Assessment of Comfortable Climate in Several Main Iranian Tourism Cities Using Physiologic Equivalence Temperature Index

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Extended Abstract

Introduction
Since 1960s, heat balance models of the human body have become more and more accepted in the assessment of thermal comfort. The basis for these models is the human energy balance equation. One of the first as well as still among the most popular heat balance models is the comfort equation defined by Fanger (1972).

Climate and tourism have a great dependence to each other, so that existence of a desirable weather condition is an advantage and potential for tourism, and most of the travelers notice to weather conditions in selecting their travel place and time. Climate comforting conditions usually are expressed by indexes which a series of meteorological, human and environmental factors have been played important roles in, and the possibility of comparison among different places is provided by.

Comfortable climate condition generally state by indexes that involve the sets of meteorology, humanities and environmental elements. Several thermal indices such as Predicted Mean Vote (PMV), Physiologically Equivalent Temperature (PET) and Standard Effective Temperature (SET*) may be calculated for the assessment of human bioclimatic in a physiologically relevant manner as shown in several applications (Matzarakis et al., 1999; Blazejczyk, Matzarakis, 2007; etc). All indices have the known grades of thermal perception for human beings and physiological stress (Höppe, 1999). PET is defined as a certain air temperature related to fixed standard indoor conditions at which the heat balance of the human body is maintained with core and skin temperature equal to those under the conditions being assessed. In this research, PET index has been used for several cities in different locations in Iran.

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Material and Methods

In this research, touristy cities including Mashad, Rasht, Isfahan and Kish Island have been selected for comparative of comfortable climatic condition. In this research, the authors have used the PET index.

The Munich energy balance model for individuals" (MEMI) (Höppe 1993) is one of the thermophysiological heat balance models. It is the basis for the calculation of the physiologically equivalent temperature (PET).

In detail the MEMI model is based on the energy balance equation (9.1) for the human body:

\[ M + W + R + C + E_D + E_{Re} + E_{Sw} + S = 0 \]

The individual heat flows in Eq. 9.1, are controlled by the following meteorological parameters (Verein Deutscher Ingenieure 1998; Höppe 1999):
- Air temperature: C, Ere
- Air humidity: ED, ERe, ESw
- Wind velocity: C, ESw
- Mean radiant temperature: R

Thermo-physiological parameters are required in addition:
- Heat resistance of clothing (clo units) – Activity of humans (in Watt)

The following assumptions are made for the indoor reference climate:
1- Mean radiant temperature equals air temperature (Tmrt = Ta). 2- Air velocity (wind speed) is fixed at \( v = 0.1 \) m/s. 3- Water vapor pressure is set to 12 hPa (approximately equivalent to a relative humidity of 50% at \( Ta = 20^\circ C \)).

The calculation of PET includes the following steps:
1. Calculation of the thermal conditions of the body with MEMI for a given combination of meteorological parameters.
2. Insertion of the calculated values for mean skin temperature and core temperature into the model MEMI and solving the energy balance equation system for the air temperature Ta (with \( v = 0.1 \) m/s, \( VP = 12 \) hPa and \( Tmrt = Ta \)).

In this research, the requirement data have been used in the long-term period on the daily scale. The calculations of PET index have been done using Reymen 2.1 software.

Results and Discussion

The length of Climatic comfort period which is recommended to be the best time for tourism affairs is 35 days of a year in Mashhad and Esfahan, 37 days in Rasht and 85 days in Kish. The most important tourism limitation for Mashhad, Esfahan and Rasht cities is the existence of excessive cold stress during months Azar (November 22 until December 21), Day (22 December until 21 January) and Bahman (January 22 until February 21). The results of this research show that duration of climatic comfortable period in the selected cities is short and is located in the separated period on the early spring and autumn. Between of selected cities, Kish island in the cold months of the year and spring season has been the best comfortable climatic condition. The cold stress in the duration of cold season has been main limitation for Mashad, Isfahan and Rasht. Among the selected cities, Kish island has been the best comfortable climatic condition that can recommend for the entire travelers in the early spring. Isfahan town that is one of the most Famous Iranian touristy cities only during the months Ordibeheesh (April 22 until May 21) and Mehr (September 22 until October 21) have suitable condition for traveling.
Conclusion
According to the results of this research, comfortable climatic period in the studied cities is short and is located in the second separated periods in the early of autumn and spring. The length of this period, in Isfahan, Mashhad, Rasht and Kish is 35, 35, 37 and 85 days of years respectively. Result comparatives of this research show that the best destination for spending of Nowrooz holidays as well as winter travelling is Kish Island. For summer travelling, only Mashhad and Rasht cities have nearly suitable conditions on the second half of September.

Keyword: Physiologic equivalent Temperature, Climate tourism, Climatic comfort, Nowrooz travel.