# RECOGNITION OF MONTHLY HUMAN BIOCLIMATIC COMFORT WITH TOURISM CLIMATE INDEX IN RAMSAR, SOUTH-WEST OF CASPIAN SEA, IRAN

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**Abstract**
Weather and climate have great importance in developing of tourism industry. Most of the tourists use the climate information for travelling and choice of destination. Knowledge of climate information and its application can assist tourism planning, tourism industries and in reducing negative effects of weather and climate on tourists and this branch of the economy. The aim of this research is recognition of suitable months in Ramsar station on the basis of Becker method and tourism climate index (TCI), for a period of 25 years (1981-2005).The results of Becker method has shown that Ramsar station has a bioclimatic comfort in 10 months. Weather in 7 months (March, April, May, September, October, November, and December) is moderate and desirable. June, July, and August have a little warm and tolerate weather, but in January and February, Ramsar station has a cool weather with moderate stimulation. Evaluation of TCI index for Ramsar station has shown that May month has the best climate conditions with 80-89 range (Excellent) for tourism activities. June and October months have a "very good" climate conditions. April, July, and September are included in the "good" category while August and November are included in the "acceptable" category. January, February, March, and December have the "unfavorable" conditions.

*Keywords:* Tourism, Tourism Climate Index, Becker, Bioclimatic comfort, Ramsar.

## 1. Introduction

Tourism is the entirely of the relationships, phenomena and experiences that arise from travelling and overnight stay of people in locations or areas other than their usual residence (Matzarakis, 2006). Nowadays, weather and climate have great importance in developing of tourism industry. Most of the tourists use the climate information for travelling and choice of destination. Knowledge of climate information and its application can assist tourism planning, tourism industries and in reducing negative effects of weather and climate on tourists and this branch of the economy (Matzarakis, 2006). Wind, humidity, temperature, drought, storminess, snow conditions, weather temperature, and degree of sunshine area a few of the variables that affect visitor's decisions, satisfaction, and the extend of spending that important economic "bottom line" for tourism businesses and tourism destinations (Curtis et al. 2011). The influences of weather and climate frequently

emerge as important criteria for choosing a tourism destination, as they help in determining the appeal of a location in absolute or relative terms. The tourism industry is particularly sensitive to climate variability (Curtis et al. 2011).

Bioclimatology or Vital Climatology is a science for studying and evaluation of the weather and climate effects on the life creature consisting botanic or zoological creatures (Jahanbakhsh, 1998). Human comfort bioclimatology is a collection of those conditions that the human feel comfort in 80% in the view of environmental conditions (heat, humidity, wind, sunshine), in such a way that the relation between human and atmosphere (relation between blood and air-pressure, relation between heatstroke and water vaporization from the skin of the body) is naturally is geographical and regional that is classified in the human climatology science (Kaviani, 1993). With consideration to the wide researches among the climate factors, such as temperature and humidity have the more important roles on human health and comfort, and in examination models for human comfort, these two facts have been used more (Alijani, 1994). In tourism planning, especially in ecotourism plans that relaxation and comfort of human is the main objective of the planning with the consideration of preserving the environment, determination of time and place limitations, are the most important aspects (Ramezani, 2010).

Weather and climate have the following characteristics in relation to tourism (Abbeg, 1996, modified).

*Weather and climate are limiting factors in tourism*. The characteristics of weather and climate can scarcely disrupt human activities absolutely but they constitute a very important financial factor if viewed in the light of tourism. This implies that some regions of the world have a minimal tourism potential, since their climatic conditions do not allow opportunities for tourism. Tourism administrators do not patronize such kinds of area, since this does not yield significant profit. The traveler who nevertheless tours these regions has to deal with high costs (e.g. transport costs) or physical inconvenience (e.g. body strain). Financial loss can also be caused by weather variations and changes. Rainy summers or less snowy winters can have negative consequences for tourism.

*Weather and climate are dominating factors in tourist demand*. Weather and climate shape not only the tourist offers but also the demand. They influence, among other things, the choice of destination or the kind of activities to be carried out. The climatic factors play a significant role in the three phases of a tour: before, during and after. The meteorological conditions also affect the design / construction of the daily schedule.

*Weather, climate, health and tourism*. Trips in climatically stressed areas of the earth can result in health problems (e.g. heat stress, UV-radiation, air pollution and

heat stroke). A purposeful climate advisory service can be helpful for the protection of travelers and particularly risk groups (elderly people, sick people and children).

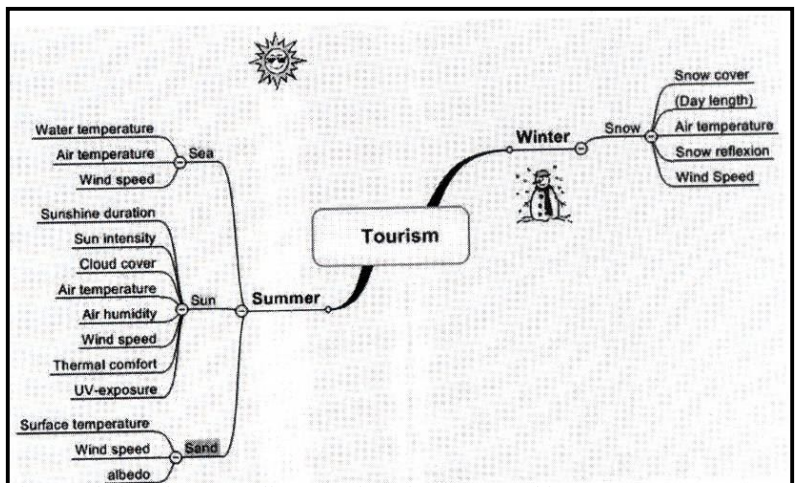

Fig. 1 Relations between climate and tourism (Matzarakis, 2006)

Fig. 1 shows the interactions of weather and climate in tourism. It is known that tourism, especially summer tourism, can be described by the triple S (sun, sea and sand). Many of the tourism factors creating the triple S are dependent on weather and climate. An additional factor that can be added to the triple S, or used as single winter S, is snow, the main decision factor for winter tourism (Matzarakis, 2006).

Weather and climate are key influences on the tourism sector worldwide (Smith, 1993; Boniface and Cooper, 1994; Perry, 1997), affecting the length and quality of tourism seasons and the environmental resources (Scott et al. 2004). Climatic conditions allow or favor certain outdoor tourist or recreational activities such as hiking, rafting, golf, and hunting, fishing and climbing (Gomez Martin, 2005). Therefore, climate, which influences tourist and 'what and when' activities can be carried out, plays a decisive role in the selection of destinations. For example, seeking and enjoying the sun is one of the main reasons why many tourists go away on holiday. Similarly, winter sports depend directly on climatic resources: without snow or low temperatures for the artificial production of snow, the development of ski resorts would not have been possible (Gomez Martin, 2005).

With consideration to this point that climate and weather play an important role in developing of tourism industry, many studies have done by the researchers in Iran and the world, for example:

Matzarakis (2006) in his article investigated the relation between weather and climate information with tourism by the use of Climate Index by Davies (1968) and Tourism Climate Index developed by Mieczkowski (1985). Also in another article he explained the importance of climate and bioclimate information for tourism in Greece. Amelung and Viner (2006) explored the impact of climate change on the TCI for the Mediterranean region. The projections indicated that particularly in spring, TCI scores will improve in most of the Mediterranean region, in particular in Spain, Greece and Turkey. Improvements are also projected for the autumn season. TCI ratings in the Mediterranean in the summer season will deteriorate markedly, whereas in the source countries of the North of Europe, conditions will improve. Daniel Scott and et al (2004) used the "tourism climate index" (TCI) to assess the spatial and temporal distribution of climate resources for tourism in North America. In another article Scott and McBoyle (2001) explored the impact of projected climate change on the tourism climate resource of a sample of tourism destinations in North America by the use of (TCI). Cengiz et al. (2008) evaluated the climatic conditions of Canakkale in terms of tourism activities. The results of the study showed that spring months have the best conditions for tourism activities. All the months of this season were included in the "very good" category according to the TCI rating system. Ramezani (2010) in his article, recognized the monthly human bioclimatic comfort for ecotourism planning in Gilan, Iran, south Western of Caspian sea by the use of Becker method and the results showed that Eastern area has more comfortable from Western area. Farajzadeh and Ahmadabadi (2010) estimated the tourism climate of Iran by the use of tourism climate index (TCI). The findings of this study indicated that in winter months, excellent tourism climate conditions are in southern parts of Iran. In spring months, the northern part of country has good tourism climatic conditions. In summer months, nearly bad tourism climatic conditions are in the country. In autumn months, the good tourism climate conditions move toward southern parts and in this date northern coasts of Iran have good conditions in initials of season. Sari Sarraf et al. (2009) evaluated the tourism climate conditions of Arasbaran for a period of 20 years (1986-2006) by the use of TCI index. Findings indicated that June, July, August and September had the best climate conditions with TCI scores between (90-100) range and December, January and February, in all stations under study had less comfortable conditions for tourism. Ranjbar et al. (2010) investigated the relation between the climate condition and annual tourism trend in Marvdasht County. The results revealed that winter months (January, February, March and December) were not suitable for tourism activities but spring and fall months (April, May, October and September) had the best conditions for tourism activities in Marvdasht.

Gandomkar (2010) specified the proper times and places for visitors in Semirom by using TCI model. The results of study showed that the best time of year was September followed by May. January, February, March and December were the worst months.

This paper aims to determine and recognize the suitable months in Ramsar station on the basis of Becker and TCI methods, in order to correct planning, attraction of tourist, and ultimately developing the tourism industry.

## 2. Location of study area

Ramsar is located in the west end of province of Mazandaran. Ramsar is limited northward by the Caspian Sea, southward by the central Alborz region (Alamot area, a dependence of Qazvin province), westward by Chaboksar a dependence of Gilan province and eastward by Tonekabon. Covering an area of 688 $km^2$. Ramsar is located at $50^o$ 40' eastern longitude and $36^o$ 52' geographical latitude (Fig. 2).

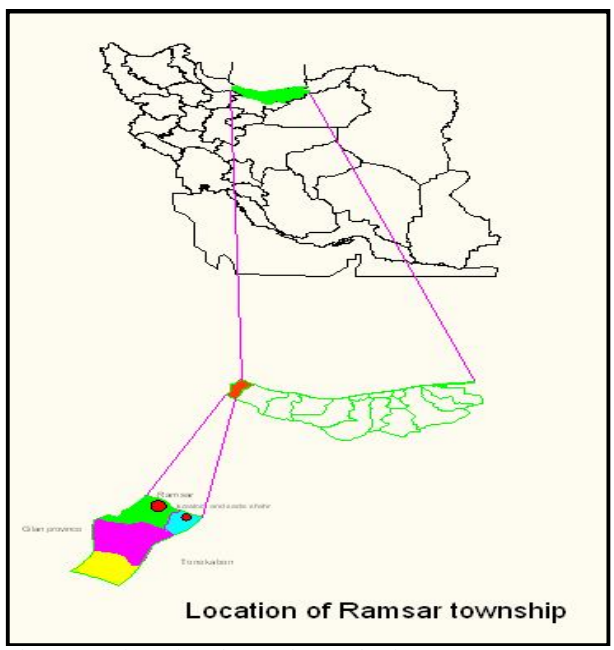

Fig. 2 Location of study area in North of Iran.

## 3. Methods

In order to determine the favorite months for tourism and recognition of bioclimatic comfort limitations for regional life comfort, climate data sets of Ramsar synoptic station were used (Table 1), consisting of (temperature, relative humidity, sunshine hours, precipitation, wind) for a period of 25 years (Table 2). Then by the use of Becker method and tourism climate index (TCI), favorite months of Ramsar station were determined for the best use of tourists.

Table 1. Location of Ramsar Station

| **Station** | **Ramsar** |
|---|---|
| Longitude | 50° 40' W |
| Latitude | 36° 54' E |
| Elevation | -20.0 m |

Table 2. Synoptic climate data of Ramsar station (1981-2005)

| Month | Mean air tempera-ture (°C) | Mean maximum air tempera-ture (°C) | Mean minimum air tempera-ture (°C) | Relative Humidity (%) | Mean minimum relative Humidity (%) | Precipitation (mm) | Sunshine Duration (h) | Mean wind speed |
|---|---|---|---|---|---|---|---|---|
| Jan | 7.51 | 11.03 | 4.30 | 84.2 | 71 | 158.3 | 6.87 | 1.39 |
| Feb | 8.37 | 10.57 | 4 | 84.32 | 71.4 | 156.8 | 6.85 | 1.54 |
| Mar | 10.99 | 11.67 | 6.16 | 87.24 | 76.28 | 168.3 | 6.82 | 1.75 |
| Apr | 15.75 | 16.54 | 10.32 | 86.44 | 75.44 | 90.5 | 8.33 | 1.74 |
| May | 20.29 | 21.16 | 14.96 | 85.08 | 74.88 | 104.5 | 10.6 | 1.64 |
| June | 23.94 | 25.82 | 19.42 | 81.4 | 70.64 | 121.3 | 11.79 | 1.63 |
| July | 25.54 | 28.56 | 22.06 | 79.88 | 69.04 | 73 | 12 | 1.6 |
| Aug | 24.24 | 28.72 | 22.52 | 81.24 | 70.48 | 118.7 | 10.14 | 1.6 |
| Sept | 20.48 | 25.87 | 19.76 | 83.6 | 73 | 345.6 | 8.27 | 1.57 |
| Oct | 16.07 | 21.7 | 15.09 | 84.72 | 73.12 | 614 | 8.27 | 1.51 |
| Nov | 11.63 | 17.06 | 10.43 | 85.12 | 72.76 | 332.2 | 7.10 | 1.37 |
| Dec | 13.03 | 13.12 | 6.20 | 84.92 | 72.2 | 225.1 | 6.4 | 1.36 |

### *3.1 Becker method*

Becker is model for recognition of Human Bioclimatic Comfort. In this method the following relation has been used:

(Equation 1) $CP= (0.26+0.34*V^{0.622}) (36.5-t)$ mcal/cm$^2$sec

In aforesaid relation:
V = Wind velocity (m/sec)
T = Daily average temperature (°C)
CP = Cooling power of the environment, cooling power of the environment in this relation is the difference between body and air temperatures (Mcal/cm$^2$/sec).

Becker presented the cooling power of environment and human bioclimatology combination limits, as the following Table 3:

Table 3. Cooling power of environment and bioclimatic limits on the basis of Becker study

| Environment cooling power | Air situation | Type of bioclimatic stimulation |
|---|---|---|
| CP=0-4 | Hot, warm, humid and undesirable | Bioclimatic pressure |
| CP=5-9 | Warm, tolerable | Bioclimatic comfort |
| CP=10-19 | Moderate and desirable | Bioclimatic comfort |
| CP=20-29 | Cool | Moderate stimulation |
| CP=30-39 | Cold | Middle to intense stimulation |
| CP=40-49 | Too cold | Pressure in middle aspect |
| CP=50-59 | Undesirable cold | Intensively pressure |
| CP=60-70 | Intolerable too cold | Intolerable |

Reference: (Kaviani, 1993)

According to Becker study, if CP will be less than 10, will cause the bioclimatic pressure and undesirable conditions that is because of high temperature. If CP will be more than 20, because of high coldness, will cause the mild stimulation, bioclimatic pressure and lack of human comfort.

*3.2 Tourism climatic indices*

The tourism climatic index as a concept has evolved from more general knowledge about the influence of climatic conditions on the physical wellbeing of humans. Mieczkowski (1985) was among the first to apply the general findings about human comfort to the specific activities related to recreation and tourism. He devised a tourism climatic index consisting of seven parameters (monthly means for maximum daily temperature, mean daily temperature, minimum daily relative humidity, mean daily relative humidity, total precipitation, total hours of sunshine, and average wind speed). These climate variables were combined into five sub-indices (three of which are independent and two in a bioclimatic combination), describing daytime thermal comfort, daily thermal comfort, precipitation, hours of sunshine, and wind speed. A standardized rating system, ranging from 5 (optimal) to -3 (extremely unfavorable), was devised to provide a common basis of measurement for each of the sub-indices (Table 4).

Table 4. Components of Mieczkowski's (1985) tourism climate index (TCI)

| Abbrev | Sub-index | Monthly climate variables | Influence on TCI | Weight (%) |
|---|---|---|---|---|
| CID | Daytime comfort | Max. daily temperature and min. daily relative humidity | Thermal comfort during max. tourist activity | **40** |
| CIA | Daily comfort | Mean daily temperature and mean daily relative humidity | Thermal comfort over 24 h | **10** |
| P | precipitation | Total precipitation | Negative impact of precipitation | **20** |
| S | sunshine | Total hours of sunshine | Influence of the amount of sunshine | **20** |
| W | wind | Average wind speed | Influence of average wind speed | **10** |

The mapping of raw data to sub-index values depends on the kind and level of tourist activity. Beach holidays require climatic conditions different from ski holidays. Values for all variables are mean monthly values. The thermal comfort sub-indices are based on effective temperature, which is a measure of temperature that takes the effect of relative humidity into account. According to the latest bio-meteorological literature, both short and long wave radiation are essential for deriving modern thermal indices (Matzarakis, 2001a, 2001b; Skinner and de Dear, 2001).

The tourism climatic index (TCI) that proposed by Mieczkowski (1985):

$$TCI = 2[4\,CID + 2CIA + 4\,R + 4\,S + 2\,W] \qquad \text{(equation 2)}$$

In this relation:

CID = is a daytime comfort index, consisting of the mean maximum air temperature (°C) and the mean minimum relative humidity RH (%)
ClA = is the daily comfort index, consisting of the mean air temperature (°C) and the mean relative humidity (%)
R = is the precipitation (mm)
S = is the daily sunshine duration (h)
W = is he mean wind speed (m/s).

The weights used in the equation are ultimately subjective; although they do have a basis in scientific knowledge. In the equation proposed by Mieczkowski (1985), the highest weight is given to the daytime comfort index to reflect the fact that tourists are generally most active during the day. The amount of sunshine and the amount of precipitation are given the second-highest weights, followed by daily thermal comfort and wind speed. After summing the weighted individual components, the result is multiplied by two, so that the maximum TCI score is 100 (Amelung and Viner, 2006). Because of a weighting factor (a value for TCI of

100), every factor can reach 5 points. TCI values >=80 are excellent, while values between 60 and 79 are regarded as good to very good. Lower values (40-59) are acceptable, but values <40 indicate bad or difficult conditions for tourism (Abegg, 1996; Mieczkowski, 1985, see Table 5).

Table 5. Rating categories in the Mieczkowski (1985) Tourism Climate Index

| TCI score | Descriptive category |
|---|---|
| 90-100 | ideal |
| 80-89 | excellent |
| 70-79 | Very good |
| 60-69 | Good |
| 50-59 | Acceptable |
| 40-49 | Acceptable |
| 30-39 | unfavorable |
| 20-29 | Very unfavorable |
| 10-19 | Extremely unfavorable |
| -30 -9 | impossible |

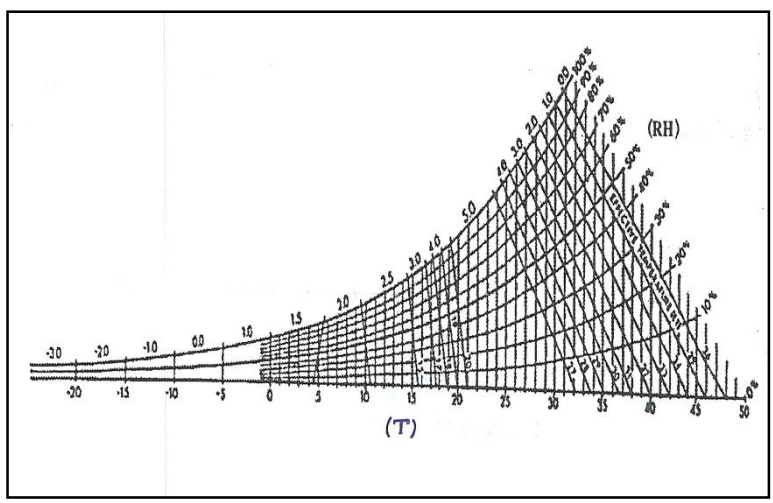


Fig. 3 Determination of Tourism Climate Index (Mieczkowski, 1985)

*3.3 Annual tourism climate typology*

Scott and McBoyle (2001) theorized that the tourism climate resource of every destination could be classified into one of 6 annual distributions (Scott et al. 2004), (Fig. 3). The spectrum runs from the "optimal" year-round tourism climate (TCI rating of 80 or above for each month of the year) through to a "poor" year-round tourism climate (TCI rating under 40 throughout the year). The "summer" and "winter peak" curves have similar distributions, but are distinguished by the season in which the higher TCI scores occur. The "summer peak" curve is indicative of

many mid- to high-latitude locations where summer is the most pleasant period of the year for tourism. On the other hand, the "winter peak" curve represents more equatorial and mid-latitude locations where cooler and/or lower humidity conditions in winter are more comfortable for tourists compared to hot and/or humid summer conditions. Where spring and fall periods are more acceptable to the tourist a "bimodal" or "shoulder peak" distribution is obtained. The tourism climate resource in regions with distinct wet and dry seasons will be determined to a large extent by precipitation. The TCI in these regions will display a dry season peak, when the climate in most conducive to tourism activity.

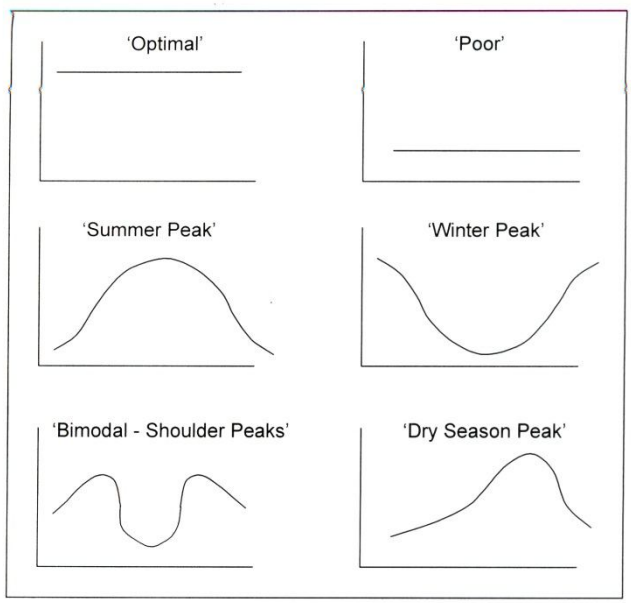


Fig. 4 Conceptual tourism climate distributions

## 4. Results and Analysis

### *4.1 Becker method*

With consideration to the equation (1) and Table 3, the amount of cooling power of Ramsar station is calculated and the result is showing in Table 6.

Table 6. Evaluation of cooling power of Ramsar station, on the basis of Becker bioclimatic method

| Months | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean air temperature(C) | 7.51 | 8.37 | 10.99 | 15.75 | 20.29 | 23.94 | 25.54 | 24.24 | 20.48 | 16.7 | 11.63 | 13.03 |
| Mean wind speed | 1.39 | 1.54 | 1.75 | 1.74 | 1.64 | 1.63 | 1.6 | 1.6 | 1.57 | 1.51 | 1.37 | 1.36 |
| cp | 20 | 20 | 19 | 15 | 12 | 9 | 8 | 9 | 11 | 14 | 17 | 16 |
| Index | D | D | C | C | C | B | B | B | C | C | C | C |

(1981-2005)

According to Table 6 and the amount of CP, it can be said that Ramsar station was located in bioclimatic comfort limitation during the year except January and February months, it means that it had a cool weather with moderate stimulation in January and February months, so the climate condition was not suitable for entrance of tourists and recreation, but it had moderate and desirable weather with bioclimatic comfort in seven months (March, April, May, September, October, November, and December), and also June, July, and August months had a little warm and tolerable weather with bioclimatic comfort (Fig. 4).

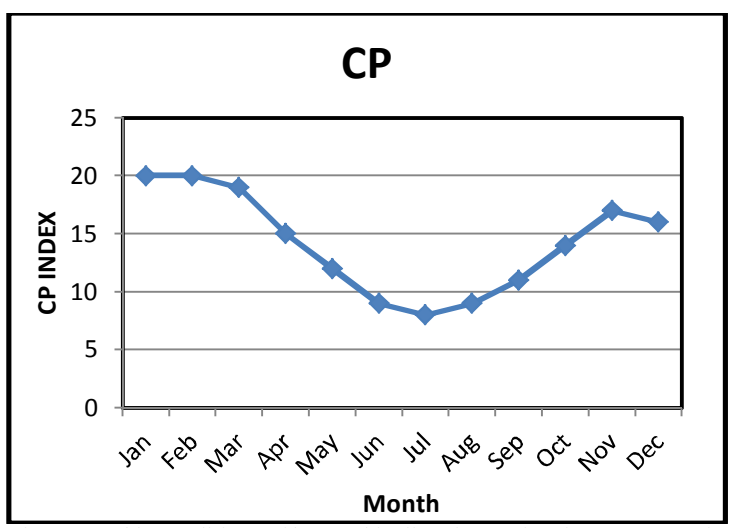


Fig. 5 Monthly conditions of human bioclimatic comfort for Ramsar station

*4.2 Tourism climate index*

Fig. 6 shows the result of TCI scores for Ramsar station with attention to the Table 5 and Conceptual TCI distribution (Fig. 4). It can be seen that Ramsar station had a "Bimodal-Shoulder Peak".

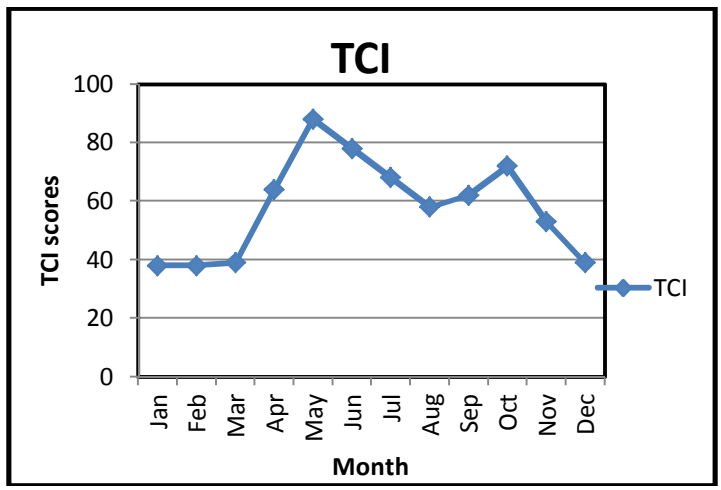


Fig. 6 The result of TCI for Ramsar station. Statistic period (1981-2005)

Winter months (January, February, and March) because of the reducing temperature, had "unfavorable" conditions with TCI scores in the 30-39 range. In spring, with increasing temperature, the TCI curve ascended. April had a "good" condition with 60-69 range. The best climate condition for tourism activities was May with a TCI over 80 (excellent), but gradually with the beginning of warm season (increasing of weather temperature and reducing of rainfall) the TCI curve descended. In June, the climate condition was "very good". July was included in the "good" category according to the TCI rating system. August month had an acceptable condition, so these months were also suitable for entrance of tourism.

Again, in September temperature decreased a little, the TCI scores increased and were included in the "good" category. During the autumn season, the October month with 70-79 range had a "very good" condition for touristic purposes and with reducing of weather temperature, the November and December months had "acceptable" and "unfavorable" conditions, respectively (Table 7).

Table 7. Monthly TCI in Ramsar

| month | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TCI score** | 38 | 38 | 39 | 64 | 88 | 78 | 68 | 58 | 62 | 72 | 53 | 39 |
| **Descriptive category** | U | U | U | G | E | VG | G | A | G | VG | A | U |

U: Unfavorable, A: Acceptable, G: Good, VG: Very good, E: Excellent

## 5. Conclusions

In this study, in order to determination of favorite months for tourism activities and the entrance of tourists in Ramsar station is used Becker method and tourism climate index (TCI). The results of Becker method shows that Ramsar station has a bioclimatic comfort in 10 months. The weather in 7 months (March, April, May, September, October, November, and December) is moderate and desirable and June, July, and August months have a little warm and tolerable weather, but in January and February months, Ramsar station has a cool weather with moderate stimulation.

According to the results of TCI, May is the best month for tourism activities with a TCI score over 80 (excellent). June and October have a "very good" climate conditions. April, July, and September are included in the "good" category while August and November are included in the "acceptable" category. January, February, March, and December because of the reducing of weather temperature have the "unfavorable" conditions. Consequently, with attention to this point Ramsar city has a great potentiality to attract tourists from all over the world, because of its geographical conditions and weather variety. Thus, assessment and evaluation of climate conditions for Ramsar station is very important and can be useful for better management, suit programs, precise strategy, and finally improvement and development of tourism industry.

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