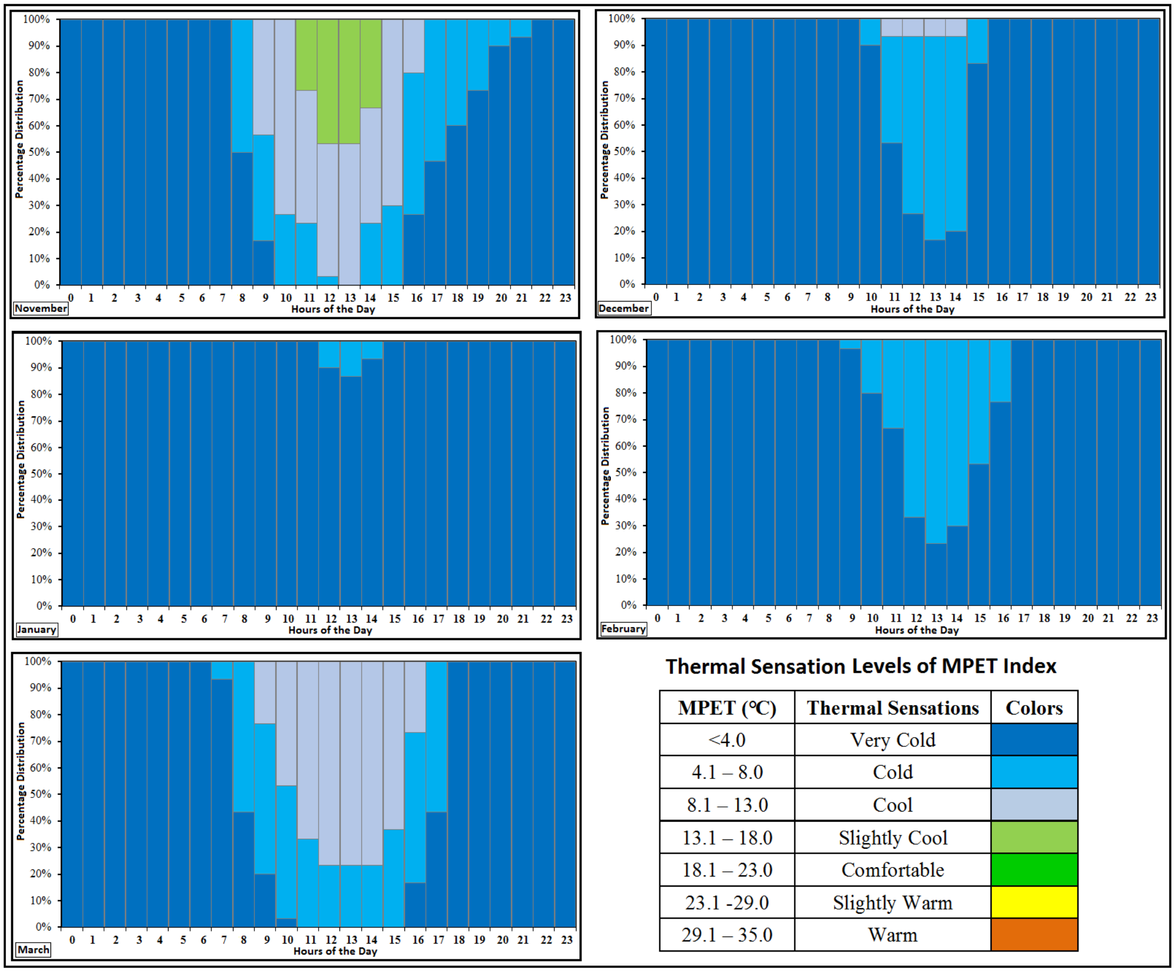


Figure 7. Hourly Distribution of Thermal Comfort Conditions for Visitors According to The MPET Index

When the hourly thermal comfort conditions of the months are examined for the visitors, while "cool" and "slightly cool" stresses are effective between 10:00 and 15:00 in November, "very cold" stresses are effective in other hours. In December and February, "cold" stress is perceived between 11:00 and 14:00 during the day, and "very cold" stress is perceived at other hours.

"Very cold" stress is experienced at all hours in January; "cool" stress is experienced between 11:00 and 15:00 in March; and "very cold" stress is experienced during other hours (Figure 8).



MPET (°C)	Thermal Sensations	Colors
<4.0	Very Cold	
4.1 – 8.0	Cold	
8.1 – 13.0	Cool	
13.1 – 18.0	Slightly Cool	
18.1 – 23.0	Comfortable	
23.1 -29.0	Slightly Warm	
29.1 – 35.0	Warm	

Figure 8. The Hourly Distribution of Thermal Comfort Conditions for Visitors According to The MPET Index by Month

Examine thermal comfort conditions for skiers according to the MPET (Modified Physiologically Equivalent Temperature) Index.

In the calculation of the MPET index, which determines the human thermal comfort conditions according to the body heat energy balance, for the skiers, the clothing resistance was calculated as 2.5 clo and the metabolic energy amount was 405 W. As a result of the calculation, daily evaluations were divided into 10-day intervals, and thermal comfort conditions were explained with percentage distributions. According to daily evaluations, "slightly cool" stress is perceived for skiers in November, and "cool" stress is perceived from the first day of December to the 10th day of January and the last 20 days of February for skiers. From the 10th day of January to the 10th day of February, the "cold" stress and the "slightly cool" stress in March are perceived (Figure 9).

According to hourly assessments, skiers' "cold" stress is from 20:00 to 07:00 in the morning, "cool" stress is between 07:00 and 10:00, and from 16:00 to 20:00, 10 o'clock: Between 00 and 16:00, it was determined that "comfortable" conditions were perceived together with "slightly cool" stress (Figure 10).

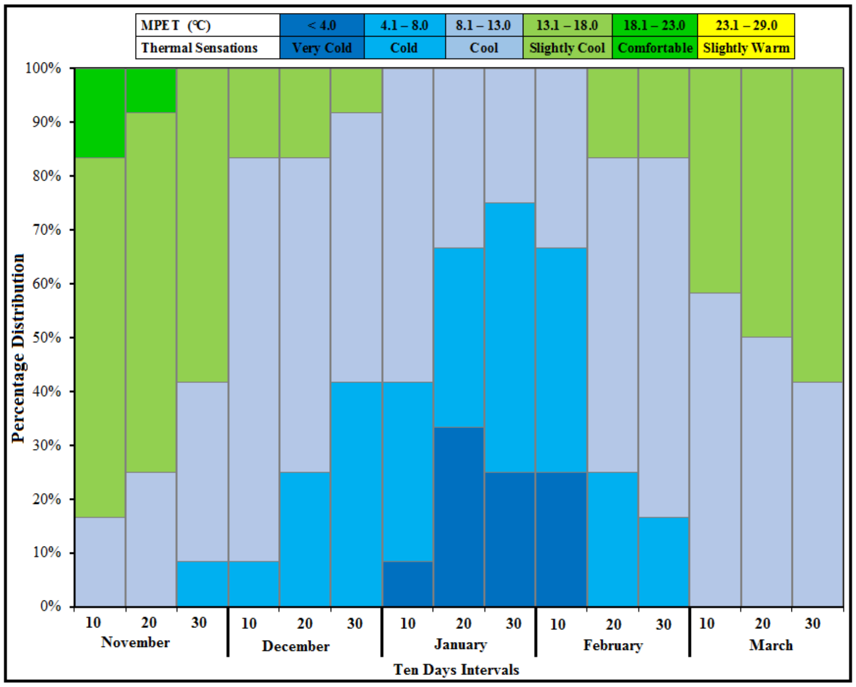


Figure 9. Daily Distribution of Thermal Comfort Conditions for Skiers According to The MPET Index

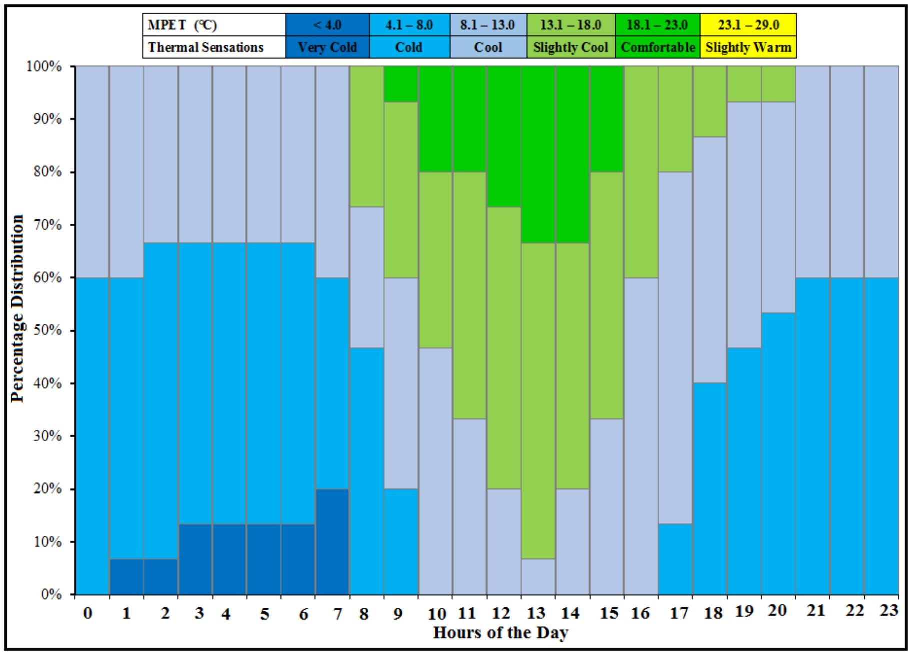
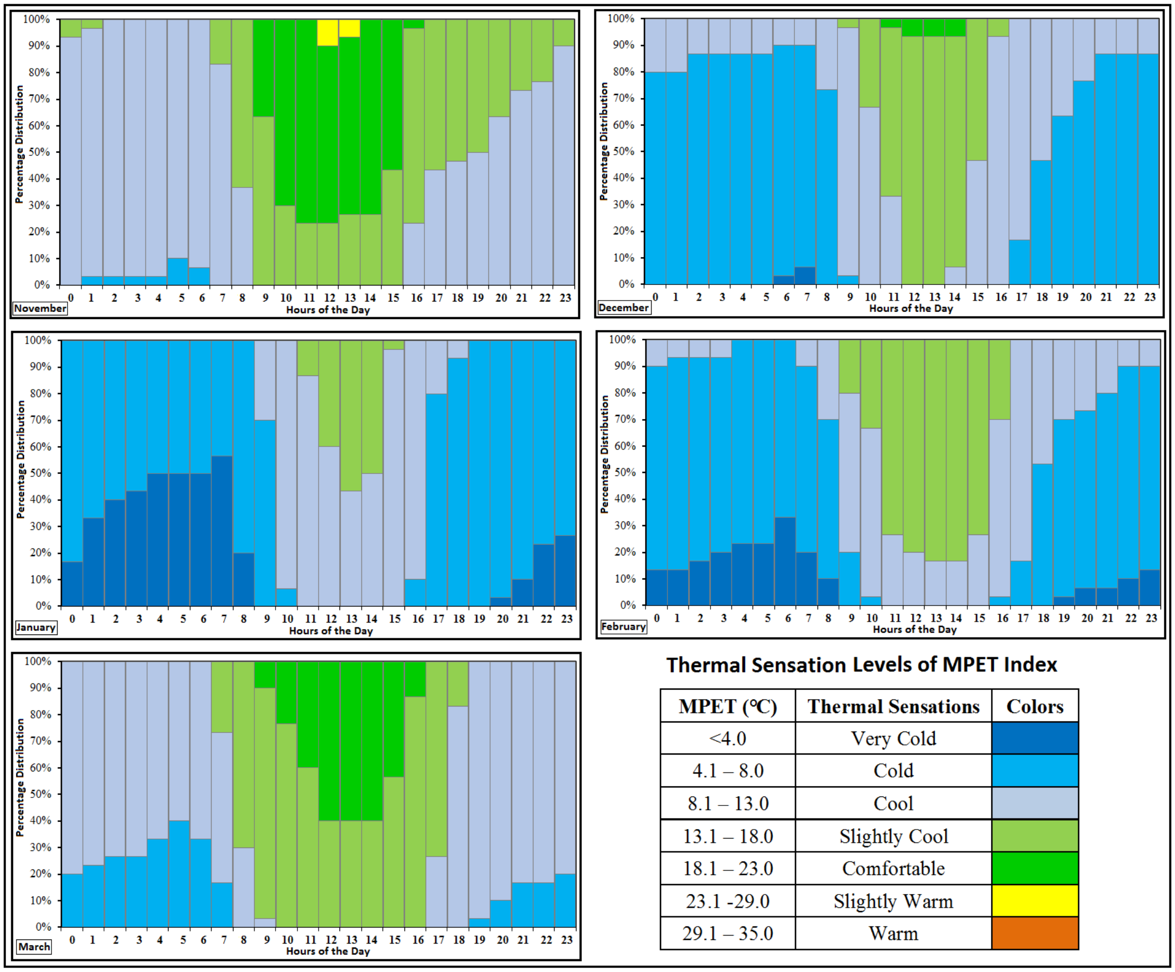


Figure 10. Hourly Distribution of Thermal Comfort Conditions for Skiers According to The MPET Index

When the distribution of hourly thermal comfort conditions by month is examined, in November, “cool” and “slightly cool” stresses are experienced between 16:00 and 09:00 in the morning, and “comfortable” conditions are experienced between 10:00 and 16:00. In December, “cold” and “cool” stresses are perceived between 16:00 and 10:00 in the morning, and “slightly cool” stress is perceived between 10:00 and 15:00. In January, “cool” and “slightly cool” stresses are experienced between 10:00 and 16:00, while “very cold” and “cold” stresses are experienced at other hours. In February, between 10:00 and 15:00, “slightly cool" stress is effective, and at other times, "cold" stress is effective. While "comfortable" conditions are perceived between 12:00 and 14:00 in March, "cool" stress is mostly perceived at other hours (Figure 11).



MPET (℃)	Thermal Sensations	Colors
<4.0	Very Cold	
4.1 – 8.0	Cold	
8.1 – 13.0	Cool	
13.1 – 18.0	Slightly Cool	
18.1 – 23.0	Comfortable	
23.1 -29.0	Slightly Warm	
29.1 – 35.0	Warm	

Figure 11. Monthly Distribution of Thermal Comfort Conditions for Skiers According to The MPET Index

CONCLUSION AND RECOMMENDATIONS

Tourism activities have an essential role in the economies of their countries. Especially in the winter, tourism has become popular in recent years. Both local administrators and investors try to determine suitable winter tourism centers and make plans in this regard. Since winter tourism is dependent on snowfall, it is carried out during the cold period of the year. This situation makes individuals and investors who participate in tourism consider climatic conditions. Determining the thermal comfort conditions of tourism centers provides important information to planners, investors, and individuals who will participate in tourism. Thus, better-quality tourism activities can be carried out.

The calculation should consider multiple indices and the activities performed in determining the thermal comfort conditions. This study is important in terms of using different indices and incorporating the activities into the calculation. The thermal comfort conditions of ZWTC, a popular winter tourism center in Turkey with significant tourism wealth, were calculated with direct and complex indices. The findings were examined in detail on a daily and hourly basis.

As a result of the study, according to the Wind Chill Index, in ZWTC, comfortable conditions with no risk in November, "moderate risk" conditions from the 10th day of January to the 10th day of February, and "low risk" conditions on other days are effective. According to the MPET index, there are "cold" risks for visitors who do not do any activity, while the cold risks for skiers due to their metabolic energies are in the period from the 10th day of January to the 10th day of February, as determined by the Wind Chill Index. In hourly evaluations, it has been determined in the calculations of all indices that it is suitable for winter tourism during the 6 hours of the day between 10:00 and 16:00, when the sun's rays fall at the greatest angles, depending on the daily movement of the Earth. In hourly evaluations according to months, risks are seen in January during daylight hours. During the winter tourism to be held at ZWTC, it is recommended that the tourists stay active and, as a result, increase their metabolic energy amounts, dress thickly, and stay dry.

It is suggested that individuals, investors, planners, and decision-makers who will participate in winter tourism activities at the Zigana Winter Tourism Center consider these results. In addition, this study is expected to set an example by considering the thermal comfort conditions of winter tourism centers according to different indices and activities. It is thought that this study will contribute to the literature and will be a pioneering study in this regard.

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