DESERT

National assessment of climate resources for tourism seasonality in Iran using the tourism climate index

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Abstract

Weather and climate have a strong influence on tourism and the recreation sector, which is a very important industry. Since tourism is becoming one of the main industries all over the world, it plays an important role in promoting national and local economic development. This paper attempts to show the role of climate in tourism seasonality and tries to study the impacts of climate resources on tourism seasonality using the Tourism Climate Index (TCI) in Iran. This index systematically evaluates climatic conditions for tourism activities using climate parameters. To assess Tourism Climate Index in Iran, 54 weather stations were selected. The results have been generalized in 12 monthly world maps using ArcGIS10.1. According to the results, April and October are the best time for tourism during the year, actually more area of Iran has the good potential during these months. In January and February, potential of TCI decreased and the lowest area are located in suitable class. While, based on Scott and Mc Boyle classification summer peak, dry season peak, Bi-modal shoulder peak and winter peak can be seen in Iran, most of Iran is classified in Bi-modal shoulder peak. South, south east and west of Iran have the best condition in winter peak. The peak in dry seasons including dry and without rainy seasons have the best situations in west north and east parts of Iran. Bi-modal shoulder peak, in spring and autumn, are seen in north, all east and center of Iran toward west and west east.

Keywords: Climate; Tourism; Season; TCI; ArcGIS; Iran

1. Introduction

Recreation is viewed as a main factor for maintaining physically and mentally adult health. The recreation purpose is physical or psychological revitalization by the voluntary pursuit of leisure time. Recently, investigation on tourist destinations has been done at the international academic research center (Bakhtiari and Bakhtiari, 2013; Lemaire and Viassone, 2014). With international tourism receipts of about 439 billion dollars, tourism was a major sector of the global economy in 1998 (World Tourism Organization, 1999).It has been proposed that there will be around 1.6 billion international tourist arrivals by 2020, spending over 2 trillion dollars (World Tourism Organization, 1998). Statistics data of World Tourism and Travel (WTTC) showed that the travel and tourism direct contribution to the global economy increase by 3.1% in 2013, accounting for 9.5% of total gross domestic product, one in 11 of the world's jobs, 5.4% of world exports, as well as 4.4% of global investment (WTTC, 2014). Eachzone has a specific natural resource including landscape, topography, geographical location, flora and fauna as well as weather and climate conditions for recreation and tourism (Brosy *et al*., 2013). These factors determine the attractiveness of a zone and play an important role in tourism potential limitation (De Freitas, 2001, 2003; Matzarakis, 2006). Iran with its rich natural and historical resources is one of the 10 excellent countries of the world in regard to the tourism-attraction (Iran Tourism Organization, 2008).

One of the most effective impacts of climate change on tourism is the redistribution of

climatic assets among tourism regions, with subsequent implications for tourism demand, travel patterns and tourism seasonality (Scott *et al*., 2004; Babaeiana, 2013). Despite the climatic resources importance, few researches have comparatively studied the relationships between tourism and climate (De Freitas, 1990; Wall, 1992; Smith, 1993; Perry, 1997). Tourism is a very highly climate-sensitive human activity that depends on a diverse set of climate variables for example rainfall, temperature, relative humidity, hours of sunshine and wind speed (De Freitas, 1985, 1990). Climate and weather have an important effect on the spatial distribution of tourism resources (e.g., tourism climate resources patterns), tourism zone (e.g., the zone for sun and beach tourism or winter sport tourism), tourism seasons (e.g., snow cover for sky), tourism supply and demand (e.g., tour schedules of travel agencies and tourists), etc. In other words, climate and weather can be featured as a significant attraction for tourists. The Iran's diverse climatic conditions provide a tremendous potential to develop tourist resort (Day *et al*., 2013). Seasonal tourism is a main issue that has been noted by tourism researchers for several decades.

When discussing the seasonal tourism of climate resources, one should select a proper index for assessing tourism climate (Fang and Yin, 2015). Several indicators have been developed to assessment of the climate suitability for tourism activities (Mieczkowski, 1998. Matzarakis *et al*., 2001, 2004. Scott and Mc Boyle, 2001). These indices were developed by the aim of assessment of the climate suitability for tourism that could be used in decision making by tourists and the tourism industry (Scott *et al*., 2004).

The tourism climate index (TCI) is the most widely famous and applied index that proposed by Mieczkowski (Mieczkowski, 1985). This index is combination of seven factors and parameters. Mieczkowski's "Tourism Climate Index" (TCI) was provided to use climate data, being widely available for tourist around the world (Mieczkowski, 1985). The TCI is the most comprehensive climate index that developed specifically for tourism. The TCI concept was originally a composite measure for assessment the climatic factors most relevant to the tourism experience quality for general tourism activities occurring everywhere from urban area to the national parks (Verbecke, 2001).

Jacqueline *et al*.(2007) in a study entitled: impact of climate change on tourism in Germany, Great Britain and Ireland, came to the conclusion that models show that during future years according to climate changes in Britain and Ireland, tourism attractions would have easy and quiet movement towards more northern areas. In Germany, due to warmer weather and the creation of favorable conditions in the inner regions of the country compared to coastal regions, tourism attraction flow is toward south. Gandomkar (2014) investigated on time and location distribution of tourism climate index in Isfahan concluded that October is the best time for presentation of tourists. After that, there are May and April. January February, March, July, August, and December have the best situations for presentation of tourists. Central parts of the province have the better situations for attracting tourists than other areas.

Hein *et al*. (2009) investigated on tourism status in Spain by TCI method. Pointing to summer season in terms of optimum comfort tourism status has predicted there would be no difference in situations by 2060.

Moreno and Amelung (2009) investigated on effects of weather, looking specifically at coastal tourism in the summer; especially the Mediterranean predicted that status of tourism in the next 50 years will be the upper limit. Hence, due to the climate more attention is paid to maintaining the environmental quality of the region.

Li *et al*. (2017) introduced Relative Climate Index using TCI method studied for the city of Hong Kong than 13 other Chinese city. The results showed that the intra annual relative climate positively influences tourism demand in Mainland regions, where the climate is significantly different from the climate in Hong Kong.

Scott *et al*. (2016) comparing the Tourism Climate Index (TCI) and Holiday Climate Index (HCI) illustrate how the HCI Urban rates the climate of many cities higher than the TCI in Europe, particularly in shoulder seasons and the winter months, which is more consistent with observed visitation patterns.

Fang and Yin (2015) by examining the TCI in China came to the conclusion that a good number of months in terms of tourism throughout China from zero (the Tibetan plateau region) to 10 (Yunnan Province) per year is different. Kubokawa *et al*. (2014) investigated on the effect of climate on tourism in Japan has concluded that TCI is positively correlated with the number of tourists.

Iran requires different capabilities for attracting tourists, so identifying and assessing relief climate by acceptable scientific methods is necessary to determine impact of climatic

elements on activities of tourists systematically. This paper aimed to apply the TCI developed by Mieczkowski (1988) to make determinations of the most suitable months for areas for tourism and tourist activities in Iran which is the first attempt to use this index for all over Iran.

2. Materials and Methods

2.1. The Study Area

Iran is located between 25°3′–39°47′ N in latitude and 44°5′–63°18′ E in longitude in the south-west of Asia (Figure 1). The total area of Iran is approximately 1,648,195 km². In general, a year can be divided into two warm and cold seasons. Iran is one of the unique countries in terms of climate, and weather conditions are very different in Iran. It is a vast country with different types of climate: continental and arid in the plateau, desert and hot in the southern coast and the southeast wet and mild on the coast of the Caspian Sea, cold in high mountains. In most of the areas, summers are warm to hot with virtually continuous sunshine, but high humidity on the southern coastal areas of the Persian Gulf. Daily temperatures can be very hot; on some days temperatures can reach easily 40°C or more, especially along the Persian Gulf and Oman Sea which causes a danger of heat exhaustion. In most of the areas, summers are warm to hot with virtually continuous sunshine, but high humidity on the south coastal areas of the Persian Gulf. Daily temperatures can be very hot; on some days temperatures can reach easily 40°C or more, especially along the Persian Gulf and Oman Sea which causes a danger of heat exhaustion (Farajzadeh and Ahmadiyan, 2014).
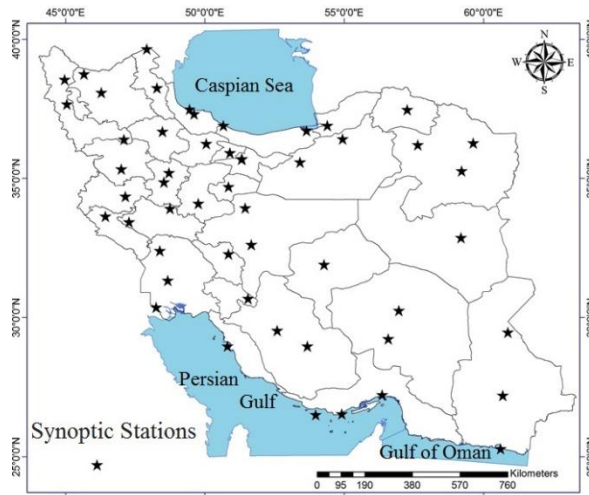

Fig. 1. Iran's geographical location and studied synoptic stations

2.2. Methodology

This investigation is an attempt to evaluate Iran tourism climate by TCI. Score of TCI than other indexes is so this index uses all important climate variables such as temperature, humidity, raining, sunny times, wind which control thermal conditions of the human body. The climate index is composed of five sub-indices. The sub-index measurement is done by different climatic variables. These variables include the average maximum daily temperature, mean daily temperature, daily minimum relative humidity, mean daily relative humidity, precipitation, total sunshine hours and average wind speed (km/h). It should be noted that each of the sub-index are weighted by respect to the importance and impact on tourists (Table 1).

Table 1. Sub-indices characteristic of 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 24h	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

In this study, the tourism climate index was conducted in the following steps:

2.2.1. Selecting weather stations

In this investigation for calculating TCI, data of 54 weather stations were selected in different provinces of Iran, at least on station in each province (Figure 1).

2.2.2. Calculating sub-indices of CID and CIA using effective temperature index curves

Daytime Comfort Index (CID) was calculated using average monthly maximum temperature and minimum relative humidity of air. Daily Comfort Index (CIA) was calculated by monthly average temperature and average relative humidity (Figure 2).
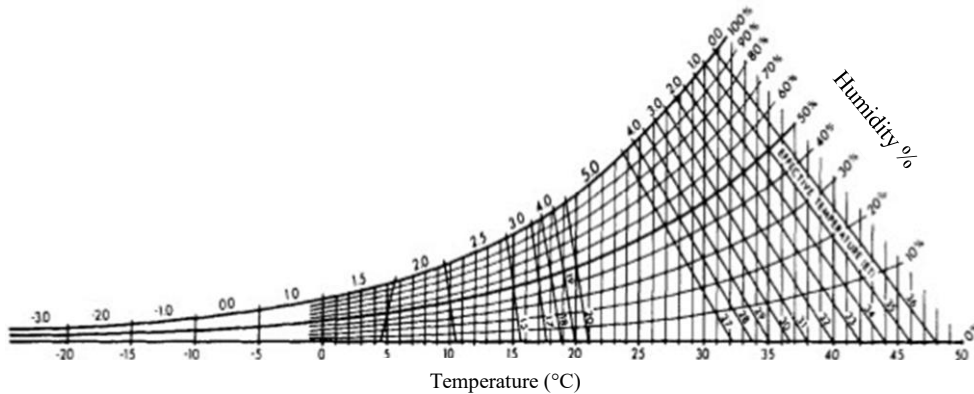

Fig. 2. Classification of thermal comfort climate condition tourism on base of effective temperature index (Mieczkowski, 1985)

2.2.3. Calculate the P index or precipitation

Rainfall plays significant role on tourist's climate relief through the precipitation amount and the time distribution (Saraf Sari *et.al*, 2010). The short-term storm rainfall is more tolerable for tourist than a long-lasting rainfall style. In this sub-index the absolute amount of monthly precipitation is considered. By calculating the amount of monthly precipitation, rank of the sub-index is obtained (Table 2). This weight shows the negative effect of high rainfall on the leisure and tourist easiness.

Table 2. Rank determination related to raining for each station

Rating precipitation	Total monthly rainfall
5.0	0.0-14.5
4.5	15.0-29.5
4.0	30.0-44.9
3.5	45.0-59.9
3.0	60.0-74.9
2.5	75.0-89.9
2.0	90.0-104.9
1.5	105.0-119.9
1.0	120.0-134.9
0.5	135.0-149.9
0.0	>150.0

2.2.4. Ranking of sunshine (S)

In general, sunlight has a positive effect on tourism activities. This effect is important both psychologically and in terms of image quality taken by tourists (Farajzadeh and Ahmedabadi, 2010), but the factor will has the disturbing effect on tourists in hot climates or in the warm months (Hassanvand *et al.*, 2011).Having daily average sunshine hours the rank of this index is determined (Table 3).

2.2.5. Rate of wind speed indicator (w)

Wind in the tourism climate is a positive index and changes from zero to 5 as the ideal point. Estimating wind rate is different in different climates. For normal systems, the mean maximum air temperature is between 15 and 24 degrees centigrade. In Elysee system temperature is between 24 and 33 degrees centigrade, but in warm climate system the temperature is more than 33 degrees centigrade. After determining the type of system and the average monthly wind speed, wind speed index is rated according to the Table (4).

Table 3. Rank determination of radiation for each station

The number of sunshine hours per day	Radiation Rank
10.00 and more	5.0
9.00-9.59	4.5
8.00-8.59	4.0
7.00-7.59	3.5
6.00-6.59	3.0
5.00-5.59	2.5
4.00-4.59	2.0
3.00-3.59	1.5
2.00-2.59	1.0
1.00-1.59	0.5
<1.00	0.0

Table 4. Rank determination related to wind for each station

Wind speed (km/h)	Normal System	Elysee system	Warm climate system
<2.88	5.0	2.0	2.0
5.75-2.88	4.5	2.5	1.5
9.03-5.76	4.0	3.0	0.5
12.23-9.04	3.5	0.0	0.0
19.79-12.24	3.0	5.0	0.0
24.79-19.8	2.5	4.0	0.0
28.79-24.3	2.0	3.0	0.0
38.52-28.8	1.0	2.0	0.0
>38.52	0.0	0.0	0.0

2.2.6. Calculating TCI in different months

After calculating the rate of each sub-index, the rates are put in the TCI formula (Eq. 1) and the TCI is calculated:

$$TCI=2[(4\times CID)+CIA+(2\times P)+(2\times S)+W] \qquad (1)$$

It should be noted that after calculating the Eq 1, the obtained rate is between 0-100 that each amount shows the quality of tourism climate in the region. The final obtained value is adjusted by the table (5) and ultimately the quality of tourism climate of an area is specified.

Table 5. Classification of TCI

Rating System for TCI	Descriptive value for TCI
90-100	Ideal
80-89	Excellent
70-79	Very good
60-69	Good
50-59	Acceptable
40-49	Marginal
30-39	Unfavorable
20-29	Very unfavorable
10-19	Extremely unfavorable
Below 9	Impossible

2.2.7. Zoning and classification of TCI in Iran

After calculating sub-index and TCI for each of the 54 stations, monthly zonation map of each sub-index TCI were provided by ArcGIS10.1andmonthly TCI maps were classified according to table (5) and the graphs of TCI changes were drawn for different months.

2.2.8. TCI zoning based on Scott and Mack Boyle classification (2001)

Scott and Mc Boyle (2001) introduced 6 classes for TCI according to the monthly change in the index (Table 6).

Table 6. Annual Classification of TCI

Class	Description
Optimal	TCI scores ≥ 80 for each month of the year
Poor	TCI scores < 40 for every month of the year
Summer peak	Summer is the best season in terms of climate conditions
Winter peak	Winter is the best season in terms of climate conditions
Bi-modal shoulder peak	Spring and fall months are more suitable for tourism activities in terms of climate conditions
Dry season peak	The dry season is more conducive to tourist activity in terms of climate conditions

3. Results and Discussion

In this research, TCI was calculated and then zoning map of TCI was provided for each month. According to the results in December, the first month in winter, due to raining and wind, TCI decreased in northern parts of Iran up to centers. Most of these areas replaced in acceptable class (44.1% of total square of Iran) and in some area is classified in marginal class. In the South East, East and on the sidelines of Oman Sea and the Persian Gulf are places in ideal good class (Figure 3, December).

In January, 5.47 percent of Iran belongs to the acceptable class. In northwestern of Iran marginal and unfavorable class are common and only the north east and the sidelines of Oman Sea have good potential for tourism in this month (Figure 3, January). In general, it can be stated that in winter, most parts of Iran placed in acceptable class, and favorable conditions for tourism can be observed in the South and South East.

In March, conditions is improved in terms of tourism and 89.8 percent of Iran is in the excellent and good class and all of South and Central parts of Iran are in excellent condition of TCI.

In April, due to increasing temperature than previous months (December, January, February and March), TCI is better in southern parts of Iran rather than northern parts and excellent class belongs to these regions covers 32.2%. Also Northern parts have better TCI than previous months and located in good class (Figure3, March). In April, tourism potential decreases in southern parts but increases from north east to south east toward center and west south; more than 55.5% of Iran is located in excellent class. Only a small percentage is belonged to acceptable class (Figure 3, April).

Ideal class, covers 24.5% of Iran, increases in May than the previous months and 45.8% of Iran is placed in excellent class. Tourism indicator is not desirable in the southern part of the Persian Gulf and Oman Sea due to rising temperatures in this month, and TCI has decreased in May (Figure 3, May). It can be concluded that in spring season, due to increasing temperature and day length that is along with increasing sunny hours, TCI increases than winter season and reaches to its maximum amount in the last month of spring season.

In June, with rising temperatures tourism potential is fallen. There is ideal conditions for tourism in North West of Iran and much more area of Iran with 34.1 percent belongs to the very good class in this month. In the southern part of Iran due to high temperature and increasing sunshine hours, TCI is placed in acceptable and marginal class (Figure 3, June). In July in all over the Iran, due to increasing temperature mean and warm weather, tourism potential decreased and52% of Iran is placed in good class. In this month, North West of Iran is in better situation than other regions of Iran (Figure 3, July). In August, North West of Iran have better situation than other regions. In August, along with better situation of the average temperature, percent of excellent class becomes higher and ideal class can also be seen, acceptable class has been reduced too. In south of Iran, there is also marginal and acceptable class. The most percentage of area in this month is41.5% belongs to good class (Figure 3, August). In summer season, due to increasing temperature mean we faced with decreasing tourism potential especially in southern parts. This index increases along with the balance of mean temperature in last summer.

In September, the tourism potential is located in the ideal class in the northwest and northeast toward the central area. 34.1 percent of Iran classified in excellent class. It can be said that tourism potential in good condition in all parts of Iran except in southern parts where the class of acceptable has decreased (Figure 3, September).

In October 68.9 percent of the country is in excellent class due to the weather moderate, that is the highest amount during the year. This month has the best conditions for tourism index in Iran. In this month also unfavorable and acceptable conditions are seen in some parts of the south, but the percentage of the class has been reduced compared to previous months (Figure 3, October).By reducing the average temperature in November, the potential of tourism in northern Iran has declined. From center of Iran toward south of Iran, there are the best potential of tourism, and 32.2% of Iran is placed in excellent class. In the North and North West of Iran, acceptable and poor classes are seen (Figure 3, November). In autumn tourism potential has increased. In this season, the most percentage of excellent percentage in Iran observed. In the beginning of this season, in southern areas, tourism potential is not well, but at last season we observe increasing tourism potential in these areas, as the best tourism potential allocated to these areas.
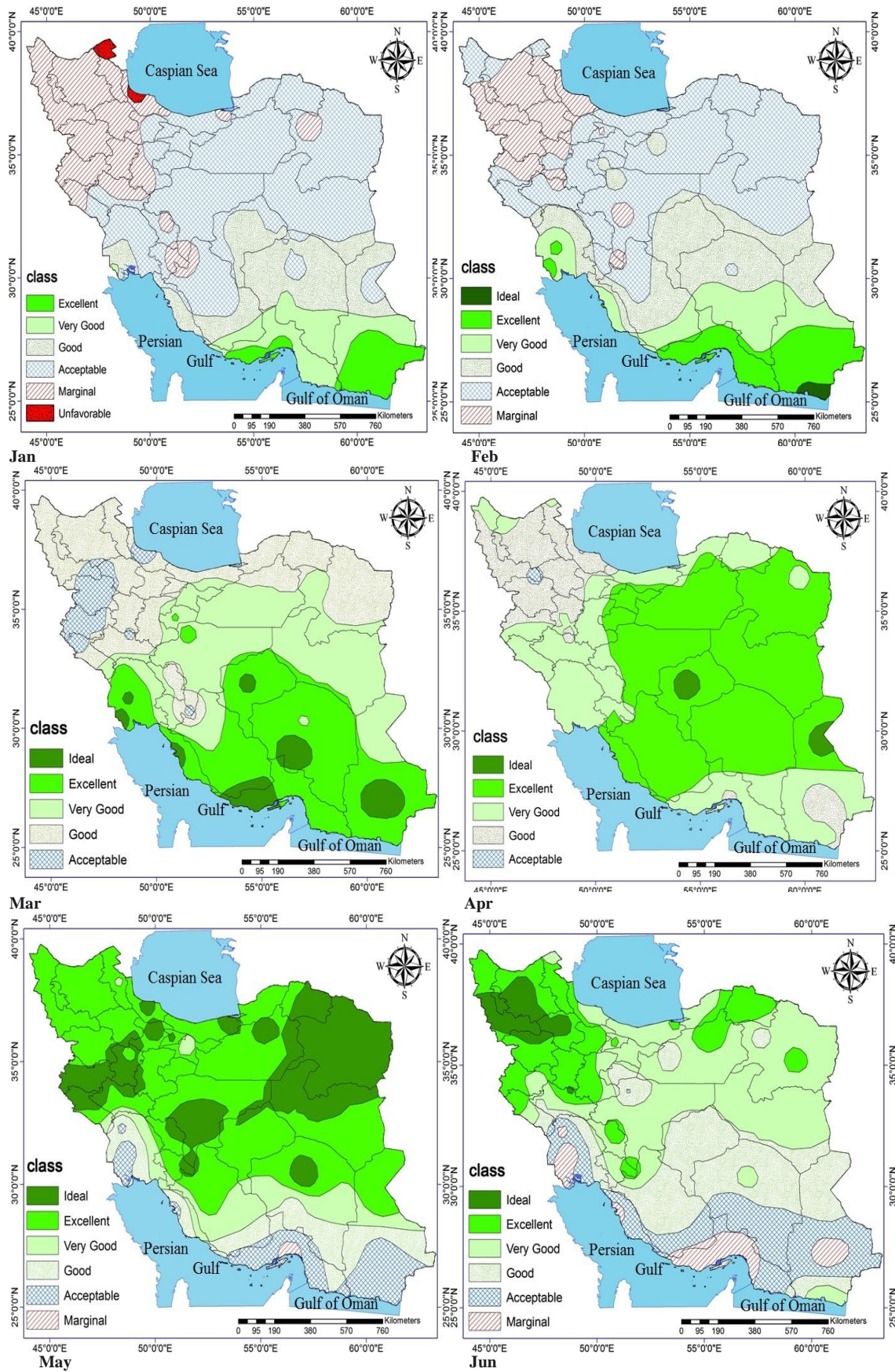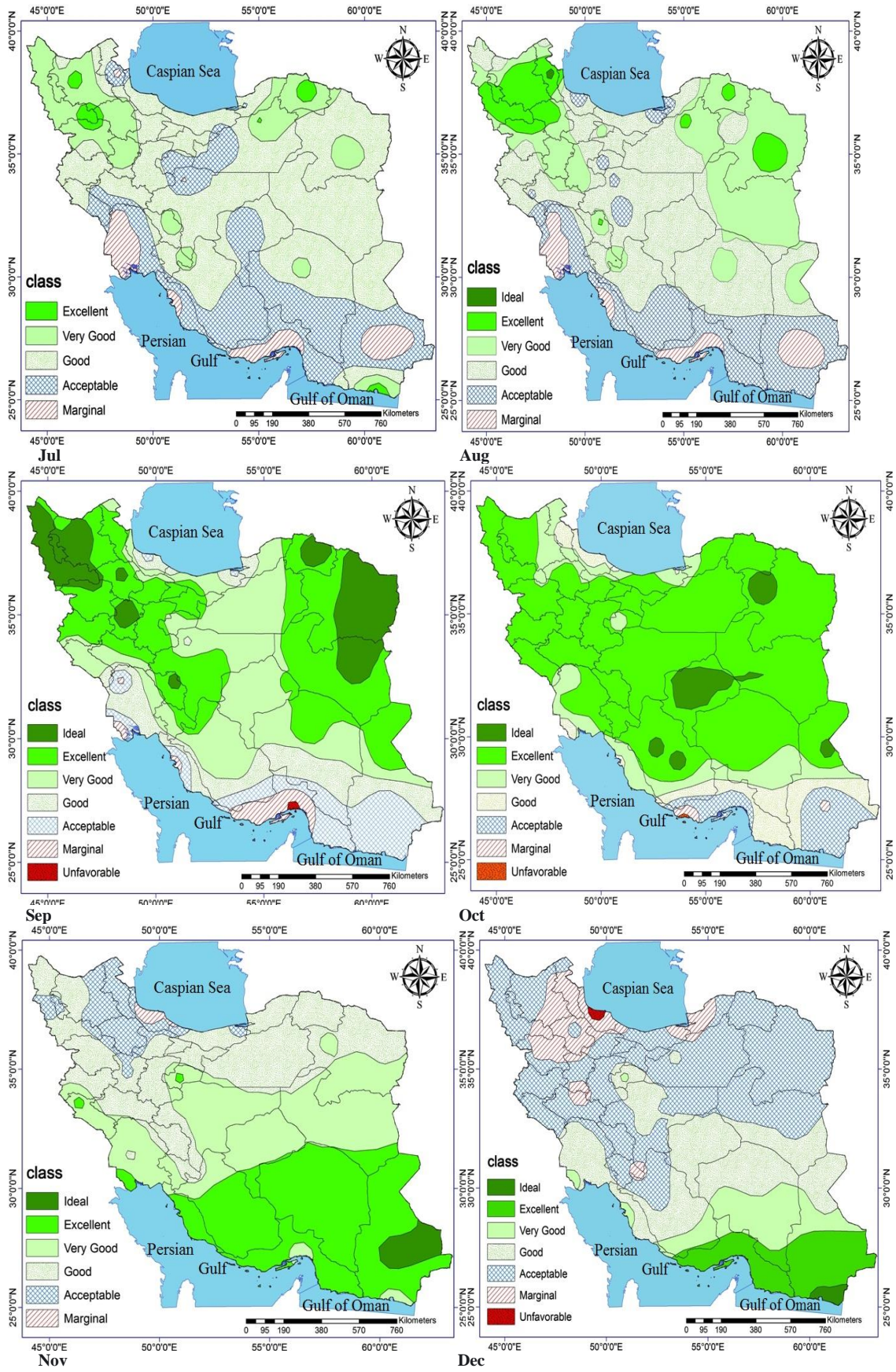
Fig. 3. Zonation map of Iran TCI in different months

Continued Fig. 3. Zonation map of Iran TCI in different months

Figures 4 and 5 show the mean changes of five-sub index (CID, CIA, R, S and W) for Iran. According to figure 4, it is concluded that sub-index CIA in August and September is in the highest amount. Sub-indexes CID and W in summer have the fewer amounts and have negative effect on TCI, and the highest amount of CID index amount belong to October as 4.2 values. Sunshine index like CIA is in the highest value in summer and fall.

Changing trend of R index: is steady, and its fewer amounts is in March, and its effect on TCI is negligible.
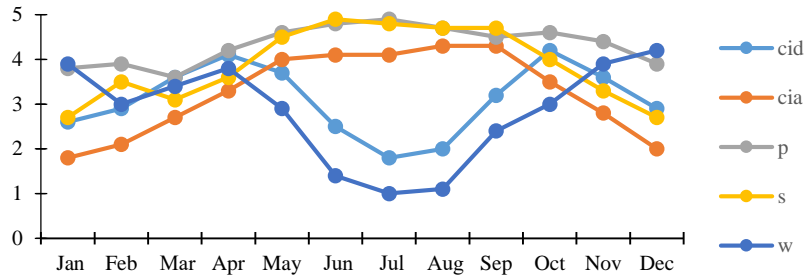
Fig. 4. The mean changes of TCI sub-indices in Iran

According to the figure (5), it can be stated that TCI average has the same trend of CID, and TCI average is decreased in summer, and the highest value of this index happens in spring and fall. Additionally, the less values of TCI average are respectively in January, February, and December.
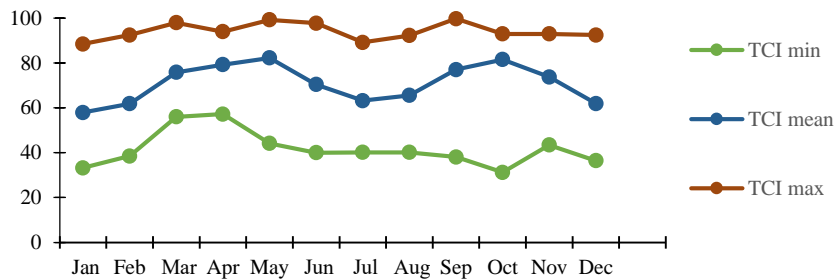
Fig. 5. The mean, min and max changes of TCI sub-indices in Iran

The annual classification results based on Scott and Mc Boyle classification of TCI show that 66% of Iran are located in peak class in mild seasons (Bi-modal shoulder peak), 13% in winter peak, 19.5% in dry season peak and 1.5% in summer peak (Figure 6).
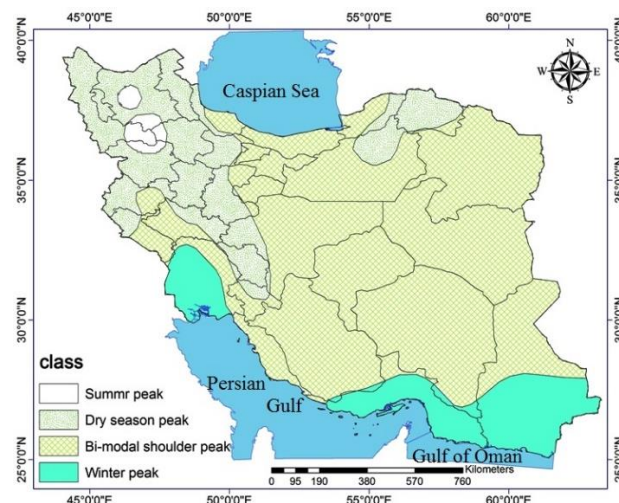
Fig. 6. Classification of TCI based on Mc Boyle and Scott classification

4. Conclusion

This paper presents an empirical analysis of the climate impact on tourism seasonality in Iran during, by combining high quality national meteorological datasets with GIS. According to studying relief climate index, TCI in Iran is very diverse, as seven regions could be determined based on annually TCI specifications. Each class has unique specification, and based on it has different tourism climate conditions during a year. In winter, TCI average has the fewer amounts during a year (Roshan *et al.*, 2015) that is due to decreasing temperature and increasing raining in most points of Iran. But in southern parts of the country where temperature is higher associated with increasing potential of tourism in this season. When spring starts, CID index increases due to increasing temperature mean as in April it reaches to its maximum value in first six months. This trend decreases due to warm weather in summer in May. When summer starts, situation of weather is bad for tourism by increasing day length. CID sub-index decreases in this season, and it is minimum amount in July. CID sub-index in this season increases up to peak point, but paying attention to its low effect on TCI has no impact on this index. Change trend in wind sub-index is such as CID sub-index. Temperature is high in southern areas in this season, wind impacts on TCI negatively. Sundial sub-index in this season has reached its peak and it is noteworthy that the effect of this sub-index in high temperature is negative on TCI. in this season, for the mentioned reasons, the percentage of classes square that are suitable in terms of tourism reduced and the poor areas has increased.

By the end of the summer and enter into the autumn, sub-indices that have a high impact on tourism index has begun to rise. This trend reached to its maximum amount. This trend for CID sub-index in October reaches to its maximum amount in year which results in being the best tourism potential in year in this month. Gradually we reach to autumn season and face with decreasing CID sub-index along with decreasing temperature. Wind sub-index with its positive or negative impact according to temperature, has increasing trend in this season. Sunny hour sub-index deceases along with decreasing day length. Tourism potential is not appropriate in September and October in southern areas, but in November tourism potential increased in south of Iran.

According to Scot and Mc Boyle classification, it is stated that the best situation in Iran belongs to peak class in mild seasons including spring and autumn seasons. There are two tourism peak points in this class in October and April. This class allocates the most points of Iran to itself except North-West and South-South East of the Oman Sea and the Strait of Hormuz, and 66% of this class belongs to it. In addition, peak class in dry seasons is placed in north-west area and west and north of this class as 19.5% of Iran is allocated to it. In this viewpoint of classification, the peak class is in dry seasons and without raining of a year. Summer peak class has allocated a small part of west of country to itself. Summer has the best season in the field of TCI. Winter peak class is the best season of year in TCI including southeastern of Iran toward the Strait of Hormuz and part of the West of Iran (Rahimi *et al.*, 2016).

Generally, situations that draw TCI for Iran are matched with reality for south, west north and east areas, but in coastal northern regions there is different image than public thought which is due to cloud and raining in this area. Totally, raining has a positive effect on climate and is a positive factor. As tourists are there temporarily and intend to buy or visit those regions, it is considered as a limited and unfavorable factor. So, tourist prefers short-time volley than long-term raining. Hence, raining has negative effect on tourism index and has unfavorable effect and is inversely. Precipitation correlated and has adverse impact on tourism index. According to Iran's good potential for tourism can serve as a model country. According to results of this investigation and other researches in this field in Iran, it is suggested to establish Ski resort in snowy areas to develop tourism in winter in this area. Also it is suggested to use advertise to attract tourists in south of Iran which has a good situation. In general, atmospheric elements such as temperature, rain, wind, sunshine and humidity significant impact on annual tourism trends in different regions, respectively. according to significant relationship between tourism and climate changes, using TCI method as a main method in thus research was used it is possible to use this index in tourism programs and future plans and provide a suitable tourism calendar for each region and help sustainable economies and sustainable development.

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