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Analyzing the Climatic Potentials for Development of Tourism and Water Sports in Khorassan Razavi Province of Iran

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ABSTRACT: Nowadays, tourism is affected by the knowledge of a region's climatic characteristics. Therefore, it is crucial to identify the potential regions and appropriate time for attracting tourists in relation with climatic comfort. Due to having climatic diversity and water resources such as rivers, waterfalls, caves and hot springs, Khorassan Razavi province is one of the potential regions for tourism attraction in IRAN. This study attempts to assess human comfort or discomfort for recreational and water sport activities according to Equivalent Effective Temperature (EET) index using meteorological data from Khorassan Razavi synoptic station for 1990-2011. Furthermore, the climatic comfort zoning map for tourism in the province were made by ArcGIS and Geographic Information System (GIS) potentials by inverse distance weighting (IDW) interpolation method. The results showed that October, June, September, April, May, August and July have the best comfort conditions for recreational activities and water sports, respectively. Also Nishabur and Chenaran cities with 4 and Mashhad with 1 month had the longest and the shortest monthly periods for using water resorts, respectively. Similarly, in this research, available appropriate tourism areas are introduced according to EET index for different months in order to achieve higher understanding of the province's potentials.

Keywords: *EET Index, Climatic Comfort, Tourism, Zoning Map, GIS.*

INTRODUCTION

Today global tourism is a new movement and one of the important elements affecting the relationship between different cultures, and tourism industry has a powerful role in countries development (Mahmoudian, 2009). Also tourism is currently well on its way of becoming the world's largest industry, and it already has 10% of the world's total employment (UNWTO, 2008). From the year 1950 to 2007 the number of international tourists has increased from 25 million to 903 million people (UNWTO, 2001; Esmaeli et al., 2010a) and the earnings from this process has reached 865 billion dollars (Moreno & Amelung, 2009). Tourism is the fastest growing factor in the economics (Hamilton et al., 2005), and it has been predicted that by the year 2020 this number will increase to 1.6 billion people (WTO, 1998; UNWTO, 2001; Scott & Lemieux, 2010). The climate determines the local attractions, the duration and quality of tourism, the travelers' well-being and the investments done towards the tourism industry (Scott et al., 2004; Zoulfaghary, 2007; Zoulfaghary, 2012). Considering climatic conditions as the most important environmental factor that is affecting tourism activities (Perry, 1993; Boniface & Cooper, 1994; Zoulfaghary, 1999; De Freitas, 2003; Ebrahimi, 2004; Mohammadi & Saidi, 2008; Ranjbar et al., 2010; Ezatian et al., 2012), including climatic conditions would be necessary in order to make a travel plan for travelers, because majority of travelers choose destinations with enjoyable and comfortable climatic conditions (Matzarakis, 2001; De Freites et al., 2004; Jacqueline et al., 2004; Mahmoudi, 2008; De Freitas et al., 2008; Becken, 2010).

Although, Iran is considered to be one of the top 10 countries in the world in terms of tourist attractions, one of the top 5 countries in terms of variety of tourist attractions and one of the top 3 countries in terms of variety of handicrafts, it is one of the lowest ranked countries when it comes to global tourism (Nemati, 2005; Zangi et al., 2006; Esmaeli et al., 2010b; Hejrati et al., 2011). Determining the potentials of tourism in the country is one method for increasing tourists and related incomes. The proper time and place of tourist attractions can improve the overall quality of tourism and lead to its growth.

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Some researchers indicated that meteorological parameters such as temperature, the amount and duration of sunshine, the number of rainy and windy days affect tourism phenomenon in Bursa of Turkey (Caliscan et al., 2012). Other researchers have made much efforts to develop indices for determining comfortable weather conditions in order to determine appropriate climatic conditions for tourism (Mieczkowski, 1985; Perry, 1993; Becker, 2000; Hamilton, 2002; Lise & Tol, 2002; Johnstone, 2007; Matzarakis &Alcoforado, 2007). Climate change on tourism has been assessed (Wall, 1992; Wall, 1998; Viner & Amelung, 2003; Scott et al., 2004; Amelung et al., 2007) and also this has been attempted by some indices such as PET (Physiological Equivalent Temperature) index (Esmaeli et al., 2010b; Matzarakis & Endler, 2010), EET index (Abusiani, 2010), RET (Radiation Effective Temperature) and EET indices (Grigorieva & Fetisov, 2007). TCI approach has been used by (Shamsipour, 2008; Gandomkar, 2010; Farajzade & AhmadAbadi, 2010; Hassanvand et al., 2011; Ezatian et al., 2012) and finally presented tourism schedule for tourists and tourism agency planning. Other researchers have used the TCI climatic index to evaluate and optimize tourism climates in Iran and up to now, much effort has gone towards determining appropriate regions for tourism based on climatology using experimental approaches or more complex biophysical methods (Farajzade& AhmadAbadi, 2010).

Although these models are capable of analyzing climatic conditions, they cannot completely predict the comfortable conditions for tourists. As a result, heat-indices are used to determine comfortable conditions for tourists and determine the potential of tourism in different regions. Comfort indices are diagrams and tables that represent the overall concurrent influence of various factors affecting human comfort. Heat indices can be used to analyze conditions for tourism, make tourists aware of the climatic conditions of their destinations and determine the tourism potential of different regions (Gandomkar, 2011). There have been many studies done in global scientific community about the effects of climate on tourism, for example Nemeth et al. (2007) studied bioclimatic comfort and its effects on tourism for Balaton Lake in Georgia. They concluded that summers become longer and winters have become much shorter and these variations will directly and indirectly affect the tourism potentials of this region. Also, in another study, climatic comfort for the state of Arizona was assessed by Hartz et al. (2006). Grigorieva & Fetisov (2007) studied the autonomous Jewish state located in south eastern Russia using EET and RET indices, and determined the appropriate time for summer sports in this state. Matzarakis & Endler (2010) analyzed physiological equivalent temperature for Freeburg Germany, upon which in the future (1961-2050), winters are going to be shorter and summers going to last longer and lower regions can be affected by heat and humidity which lowers the climatic conditions in those regions, and thus affects the tourism conditions of the whole region. Tseliou et al. (2010) evaluated three bioclimatic indices for the effects of climate on comfort in areas outside cities; the results indicated that an important relationship exists between temperature and human sense of comfort. Garigorieva & Matzarakis (2011) assessed physiological equivalent conditions of Far East Russia and identified bioclimatic comfort conditions for all seasons. The results of their study showed that climatic and bioclimatic conditions can affect the lives of the residents and tourism in the region. Ramezani (2006) used Psychometrics model and Evans approach to determine climatic comfort of day and night during the different months of the year in Kia Langroud lagoon area for tourism development. Abusiani (2010) determined human comfort for recreational activities and water sports in Northern Khorassan province according to EET index, the results indicated that for most regions of this province, the months of July and August have adequate conditions in order to use water resources, rivers and lakes for recreational activities and water sports, thus Jajarm and Sisab have highest and lowest number of adequate days to use water resorts, respectively. Hejrati et al. (2011) assessed climatic comfort and appropriate strategy for tourism development, the results indicated that the most appropriate climatic comfort conditions for the city of Ghuchan happen in the months of Khordad and Mehr. Shemshad & Mohammadi (2012) studied the Analysis of Factors Affecting the Ecotourism Development; Results of stepwise regression test showed that organizing service providers and training local population in cooperatives have positive effects on ecotourism development. Farshidfar & Pourkhiz (2014) studied the Architecture of Tourism and its Effect on Attract Tourism in Iran; Results confirm the impact of tourism on nonlinearity residential resort complex architecture that entertainment complex architecture has resided in both the positive and significant effect on the tourism industry during the period.

This study will evaluate climatic comfort conditions for recreational activities and water sports in Khorassan-razavi province in IRAN according to meteorological data (1990-2010) and using EET index.

MATERIALS AND METHODS

Study Area

Khorassan-Razavi province is the fourth biggest province of IRAN and is located in North-East of the country. This province by area is about 127600 km2 and has about 7.7% of total area of Iran. Also, it is located at 34 to 38° NL and 57 to 61° EL. This province has 531.6 km of common borders with the country of Turkmenistan and 302 km with Afghanistan and it also reaches province of Khorassan-Jonobi from the south, Khorassan-Shomali province from the North West, and Semnan and Yazd provinces from the west. The mean annual precipitation is 200 mm with winter and early spring as the rainiest seasons. The average altitude of this province is about 1000 meters from mean sea level, with its highest point at Binaloud Mountain with 3200 meters from mean sea level and it's lowest at the area around the town of Sarakhas with 300 meter from mean sea level (Fig. 1).

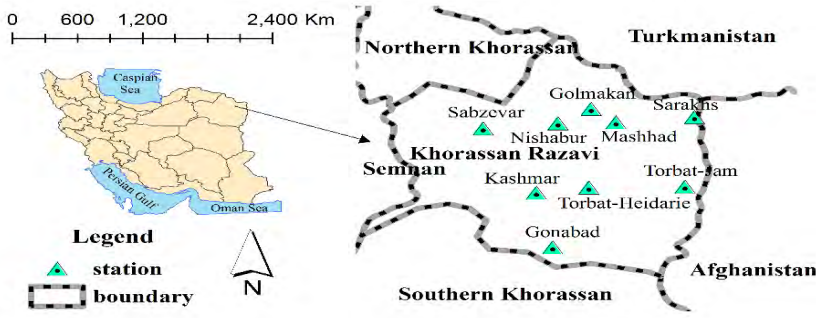

Fig. 1: Geographical position of Khorassan-Razavi province and the used stations in Iran.

Table 1: Environmental conditions classification according to EET index (Source: Abusiani, 2010)

EET	Thermal conditions	Environmental and thermal conditions
Over 23	Very Hot	Very Hot
22-17	Comfortable	Mild and Pleasant
16-8	Cool	Cool
Less than 8	Cold	Cold

Method

Caves, springs, mineral waters, waterfalls, flumes, dams, ski resorts, rivers and lakes are considered the most important tourism attractions and identifying appropriate temporal range for adequate use of these attractions is very important. Hence, in this research, EET index and IDW Interpolation method were used as described in the following sections.

EET Index

The Equivalent Effective Temperature (EET) index is one of the bioclimatic indices that was first proposed by Aizenshtat (1964) and it has been optimized and updated. This index is calculated by using the Equation 1 as:

Equation 1: EET= t (1-0.003(100 - F)) - 0.365*V0.59 ((36.6 - t) + 0.622(V-1)) + ((0.0015V + 0.008) (36.6-t)-0.167)*(100-F)

Where:

t: Air temperature (Celsius degree)

V: Wind speed (Meters per second)

F: Average humidity (Percent)

By using the EET index we can determine appropriate periods for recreational activities and water sports during the year. We used Kolotova (1998) classification approach which has been optimized and updated by Abusiani (2010) for the assortment of climatic conditions (Table 1).

Humans look for adequate climatic conditions to choose a tourism destination. Ideal tourism areas are introduced in Khorassan Razavi considering appropriateness of the area with tourism conditions for each month. According to this classification, when EET index is higher than 23, very hot climatic conditions will be present in the area. Hence, in warm months, people do not prefer these areas as a tourism destination and instead they would rather choose cooler areas. When EET index is between 17 and 22, comfortable and pleasant conditions will be present and people tend to choose such places as tourism destinations. Also, cool environmental conditions exist in the EET index number between 8 and 16, meaning that in warm months, these areas are adequate for tourism and in cold months, some areas such as caves can be suitable for tourism attractions. Furthermore, when this index is below 8, cold environmental conditions will be dominant in this region and these areas are rarely chosen by regular tourists and are more suitable for ski sports, which is something professional athletes would be interested in.

IDW Interpolation

IDW method is one of the interpolation methods in which estimation is based on values close to the unknown point. This method is weighted according to inverse distance. In other words, more weight is given to points near the unknown point compared to farther points. Unlike Kriging method, this method does not assume any relationships between the data (no Variogram), so it's only based on the assumption that, the points which are closer to unknown points have more similarities to them compared to those which are located farther away from unknown points.

In this method often a power is chosen for inverse distance which is between 1 and 5, however number 2 is used most often. An interesting characteristic of this method is that the weight used decreases rapidly with increasing distance. Therefore, interpolation in this method is entirely local and weights never reach 0, so no interruption or discontinuity occurs in the estimates. Two-dimensional IDW method is shown in Equation 2 (Fathi et al., 2014).

Equation 2:

$$W(x,y) = \sum_{i=1}^{N} \lambda_i w_i$$

$$\lambda_i = \frac{\left(\frac{1}{d_i}\right)^p}{\sum_{k=1}^{N}\left(\frac{1}{dk}\right)^p}$$

Where W(x, y) are estimated values in situation (x, y), N is number of known adjacent points, is the assigned weight to each one of known values Wi is in situation (xi, yi), di is Euclidean distance between each point in situation (x, y) and (xi,yi) and P is amount of power affected by weight wi on W (Taghizadeh et al., 2008).

RESULTS AND DISCUSSION

We assessed tourism climatic conditions for Khorassan-Razavi province on a monthly scale for water resorts and recreational activities using climatic tourism index.

IDW have been used for finding places and determining adequate tourism areas from climatic standpoint in order to plan for capital works in tourism industry.

Tourism climatic conditions of this province from the months of January, February, March and December indicated that cold conditions exist for all stations during these months. This is because of the influence of high pressure Siberian systems which enter Iran from the North East, and also because Khorassan-razavi province is the first North Eastern Iranian province, these months can be affected by high pressure systems. These months are not adequate for sport recreational activities such as swimming; however by considering that large number of caves exist in this province, cave exploration can be an adequate pass time, Ghezlagh cave located in Dargaz, Moghan, Karde, Zari, Dezak caves located in Mashhad. One interesting fact about Moghan cave is that some fossils have been found there that are related to second age of geology. Bazangan cave located in Sarakhs, Atashgah and Zari cave in Kashmar and Fariman, respectively, are caves with hanging stalactite and stalagmite formations which are made of lime, so they create a very interesting perspective. Also there exists water springs which contain very clear and fresh and cold drinkable water (Fig.2).

Khorassan-Razavi's tourism climatic conditions from month of April indicated that the Southern, Eastern and Western areas of this province have comfort conditions, meaning Sabzevar, Gonabad, Sarakhs, Khaf, Bardskan, Khalilabad, Ferdos, Tayebad and Kashmar cities. Considering that this area has many waterfalls and hot mineral water springs which have appropriate comfort conditions for recreational activities and water sports while the rest of the cities have cool conditions which are not appropriate for water based recreational activities. Among important waterfalls, Barghamad waterfall in Sabzevar is an adequate place to get away from warm weather and relax, we can also mention to Sarborj waterfall in Bardaskan, Kariz waterfall in Kashmar, and Razdane waterfall in Khaf. Among hot springs, hot mineral water spring in Tabas is famous between locals for its healing properties such as curing hives, measles and leg aches.

Hassanabad sabe hot mineral water spring in Sabzevar, and Abgarm spring in Ferdos are other tourism attractions in the province. It's also worth mentioning that Ghasabe flume located near Gonabad is the biggest flume in the Middle East. For the month of May, tourism climatic conditions for recreational activities and water sports are the same as the month of April (Fig. 3).

In the month of June (Fig.4), Mashhad, Nishabur, Torbat-Heidarie, Chenaran, Dargaz, Fariman, Chenaran and North of Sabzavar are all between 17 to 22 comfort condition ranges which indicate physiological comfort conditions in these areas. Considering that these areas have many dams,

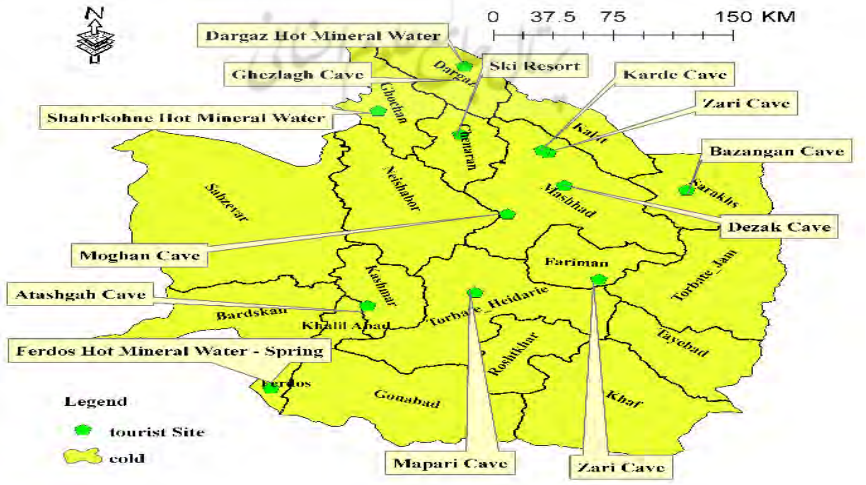

Fig. 2 : EET distribution in the months of December, January, February and March and the appropriate places for tourism.

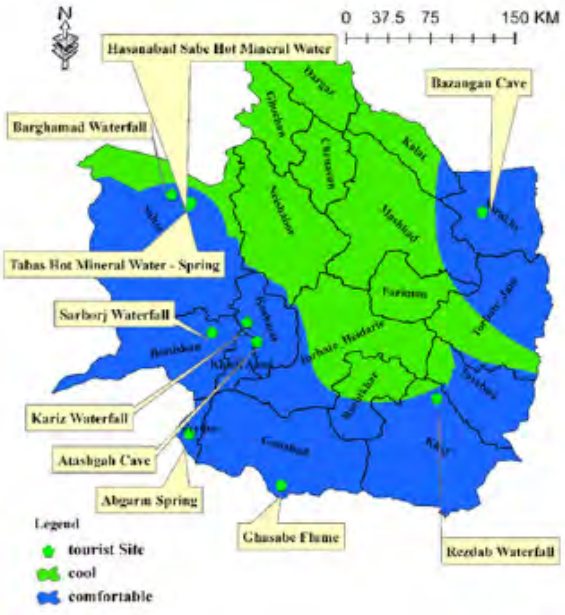

Fig. 3: EET distribution in the month of April and May and the appropriate places for tourism

waterfalls, springs and caves it is clear that they have adequate conditions for natural tourism and sport recreational activities. Among waterfalls, Bojan and Bar waterfalls in Neishabur are notable tourism attractions because of the tangible temperature difference between them and the surrounding areas, we can also mention Kimshah, and Darod waterfalls in Neishabur, and Bordo waterfall in Torbat_Jam. Among other natural attractions we can mention Akhlamad dam which is one of Mashhad's most important tourism attractions. We can also view other tourism attractions in the area such as Gilas galsab spring, and a ski resort in Chenaran, Karde, moghan and Gharib caves and Golestan Dam in Mashhad, Tondore, Dargaz hot mineral water, and Ghezlagh cave in Dargaz. All cities have faced very warm conditions, except Ghuchan city which has cool condition; however if someone traveled to this city and wanted to use water sport facilities, he/she can use the Shahrkohne hot mineral water.

In the month of July (Fig. 5), Ghuchan, DargazChenaran and North of Nishabur and Chenaran have appropriate conditions for Water sports such as swimming and natural tourism like cave exploration. Both these activities are great ways to counter hot weather in this month and in the rest of province exist very hot physiological conditions (with a coefficient above 23).

In the month of August (Fig. 6), Ghuchan, Dargaz, Chenarancentral, parts of Torbat-Heidarie, North of Nishabur and Chenaran have comfort physiological conditions. These

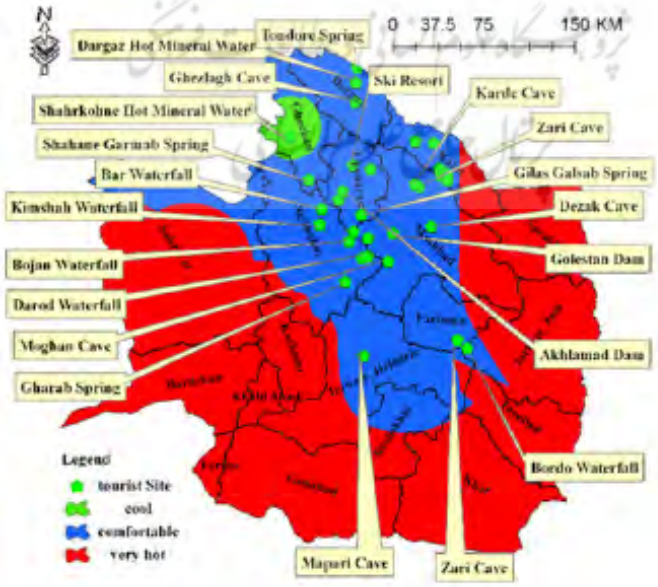

Fig. 4 : EET distribution in the month of June and the appropriate places for tourism

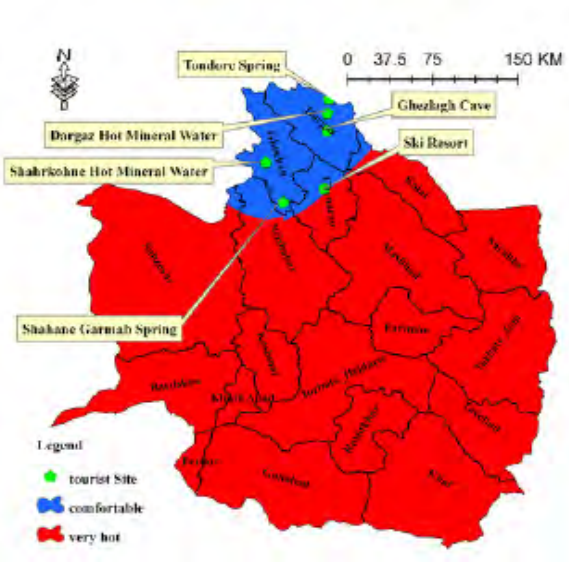

Fig. 5: EET distribution in the month of July and the appropriate places for tourism

comfort conditions can be adequate for water sports, cave exploration and hot mineral water usage. Mapari cave is one of those interesting caves that are located in Torbat Heidarie and as archeologists say, it is one of the first habitats from ancient times (April 15, 2012), among other natural attractions, Ghezlagh cave and Tondore spring in Dargaz and Shahane Garmab spring in Ghochan can be mentioned. We should also mention that water in Shahane garmab spring is about 48°C and between locals it's famous for its healing properties such as curing several skin conditions and bone aches. The rest of the province is in range of over 23 coefficient which means very hot physiological condition.

Comfort physiological conditions exist for some parts of this province such as ChenaranNishabur, Gonabad, Chenaran, Dargaz, Ghuchan and central areas of Torbat-Heidarie in September. One of the tourism attractions in the area are the Akhlamad dam and waterfall which are notable because due to high altitude and precipitation, it has the most amount of water and beautiful and interesting scenery. Shah abbas the second Iranian Safavid king after annexing Ghandahar, while going back to Mashhad and Esphahan took a rest there. Also the biggest flume in the world exists in Gonabad and it is called Ghasabe and along with Ghasabe spring and Girin, Abghad, Charm and Kimshah waterfalls which can be adequate for water sports. The rest of province has very hot physiological conditions with a coefficient above 23. (Fig. 7)

In the month of October (Fig. 8) Khorassan-Razavi province has the most appropriate conditions for tourism, recreational and water sports activities (Table 2). Nishabur, North and West of Mashhad, west of Fariman, Dargaz, Ghuchan and Chenaran

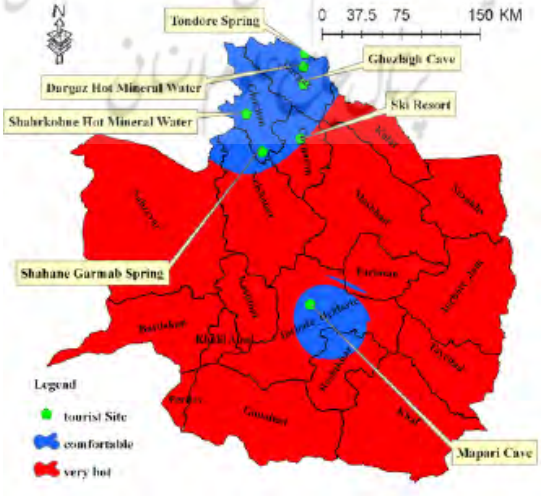

Fig. 6 : EET distribution in the month of August and the appropriate places for tourism

are between 8 and 16 which indicates that cool physiological conditions, and comfort physiological conditions exist in the rest of this province except Sarakhs. One of its tourism attractions is mineral waters in Ferdous are locally famous for their healing properties, it's said that performing water therapy in these waters can cure skin conditions, and is useful for high blood pressure, metabolism, nervous system, blood composition, and the amount of secretion of glands. It's also said that they can even lift a person's spirit.

Among other adequate tourism destinations for this month, we can also mention Kariz water, Majan, Razdad, Dafi waterfalls which can be used for swimming activities by tourists.

In the month of November (Fig. 9) because of the decreasing temperature, every station in the province has cool and cold physiological conditions, and comfort conditions do not exist in this month. If a tourist intends to use water tourism attractions in this month, he or she should consider using hot water springs in the area because of their healing properties; hence professional tourists prefer them for cave exploration and also enjoy the waterfall.

With calculating areas for different regions of EET distribution in different months (Table 2), we can conclude that between months of April, May, June, July, August, September and October which have comfortable climatic conditions, months of October and July have the highest and lowest areas of normal tourist attractions, respectively. Of course between months of July, June, August, September and October which have warm climatic conditions and tourists usually don't prefer these destinations for tourism, months of July and October

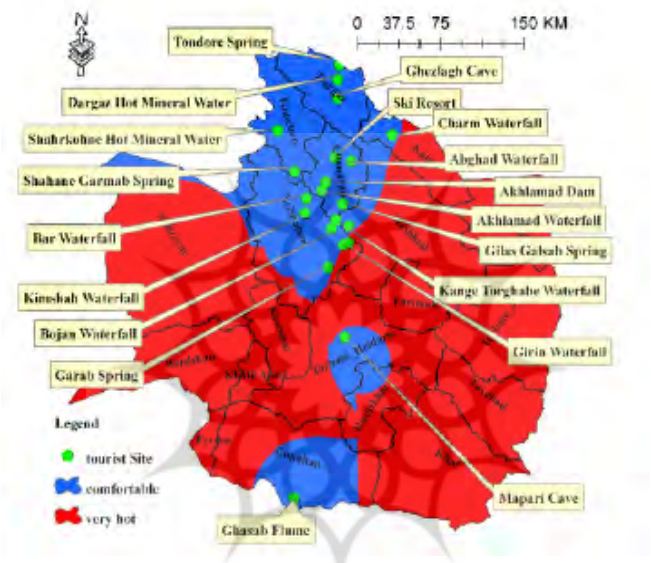

Fig. 7: EET distribution in the month of September and the appropriate places for tourism

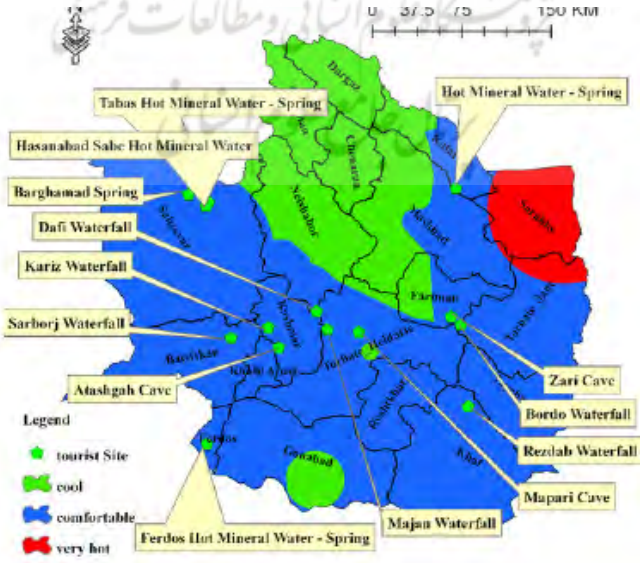

Fig. 8 :EET distribution in the month of October and the appropriate places for tourism

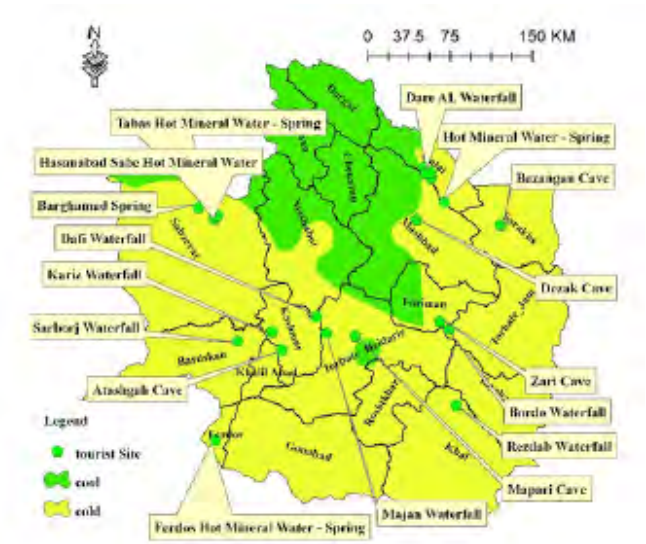

Fig. 9: EET distribution in the month of November and the appropriate places for tourism

Table 2:Area of regions for different Environmental conditions in Month.

Month	Thermal Conditions	(Area (KM^2
Jan - Feb - March - Des	Cold	187565.14
Apr and may	Cool	66974.470954
	Comfortable	49088.735084
June	Cool	6665.120289
	Comfortable	90045.352496
	Very hot	90854.667215
July	Comfortable	34565.014714
	Very hot	153000.125286
Aug	Comfortable	46907.507383
	Very hot	140657.632617
Sep	Comfortable	83701.28791
	Very hot	103863.85209
Nov	Cool	64062.496608
	Cold	123502.643392
Oct	Cool	83475.514194
	Comfortable	97352.883467
	Very hot	6736.742339

have the highest and lowest amount of inadequate areas for tourism attraction, respectively.

CONCLUSION

Tourism climatic comfort index or EET index can be used to determine tourist comfort levels for recreational activities and water sports in a region. This index uses monthly average temperature, average humidity and minimum wind speed and then classifies tourism climatic comfort conditions for recreational activities and water sports.

By making use of the abilities of GIS in interpolation and transforming pointy data to zoning map, we can synthesize climatic comfort conditions and instead of discussing one or a few stations, we can discuss a whole zone such as a town or a province.

According to EET index for recreational activities and water sports, and the use of GIS in Khorassan Razavi province, months of October, June, September, April, May, August and

July have the most appropriate conditions respectively. The potential tourism for this province is affected by its many waterfalls, caves and hot mineral water springs.

Thus by using our stated priority, developmental activities which can be affected by climatic conditions can be planned and done in these months.

As a result, we suggest that studies like this be done for all regions individually, so the data can be used to create the most appropriate model of tourism demand for recreational activities and water sports for each region, hence improving tourism in these regions.

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