Evaluation of tourism climate comfort in order to attract more tourists - Case study: Sanandaj city in Iran

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Abstract: Sanandaj is ready for tourism industry considering all aspects by having ancient and enduring culture consists of tribes, ethnic groups, and climate variability, historical, cultural and natural attractions. But one of the required information for tourists to travel is climate conditions of the destination, namely tourist chooses a time for travelling when the climate conditions are favorable. The climatic conditions that the tourist is interested in are temperature, humidity, radiation and air flow and these climatic conditions factors provide an index called comfort in relation to the reaction of human to thermal environmental conditions that all these factors must be considered altogether. The study area has the ability to attract and attend tourist in national and international level due to the Zagros Mountains, vegetation, local winds and latitude. Therefore, in this article, using climate data from weather stations, first meteorological parameters, hydrological phenomena, summary of regional climate based on various climatic methods (Blair, Gorsczynski, modified koppens, Goussen, silyaninof, Domarton, Barat, Emberger and the best climate in the region were studied and determined, and then climatic conditions of Sanandaj city were evaluated based on tourism comfort climate, to identify the best times and provide the tourists. According to the conducted studies in this area, the best time for tourists in which they can be physically and mentally in comfort is from late May to late October. Generally, it can be said that 6 months of the year has comfort climate conditions for recreational programs in the city of Sanandaj.
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1. Introduction

Tourism is one of the world's largest industries and is affiliated to a major part of economy and global. Such a phenomenon is difficult to be defined with simple words, because this phenomenon has been integrated with human life and states in terms of economic, social, culture, environment. Tourism has always been considered and praised for having high potential in creating and promoting components of national, regional, urban and rural development. Increasing urbanization and approach to leisure time geography in recent decades has caused that attention to tourism industry as the largest and most diverse industry as well as an attainable goal in the process of sustainable development be considered in many countries. Many countries consider this dynamic industry as the main source of income, job creation, private sector growth, human and cultural exchanges and infrastructure development. There is no doubt that one of the required information for tourists is climatic conditions of the destination; and many tourists consider weather conditions for selecting tourist destination. To evaluate the effect of climatic elements of human thermal comfort conditions, it is required that human comfort indices be used.

Tourism comfort climate index is an index that will systematically determine the influence of climatic elements on tourism. In this index, climatic elements of temperature precipitation, humidity, radiation and wind are used. Therefore, using data from weather stations and statistical analysis, the suitable time for the presence of tourists are specified with the help of this index (Mieczkowski, 1985).

The first directional climate categories by the weather experts who were eager to classify weather based on human perspective were in 1931 by Koppen, in 1931 and 1948 by Thornth Waite and in 1954 by Trewartha. In 1954, Brazol provided a map of convenience and the same in Argentina. In 1962, Maunder classified weather in 22 states of New Zealand based on individuals; and Burnet classified climate regions by the sea in France in 1963. In 1966, Tehang developed and implemented climatic classification related to weather based on the individuals in the U.S. In 1968, Davis declared that Great Britain has the best climate. In 1973, Gates introduced and determined regions where had the best state in terms of temperature and humidity and people witnessed the study. In 1974, Kandror invented physical-climate zoning system in the Soviet Union based on similarity and frequency of various weathers. In 2001, Perry investigated the tourism climate condition in hot and dry areas especially

Mediterranean areas. In 2001, Maureen et al. investigated climate and international tourism. Daniel Scott and Ceoff mc Boyle (2001) found that given the global trend of climate change up to 2050 and 2080, the condition of tourism comfort climate index will be better than current condition in most areas of Canada. Jacqueline et al. (2007) concluded that in the coming years, tourist attraction will move slowly toward the north in Britain and Ireland, and the Germany, due to warmer weather and creation of more favorable conditions in the inner coastal areas, tourism attraction process will be toward the south.

Some studies have been conducted in the field of tourism in Iran by Kaviani (1993), Jahanbakhsh (1998), Feyzi and Mohammadi (2008), Farajzadeh et al. (2009), Ziayee and Bakhtiari (2009), Shayan et al. (2010), Farajzadeh (2011).

2. Research methodology

In this study, in order to evaluate tourism climatic conditions and climatic attractions of Sanandaj city, first various climatic parameters and also different climates were studied and determined in order to identify the overall climate of the region and use the obtained results in different parts including water resources, vegetation, environment, agriculture, tourism, etc.

In this study, using Baker's index in the following equation which is used to calculate the cooling power of the environment, climate and comfort of the region were studied.

$$CP = (0.26 + 0.34V^{0.672})(36.5 - T)$$

In the above equation

CP: cooling power in terms of micro-calorie in square centimeter per second

V: average wind speed in terms of meter per second

T: average daily temperature terms of degrees Celsius

Map of depth view

Based on Baker's index, when CP is less than 5 or more than 20, bioclimatic power will appear. Generally, the obtained result of Baker's index for evaluating environmental comfort conditions can be stated as:

- CP value below 10 indicates unfavorable bio-climatology condition (warm) in the environment (A)

- CP value 10 to 20 indicates natural favorable bio-climatology in the environment (B)

- CP value 20 to 30 indicates unfavorable bio-climatology conditions (cold) in the environment (C)

- CP value more than 30 indicates unfavorable bio-climatology conditions (very cold) in the environment (D).

3. Climate and tourism comfort

As we know, one of the factors affecting life, health and comfort of human is climate and atmospheric conditions. Hence, studying the effect of climate and atmospheric conditions has an important role in human's life and health. Today, the study of climate and atmospheric conditions on life, health, comfort and behavior of human is investigated and examined in terms of one of the scientific branches namely human bioclimatology or biometeorology. This branch of science is in close connection with meteorology, climatology and physiology. Overall, it can be stated that almost all atmospheric elements affect human's comfort and feeling but some of them are clearer and more prominent, while others are mild and invisible. However, temperature, humidity, wind and radiation have the most impact. Considering that each of the four elements above has impact together, their combined effects should be considered. For example, radiation at low temperature is favorable while it's unfavorable and annoying at high temperature.

Urban structure and its different activities cause air pollution and noticeable changes in the level of atmospheric elements. Among the atmospheric elements, the overall radiation reached the earth can be mentioned which is completely influenced by the amount of atmosphere darkness.

3.1. Atmospheric factors affecting the tourism industry

Climate is considered as one of basic and ground factors in natural tourism planning. Studies have shown that climate is the most important source of tourism in natural environments (Hozuri, 1381). In fact, time and type of natural tourism activity depends on the climate type and its governing conditions. Therefore, the identification of climatic factors is very essential. Several climatic factors in different seasons of the year in the process of implementing programs affect various activities including the tourism industry.

4. Results

4.1. Climatic view of Sanandaj city

Several factors are effective in the formation of climatic view of the desired region, that the most important one is altitude after altitude, other factors such as humidity resources, air masses, weather systems and latitude are evaluated as main factors affecting the region's climate. Besides the four factors above, some secondary factors such as

vegetation and agricultural activities affect the formation of varied climates in a more limited scale.

In the field of climate classification especially in arid areas, many efforts have been made. Climate classification is carried out in some methods by formula and in others by chart. Climate formulas are functions of two or more meteorological parameters that by substituting in these functions, numbers called climatic coefficients have been obtained and these coefficients are basis of the classification. In the appendix of this study, a summary of the results of climate determination based on the type of classification, the calculated climate and the obtained coefficients of the desired method have been provided, and they have been mentioned in detail as follows:

Blair method is the most simple climate classification based on annual rainfall of the regional climate, according to this method, Sanandaj station with 459.1 mm rainfall has been estimated a semi-arid region. Domarton believes that the amount of evaporation is proportional to the mean annual temperature; and various climates can be specified using drought coefficient calculation, accordingly, based on Domarton method, 6 types of climates can be specified. Therefore given the 19.58 drought coefficient, this is a semi-arid region. Based on Gorsczynski classification, continental coefficient calculated for this region is 22.36%; and based on this classification, Sanandaj has continental climate with a relatively cold and semi-arid winter. But in the classification system of modified coupon, five climate groups can be distinguished. In this method, climate of the region can be determined based on annual temperature (^{0}C), annual rainfall (mm), the amount of evaporation (mm) (Faraji, 1995). Therefore this region has a dried dessert climate with 459.1 mm annual rainfall and 1602.4 mm annual evaporation.

Since there is no evaporation measuring station near Sanandaj city, evaporation must be achieved by meteorological data. Two common methods in this regard are Thornth Waite and Ivanov methods. In Thornth Waite's method, evaporation and transpiration potential which has been considered based on monthly mean temperature and day length mean is calculated. Thornth Waite suggested a special classification for arid climates by comparing the potential evapotranspiration and rainfall. Climatic classification is this way that after calculating monthly evapotranspiration, rainfall changes curve and potential evapotranspiration than different months of the year is drawn in a coordinate axis. By comparing the two curves, it can be determined that whether rainfall exceeds evapotranspiration or not, and if exceeds, when does this happen (Figure 1).

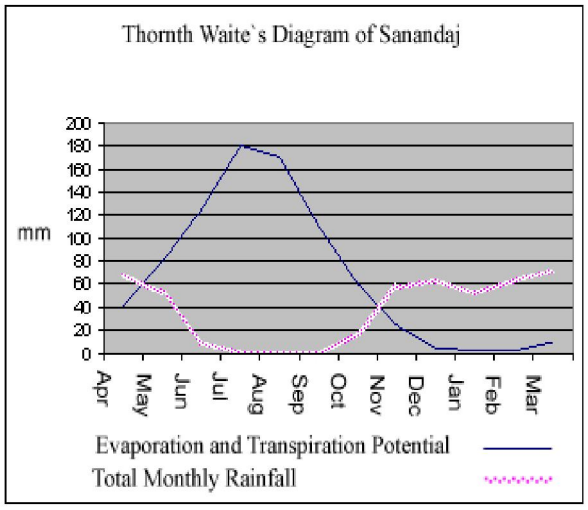

Figure 1. Thornth Waite's diagram for Sanandaj city

Ivanov method is based on the comparison of precipitation and evaporation. In this method, it is necessary that first monthly evaporation and then annual evaporation be calculated according to the relative humidity and temperature. After calculating humidity coefficient of Ivanov, climate classification is done according to the six climate areas. According to this method, humidity coefficient of Ivanov was calculated 0.81243 which is forest steppe climate type. Ivanov evaporation and Torrent White evapotranspiration has been compared (Figure 2).

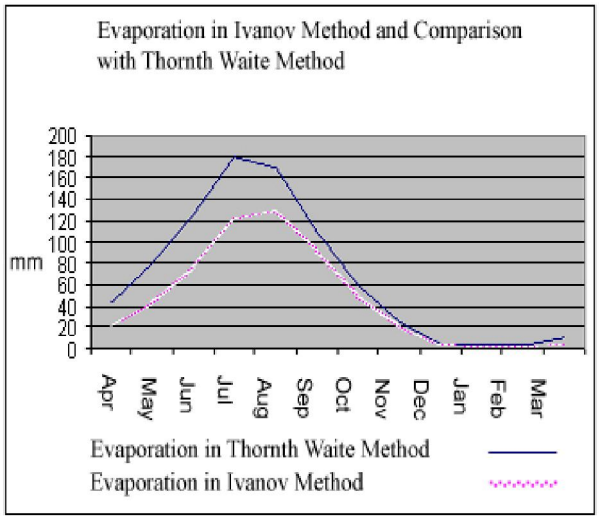

Figure 2. Comparison Ivanov evaporation with Torrent White in Sanandaj city

In Barat method climate classification system is based on aqueous of the region. According to this method, Barat's coefficient determines 4 climates; in this region I=1.98943 which represent the semi-humid climate. In Emberger method of classification, determining factors of each region's

climate include average maximum temperature in the warmest month of the year, average minimum temperature in the coldest month of the year, and average annual rainfall. Emberger provided an exponential climate based on his experiences which are divided into different parts each of which specifies particular climatic conditions. Coordinates of each point in terms of minimum temperature in the coldest month of the year and Emberger's coefficient is located in one of these regions. Based on old formula of Emberger, this region is a semi-arid cold climate. But based on new formula of Emberger it is a semi-humid cold climate. In Goussen method, parameters of number of raining days, relative humidity of the air, number of foggy or dew days are used, which is based on drawing embrothermic curves and calculating xerothermic coefficient. Considering that there is no information about number of foggy or dew days, therefore, it is not possible to calculate xerothermic coefficient. But the embrometric curve has been presented. Thus it's possible to calculate dry days. The level related to drought introduces the drought severity. Finally, in the last method, Silyaninov has used the coefficient related to this method in Russia. These coefficients are defined based on the relative humidity to the heat. This method has a good application in terms of agriculture; because largely shows specified and obvious differences of various regions in this regard; accordingly Sanandaj has a severe semi-arid climate.

4.2. The effect of altitude on the climate of Sanandaj

Sanandaj city is a mountainous area and this feature has led that climatic conditions of Sanandaj is a function of mountainous and high conditions in a large scale. Since the studied region in an elevation range from 1600 to 2400 from sea level, as a result we are faced with climatic in different altitudes. Therefore, map of the region's altitude in Arc view software was divided into 5 categories after DEM preparation. Rainfalls in high altitudes (2400 and above) has cold winters, and is often as snow; and in low altitudes mostly as rain. Generally, the resulting materials from the mountains and the land are influenced by climate, topography and other environmental factors.

4.3. Effects of air masses and meteorology systems on the climate of Sanandaj

The regional climate is mainly influenced by the Mediterranean and high-pressure Siberian flow. Atlantic air flow carries Mediterranean vapors that cause rain. So they provide more or less. Adequate rainfall in autumn, winter and early spring in the province; and on the other hand, Siberian polar air masses enter the region in late autumn to early spring through the northeast of the country and affect it which create a cold high-pressure, strong and dry front known as anti-cyclone; winds of this front has been known as Zalan wind in the region, and its direction is usually north and northwest which is the messenger of the onset of winter and cold.

4.4. The effect of latitude on the climate of Sanandaj

since Kurdistan is the first region of the West Country and subjected to the influence of. Adjacent air masses, therefore, the first rainfalls of western rain-bearing systems take place on it; and also resulted in significant difference between the hours of sunshine during the day and sunshade percentage, etc.

4.5. The effect of vegetation on the climate of Sanandaj

Mountainous location, expansion direction of altitude, rainfalls, and the amount of solar radiation are factors affecting vegetation of the region. Generally, climatic heterogeneity is the result of temperature difference, rainfall season and drought level. Therefore, identification of vegetation (grass, bush, shrub, and tree) and how these species are deployed adapted according to their needs, in harsh conditions that naturally have high flexibility, would be possible in determining the type of climate. Among the main factors, altitude, latitude and air masses, and the secondary factor of vegetation, the two factors of altitude and air masses have the greatest role in the formation of the region's climate.

4.6. The number of frost days in Sanandaj

In Sanandaj, frost occurs more than three months of the year, and the average annual number of frost days in this city is 110 days, there is frost during autumn, winter and the first two months of spring. Among different months of the year, January has the most frost days with 27 days and next December and February with 24 days. Given the frost information, it is essential that the impact of this phenomenon in a variety of activities and programs of the province be considered by provincial officials and planners.

4.7. The effect of temperature on the human comfort in Sanandaj

In order to establish thermal equilibrium between himself and his surroundings, human has always attempted; and providing this equilibrium is of his certain requirements for achieving comfort and case. To create this equilibrium, it is necessary that skin temperature remain constant or change so little despite large changes in the ambient temperature. Establishing this equilibrium depends on several factors such as metabolic characteristics of human,

physical activities, type of coating used, and how people adapt and adjust to the ambient temperature, that climatic factors such as temperature, solar, radiation, humidity, air flow are effective in turn in this case. Heat exchange occurs in any environment between human's body and its surrounding temperature; that in case of lack of thermal balance, various complications appear. In normal conditions, internal temperature of human's body is 37 and skin temperature is 32 degrees Celsius. If the body is placed in an environment warmer than the skin, it will absorb heat, and if in a colder environment than the skin, it will gradually lose heat. The effect of temperature on human comfort is completely affected by other atmospheric conditions, physical and mental conditions and his blood circulation. Given that human comfort is in relation to maintaining his core body temperature which is approximately 37^0C, being in climates with temperatures between 25 and 30 degrees, will be the best living conditions (Eshghi zadeh, 1382). In order to achieve thermal comfort situations, two conditions are necessary. First, loss of skin and core body temperature leads to a state in which the person neither feels cold nor heat; second, body energy balance is established, i.e. there is balance between the heats of metabolism with the heat wasted from the body (Russell et al, 1997). In addition to temperature, the time of human presence in those thermal conditions is also important so when the ambient temperature is higher or lower human body temperature, cooling or heating equipment should be used to maintain the body temperature.

Following diagrams show months of year in which cooling and heating equipment must be used (Figure 3, 4).

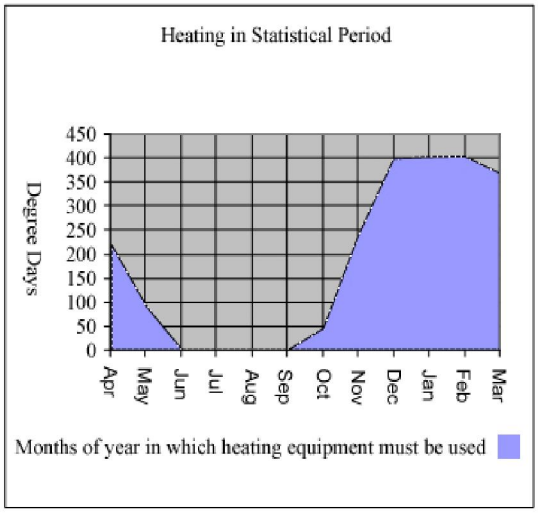

Figure 3. Months in terms of degree days in which heating equipment must be used.

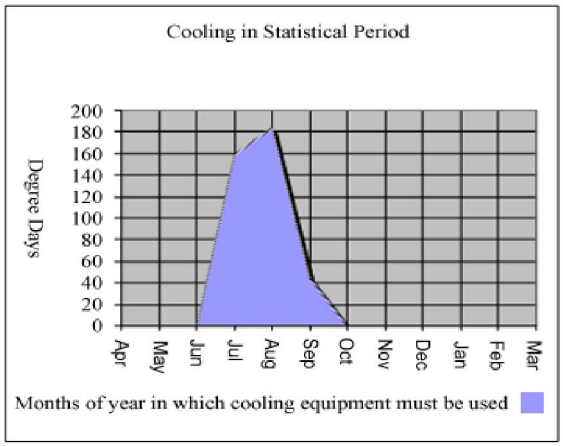

Figure 4. Months in terms of degree days in which cooling equipment must be used

Baker's index: in this study, climate and comfort of the region were investigated and the results were specified using Baker's index.

Following diagrams show months of year in which climatic comfort conditions are favorable and unfavorable (Figure 5, 6).

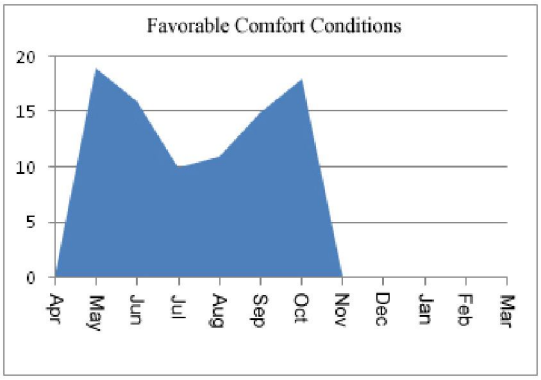

Figure 5. Months of year in which climatic comfort conditions are favorable.

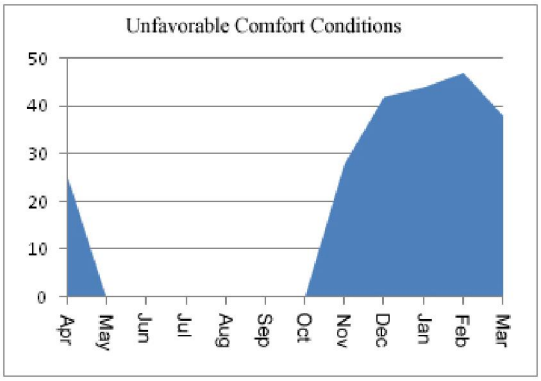

Figure 6. Months of year in which climatic comfort conditions are unfavorable

In terms of spatial dispersion in suitable months, by providing welfare-comfort services, we can be a god host for tourists (Figure 7).

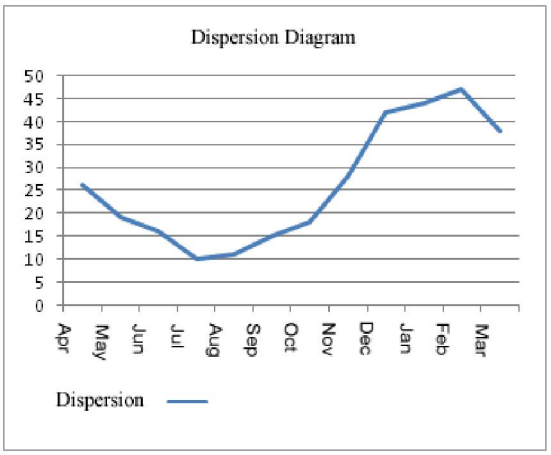

Figure 7. Dispersion diagram's index of comfort climate tourism in Sanandaj city

5. Conclusion

Considering that Sanandaj city is considered a semi-arid region given the experiences and existing statistics, features of semi-arid regions i.e. extreme temperature fluctuations and scattered rainfall are seen inadequately and heterogeneously. Due to the different methods that have been studied for climatic classification, Domarton method is suggested because it has a good application in phytogeography studies, and high importance in forest and pasture sectors, and is largely consistent with vegetation conditions of the region; and Silyaninov method is suggested as well because it is consistent with agricultural expansion and diversification of its products. It also became clear that both factors of altitude and air masses have the greatest role in shaping the climate of this region. As mentioned in the article, all atmospheric elements involved in the natural tourism have meaning together and their combined impact should be considered; only then climatic conditions of the environment can be evaluated accurately. However, considering some important climatic factors and indices such as temperature, humidity and wind, climatic comfort condition of regions can be clarified to a large extent. In general, with regard to climatic factors of temperature and humidity, it can be concluded that May, June, October, September, July and August respectively has resort priority in terms of climatic parameters affecting resort and tourism in the region. Based on tourism comfort climate index (Baker); the results of this study show that in the city of Sanandaj, in the months of May, June, July, August, September and October comfort condition is the best and completely favorable for the presence of tourists, but in other months the condition is slightly unfavorable and tends to cold. In April and November the condition is unfavorable and cold but in January, February, March and April the condition is completely unfavorable and very cold, in which there are no recreational comfort conditions. In general, it can be said that 6 months of the year has climatic comfort conditions for recreational planning in the city of Sanandaj. It should be noted that this does not mean impossibility of recreational planning in the cold months of the year. But given the potentials of winter recreational planning in the region, the possibility of establishing recreational activities appropriate for cold climatic conditions is also provided.

6. Suggestions

1. Conducting comprehensive climatic studies for the region based on suitable tourism conditions
2. Creating ecotourism calendar based on climatic conditions of seasons and months of the year
3. Introducing the region's ecotourism effects and potentials by experts
4. Fundamental planning on sustainable ecotourism
5. Creating appropriate infrastructure in sustainable tourism
6. Creating virtual tourist networks
7. Creating nature tours in the province in order to understand its ecotourism aspects more
8. Further activity of nature tour committee and more coordination with sports committee of the province
9. More coordination of organizations involved in nature tour and leisure time.

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