Comfortable climate to attract tourist by enjoying the PET and PMV indicators (case study: Savar Village)

Hadi Rezanezhadasl Bonab[1], Behnam Ghasemzadeh[2]*
[1]Sama technical and vocational training college, Islamic Azad University, Bonab Branch, Bonab, Iran
[2]Young Researchers And Elite Club, Tabriz Branch, Islamic Azad University, Tabriz, Iran
Behnam.Ghasemzadeh@yahoo.com

ABSTRAK

Today, several indicators have been suggested by scientists for ecological climatology study that are used specifically in tourism meteorological study. Among them, composite indicators of temperature-physiology can be named that are based on energy balance of human body and have more credibility. In this study, two PET[1] and PMV[2] indicators have been used to analyze comfortable climate of Savar Village. Climatic information which have been provided from the nearest synoptic station of the region evaluate daily and monthly comfortable climatic condition of the studied village. Similarity of the results obtained from two above mentioned indicators by using two Ray Man software indicates that the period of comfortable climate in this village is short and limited to 44 days which mostly occurs in June and October; so that in spite of lacking in heat stress and extreme heat stress, 179 days of a year are in extreme cold stress to moderate cold stress conditions and four months of a year in addition to the above months are also specified appropriate for tourism. Research method is analytical and then descriptive which has been done by the output of data analysis software model.

Keywords: *PET Indicator, PMV Indicator, Ray Man Software, Savar Village, Attracting Tourist.*

INTRODUCTION

With world speed toward mechanical life, the importance of tourism industry appears in personal and social life more than at any time in the past. In spite of early response, investment in tourism substructures has important effects on socio economic development of local societies and residents of tourism destinations (Majidi, 2010). Tourism industry is one of the most important economic parts in the world that has increasingly developed in the recent years. International tourism organization has predicted that the population of tourists in the world will be 1 billion by 2020 and the earned income will be 1.6 billion $ (W.O.T;2006). European commission supports tourism as a main industry (Richard;2007). UNESCO has also announced tourism as one of protection elements for world cultural heritage (Ebrahimzadeh, 2010). Many factors affect the tourism industry, one of them is climate. Along with geographical position, landscape, vegetation, animal diversity; climate as one of the most important sources of local base play a role in development of tourism industry. So, it can be said that the impact of climate controls duration, tourism quality, tourists' health and even tourists' personal experiences

[1] Physiological Equivalent Temperature.
[2] Predicted Mean Vote.

(Scott, 2004). Tourism destinations often require the information about weather condition to assess the potential of climatic condition in the location (Matzarakis et al., 2013). In fact, weather and its diversities are raised as a tourism source and most tourists consider it when selecting residency location and length. But, stating conditions of climatic quality due to enjoying them from several elements may seem a little difficult. Hence, climatic data should be presented in a form to indicate individuals' reaction to weather or climatic conditions and includes the highest to unacceptable degrees in a quantitative classification (Esmaeili, 2010). Researchers have conducted large efforts to advance this branch of science; determination of appropriate digital indexes to evaluate composite effects of climatic elements on tourists and determining comfortable environment are among them (Skinner,2001). The results of these studies can be used in setting schedules for tourism tours and also making necessary plans to increase the quantity and quality of tourism services.

Comfort temperature is an internal situation that indicates satisfaction with environmental heat (Ndetto and matzarakis,2013). Comfort zone is a situation in which about 80% of people feel comfortable (Farajzadeh Asl, 2008). Accordingly, six main factors are air temperature, humidity, radiation, airflow, and coverage and activity level. Of course, other factors such as age, sex, body form, state of health, diet, clothing color, climate adaption and ambient air also affect comfort level (Olu ola and Bogda,2003). The factors such as prevailing weather conditions, climate type and tourism are three important parameters that communicate with each other; and climate data obtained from climatic conditions for leisure are very beneficial. Due to the importance of issue, many researches have been conducted in the field of relationship between climate and human comfort (Kasmaei, 2004). Today, applying a new generation of climatic indicators is known under the title of physiological-temperature indicators. These indicators are based on energy balance of human body that explains the effect of weather conditions, thermo-physiology and activity on human. In these years, however there has generally been an increasing demand to evaluate human comfortable climate and urban weather models; this method is not only for these researches but also applicable for architectures and urban planners (Matzarakis,2010). So, this study with two above indicators to assess comfortable climate of the studied village with the aim of scheduling and appropriate attendance of tourists, is for better attraction of tourists(figure 4,5). If tourism continues its positive participation in villages development, better understanding of these dependencies are vital (Garrod,2006).

RESEARCH METHOD

First in this research, data were collected by field method. Then in the next stage, data were obtained by software analysis and the formations of comfortable climate of the village were presented in a chart (diagram-1). It is necessary to mention that Savar Village does not have meteorology station. But, because of village vicinity to Maraghe meteorology station and the location of this station approximately at the same height level of this city, meteorology statistics of this station have been used. Also, average 22-year climatology data since 1990 to 2011 have been used as daily statistics

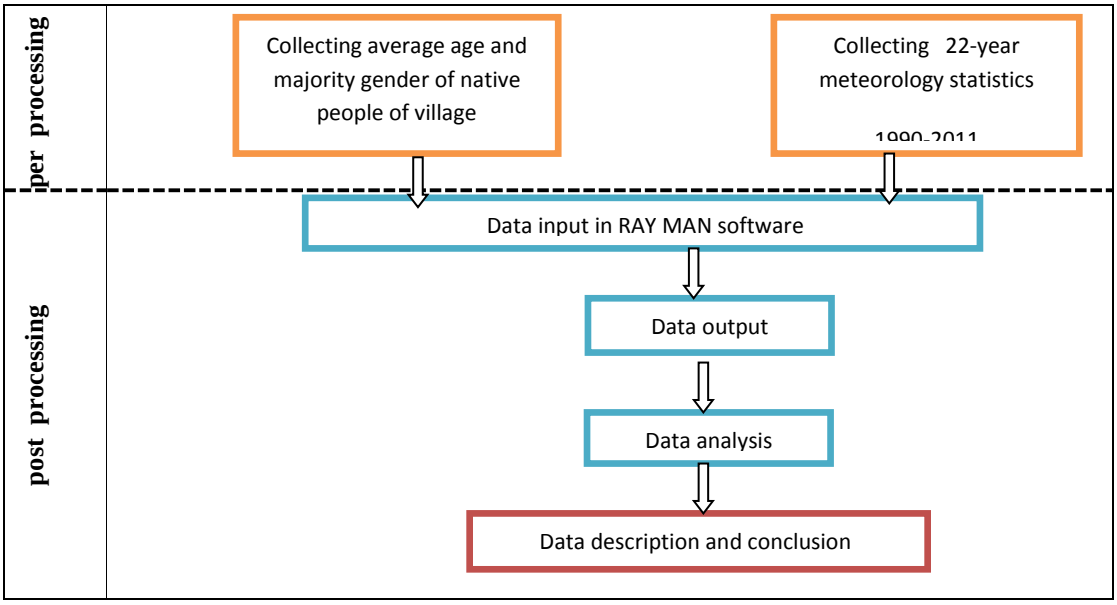

Diagram 1- Research process

The process of this research in terms of research results, research implementation process, research objective, executive logic and research implementation time is as the following diagram (diagram 2). Climatic data including air temperature, relative humidity, wind speed, vapor pressure, and amount of cloud besides attracting tourist are as independent variables and Savar village as dependent variable.

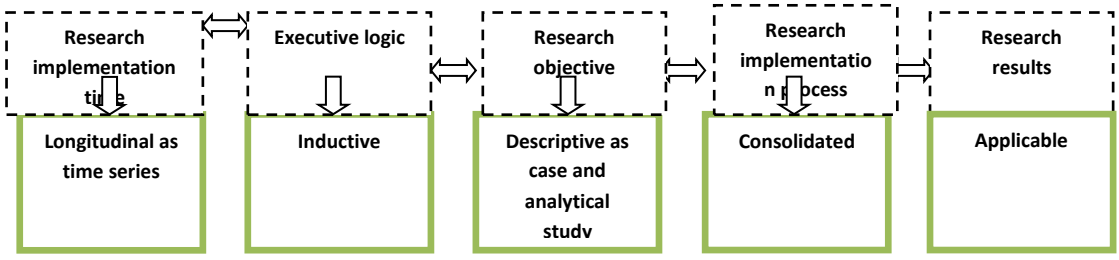

Diagram2- Methodology formation

Savar village is one of the villages of east Azerbaijan province located at 24 km. of Bonab city with 37˚and 31' north latitude and 46˚ and 10' east longitude at the altitude of 1473 m. above open seas level (figure-1). This village with the oldness over 300 years has been registered by cultural heritage handicraft and tourism organization of the

province as one of tourism destination villages and among valuable rocky mountain villages and national monuments in the province(figure- 6). Rocky architecture of this village was first recognized in 1997 by cultural heritage organization of Bonab city(figure-7). This village is located in a valley which a river runs through the middle of it and divides this village into northern and southern parts. Rocky architectures are also located in both directions below current residential houses which many of them have gradually filled and need to clean up(figure 8). There is a way from each rocky unit to adjacent units. Some of these rocky units are multi-storey (Sadraei, 2005). Linking ways to adjacent units and basement were through the holes that were used in emergencies. Now, rural houses located on this rocky architecture in form of staircase that their statuses are also noticeable (figure-2).

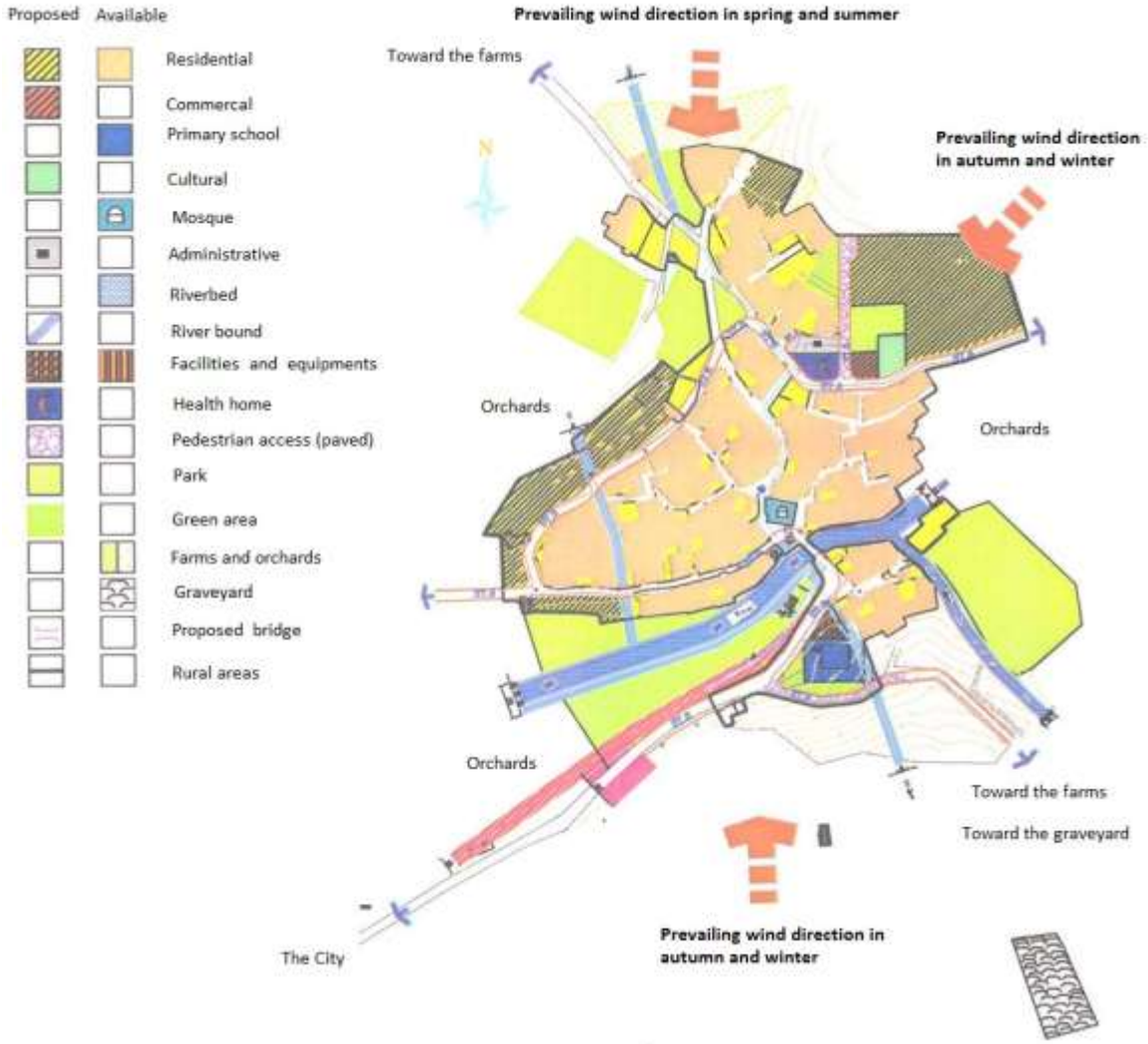

Figure 1- Aerial photograph of the village (source: Guiding plan for Savar Village)

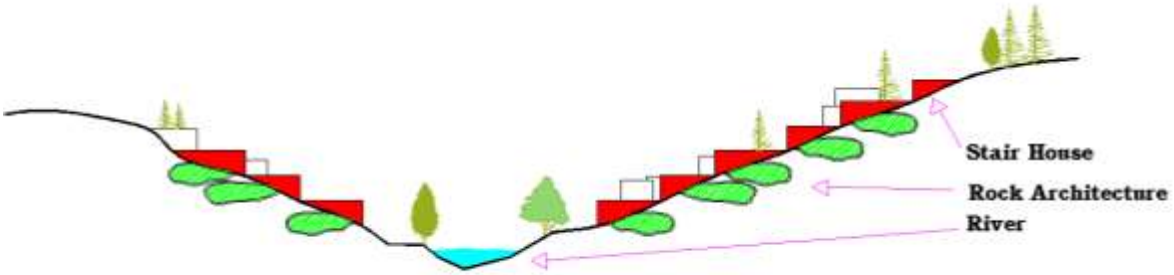

Figure 2- Village profile

RESEARCH BACKGROUND

Many researches have been done in relation to architecture, climate and human comfort; a set of comfortable indexes introduced for outside and inside environment of the building to advance these goals, some of them were as chart and some others as table like Olgyay bioclimatic indicator (1975), Givoni building bioclimatic indicator (1977), Mahoney indicator (1971), Evans indicator (1980) or Matzarakis energy and physiological-temperature balance models (1999) and …. These indicators can be used for: 1- evaluating thermal status in one place 2- determining architectural problems related to site climate and 3- recognition of policies dealing with architectural-climatic problems (Razjouyan, 2006) or assessing favorable climate for tourists.

Table 1- Research background of some Iranian authors' studies in the field of climate and architecture

Date	Author	Research title	Source	Result
2010	Esmaeili Reza, Adab Hamed, Hatami nejad Hosein	Architecture compatible with climate (case study of Faizabad city).	Scientific and research journal of geographical space, tenth year, No. 32, Pages 53-74.	- Considering radiation angle, solar radiation direction, useful and harmful winds direction and regarding the importance of shade in the summer, guidelines appropriate to climatic condition of this city were provided. -Maximum use of environmental potentials for energy saving and increasing comfort quality in residential environment and making environment healthy.
2009	Moshiri Shahriar	Sustainable design based on hot and humid climate	City identity, third year, No. 4, pages 39- 46.	-Comparing two cities, Bandar Abbas of Iran and Belem of Brazil which have the same climate (hot and humid), however, buildings design is quite different in these cities and each of them supplies its residents' needs due to climatic conditions.

Date	Author	Research title	Source	Result
2009	Lashkari Hassan, Selki Hiva	Optimization and orientation of open spaces in Saqqez city according to climatic conditions.	Journal of natural geography, first year, No.3, pages 27- 41.	- According to temperature index, it was determined that the weather is quite cold in about 54.9% per year and relative comfort is gained in only 15.6% per year, and appropriate conditions can be provided in Saqqez approximately in 29.8% of times enjoying the sunshine. - Some suggestions have been offered about optimal establishment of constructions and pathways in Saqqez.
2008	Farajzadeh Asl Manouchehr, Ghorbani Ahmad, Lashkari Hassan	Investigating the conformity between buildings of Sanandaj city and environmental conditions with Mahoney method.	Journal of human sciences school, period 12, No. 2, pages 161-180.	-According to Mahoney criteria, old tissue of the city has the most compatibility with local climate and its new tissue has the least compatibility. -In total, about 50% of Sanandaj housing are compatible with climatic conditions.
2007	Zolfaghari Hassan	Determination of appropriate schedule for tourism in Tabriz using Physiological Equivalent Temperature (PET) and Predicted Mean Vote (PMV) indictors.	Journal of geographical research, No. 62, pages 129-141.	-Applicable field of comfortable climate in tourism industry has been investigated for Chabahar and Tabriz, respectively.
2005	Lashkari Hassan, Pour Kahdem Namin Zahra	Optimization and orientation of open spaces in Ardebil city based on climatic conditions.	Journal of geographical research, No. 79, pages 19-36.	-According to Olgyay indicator, it was determined that the weather is quite cold in about 53.77% per year and relative comfort is gained in only 11.9% per year, and appropriate conditions can be provided in Ardabil approximately in 44% of times enjoying the sunshine. - Some suggestions have been offered about optimal establishment of constructions and pathways in Ardabil.
1998	Jahanbakhsh Saeed	Assessment of human bioclimatic of Tabriz and thermal requirements of building.	Journal of geographical researches, No. 48.	-Thermal requirements of Tabriz have been assessed. - The effect of climate on living conditions has been investigated calculating heating degree days and cooling degree days. -Usual guidelines have been provided using Baker's method and effective temperature method to control indoor conditions of building.

Table 2- Research background of some foreign authors' studies in the field of climate and architecture

Date	Author	Research title	Source	Result
1999	Matzarakis, A.,Mayer, H.,and Iziomon M G	Applications of a Universal Thermal Index: Physiological Equivalent Temperature	International Journal of Biometeorology	PET results which obtained from evaluating different components of the climate are used in investigating human comfortable climate; also bioclimatic map can be provided of the whole city and applied in urban scheduling by using PET indicator.

2003	Olu Ola O. Bogda M., Prucnal-O.	Choice of thermal index for architectural design with climate in Nigeria	Habitat international	-Comfort range between 20-25 degree is recommended for ET indicator. -Heat stresses provide information necessary to design walls, roofs and canopies using this indicator.
2006	Andreas Matzarakis, Frank Rutz and Helmut Mayer.	Modeling the thermal bioclimatic in urban areas with the RayMan Model	2006PLEA-The23 rd Conference on Passive and Low Energy Architecture, Geneva, Switzerland, 6-8 September 2006.	-Rayman model is a valuable tool for climate scheduling for tourists and urban planners. The shadows rates can be calculated in this model; so, tourists can have fun in the right time and comfort conditions in the sunlight and its small-scale of the model is to study urban climate.
2010	Matzarakis, A., Rutz, F., Mayer, H.	Modeling Radiation fluxes in simple and complex environments–Basics of the Rayman model.	International Journal of Biometeorology	-In Rayman model, comparison between measured and simulated values for global radiation shows that simulated data are similar to measured data; and investigation and researching of human comfortable climate with Ryman model is more provided, not only in urban climate zones but also for designers and architects.
2013	Matzarakis, A., Rammelberg, J., Junk, J	Assessment of thermal bioclimatic and tourism climate potential for central Europe—the example of Luxembourg	International Journal Theoretical and Applied Climatology	The results of this research are the basis for an appropriate evaluation to provide information related to different problems of environment scheduling and as well as developing tourism in Luxembourg. The obtained results about climate change conditions indicate increase in heat stress and decrease in cold stress.
2013	L.Ndetto, E., Matzarakis, A.	Basic analysis of climate and urban bioclimatic of Dar es Salaam, Tanzania	International Journal Theoretical and Applied Climatology	The results of this research are as the study of urban climate in Dar es Salaam between the years 2001-2011using PET indicators.

ANALYTICAL BASIS OF RESEARCH

Physiological Equivalent Temperature (PET) and Predicted Mean Vote (PMV) indicators are considered to be among the most important physiological-temperature indicators; so, according to De Freitas an ideal indicator should be included three aspects: physical (Ex. rain and snow), physiological (Ex. temperature) and psychological (no cloudy sky). Moreover, energy balance between body and atmosphere should be considered (De freitas,2002); although, these indicators have not essentially been designed for tourism purposes but with doing changes and adjustments they are today the most important indicators in tourism climatology studies (matzarakis,2001), and they have had wide applications in evaluating comfortable climate environments for tourists.

PMV indicator can be calculated through the following equations:

$$PMV = (0.303\, e^{-0.036M} + 0.028)[(M-W) - H - E_c - C_{rec} - E_{rec}]$$

$$E = 3.05\times10^{-3}\,(256\, t_{sk} - 3373 - P_a) + E_{sw}$$

$$E_c = 3.05\times10^{-3}\,[5733 - 6.99 \times (M-W) - P_a] + 0.42\,(M-W-58.15)$$

$$C_{rec} = 0.0014\, M\,(34-Ta)$$

$$E_{rec} = 1.72 \times 10^{-5}\, M\,(5867 - P_a)$$

H, is obtained from the following equation:
$H = K_{cl} = t_{sk} - t_{cl} / I_{cl}$

Table 3- Abbreviations used in the above equation

C_{rec}= Exchange of perspiration convective heat (w/m^2)
E_{rec}= Exchange of heat evapotranspiration(w/m^2)
E_{sw}= Heat losses by evapotranspiration(w/m^2)
E_c= Evaporative heat exchange in skin surface when it is in thermo-neutral status(w/m^2)
I_{cl}= Average radiation clothing for the whole body(w/m^2)
M= The rate of body metabolism (w/m^2)
T_{cl}= Dress surface temperature (c)
T_{sk}= Average skin temperature(c)
W= Effective mechanical power (w/m^2)
e= Evaporative heat exchange in skin surface(w/m^2)
H= Dry heat losses through convection, conduction and radiation(w/m^2)
P_a= Humidity, partial vapor pressure of the air (pa)
T_a= Temperature (c)

PMV scale is a kind of thermal sensation segmentation with degree 7 which its range changes from -3.5 to +3.5. In this scale, 0 indicates neutral thermal sensation (table-4). Physiological Equivalent Temperature or PET is also another famous temperature-physiological indicator derived from energy balance equation of human body. To define this indicator in outdoor condition, it can be said a temperature that during it thermal balance of human body in a typical room (metabolic rate results of 80 Watt light work is added to basic metabolic rate and the value of clothe inefficiency is about 0.9 Clo) is in balance with the skin temperature and central temperature of human body in outdoor conditions. To calculate Physiological Equivalent Temperature or PET, all meteorology elements effective on human energy balance are measured in a height appropriate to ecological climatology such as 1.5 m. height above the ground. Effective parameters such as air temperature, vapor pressure, wind speed, average radiation temperature in surroundings are measured depending on the studied issue or calculated through digital models (Zolfaghari, 2007). In table 4, numerical thresholds of these indicators have been given along with descriptive status of physiological conditions and thermal sensitivity.

Table 4- Threshold values of PET and PMV indicators in different degrees of human sensitivity

Degree of physiological stress	Thermal sensitivity	PET(^{o}C)	PMV
Extreme cold stress	Very cold	-	-
Strong cold stress	Cold	4	3.5

Moderate cold stress	Cool	8	2.5
Slight cold stress	Slightly cool	13	-1.5
No thermal stress	Comfortable	18	-0.5
Slight heat stress	Slightly warm	23	0.5
Moderate heat stress	Warm	29	1.5
Strong heat stress	Hot	35	2.5
Extreme heat stress	Very hot	41	3.5

Source: (Matzarakis et al ,1999)

To calculate thermal indicators, providing meteorological data such as air temperature, air humidity and wind speed is as simple as possible; however, some data like mean radiation temperature of the environment (Tmrt), which is one of the most important meteorological input parameters in calculating energy balance of human body in warm conditions of summer, is not simply available (Zolfaghari, 2007). Regarding that mean radiation temperature has the greatest impact on physiological-temperature indicators; so, the following equation can be used in calculating Tmrt:

$$T_{mrt}=[1/6\sum(Ei-a_k\text{-}Di/\varepsilon_p)Fi]^{0/25}$$

In the above equation:
ε_p= Diffusion coefficient of human body (standard value is equal to 0.97)
D_i= Total scattered solar radiation and global reflecting radiation
a_k= Shortwave absorption coefficient reflected from human body (standard is equal to 0.7)

The equation will be as follows if there is also direct radiation, *I* is the intensity of solar radiation on a surface perpendicular to incoming radiation direction and f_p is a function of incoming radiation direction and human body status:

$$T_{mrt}=[T_{mrt}^{4}+f_p a_k I^{*}/(\varepsilon_p * \delta)^{0/25}$$

&=Stefan Boltzmann constant coefficient is equal to $5.67 * 8^{-10}$ $W/m^2/K^4$

Ray Man software which was designed by Dr. Andreas Matzarakis to calculate radiative fluxes is one of the most appropriate methods for calculation of mean radiation temperature and finally calculating PET and PMV (figure-5). Ray Man model estimates radiative fluxes, clouds effects and solid barriers (urban morphology) by effects of short-wave solar radiation. This model uses simple and complex structures due to their proper use in site and various local and regional scheduling purposes. Final output of this model is calculation of mean radiation temperature that needs to be used in energy balance model for human, and its result is for evaluation required in urban climates and several thermal indicators including Predicted Mean Vote (PMV), Physiological Equivalent Temperature(PET) and Standard effective temperature (SET)(Matzarakis,2006). The introduced software was designed according to VDI guidelines of Germany, clauses 3787 and 3789, to evaluate human bioclimatic and climate quality for use in local urban planning at regional level.

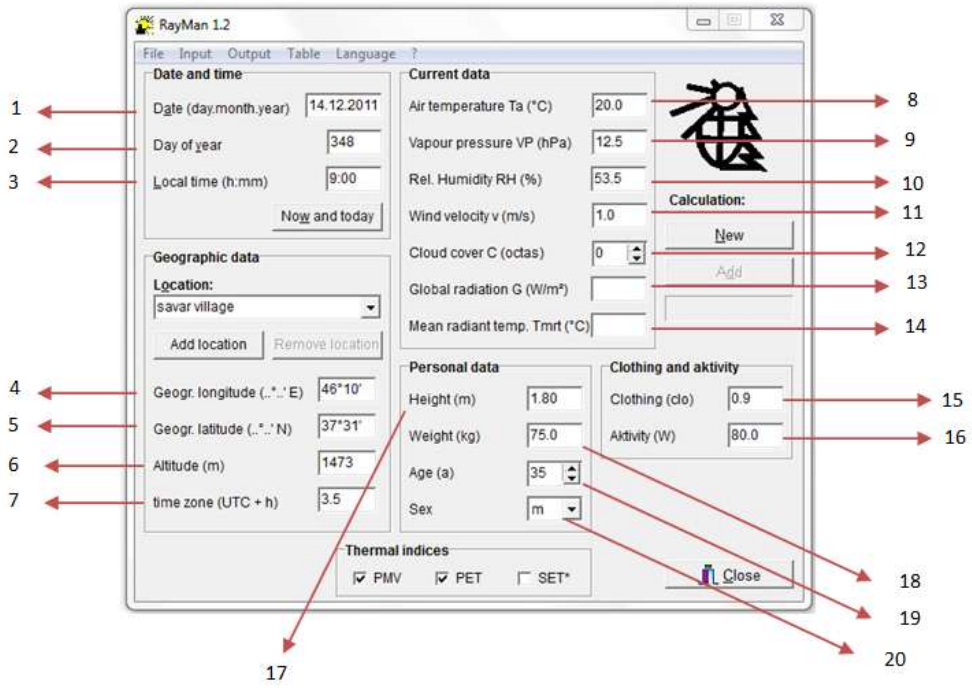

Figure 3- Input data in Ray Man software

1- Date (day, month, year)
2- Days of the year
3- Local time
4- Location longitude
5- Location latitude
6- Altitude from sea level
7- Time difference with Greenwich (in the first half of the year 3.5 hours and in the second half of the year 4.5 hours)
8- Air temperature in Celsius
9- Vapor pressure in hpa
10- Air humidity
11- Wind speed in m/s
12- Air cloudy in Octas
13- Global radiation in w/m^2 (to be calculate by software itself)
14- Mean radiation temperature of the environment (to be calculate by software itself)
15- Non-conductivity value in Clo
16- Metabolism rate in Watt
17- Average height of people in meter
18- Average weight of people in Kg
19- Average age of people
20- Sex according to the majority

This software is accessible to researchers through software site; they can install and run it in windows by PCs. The mentioned software has a window to enter urban tariffs data such as buildings, deciduous and evergreen trees. The factor related to sky landscape is also among the most important capabilities of this software. Sky cloudy rate and its effect on radiative fluxes were also considered in the model. In this model, the role of natural and artificial phenomena is also considered. Also, the calculation of average hourly, daily, duration of sunshine radiation, long and short wavelengths radiative fluxes

without and with the presence of tariffs for topography are possible with this model. Final output of the model is mean radiation temperature of the environment which is required in energy balance model for human body. This is the most important component in calculating physiological-temperature indicators of PMV and PET that have had many applications in different specialties including in tourism climatology (Zolfaghari, 2007). The mentioned indicators can be calculated and evaluated through different methods and equations but due to complexity of equations and calculation method, researchers with different specialties use suitable models and software that designed for these indicators; one of the most important models that has been used in this study is Ray Man software.

The following variables are needed to use this model:

1- Meteorological data include air temperature in Celsius, relative humidity in percent, wind speed in *m/s*, vapor pressure in hpa and air cloudy in Octas; all climatic data were obtained from the nearest synoptic station in the region of Savar Village. It should be noted that average 22-year meteorological data (1990-2011) were included in the model, as daily statistics at 9 o'clock local time which are recognized as the most convenient time for rural tourism, along with average daily air temperature to calculate comfortable climate.

Table 5- Comparing climate conditions of Savar Village in terms of altitude from sea level

Bonab	Savar Village	Maragheh
1300 m.	1473 m.	1485 m.

2- Position data including longitude, latitude and altitude from sea level with 37° 31' north latitude, 46° 10' east longitude and 1473 altitude from open seas level.

3- Individual data according to weight, height and sex. Input variables are 75 kg weight, 180 cm height, 35 years age and masculine sex, respectively (table-6).

Table 6- Age and sex statistics of the village

	Description	Number	Percentage
Major age groups (statistics until the year 2009)	0-14	104	32.3
	15-64	214	63.7
	65 years old and above	13	4
Gender ratio	Male	180	54.39
	Female	151	45.61

(Source: Home health of village)

4- Type of dressing in Clo and human activities rate in Watt. Number 0.9 was selected for dressing (table 7) and 80 Watt for medium activity like driving in which the difference between male and female is negligible.

Table 7- Inefficiency value of types of clothe

Clothing sets	Inefficiency value in Clo
Naked	0
Short pants	0.1
Thin cotton underwear and short sleeves, with long and thin pants and cotton socks	0.35
The above sample + Decollete short sleeves shirt	0.5

Light pants, waistcoat, long sleeved shirt and coat	1
The above sample + cotton overcoat	1.5
Polar region clothing	3.5

(Source: Razjouyan, 2009)

FINDINGS

After inputting variables in Ray Man model, the resulting outputs are in form of numerical values calculated for each of the mentioned physiological-temperature indicators which have been arranged in diagrams 3 to 6. The presented diagrams indicate the final results of comfort indicators of PET and PMV for Savar Village which have been categorized yearly, monthly, and daily and according to the numerical value of thermal sensitivity noted in table 2. However, the results of two comfort indicators used in this study show that the outputs are approximately similar and their monthly statistics also close to each other; but there is a slight tendency to coldness in medium indicator results of the predicted survey and days and months of the year are relatively cooler than Physiological Equivalent Temperature indicator, and strong and extreme cold stresses are not observed in two indicators.

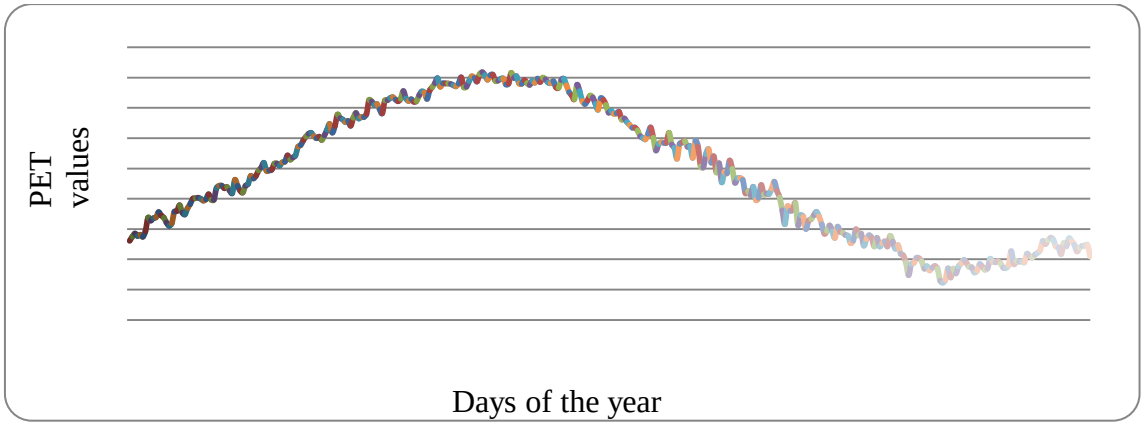

Diagram 3- Changes of PET values during the year in Savar Village

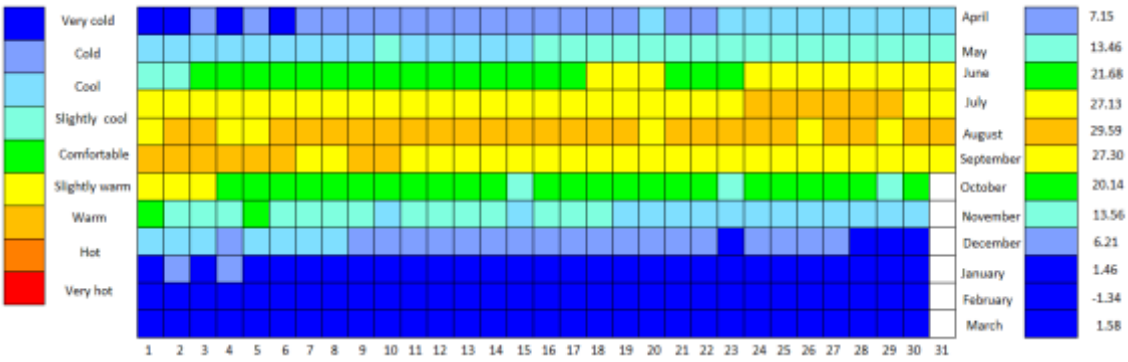

Diagram 4**-** Daily and monthly presentation of PET indicator results according to thermal sensitivity in Savar Village.

Table 8- The results of PET and PMV diagrams

Physiological Degree	**Stress**	**PET (Oc)**		**PMV (Oc)**	
		Day	month	Day	month
Extreme cold stress	Very cold	96	3	111	3
Strong cold stress	cold	38	2	37	2
Moderate cold stress	Cool	45	0	42	1
Slight cold stress	Slightly cool	36	2	40	1
No thermal stress	comfortable	44	2	43	2
Slight heat stress	Slightly warm	68	2	72	2
Moderate heat stress	Warm	39	1	21	1
Strong heat stress	Hot	0	0	0	0
Extreme heat stress	Very hot	0	0	0	0

CONCLUSION

In terms of tourists' attraction, comfortable climate in Savar Village is limited to two months throughout the year. The data result from comfortable climate evaluation by two indicators of Physiological Equivalent Temperature (PET) and Predicted Mean Vote (PMV) in the studied village , respectively 44 and 43 days of the year are in the range of no stress or comfortable climate; these results put Savar Village out of comfortable zone in most times of the year. Two above indicators from outputs of Ray Man model are categorized among cold regions of the country with 96 and 111 days extreme cold stress, 38 and 37 days strong cold stress, 45 and 42 days moderate cold stress and no thermal stress, respectively; and the months of May, June, July, August, September and October are also suitable for leisure and tourism in the village.

FURTHER RESEARCH

Due to conducted studies, some suggestions are offered for better attraction of tourists:

1- Identifying all rocky homes of the village and preventing risk of manipulation in these units.
2- Improving and protecting rural homes by villagers themselves.
3- Converting some of rocky homes to a place to visit and presenting an exhibition of traditional and local cuisine in the village.

4- Due to lack of facilities for tourists, some of rocky homes should be considered for short-term accommodation and providing services, this work has double impacts on tourist' attraction.

REFERENCE

De freitas, C.R. (2002), Theory, concept and Methods in Tourism climate Research, School of Geography and Environmental science, the university of Auckland.

Ebrahimzadeh, I., Taromian, H.and Kazimizad, Sh. (2010), "Role of Sistan civilization on cultural tourism in south- east Iran", Forth international congress of the Islamic world geographers (ICIW 2010), Iran, April, Zahedan.

Esmaeili, R., Saber Haghighat, A., and albousi, Sh. (2010), "Evaluation of comfortable climate in Chabahar port for tourism development", Forth international congress of the Islamic world geographers (ICIW 2010) Iran, April, Zahedan.

Esmaeili, R.,Adab, H. and Hataminejad, H. (2010), "Architecture compatible with climate (case study of Faizabad city)", Scientific research journal of geographical space, Vol..10, No. 32, pp. 53-74.

Farajzadeh Asl, M., Ghorbani, A.and Lashkari, H. (2008), "Investigating the compatibility of buildings architecture of Sanandaj city with its bioclimatic conditions by Mahoney method", Journal of human sciences teaching, Vol. 12, No.2, pp. 161-180.

Garrod,B.,Wornell,R.and Youell,R. (2006), "Re-conceptualizing rural resources as countryside capital: The case of rural tourism", Journal of Rural Studies,No. 22, pp.117-128.

Kasmaei, M. (2004), Climate and architecture, Publication of housing research center, Tehran.

L.Ndetto, E.and Matzarakis, A. (2013), "Basic analysis of climate and urban bioclimatic of Dar es Salaam, Tanzania", International Journal Theoretical and Applied Climatology,

Majidi, M. (2010),"Foreign tourism policy in Iran, searching of optimal model", Journal of politics, Vol.40, No.4, pp. 257-272.

Matzarakis, A., Rammelberg, J. and Junk, J. (2013), "Assessment of thermal bioclimatic and tourism climate potential for central Europe,the example of Luxembourg", International Journal Theoretical and Applied Climatology,

Matzarakis, A., Rutz, F. and Mayer, H.(2010), "Modeling Radiation fluxes in simple and complex environments – Basics of the RayMan model", International Journal of Biometeorology, No.54, pp. 131-139.

Matzarakis, A., Mayer, H. and Iziomon, M G. (1999), "Applications of a Universal Thermal Index: Physiological Equivalent Temperature", International Journal of Biometeorology , No. 43, pp. 78-84.

Matzarakis, A.(2001), "Climate and Bioclimatic Information for the Tourism in Greece", Proceedings of the 1st International workshop on climate, tourism and recreation, pp.171-183.

Matzarakis, A., Mayer, H. and Rutz, F. (2006)," Modeling the thermal bioclimatic in urban areas with the RayMan Model", The 23rd Conference on Passive and Low Energy Architecture- PLEA2006, Geneva, Switzerland, 6-8 September.

Meteorological statistics of east Azerbaijan province, synoptic stations of Bonab and Maragheh.

Olu Ola O,.and Bogda, P. O. (2003), "Choice of thermal index for architectural design with climate in Nigeria", Habitat international, No.27 pp.63-81.

Razjouyan, M. (2009), Comfort in the shelter of architecture compatible with climate, Publication of Shahid Beheshti University, Tehran.
Richards, G. (2007), Cultural Tourism Golbal and Local Perspectives, The Haworth Hosoitality Press.
Sadraei, A. (2005), Preliminary report on the archeological investigation of Bonab region, Ganjineh Honar publication, Tehran.
Scott, D., Johnes,B. and Mac Boyle,G. (2004), Climate,Tourism and Recreatio, A bibliograph Univercity of Waterloo, Canada.
Skinner,C.and Jand De Dear, R. (2001),"Climate and Tourism, an Australian Perspective", Proceedings of the15t International Workshop on Climate, Tourism and Recreation, International Society of Biometeorology, Commission on Climate, Tourism and Recreation.
Tarh Abriz consulting engineers company. (2009), Guiding plan for Savar Village, Housing foundation of Islamic revolution in east Azerbaijan province, Bonab city, pp.12-84.
World Tourist Organization.(2006), Tourism 2020 Vision, WTO Publication Unit, World Tourism Organization, Madrid, Spain.
Zolfaghari, H. (2007), "Determination of appropriate time scheduling for tourism in Tabriz using Physiological Equivalent Temperature (PET) and Predicted Mean Vote (PMV)", Journal of geographical research, No. 62, pp. 129-141.

APPENDIX

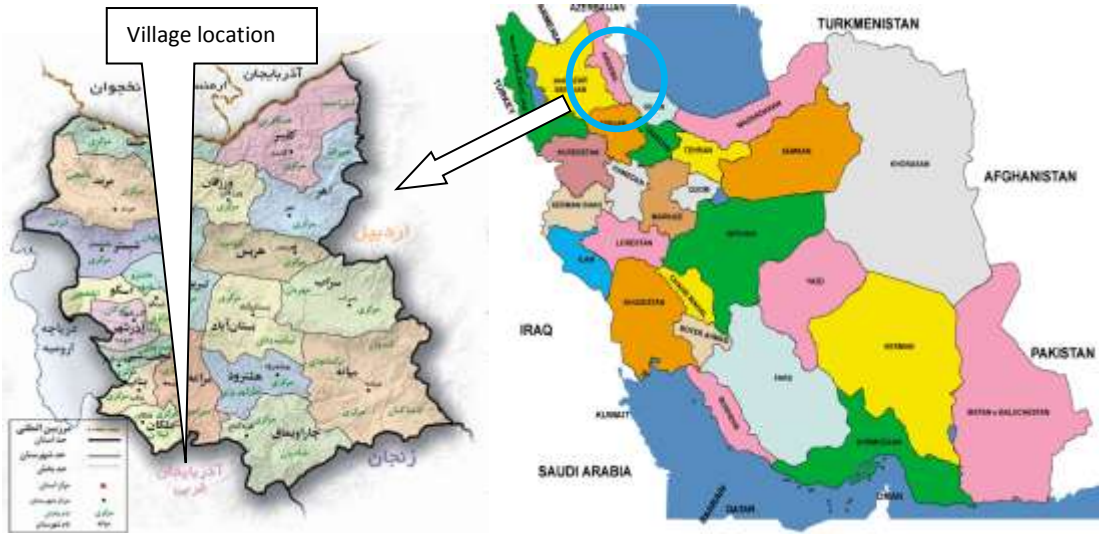

Figure 4- Village location in east Azerbaijan province and Bonab city

Figure 5**-** View from the southwest of the village.

Figure 6- Interior space of rocky architecture

Figure 7- Entrance from inside .

Figure 8- Entry of rocky architecture and stairway residential houses.