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Evaluating the thermal comfort of humans by RayMan model in Lake Urmia Basin, Iran

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Abstract
Tourism is one of the largest economic sectors globally. It is a climate sensitive sector, with climate being one of the most important attributes for a destination. In order to know that a region's climate what extent is suitable to the given tourism activities, the tourism climate potential must be determined. This study aims to illustrate observed the tourism climate potential of Lake Urmia Basin during 1988-2012, by using physiologically equivalent temperature (PET), the predicted mean vote (PMV) and standard effective temperature (SET). The RayMan model was used to calculate the indices PET, PMV and SET. The analysis is based on the monthly measured datasets of 8 synoptic stations. Results demonstrate that according to PET and PMV, July and August are the best months for tourists in terms of thermal comfort in Lake Urmia Basin. Also, June and September have Slight cold stress and provide acceptable conditions for tourists. In SET, the thermal perceptions in no month are comfortable. But July and August have Slight cold stress and provide acceptable conditions for tourists.

Keywords: *Thermal comfort, physiologically equivalent temperature (PET), the predicted mean vote (PMV), standard effective temperature (SET), Lake Urmia Basin.*

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Introduction

Tourism is one of the world’s biggest and fastest-growing industries (de Freitas 2003). Over the decades, tourism has experienced continued growth and deepening diversification to become one of the fastest growing economic sectors in the world .Modern tourism is closely linked to development and encompasses a growing number of new destinations. These dynamics have turned tourism into a key driver for socio-economic progress (World Tourism Organization 2014).

The weather and the climate is a key factor in tourism. Weather and climate, together with natural resources such as geographical location, topography and landscape, play a vital role in tourism and recreation (de Freitas, 2003). Questionnaire results indicate that climate information is the first or second factor tourists use when choosing a travel destination (Hamilton and Lau, 2005). Analysis of tourism climatology is based on climate indices, such as those used in applied climatology and human biometeorology (Matzarakis et al., 2004). With the appropriate quality controls in place, a good tourism climate index would provide a measure of the integrated effects of the atmospheric environment useful for both tourists and the tourism industry. Tourists and tour operators could use the index to select the best time and place for vacation travel or plan activities appropriate to the expected climate (de Freitas et al., 2008).

Several climate–tourism indices have been employed in past research. A summary and short explanation of these is given in Matzarakis (2006, 2010). In the past 30 years, many indices based on different aims and goals were developed to assess the suitability of climate for tourism activities and thermal comfort issues including adaptation factors (Mieczkowski, 1985; Morgan et al. 2000; Scott and McBoyle 2001; Lise and Tol 2002; Martın 2004; Hamilton and Lau 2005; Nikolopoulou and Lykoudis 2006, 2007; de Freitas et al. 2008; Lin and Matzarakis 2008; Lin 2009; Kántor and Unger 2011; Lin et al. 2011).

The most widely known and applied indices that measure the effect of the thermal environment on humans are PET (physiologically equivalent temperature), PMV (predicted mean vote) (Fanger 1972), and SET (standard effective temperature) (Gagge et al. 1986). The physiologically equivalent temperature (PET), a thermal index derived from the human energy balance (Mayer and Höppe 1987; Höppe 1993, 1999), has been used to quantify the thermal facet of tourism climate. PET is well suited to evaluate thermal components of different climates and different demands in applied sciences. PMV is derived from the physics of heat transfer combined with an empirical fit to sensation, and it establishes a thermal strain based on steady-state heat transfer between the body and the environment. PMV assigns a comfort vote to that amount of strain. The SET index represents the thermal strain experienced by a cylinder relative to a "standard" person in a "standard" environment (Mazon, 2013). The advantage of any one of these three thermal indices is that they can evaluate the thermal conditions year round; they require input from the same meteorological variables (air temperature, air humidity, wind speed, short and long-wave radiation fluxes), and they can all be calculated with free software packages, e.g., RayMan (Matzarakis et al. 2007).

The Lake Urmia Basin has considerable potential for domestic and international tourism. This study, which focuses on Lake Urmia Basin, generates tourism climate information based on the thermal requirements of tourists. The main purpose of this paper is to determine tourism climate conditions and the most suitable months and areas for tourism and tourist activities in Lake Urmia Basin in Iran during the 1988–2012 period, based on PET, PMV and SET indices.

2. Data and Methods

2.1. Study area

The Lake Urmia Basin is located between 37°4′ to 38°17′ latitude and 45°13′ to 46° longitude in northwest Iran and covers an area of 51,800 km^2 which composed 3.15 % of the entire country and included 7 % of the total surface water in Iran (Fig. 1). The Lake Urmia is the largest lake in the country and is also the second Hypersaline Lake (before September 2010) in the world and it is an important natural asset with considerable cultural, economic, aesthetic, recreational, scientific, conservation and ecological value. The lake basin includes 14 main sub basins that surround the lake with the areas that vary from 431 to 11,759 km^2. The most important rivers are ZarrinehRoud, SiminehRoud, and Aji Chai (fathian et al., 2015). Climate in the Urmia Lake Basin is harsh and continental, affected mainly by the mountains surrounding the lake (Delju et al., 2013).

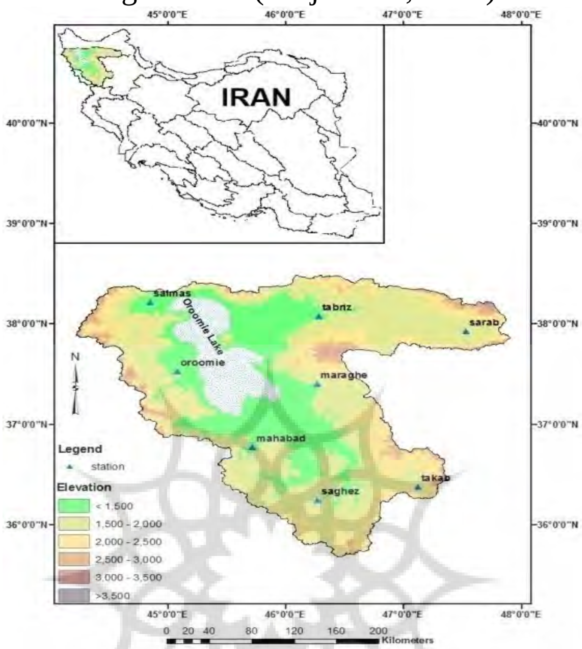

Fig. 1. The DEM and location of meteorological stations in the Lake Urmia Basin

2.2. Data

In this study, eight weather stations listed in Table 1 are selected to provide a broad range of coverage in the region in terms of data length, homogeneity, and geographical distribution. The parameters used in this study are divided into four categories, as follows:

- Meteorological parameters: air temperature (°c), relative humidity (%), wind velocity (m/s), cloud cover (octas) and mean radiant temperature (°c)
- Geographic data: latitude, longitude and elevation
- Personal data: height (m), weight (kg), age and sex.
- Body parameters: human activity and body heat production (w) and heat transfer of clothing (clo)

For this study, meteorological data from 1988 to 2012 was obtained from the database of the Islamic Republic of Iran Meteorological Organization (IRIMO).

Table 1: Selected stations of Lake Urmia Basin

Elevation m	Longitude E	Latitude N	Station
1385	45.72	36.76	Mahabad

1477.7	46.26	37.40	Maraghe
1522.8	46.26	36.25	Saghez
1337	44.85	38.21	Salmas
1682	47.53	37.93	Sarab
1361	46.28	38.08	Tabriz
1765	48.12	37.38	Takab
1328	45.08	37.53	Urmia

2.3. Methods

Thermal indices

According to previous studies in tourism climatology (i.e., de Freitas 2003; Matzarakis et al. 2004), regional features, including visual factors, the physical environment and thermal comfort, are important to tourism. The thermal comfort is described and quantified by many thermal indices that contain the meteorological parameters of air temperature, humidity and wind speed; some of them include short and long wave. Over the past century more than 100 indices have been developed and used to assess bioclimatic conditions for human beings. Thermal stress indices can be divided into three groups according to their rationale (Parsons 14): (1) indices based on calculations involving the heat balance equation ("rational indices"), e.g., the heat stress index (HSI) for warm weather (Belding and Hatch 1955) or the required clothing insulations (Holmér 1984) for cold environments; (2) indices based on objective and subjective strain ("empirical indices"), e.g., the physiological strain index (PSI; Moran et al. 1998); and (3) indices based on direct measurements of environmental variables ("direct indices"); e.g., the apparent temperature (AT) (Steadman 1984), the operative temperature (Blazejczyk et al. 1998) and the wet-bulb globe temperature (WBGT) (Yaglou and Minard 1957). Obviously, indices of the first two groups are more difficult to implement for daily use, since they depend on many variables and some of them require invasive measurements. The third group of indices, based on monitoring of environmental variables, is more user-friendly and applicable. Thermal indices were frequently used to estimate the thermal environment. A common model for the human energy balance is MEMI (Munich energy balance for individuals). The three thermal indices PET, PMV and SET are part of the RayMan model, as are energy fluxes and body parameters by MEMI (Matzarakis et al., 2007). The PMV, PET and SET indices facilitate the thermo-physiological acquisition of thermal conditions of indoor and surrounding outdoor air as point layers (VDI 1998).

2.3.1. Physiologically Equivalent Temperature (PET)

The physiologically equivalent temperature (PET) is one of the most used thermal indices and it contains all meteorological parameters that affect thermal comfort, as well as physical activity and the clothing an individual wears. PET was developed as an index which takes into account all basic thermoregulatory processes (Höppe, 1993) and is based on a thermo-physiological heat balance model called Munich energy balance model for individuals (MEMI) (Höppe, 1999). According to Mayer and Höppe (1987) and Höppe (1999), PET is defined as the equivalent air temperature at which, in a typical indoor condition heat balance of the human body exists (work metabolism 80 W of light activity, and clothing of 0.9 clo). The following assumptions are made for the indoor reference climate: Mean radiant temperature equals air temperature (Tmrt=Ta). Air velocity is set to 0.1 m/s. Water vapour pressure is set to 12 hPa (approximately equivalent to a relative humidity of 50% at Ta=20°C). Although PET is the equivalent temperature under a virtual indoor condition, it is applicable to a wide range of real outdoor conditions. PET is one of the recommended indices in new German guidelines for urban and regional planners (VDI, 1998) and is used for the prediction of changes in the thermal component of urban or regional climates. The range of thermal perception and physiological stress of PET is shown in Table 2.

Hence, PET enables users to compare the integral effects of complex thermal conditions outside with their own experience indoors. Meteorological parameters influencing the human energy balance, such as air temperature, air humidity, wind speed and short- and long-wave radiation, are represented in the PET values, as it also considers the heat transfer resistance of clothing and internal heat production (Matzarakis et al. 1999). As applications of PET: Matzarakis et al. (1999); Svensson et al. (2003); Gulyás et al. (2006); Ali-Toudert and Mayer (2006); Bouyer et al. (2007); Thorsson et al. (2007); Alexandri and Jones (2008); Honjo (2009); Farajzadeh and Matzarakis (2009); Lin and Matzarakis (2011); Blazejczyk et al. (2012); Nastos and Matzarakis (2013); Mazon (2014).

Table 2: Ranges of PET, PMV and SET for different grades of thermal perception and physiological stress (Matzarakis & Mayer, 1997).

Grade of physiological stress	Thermal perception	PET (°C)	PMV	SET
Extreme cold stress	Very cold	<4	<-3.5	-20 - -10
Strong cold stress	Cold	4	–3.5	-10 - 1.67
Moderate cold stress	Cool	8	–2.5	1.67 - 15.5
Slight cold stress	Slightly cool	13	–1.5	15.5 - 17.8
No thermal stress	Comfortable	18	–0.5	17.8 – 22.2
Slight heat stress	Slightly warm	23	0.5	22.2 – 25.6

Moderate heat stress	Warm	29	1.5	25.6 – 27.5
heat stress	Hot Strong	35	2.5	27.5 - 30
Extreme heat stress	Very hot	41	3.5	>30

2.3.2. Predicted Mean Vote (PMV)

Fanger (1970, 1972) developed PMV (predicted mean vote) for indoor climates with the aim to provide an index for ratings of thermal (dis)comfort at various states of activity and clothing insulation. Assuming that the sensation experienced by a person is a function of the physiological strain imposed by the environment, Fanger predicted the actual thermal sensation as the mean vote (PMV) of a large group of persons on the ASHRAE (1997) 7-point scale of thermal sensation. This he defined as "the difference between the internal heat production and the heat loss to the actual environment for a person kept at the comfort values for skin temperature and sweat production at the actual activity level". Fanger calculated this extra load for people engaged in climate chamber experiments and plotted their comfort vote against it. Accordingly, Fanger was able to predict the comfort vote that would arise from a given set of environmental conditions for a given clothing insulation and metabolic rate. The final equation for optimal thermal comfort is fairly complex. PMV is also used as ISO 7730 (2005). However, ISO Standard 7730 includes a computer program for calculating PMV. In Table 2, the relation of PMV value with thermal perception and physiological stress level is shown for low activity and normal indoor clothing. Several studies related to thermal comfort and PMV has been done (e.g. Matzarakis and Mayer, 1997; Nikolopoulou et al., 2001; Thorsson et al., 2004; Hodder and Parsons, 2007; Honjo, 2009; Blazejczyk et al., 2012; Yahia and Johansson, 2013; Mazon, 2014).

2.3.3. Standard Effective Temperature (SET)

The new effective temperature (ET) is based on human energy balance and two-node model (Gagge et al., 1971). With ET the thermal conditions can be compared to the conditions in a standardized room with a mean radiant temperature equal to air temperature and a constant relative humidity of 50%. Gagge et al. (1986) improved ET and proposed the new standard effective temperature (SET) which is used frequently both as indoor and outdoor comfort index. SET, is defined as the equivalent air temperature of an isothermal environment at 50% RH in which a subject, while wearing clothing standardized for the activity concerned, has the same heat stress (skin temperature Tsk) and thermoregulatory strain (skin wettedness, w) as in the actual environment. SET uses skin temperature and skin wettedness as the limiting conditions. Below the lower threshold value of w, SET is identical with the operative temperature, i.e., the mean of convective and radiative sensible fluxes weighted by their respective heat transfer coefficients. For outdoor application, SET has been adapted to OUT_SET (Pickup and de Dear 2000). For SET calculations, this paper uses a metabolic rate set at 1.5 MET (about 90 W m^{-2}) and intrinsic clothing insulation of 0.50 clo. Because SET aims originally at an improved evaluation of warm / humid conditions, the lowest threshold value of the assessment scale (Table 2) is set at +17°C for cool conditions. Many previous studies have focused on thermal comfort and SET (e.g. Pickup and Dear, 2000; Lin et al., 2008; Chen et al., 2004; Ono et al., 2008; Honjo, 2009; Blazejczyk et al., 2012; Yahia and Johansson, 2013; Mazon, 2014).

The RayMan Pro model (Matzarakis et al. 2007, 2010) was used to calculate the indices PET, PMV and SET. This model is free software developed by the Meteorological Institute of the University of Freiburg (available at http://www.urbanclimate.net/rayman) and it is suitable for calculating the radiation fluxes and these thermal indices.

3. Results and discussion

3.1. Physiologically Equivalent Temperature (PET)

Table 3 shows the calculated physiologically equivalent temperature (PET) for all studied locations in Lake Urmia Basin. The area of PET zones in percent is shown in Table 4. The results reveal that in December, January, February and March, thermal comfort in all stations is unfavorable. In terms of Grade of physiological stress, these months have Extreme cold stress and in terms of Thermal perception, are Very cold. So, due to the cold weather and snowfall in these months, travel conditions in Lake Urmia Basin are not suitable. In April that the spring has started, Thermal perception in Takab, Saghez and Salmas are Very cold and in Sarab, Tabriz, Mahabad and Maragheh are cold. Only in Urmia station there is Moderate cold stress and Thermal perception is cool. In May, Thermal perception in most stations is Strong and Moderate cold stress. An acceptable thermal comfort condition in June covers all regions. In this month, most stations have Slight cold stress Except Takab and Sarab, that have Moderate cold stress and Urmia that has comfort conditions. Therefore, weather conditions are very convenient for travel and excursions. In July and August, there are thermal comfort conditions in most stations. So, these months are the best months for tourists in terms of thermal comfort in Lake Urmia Basin**.** Similar June, in September, most stations have Slight cold stress too, and weather conditions are convenient. In October due to beginning autumn and decreasing temperature, the optimum thermal comfort conditions in this region are not observed. In November due to the cold weather dominance, the most stations have Extreme and Strong cold stress. It can be said that there are not thermal comfort from November to March in Lake Urmia Basin.

Table 3: Calculated values for the physiological equivalent temperature (PET) in studied locations in Lake Urmia Basin

station	jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Takab	-12	-11.1	-5.5	1	5.7	11	17.6	19.1	15.4	10.4	5.1	0.9
Sarab	-4.8	-4.6	-0.4	4.6	7.6	10.2	13.4	13.6	9.3	3.4	-3.3	-9.2
Tabriz	-9.9	-7.8	-2.5	4	9.6	15.3	19.7	19.5	14.7	7.4	-0.3	-6.7
Urmia	-9	-5	2.2	9.5	16.3	22	28.1	27.6	20.9	14.3	5.5	-3.1
Saghez	-10.6	-9	-2.9	3.1	7.9	13.2	18.2	17.7	12.3	6.3	-0.6	-6.8
Mahabad	-7.9	-6.5	-1.6	5.1	10	15.3	19.3	19.1	14.6	8.2	1.1	-4.6
Marhghe	-7.6	-6.7	-2.1	4.7	9.7	15.7	20.1	19.7	14.7	7.9	0.9	-5
Salmas	-9.2	-7.5	-2.5	2.8	7.4	13.1	19.4	22	17.7	13.1	6.3	-0.7

Table 4: Area of PET zones in percent in Lake Urmia Basin

Grade of physiological stress	Thermal perception	Area in%											
		jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Extreme cold stress	Very cold	100	100	100	37						13	62	100
Strong cold stress	Cold				50	37					37	38	
Moderate cold stress	Cool				13	50	25			25	25		
Slight cold stress	Slightly cool					13	62	25	25	62	25		
No thermal stress	Comfortable						13	62	62	13			
Slight heat stress	Slightly warm							13	13				
Moderate heat stress	Warm												
heat stress	Hot Strong												
Extreme heat stress	Very hot												
Sum		100	100	100	100	100	100	100	100	100	100	100	100

3.2. Predicted Mean Vote (PMV)

Table 5 shows the calculated Predicted Mean Vote (PMV) for all studied locations and Table 6 shows the area of PMV zones in percent in Lake Urmia Basin Similarly, in December, January, February and March, thermal comfort in all stations is unfavorable. In terms of Grade of physiological stress, these months have Extreme cold stress and in terms of Thermal perception, are Very cold. So, due to the cold weather and snowfall in these months, travel conditions in Lake Urmia Basin are not suitable. In April, Thermal perception in Takab, Saghez and Salmas are Very cold and in Sarab, Tabriz, Mahabad and Maragheh are cold. Only in Urmia station there is Moderate cold stress and Thermal perception is cool. In May, Thermal perception in most stations is Strong and Moderate cold stress except in Urmia that has Slight cold stress. In June and September most stations have Slight cold stress, and weather conditions are convenient. Similar PET, in July and August, there are thermal comfort conditions in most stations. So, these months are the best months for tourists in terms of thermal comfort in Lake Urmia Basin. Along with decreasing temperature in October, the physiological stress in most stations is Strong and Moderate. In November, the most stations have Extreme and Strong cold stress. Similar PET, It can be said that there are not thermal comfort from November to March in Lake Urmia Basin.

Table 5: Calculated values for the Predicted Mean Vote (PMV) in studied locations in Lake Urmia Basin

station	jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Takab	-7	-6.9	-5.7	-4.2	-3.1	-1.9	-0.4	-0.2	-1.2	-2.4	-3.6	-4.6
Sarab	-5.9	-5.8	-4.8	-3.6	-2.7	-2	-1.3	-1.2	-2.3	-3.6	-5.1	-6.5
Tabriz	-6.7	-6.3	-5.1	-3.6	-2.2	-0.8	0.2	0.2	-1	-2.7	-4.5	-6
Urmia	-6.2	-5.5	-4.1	-2.5	-1	0.2	1.2	1.1	0	-1.5	-3.3	-5
Saghez	-6.7	-6.5	-5.1	-3.8	-2.6	-1.4	-0.2	-0.3	-1.6	-3	-4.5	-5.9
Mahabad	-6.2	-6	-4.8	-3.3	-2.1	-0.9	0	0	-1.1	-2.5	-4.1	-5.4
Marhghe	-6	-5.9	-4.9	-3.4	-2.2	-0.8	0.3	0.2	-1	-2.6	-4.2	-5.4
Salmas	-6.4	-6.1	-5.1	-3.8	-2.7	-1.4	0	0.4	-0.6	-1.7	-3.4	-5

Table 6: Area of PMV zones in percent in Lake Urmia Basin

Grade of physiological stress	Thermal perception	Area in%											
		jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Extreme cold stress	Very cold	100	100	100	37						13	75	100
Strong cold stress	Cold				50	50					50	25	
Moderate cold stress	Cool				13	37	25			25	37		
Slight cold stress	Slightly cool					13	62	13	13	62			
No thermal stress	Comfortable						13	75	75	13			
Slight heat stress	Slightly warm							12	12				
Moderate heat stress	Warm												
heat stress	Hot Strong												
Extreme heat stress	Very hot												
Sum		100	100	100	100	100	100	100	100	100	100	100	100

3.3. Standard effective temperature (SET)

The calculated Standard effective temperature (SET) values are shown in table 7 and the area of SET zones in percent in Lake Urmia Basin is shown in table 8. According to these tables, in January and February all stations have Extreme cold stress and are very cold, except Sarab that has Strong cold stress and is cold. In March and April, most stations have Strong cold stress. In May and June all stations have Moderate cold stress and are cool, except Urmia that is slightly cool and Comfortable respectively. In these months weather conditions are convenient for tourists. In July and August, most stations have slight cold stress and are slightly cool. These months are the best months for tourists in terms of thermal comfort in Lake Urmia Basin**.** Similar May and June, in September and October, most stations have Moderate cold stress and are cool. In November due to beginning autumn and decreasing temperature, the most stations have Strong cold stress and are cold. Due to the cold weather dominance in December, most stations have Extreme and Strong cold stress. According to SET index, In terms of thermal comfort, December, January and February are not in good condition.

Table 7: Calculated values for the Standard effective temperature (SET) in studied locations in Lake Urmia Basin

station	jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Takab	-18.1	-17.7	-11.8	-4.2	1.7	8.1	15.3	17.1	14.3	9.8	4.6	0.6
Sarab	-6.3	-7	-3.1	2.2	5.2	7.4	11.2	11.4	6.4	-0.6	-8.4	-15.5
Tabriz	-17.4	-15.1	-8.6	-0.5	6.4	12.7	16.8	16.6	12.1	3.9	-5	-13
Urmia	-13.4	-8.4	0.2	8.6	15.7	20.3	24.1	23.8	19.5	14	4.6	-5.4
Saghez	-16.6	-15.8	-8.7	-1.4	4.6	10.8	15.5	15	9.6	2.7	-4.7	-12.2
Mahabad	-14.1	-13.1	-6.9	1.3	7.3	13	16.6	16.3	12.3	5.3	-2.9	-10
Marhghe	-12.9	-12.7	-7.4	0.8	6.7	13.1	17.1	16.7	12.2	4.6	-3	-9
Salmas	-14.7	-13.9	-8.4	-1.8	4.1	10.7	17.2	19.7	16.4	12.9	5.9	-18

Table 8: Area of SET zones in percent in Lake Urmia Basin

Grade of physiological stress	Thermal perception	Area in%											
		jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
Extreme cold stress	Very cold	87	87	13									62
Strong cold stress	Cold	13	13	87	75						13	62	37
Moderate cold stress	Cool				25	87	87	25	25	75	87	37	
Slight cold stress	Slightly cool					13	0	62	50	12			
No thermal stress	Comfortable						13	0	12	13			
Slight heat stress	Slightly warm							13	13				
Moderate heat stress	Warm												
heat stress	Hot Strong												
Extreme heat stress	Very hot												
Sum		100	100	100	100	100	100	100	100	100	100	100	100

Maximum values of the area of the thermal indices zones in percent in Lake Urmia Basin are shown in table 9. According to this table, January, February and December in all three indices have Extreme cold stress and the thermal perception in these months are very cold. March and November with PET and PMV have Extreme cold stress but with SET have Strong cold stress. April in all three indices has Strong cold stress and is cold. May in PET and SET have Moderate cold stress but with PMV has Strong cold stress. However, October with PET and PMV has Strong cold stress but with SET has Moderate cold stress.

According to PET and PMV, July and August are the best months for tourists in terms of thermal comfort in Lake Urmia Basin. Also, June and September have Slight cold stress and provide acceptable conditions for tourists. In SET, the thermal perceptions in no month are not comfortable. But July and August have Slight cold stress and provide acceptable conditions for tourists.

Table 9: Maximum values of the area of the thermal indices zones in percent in Lake Urmia Basin

Thermal indices / Area in%	PET	PMV	SET
jan	100% with Extreme cold stress	100% with Extreme cold stress	87% with Extreme cold stress
Feb	100% with Extreme cold stress	100% with Extreme cold stress	87% with Extreme cold stress
Mar	100% with Extreme cold stress	100% with Extreme cold stress	87% with Strong cold stress
Apr	50% with Strong cold stress	50% with Strong cold stress	75% with Strong cold stress
May	50% with Moderate cold stress	50% with Strong cold stress	87% with Moderate cold stress
Jun	62% with Slight cold stress	62% with Slight cold stress	87% with Moderate cold stress
Jul	62% with No thermal stress	75% with No thermal stress	62% with Slight cold stress
Agu	62% with No thermal stress	75% with No thermal stress	50% with Slight cold stress
Sep	62% with Slight cold stress	62% with Slight cold stress	75% with Moderate cold stress
Oct	37% with Strong cold stress	50% with Strong cold stress	87% with Moderate cold stress
Nov	62 % with Extreme cold stress	73% with Extreme cold stress	62% with Strong cold stress
Des	100% with Extreme cold stress	100% with Extreme cold stress	62% with Extreme cold stress

4. Conclusions

An analysis of climate and bioclimate conditions, when presented in a clear and simple way, can be understood by everyone. It provides a basis for the promotion of the natural potential of tourist destinations. Tourist managers can use climatological information for promotions offering a wider spectrum of possibilities for holiday activities. This study was based on meteorological and geographical date from 8 stations during 1988 to 2012 to analyzing the thermal comfort in the Lake Urmia Basin. For this purpose, PET, PMV and SET were used. The results of three thermal indices show that in PET and PMV, July and August are the best months for tourists in terms of thermal comfort in Lake Urmia Basin. Also, June and September have Slight cold stress and provide acceptable conditions for tourists. In SET, the thermal perceptions in no month are not comfortable. But July and August have Slight cold stress and provide acceptable conditions for tourists. Although the output of PET and PMV are almost the same, But in the PMV, there is a little tendency to cold. It means that the number of months is shown cold or colder than what they are. In SET there is a tendency to warm conditions. That means the number of months is shown warmer than what they are. So, it seems the results of the PET are more consistent with the Climate realities of Lake Urmia Basin.

Generally, Thermal comfort conditions in Lake Urmia Basin are limited to July and August. In the other months of the year are seen the different degrees of cold stress (mainly) and heat stress (in less). The main problem of climate tourism in the Lake Urmia Basin is the Long period of cold stress. Therefore, the winter is not conducive to Excursions in nature but it is the best season for lovers of winter tourism. The methods evaluated here allow end users to include climate in their holiday and recreation planning, to adjust infrastructure planning, and to protect humans from climate extremes.

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