J. Basic. Appl. Sci. Res., 4(8)105-113, 2014

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

The Study of Climatic Comfort of Historical and Archaeological Museum Sites of Bouye (Amlash Country)

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Received: April 14, 2014
Accepted: July 14, 2014

ABSTRACT

The study of climate is about the priority in estimating the natural abilities of tourism especially ecotourism. Many attempts have been made in order to design the practical measures of human thermal comfort evaluation. Buoye historical village is in the south of Amlash city. It is a part of Samam rural district of Rankouh in Guilan province that is important for tourist regions. In this study, it is attempted to evaluate the comfort or lack of comfort of human based on models and indicators like Evans, Becker method (CP), Effective Temperature (ET) and Olgay method by using the data which has been collected from the nearest weather station during 20 years. In this study was observed for 4 months appropriate climate comfort by ETI, GIVON, EVANZ, BEAKER methods in the Bouye site.
The results of this study show that the best months for tourists' excursion are May, June, July, August and September, since these months have comfortable environment and at this time of year, the comfortable conditions are prepared in this region. Thus, climatic comfort can be considered as an important and specific factor in the advertisement so that foreign and domestic tourists can visit historical, natural and cultural attractions in a climatic comfort zone.

KEY WORDS: climatic comfort, human bioclimatic, environmental comfort climate, effective temperature indicator, Bouye site.

1. INTRODUCTION

Tourism is one of the largest industries in the world and is affiliated to a major part of economy. Such a phenomenon is difficult to be defined with simple words, because this phenomenon has been integrated with human life and states in terms of economy, society, culture, and environment [1]. Tourism forms the major part of the global economic and is one of the most important industries in the world. It is predicted that by 2020, international tourists reach 1/6 billion and the financial benefit due to this industry will be over 2 trillion around the world [2]. There is no doubt that one of the required information for tourists is climatic conditions of the destination; and many tourists consider weather conditions for selecting tourist destination [1].

Climatic conditions or destination is one of the tourists' required information for traveling. Majority of tourists pay attention to evaluate the effect of factors of climate on the heat-comfort condition, human comfort should be considered in relation to human response to environmental heat condition[3].To evaluate the effect of climatic elements of human thermal comfort conditions, human comfort indices should be used. Tourism comfort climate index is an index that will systematically determine the influence of climatic elements on tourism. In this index, climatic elements of temperature, precipitation, humidity, radiation and wind are used. Therefore, the suitable time for the presence of tourists are specified with the help of this index [4]. So, regionalization and potential evaluation of human bioclimatic with climatic factors in different courses and sites can lead us to achieve comfortable environment which results in pleasant or fairly pleasant human's livelihood and biological activities [5]. The first directional climate categories by the weather experts who were eager to classify weather based on human perspective were in 1931 by Koppen, in 1931 and 1948 by Thornth Waite and in 1954 by Trewartha. In 1954, Brazol provided a map of convenience in Argentina [1].

2. LITERATURE REVIEW

Various outdoor spaces, including city parks, squares, pedestrian streets, residential areas, sports stadiums, museum site, tourism location etc., provide places for citizens to exercise. In addition, because recreational activities

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of considerable commercial value are conducted outdoors [6] the micro climate starts to gain increasing attention during spatial planning [7], starting with the study and description of microclimate processes, and then focusing on microclimate research in relation to outdoor thermal comfort contributions such as those of Oke et al. [8].

Rural and urban microclimate depends on the type of location in terms of size, geographical situation, population size and density, and land use [9], where with great-defined planning negative effects can be mitigated [10]. Givoni et al. [11] evaluated the effect of microclimatic changes on outdoor human thermal comfort and these tools need to provide the ability to process detailed environmental information according to time and location variations and to generate analytical results to reveal the relationship among the microclimatic environment, outdoor design and thermal comfort.

Nikolopoulou et al. [12] studied a wide variety of locations in seven cities across five European countries. Their findings confirmed a strong relationship between microclimate and comfort conditions. Spagnolo et al. [13] represented various outdoor and semi-outdoor locations in Sydney. They found that the outdoor environment had a wider “comfort zone” than the indoor environment.

Lin et al., [14] reported a public square in Taiwan, and the results showed that the thermal comfort range for subjects in Taiwan were higher than those for people in a temperate region.

As regarded to the importance of climatic factors and its effect on human’s comfort, many studies related to human bioclimatic have been done. Terjung (1966) reported bioclimatic distribution and examined human in large quantity and represented result of his research in chart [15]. Zanker (1967) classified Baltic coast bioclimaticaly [16]. Gregorczuk and Cena (1967) benefited from effective temperature index that is a compound temperature and relative humidity factor; they computed world distribution of average effective temperature for both January and July [17].

Clarke and Bach (1971), using effective temperature, reformed effective temperature and nerve pressure indices and examined climatical comfort conditions on "sin sinati" in Ohio and its suburb. They found out that the suburb was more comfortable than downtown [18]. Gonzalez et. al., (1974) represented the standard effective temperature (SET) to study human thermal comfort based on a reliable physiologic perception [19]. Barradas (1991) chose five parks in Mexico City to discover the difference between thermal comfort of inner part of the parks and their surroundings. He found out that the difference of temperature is more in the early afternoon than the other times so that maximum thermal difference, water vapor pressure and water vapor deficiency pressure were 5.6˚C, 0.6 and 103mb in order [20].

Akram and zuhairy (1993) proposed compound of Mahani, MYCM, CMY and used all the factors related to climate designed building in Saudi Arabia. It is worthy to mention that Saudi Arabia has four climatic regions [21]. Rezjouyan (1997) studied effective factors on peace using Mahani Method and effective temperature [22]. Also Ramesht (1997) considered the importance of climate in human health [23]. Zain-Ahmad and et al., (1998) using Mahani chart and schrometric table in Klang Vally in Malaysia, considered staffs’ thermal comfort to find comfort in the building of humid areas [24].

Jahanbakhsh (1998) has approached bioclimatic provocations ranges in Tabriz. he evaluated temperature condition according to effective temperature [25]. Besides, Khalili (1999) has approached bioclimatic provocations rates in Tabriz and mentioned 6˚C-12˚C as maximum comfort rates [26]. Ghasemi (2000) in studied the effect of meteorologic parameters on human activities [27]. Baghbani (2002) examined regionalization of educational areas, using Biker and Gioni methods and 16-year data (1986-2001) of 16 meteorological stations in Ardabil, Azarbayjan-e Sharqi and Azarbayjan-e Gharbi. [28]. Asgari and Moeini (2002) studied climatic comfort bounds for many provinces in Iran [29]. Ataei and Basatzadeh (2004) provided bioclimatic map of a 40-year course using Terjung Method of 8 synoptic stations in Semnan province [5].

Mohammadi and Saeidi (2004) have studied comfort and discomfort using Terjung and Biker, nerve pressure, and termohigrometric as bioclimatic factors in Qom City [30]. Morllon et al., (2004) classified Mexico using Olgi and Gioni method and fenger equation during a year. But there is a limitation in use of above-mentioned cases; they can’t be used in the entire year [31].

Khoshhal et al., (2006) classified bioclimate of Esfahan using Mahani, Olgi and Terjung methods Using cluster classification for human bioclimate regionalization in Esfahan. Among above-mentioned methods, Gioni seems to be the best one. [32]. Ghasemzadeh et al., (2006) have determined construction bioclimate chart. It’s followed by introduction of important factors on institutes and students’ thermal comfort bound in various seasons considering covering and activities in Yazd province [33].

Oehier and Matzarakis (2007) studied the principles of biometrology for tourism industry. They evaluated biometrologyical conditions by thermal perception frequency and identified equal temperature of human’s physiology during ten specific days. Also determined comfort areas for tourism compounding this factor with other metrological factors such as temperature, sun shine, rate and number of days with precipitation and storm [4].

Tplin et al., (2007) state that: “tourism industry is affected by possible alteration of world climate, they analyzed temperature and rain factors first separately and then simultaneously, the comfort temperature and tolerable temperature for tourism were investigated [34].

Mahmoudi (2008) has used effective temperature and accumulative tension indices for evaluating of its comfort area in Marivan. He concluded that Marivan isn’t in comfort area, nor isn’t in approximate comfort area at no hours of a day in January, February, March, April, November and December [35].

Bazrpash et al., (2008) have evaluated Mahani, Biker and Terjung methods as climatic comfort indices in outdoors for the purpose of echotourism in Babolsar. During the research, they discovered that nature and outdoors in Babolsar have the best conditions as thermal comfort from the second month of spring to the second month of fall for tourism [36]. Zengin et al., (2009) using meteorological date of 9 stations in summer for studied comfort along the road of Turkey using GIS" concluded that topography have been an effective factor in Turkey. Furthermore, he found out that an area in south of Meseit Mount is out of comfort [24].

Ping Lin and et al., (2010) evaluated Shading effect on long-term outdoor thermal comfort in Taiwan by PET index (physiological equal temperature) and SVF (sky vastness factor) and considered 10-year meteorological data. First, they determined climatical comfort area for the Taiwanese during a particular year. Then, they applied SVF rates which showed that high SVF rates in summer and low ones in winter would cause discomfort. Next, they stated that shading effect of building and trees should be fitted with climate of area to provide comfort [37].

Zolfaqari (2010) following assessment of indices, says that climatic comfort course is restricted to 45 days from early third month of spring to the middle of first month of summer. he studied appropriate time to tour in Tabriz using physiologic equal temperature (PET) and predicted men view (PMV) [38]. The importance of tourism development in rural areas can be a positive step to present the appropriate solution for tourists’ comfort condition in rural areas of Guilan.

3. MATERIALS AND METHOD

3.1. The location of place under study

Buoye historical village lies in 50° 6´E and 36° 5´ N with the height of 1390 to 1430 m above the sea level. It is located 50 kilometers far from the south of Amlash city. Buoye is the part of Samam rural district of Rankouh in Guilan province. According to Fig 1, the border region from south and east is limited to Chakroud River and from north to Kakroud River, and from the west and northwest to Chakroud and Kakroud, respectively. To get to Buoye, there are multiple paths with different distances; the road passes through flat terrain and smooth plains and reaches to the twisting mountain roads. By passing these roads, you can find a way to Buoye. To review the climatic condition of Buoye, the data of 20 years of Spilly meteorological station was used which is the nearest one to this area. The data were temperature, moisture, rainfall and wind speed. To determine comfort months in Buoye, different methods like Olgay, Becker, Effective Temperature Indicator, Givoni, and Evans were used.

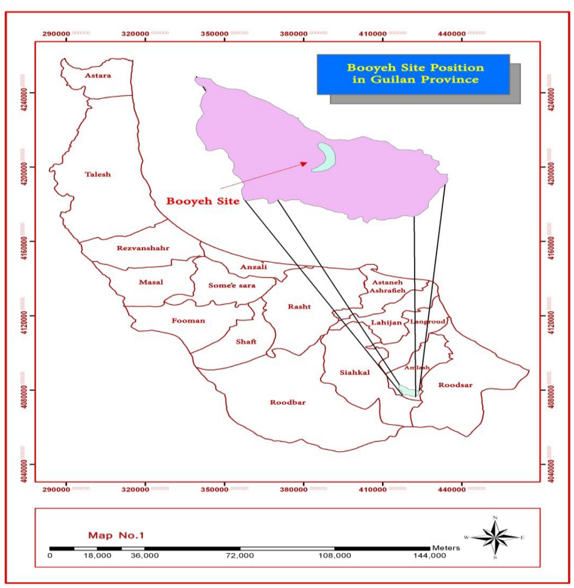

Figure. 1: Geographical location of Buoy site in Guilan

3.2. Method

In order to evaluate tourism climatic conditions and climatic attractions of Bouye, various climatic parameters and also different climates were examined in order to identify the overall climate of the region. Next, the obtained results in different parts including water resources, vegetation, environment, agriculture, tourism, etc. were used. Olgay chart is one of the complex ones that will be changed based on climate elements such as wind, shine, relative humidity and temperature. In Iran, the Olgay indicators and other sources showed that the comfort sensitive border in summer (21.1 - 27.8˚C) with relative humidity is about (70% - 80%) and in the range of 20˚C with relative humidity, it is about (30% - 65%) in winter. In this method, the amount of bioclimatic comfort in different months was shown. By using Olgay chart, the months which were in comfort zone were identified. In this chart, the extent which is below comfort zone is about 22˚C and the extent which is above it, is about 30˚C [14].

The effective temperature indicator (ETI) is calculated from the following equation:

$$E\tau = \tau - \left[\frac{0}{6}(\tau - 10)\left(1 - \frac{Rh}{100}\right)\right] \quad (1)$$

In this equation *t* is the daily heat average according to degree Celsius; *Rh* is the average relative humidity and *Et* is the effective heat that is at degree Celsius. Based on effective temperature indicator, when *Et* is less than 17.8˚C or is more than 22.2˚C, bioclimatic pressure will appear.

With the Givoni method, thermal condition of a person who wore clothes inside the house while doing light activity was compared with someone who rested in the shade. For this purpose, humidity and relative heat of the moment was figured on the Givoni graph and then the situation of figured part was evaluated with the comfort zone. If the point fall within the area, it means that the person will feel comfortable in the shade and in a situation that the weather was subtle and when the point was out of the area, it means that the person will not feel comfortable in the present climatic condition unless the measures had been taken to improve the heat.

To determine the comfort zone, Evans identifies the relation between drying temperature with relative humidity in four groups, 0 - 30 percent, 30 - 50 percent, 50 - 70 percent 70 - 100 percent and air flow from imperceptible (0.1 meters per second) to perceptible (1 meter per second). This method also defined the activity in resting mood or doing the light chores and clothes like summer style dress and winter indoor clothes. Bioclimatic indicators were shown in Table 1

Table 1: Degrees of cooling power of the **Environment Bioclimate thresholds** based on Becker review (Razjouyan, 1987)

The kind of bio-Climatic	**Cooling power**	**Weather condition**
Pressure	Cp=0-4	Warm, hot, humidity and unpleasant
Comfort	Cp=5-9	Warm and endurable
Comfort	Cp=10-19	Comfort
Slight stimulation	Cp=20-29	Cool
Middle stimulation	Cp=30-39	Cold
Average pressure	Cp=40-49	Very cold
Severe pressure	Cp=50-59	Unpleasant cold
Intolerable	Cp=60-70	Intolerable high cool

The following equation was used to calculate the cooling power of the environment:

$$CP = (0.26+0.34\times V^{0.632})(36.5-T) \quad (2)$$

(CP) is cooling power of environment at micro calorie per square centimeter per second while (V) is the average wind speed at meter per second and (T) is the average of minimum and maximum temperature. According to Becker (2000), when CP is less than 5 or more than 20, then bioclimatic pressure would appear.

4. RESULTS AND DISCUSSION

The results of bioclimatic table of Bouye in Olgay indicator and also in figure 2 showed that in August, it was close to the comfort zone and could achieve the comfort with the use of sunshine. At night, mechanical exothermic systems should be used. Days of June, July, September, May, October, November, April, December, January, February and March were below the comfort border and it was necessary to use mechanical system exothermic (12.5 to 95 kilo calorie per hour). In January, February, March, November and December, the weather was too cold and it was essential to use heat more than 100 calorie to feel comfortable. So, utilizing heavy materials was necessary to prevent heat.

4.1. Review of ETI

The effective air temperature which represents the combined effects of temperature and humidity can be seen in table 2 well. according to following table, thermal coefficient was in none months of a year and October, July, August and September settled in cool area; however, November, December, January, March, April, May and June settled in *very* cool area.

Table 2: Effective temperature around Bouye site

Month	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sep
Average temperature	14.7	9.5	4.2	1.5	1.7	4.7	8.8	12	15.6	16.1	19	17.4
Average relative humidity	66	65	69	69	60	60	61	66	57	79	73	75
ET	13.7	9.6	5.3	3.1	3.5	5.9	9.1	11.6	14.4	15.3	16.9	12.8
Thermal coefficient	Cool	Very cool	Very cool	Very cool	Very cool	Very cool	Very cool	Very cool	Very cool	Cool	Cool	Cool

4.2. Review of Olgay

The result of bioclimatic table of Buoye in Olgay indicator and also in figure 2 showed that in August, it was close to the comfort zone and could achieve the comfort with the use of sunshine. Days of June, July, September, May, October, November, April, December, January, February and March were below the comfort border and it was necessary to use mechanical exothermic systems (12/5 to 95 kilo calorie per hour). In January, February, March, November and December, the weather was too cold and it was essential to use heat more than 100 calorie to feel comfortable. So, utilizing heavy materials with much delay of warmth is necessary to prevent heat (Figure. 2).

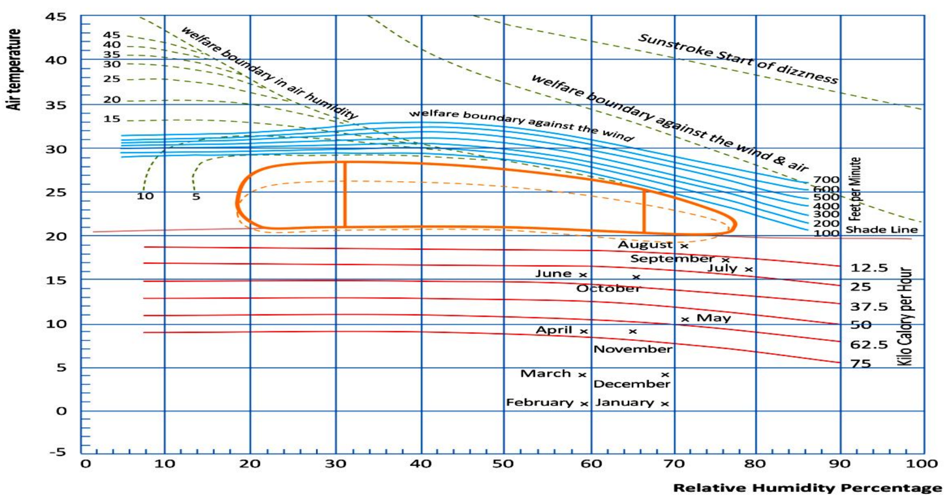

Figure .2. : EPA Climate bioclimatic Olgay chart: Buoy site of AMLASH

4.3. Review of Givoni

According to bioclimatic table of Bouye and division of Givoni to smaller tables, the researcher concluded that June, July and September were in N area border in days. This area is known as summer comfort zone in shadow and it is also recognized as an environment which, mean radiation temperature is equal to air temperature. In this area, human comfort will be prepared naturally. At night, it is not needed to use heating tools as the air temperature is good. In October, it is placed at H region and in March at H'. It is presented that in these months, the minimum air temperature inside the building is higher than the outside and it is not needed to use heating source. At night, because these months are settled out of H and H' region, thermal system is necessary to achieve comfort. In August, it is located at H region and in April, May, June, July, October, November, December, January, February and September, it is settled at H'. In this condition, the air temperature of home is normal and it is not needed to make it warm but it depends on building features .Out of this range (H, H'), in order to make comfort, it is necessary to use heating tools inside the house. Down within comfort zone that the air temperature is less than 20˚C, there is an area that range of H and H' is identified. It is essential to use thermal tools in order to make comfort (Figure 3).

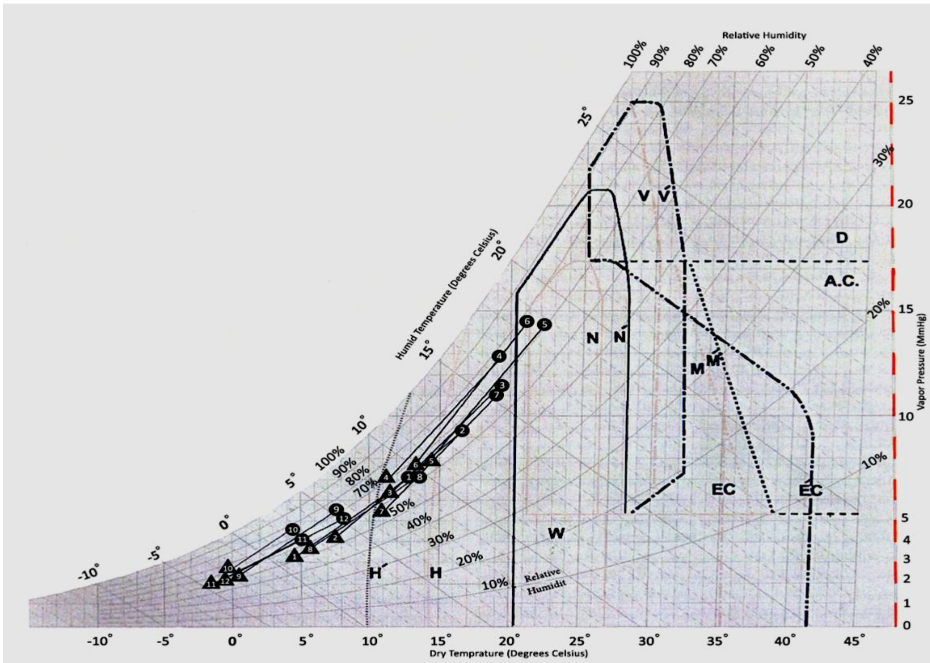

Figure 3: Diagram of Givoni in Buoye site of AMLASH

4.4. Review of Evans

By the use of Evans method, the results of table 3, 4 and 5 showed that in each moments of day and night in November, December, January, February, March, April and May, it was really cold in days and in June, July, August and September, it was comfortable at night. Though, wind direction and speed could change comfort in these months and also made the weather more favorite or colder. According to Evans criterion, when there is no comfort in the cold months, it is necessary to use different ways like proper insulation of walls, windows, floor, and ceiling and also utilize the heating gadgets to make comfort conditions in building. In the hot months of a year, it is needed to use the mechanical gadgets or natural ventilation to cool air.

Table 3: Comfort thermal region of day and night in Bouye site

Thermal state	**Day**			**Night**		
Month	A	B	C	A	B	C
October	Cold	Cold	Comfort	Cold	Cold	Comfort
November	Cold	Cold	Cold	Cold	Cold	Cold
December	Cold	Cold	Cold	Cold	Cold	Cold
January	Cold	Cold	Cold	Cold	Cold	Cold
February	Cold	Cold	Cold	Cold	Cold	Cold
March	Cold	Cold	Cold	Cold	Cold	Cold
April	Cold	Cold	Cold	Cold	Cold	Cold
May	Cold	Cold	Comfort	Cold	Cold	Cold
June	Comfort	Comfort	Comfort	Cold	Cold	Comfort
July	Comfort	Comfort	Comfort	Cold	Cold	Comfort
August	Comfort	Comfort	Comfort	Cold	Cold	Comfort
September	Comfort	Comfort	Comfort	Cold	Cold	Comfort

Table 4: Three regional climate of Evans in Buoye

Thermal State	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**
Day	Comfort	Cold	Cold	Cold	Cold	Cold	Cold	Comfort	Comfort	Comfort	Comfort	Comfort
Night	Cold	Cold	Cold	Cold	Cold	Cold	Cold	Cold	Comfort	Comfort	Comfort	Comfort

Table 5: Sycrometric pattern of climatic parameters of Evans in Buoye

Month	Relative humidity	Lower temperature	Comfort zone in day	Comfort zone at night
Oct	68.2	8	Lower limit of comfort	Lower limit of comfort
Nov	64.9	8	Cold	Cold
Dec	71.5	8	Cold	Cold
Jan	75	9	Cold	Cold
Feb	63.5	7	Cold	Cold
Mar	66	10	Cold	Cold
Apr	64	10	Lower limit of comfort	Cold
May	68	8	Lower limit of comfort	Cold
Jun	69	7	Lower limit of comfort	Cold
Jul	78	8	Lower limit of comfort	Cold
Aug	72	8	Lower limit of comfort	Lower limit of comfort
Sep	77	8	Lower limit of comfort	Lower limit of comfort

4.5. Review of Becker

According to Becker indicator, thermal state in both situation were reviewed day and night and the results showed that days of April, May, June, July, August, September, October, November, June, July, August, September and October were in bioclimatic comfort B at night. "B" represents natural favorite bioclimatic condition in the environment. December, January, February and March in days and November, December, January, March, April and May at night were in bioclimatic comfort limit C. "C" is represented as cold bioclimatic condition in environment. February was placed at bioclimatic comfort limit D, and it represented this month as an unfavorable bioclimatic condition (very cold).

Review of comfort criterion of Bouye with different climatic patterns showed that this area was in climatic comfort conditions in May, June, August and September. If there was sunshine, the environment was comfort in October, November, December and April. It was uncomfortable in January, February and March because of abundant rain, extreme cold and high wind. According to sunlight direction during the year, this area had comfort potential in 6 months of a year and this factor could contribute to tourists' leisure time, increased revenue, employment and reducing unemployment (Table 6).

Table 6: Climatic comfort condition in Bouye site according to different climatic indicators for tourism

Index		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Becker	day	*	*					*	*	*	*	*	*
	night	*								*	*	*	*
Evans	day	*							*	*	*	*	*
	night									*	*	*	*
ET	cool	*									*	*	*
	Very cool		*	*	*	*	*	*	*	*			
Becker											*		

5. CONCLUSION

Human bioclimatic study is the base of many regional development planning and the result of such studies can be considered in the main planning particularly in tourism. To reach this goal, different bioclimatic indicators like Olgay, Effective temperature, Evans and Becker were used in Bouye.

It is necessary that Iranian touring organization, tourism organization and also other institutions or relevant organs particularly tourism tour executors from inside the country or outside have great sensitivity on tour schedule and tourist attraction. It is good to put this factor as an important and specific one in their advertisement till foreign and domestic tourists can visit historical, natural and cultural attractions in a climatic comfort zone.

Comparing the results of methods in this study showed that in **ETI** method, months of October, July, August and September were appropriate climate comfort. Similarly, the months of June and July in **GIVONI** method, months of June, July, August and September in **EVANZ** method and months of June, July, August and September in **BEAKER** method has been favorable climate comfort. Only in **OLGAY** method, no month was in the range of climatic comfort. In conclusion, the appropriate time limit for tourism activities in Bouye was in Aug, Jul, Jun, Sep.

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