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A nalysis and Estimation of Tourism Climatic Index (TCI) and Temperature-Humidity Index (THI) in Dezfoul

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Abstract. Khuzestan Province, located in southwestern Iran, has a high potential in attracting visitors. The aim of this study is to determine tourism climatic index (TCI) and compare with THI index.
The findings of this study indicate that the best time of the year to attract visitors is February that is classified to be "excellent" for tourism. TCI result shows that conditions are not suitable for tourism from June to September because of high temperature. Moreover, based on THI calculation, THI result is different with TCI in May and October. THW shows different result only in May

Keywords: climate, tourism, tourism climatic index (TCI), THI index

1. Introduction

Climate has a strong influence on the tourism and recreation sector, and in some regions of the world constitutes the resource on which the tourism sector is predicated. Weather and climate play an important role in destination selection because tourists are sensitive to climate and to climate change [1], [2]. The climate is at least the third most common attribute in tourists' decision-making [3]. As an effective factor, climate is significant due to its neural and mental effects on tourists, it is valuable in choosing a destination for spending holidays [4].

Since 1960s, numerous such metrics have been developed and applied [5], [6]. One of these, the Tourism Climatic Index (TCI), has more recently been used to analyze the potential impact of climate change on tourism. The tourism climatic index (TCI) was originally conceptualized by [7] as a composite measure that would systematically assess the climatic elements most relevant to the quality of the tourism experience for the 'average' tourist (i.e., the most common tourism activity for sightseeing and shopping).

The climatic potential of tourism to Batumi by TCI. The results displayed that Batumi relates to the cities with bimodal-shoulder peak TCI distribution [8]. The climate of Batumi for tourism is favorable practically entire year. Some areas will gain attraction due to the warming because it creates a more favorable temperature range for tourism [9]. The number of cities in the US with a favorable TCI rating in the winter months was expected to increase while TCI ratings in Mexico were likely to decrease due to the projected heat and sultriness.

In other study by means of TCI index concluded that cities of Maku, Ahar, Ardebil, Takaab, and Khoy (Iran) have summer peaks, with Ardebil exhibiting the best condition for tourist attraction in summer [10].

There are two famous ancient places in Khuzestan province. Many foreign and domestic tourists visit them. The main purpose of this research is to determine the suitable times regarding climatic conditions in Dezfoul for attracting tourists. This research has used the tourist comfort climatic Index.

2. Data and Method

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The following is an example of the "Bullet" style, which you may want to use for lists. The most widely known and applied indices is the Tourism Climatic Index (TCI) proposed by Mieczkowski (1985). Meteorological data limitations reduced number of climatic variables that were integrated into the TCI to seven (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 seven climatic variables were combined into five sub-indices that comprised the TCI. Calculating the TCI developed by Mieczkowski (1985) by means of the following formula:

$$TCI = 8\,CID + 2\,CIA + 4\,R + 4\,S + 2\,U \quad (1)$$

Day time comfort index (CID) score was determined by two parameters including monthly maximum dry temperature and the minimum relative humidity. Daily time comfort index (CIA) score was done aa mean dry temperature and mean relative humidity. Precipitation ®, Sunshine(S) and wind speed(U) score based on table that presents by Mieczkowski (1985**).** TCI point is divided into 10 categories described climatic conditions for tourism TCI founded on seven meteorology parameters. Human comfort conditions are calculated by some other indices based on a combination of various meteorological parameters.

Temperature-Humidity index (THI) is one of comfort indices. THI is calculated by mean of dry bulb temperature and relative humidity. THI equation is followed:

$$THI = T - (0.55 - 0.55RH)(T - 58) \quad (2)$$

RH shows relative humidity and T is dry bulb temperature ($\dot{C}$). Different formula applies to THI calculation with other humidity index example in dew-point and wet dry bulb temperature. In THW equation, wet dry bulb temperature T_w is used.

$$THI = 0.4(T + T_w) + 10 \quad (3)$$

TCI and THI results compare to finding meteorological parameter effects in comfortable conditions.

In this study Dezfoul is chosen for TCI and THI analysis because it is near Chogha Zanbil and Apadana. For Dezfoul, all of the climatic data is a 20-year monthly for the period 1986-2005 and was provided by the Meteorological Service. Every month data were extracted and then the necessary conversions based on TCI model and THI were applied.

3. Discussion

Figure 1 shows the TCI value of Dezfoul in every month. TCI scores are somewhat higher in some months of autumn and winter (February, March, and November) than other months. According to the classification of TCI distributions, adapted from [9], the dominant seasonal regime in Dezfoul is the winter peak regime (see Figure.1). Dezfoul has a maximum score of TCI in February. Two period March-April and November are in next priority. In summertime (June, July, September and August), scores are consistently low so that corresponds to the category "insignificant" . July considered to be the worst month for tourism in terms of climate in Dezfoul. The five sub-indices of the TCI contribute differently to the TCI score at each month. The sub-indices change from month to month and the disparate climatic strengths of Dezfoul. Dezfoul has a maximum score of TCI (80) in February, thereby classifying as having 'excellent' (table. 1). CID (maximum temperature and minimum relative humidity), Precipitation and sunshine duration make the best climatic conditions for tourism in Dezful city.

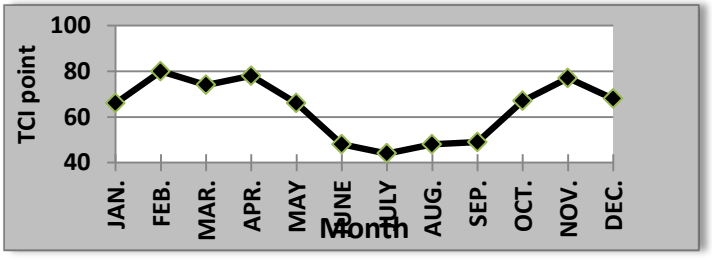

Fig. 1: Monthly TCI in Dezfoul (1986-2005)

Other months March, April and November are in next priority to categorize “very good”. March is the lowest among them. Here the thermal sub-indices (CID) contribute maximum values in March, April and November. In spite of the fact that CID (thermal comfort) is less in April, Precipitation, CIA and sunshine duration contribute to the increase of TCI Score rather than two other months. March has the lowest score among them because of CIA (daily comfort) and Precipitation score.

January, May, October and December are considered as a category “good “. Their values are close to each other 66-68. It is found by table 1, May and October are the same in sub-indices score. On the other hand, January and December are the same. There are obvious different CID values between two groups. CID value is 20 in May and October while it is 36 and 40 in January and December. It means that in January and December “good” score due to suitable temperature and relative humidity (daytime comfort) and Precipitation role is the same as CID score. So, these months are in “good” position due to rainfall and good weather. Consequently, Precipitation, CIA and sunshine duration provide suitable climatic conditions for tourism.

There is also evidence to suggest that warmer summer temperatures contribute to decreased tourism expenditures in Dezfoul. June, July, August and September owing to the hotness of weather (high temperature) are considered as having the worst conditions for tourists’ presence (table 1). CID score is zero in these months, especially, because this is caused only by excess temperature. Formally, these months can be attributed to the category of "insignificant," except for July, the values of TCI are very close to the category of “Acceptable.” Low precipitation and abundant sunshine are climatic assets in summer time and cause these months not to fall to “inappropriate” conditions (table 1). There is not “acceptable” condition in Dezfoul (values 50-59).

In general, as it follows from the table 1 the values of daytime comfort index (CID varied from 0 to 40), Precipitation and daily sunshine duration (P and S varied from 8 to 20) make the greatest share of the value TCI. Maximum values CID is 40 score in February, March, November and December that have “excellent” and “very good” score. The minimum values of daytime comfort index (CID) and the wind speed (W varied from 1 to 9) make the smallest share to the value TCI, especially in summer. CID score is zero and the wind decreases to 1 score in the summer. The share of Daily comfort index (CIA) is from 3 to 10. It is found that maximum CIA values 10 occur in April and October. They have “very good”, so daily thermal condition in the later month is better than other months. The worst that has “insignificant” is in July. By seeing the table 1, maximum values of Precipitation score is 20 that means precipitation is 0 to 14.9 mm/month, suitable for outdoor activities, and display in summer months with “insignificant” climatic conditions. The sunshine duration score is the same as precipitation. Although it provides a good situation for outdoor activities, it may cause sunburn. In summer months, precipitation and sunshine duration contribute to the increase of TCI score in Dezfoul. Wind speed has the least score in summer month and the most in January and December. So, it should be noted that wind speed is the most unfavorable factor, which reduces value of TCI in summer months and January because of flowing warm wind and cold wind. –Furthermore, the lowest and the highest wind score occur in “good” and “insignificant” climatic conditions. None of sub-indices have a relatively stable contribution to the TCI throughout a year in Dezfoul climate.

Table. 1: TCI point in Dezfoul (1986-2005)

Month	CID(40)	CIA(10)	P(20)	S(20)	W(10)	TCI	Descriptive-TCI
JAN.	36	5	8	8	9	66	Good
FEB.	40	5	14	12	9	80	Excellent
MAR.	40	7	10	12	5	74	Very good
APR.	32	10	16	14	6	78	Very good
MAY	20	9	20	16	1	66	Good
JUNE	0	7	20	20	1	48	Insignificant
JULY	0	3	20	20	1	44	Insignificant
AUG.	0	5	20	20	3	48	Insignificant
SEP.	0	6	20	20	3	49	Insignificant
OCT.	20	10	20	14	3	67	Good
NOV.	40	8	14	10	5	77	Very good
DEC.	40	5	8	6	9	68	Good

In general, THW values are less than THT(table 2). Most of people feel uncomfortable showing by both of THT and THW in July and August, but THT and THW comfort conditions are different in June and September. It was found that TCI score is insignificant in June, July, August and September (table 2.). So it seems, THW results confirm TCI score in summer time rather than THT. In addition, January, May, October and December put on "good" category in TCI index. In January and December most people feel comfortable by THT and THW index. In May and October months half and few people feel comfortable. It can be found that May and October have different weather conditions because they are transient months. Spring is the season of transition from winter to summer, and autumn is vice versa. Spring weather passes into summer in May, and summer passes into autumn in October. So, except temperature and humidity, other climatic parameters including precipitation, wind speed, and sunshine duration are important in transient months. Only temperature and humidity can be used for calculating comfort conditions in the summer months.

Table. 2: THI comfortable values in Dezfoul (1986-2005)

Month	THT	Comfortable conditions	THW	Comfortable conditions
JAN.	53.02	Most people feel comfortable	55.22	Most people feel comfortable
FEB.	55.76	Most people feel comfortable	56.64	Most people feel comfortable
MAR.	61.45	Most people feel comfortable	61.44	Most people feel comfortable
APR.	69.72	Most people feel comfortable	68.09	Most people feel comfortable
MAY	76.23	half people feel uncomfortable	72.80	Few people feel uncomfortable
JUNE	80.19	Most people feel uncomfortable	75.91	half people feel uncomfortable
JULY	82.78	Most people feel uncomfortable	79.15	Most people feel uncomfortable
AUG.	82.53	Most people feel uncomfortable	79.32	Most people feel uncomfortable
SEP.	77.77	half people feel uncomfortable	74.70	Few people feel uncomfortable
OCT.	72.09	Few people feel uncomfortable	69.89	Most people feel comfortable
NOV.	63.01	Most people feel comfortable	62.72	Most people feel comfortable
DEC.	55.39	Most people feel comfortable	57.11	Most people feel comfortable

4. Conclusion

The findings of this study indicated that the best time of the year to attract visitors is February that is excellent for tourism. Plus two other times including spring (March and April) and autumn (November) are very good for tourism based on TCI. Nowruz holidays are held in March in Iran. So this month could be favorable for tourism. But in the other three months, suitable facilities should be provided for tourism and it should be better that travel agencies arrange some tours for these months. TCI result showed that conditions are not suitable for tourism from June to September because of high temperature..

CID value was 20 in May and October while it was 36 and 40 in January and December. It means that in January and December "good" score due to suitable temperature and relative humidity (day time comfort) and Precipitation role was the same as CID score. So, these months were in "good" position due to rainfall and good weather. Consequently, Precipitation, CIA and sunshine duration provided suitable climatic conditions for tourism. There was also evidence to suggest that warmer summer temperatures contribute to decreased tourism expenditures in Dezfoul. June, July, August and September due to the hotness of weather (high temperature) were considered as having the worst condition for tourists' presence

THI finding showed different results with TCI in May and October, but THW indicated a different result in May. Because TCI calculation used some other meteorology parameters, it could be more accurate. Between THW and THI, THW has a better result than THI. Only temperature and humidity could be used for calculating comfort conditions in the summer months. In contrast, in the other months it was better to consider the effects of other climatic parameters.

In the future we plan a more detailed study of the climatic resources of Khuzestan province for the tourism (calculating TCI for another city in this province, study trends of TCI, determination of other climates and bioclimatic indices for tourism, etc.).

5. Reference

[1]. D. Maddison, 2001. In search of warmer climates? The impact of climate change on flows of British tourists. *Climatic Change* 49:193–208

[2]. A. Bigano, J. M. Hamilton, Tol RSJ. 2006. The impact of climate on holiday destination choice. *Climatic Change* 76: 389–406.

[3]. J. M. Hamilton, , M. A. Lau 2005. Tourism and global environmental change: Ecological, social, economic and political interrelationships. London: Routledge, Taylor and Francis Group. 229–250.

[4]. C. R. De Freitas, D. Scott, G. McBoyle, 2008. A second generation climate index for tourism: specification and verification. *International Journal of Biometeorology*, 52, 399-407.

[5]. J. P. Besancenot, 1990. Climate et tourisme. Massonedit. Collection geographie: Paris.

[6]. C. R. De Freita, 2003. Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *Int. J. Biometeorology 48*: 45-54.

[7]. Z. Mieczkowski, 1985. The tourism climate index: A method for evaluating world climates for tourism, *The Canadian Geographer* . 29: 220-233.

[8]. A. Amiranashvili, A. Matzarakis, L. Kartvelishvili, 2008. Tourism Climate Index in Tbilisi, Papers of the Int. Conference International Year of the Planet Earth "Climate, Natural Resources, Disasters in the South Caucasus". *Trans. of the Institute of Hydrometeorology*, 115 : 27 - 30. ISSN 1512-0902, Tbilisi, 18 – 19 November.

[9]. D. Scott, G. McBoyle, M. Schwartzentruber, 2004. Climate change and the distribution of climatic resources for tourism in North America. *Climate Research*. 27: 105-117.

[10]. H. Farajzadeh, A. Matzerakis, 2009. Quantification of Climate for Tourism in The Northwest of Iran. *Journal of Meteorological Applications*. 16 (4): 545 – 555.