Regionalization and Evaluation of Seasonal Human Bioclimate of Semnan Province

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ABSTRACT

All human activities for the purpose of health and peace is effected by climatically conditions, too. In research I used Terjung Method due to evaluation of seasonal human bioclimatic of Semnan Province using average of maximum and minimum temperature, average of sun shine hours, average of wind speed in four synoptic stations and fourteen climatologically stations in a 15-year course (1994-2008) and I also used AutoCAD map and Arc map software’s based buffering and altitudinal gradient to prepare map of regions in different seasons. The result of research indicates that bioclimatic maps of Semnan Province have remarkable differences in formation of dominant types quantities in summer and winter. Generally mentioned types are restricted to three types in winter and seven types in summer. K₁, K₂, and K₄ types are formed because of outward climatical factors in winter. For the purpose of C₂, M₃, W₁ and W₄ are five types effected by both outside and local factors in spring. Seven types (H₃, H₄, H₅, M₁, M₃, W₁, W₄) are formed solely on the basis of local factors (outside and local) three bioclimatic types (M₁, M₃, C₂) dominate in fall.

Key words: Bioclimatic, Terjung, Peace coefficient, Wind-chill, Regionalization, Semnan Province.

INTRODUCTION

Study of atmospheric and climatical conditions as effective factors on human’s life, comfort and health has been resulted in a new scientific branch called human bioclimeteorology or human biometeorology. Effect of climatic and atmospheric condition on people, plants and animals is studies in above-mentioned branch. So today, it is important to study and identify climatic limitations and threatening hazards and being informed of covert attractions and potentials in geographical properties in Semnan Province during different seasons due to profitability in different urban and provincial plans. So regionalization and potential evaluation of human bioclimatic with climatic factors in different courses and sites can lead us to achieve comfortable environment that results in pleasant or fairly pleasant human’s livelihood and biological activities. Therefore it is significant to discuss comfort for the purpose of human’s permanence of effort and psychic and physical evolution. To identify human bioclimatic and effect of every single climatic factor on human’s physiological structure in every season is the motivation of this research. As regarding the importance of climatic factors and its effect on human’s comfort many studies related to human bioclimatic have been done worldwide and in Iran. And so it has drawn many researcher’s attention as follows: Tam(1959) has studied comfort temperature and its role in the climatical regionalization and comfort area (Taghizadeh, 1988, 165). Terjung (1966) posed bioclimatic distribution and examined human in large quantity and represented result of his research in chart (Terjung, 1966, 119-123). Zanker (1967) classified Baltic coast bioclimatically (Zanker,1967,8-565). Gregorczuk and Cena (1967 ) used effective temperature index that is a compound temperature and relative humidity factor, they computed world distribution of Average effective temperature for both January and July (Gregorczuk & Cena,1967,2). Clarke and Bach (1971) using effective temperature, reformed effective temperature and nerve pressure indices and studied climatic comfort conditions on "sin sinati" in Ohio and its suburb and observed that the suburb is more comfortable than downtown (Clarke & Bach,1971, 311-318). Gonzalez and his colleagues (1974) have represented the standard effective temperature (SET) based on a reliable physiologic perception to study human thermal comfort(Gonzalez.et all,1974,1). Barradas (1991) chose five parks in Mexico City to discover the difference between thermal comfort of inner part of the parks and their surroundings. He found that the difference of temperature is more in the early afternoon rather than other hours, so that maximum thermal difference , water vapor pressure and water vapor deficiency pressure are 5.6°C, 0.6 and 103mb in order (Barradas,1991,1) . Akram and zuhairy (1993) proposed compound of Mahani, MYCM, CMY and using all the factors related to climate designed building in Saudi Arabia. It is worthy to mention Saudi Arabia has four climatic regions (Akram & Zuhairy,1993, 531-533). Rezjouyan (1997) in his book named "Peace by Architecture Harmonious with Climate" considered effective factors on peace using Mahani Method and effective temperature (Rezjouyan,1997,285). Ramesht (1997) in an article named "Human and climatic alteration" considered the role of climate in human health (Ramesht,1997,69-73). Zain-Ahmad and his colleagues (1998) using Mahani chart and schrometric table in Klang Vally in Malaysia considered staffs’ thermal comfort to find comfort in the building of humid areas (Zain-Ahmad.et all,1998, 437-440). Jahanbakhsh (1998) in an article named "Assessment of human bioclimatic in Tabriz and thermal need of building" has approached bioclimatic provocations ranges in
Tabriz. Then he evaluated temperature condition according to effective temperature (Jahanbaksh, 1998, 67-78). Khalili (1999) in an article named "Assessment of human bioclimatic in Tabriz and thermal need of building" has approached bioclimatic provocations rates in Tabriz and has mentioned 6°C-12°C as maximum comfort rates (Khalili, 1999, 5-17). Ghasemi (2000) in a research named "Effect of climate on human" studied the effect of meteorologic factors on human activities (Ghasemi, 2000, 25). Baghban (2002) did regionalization of educational areas, using Biker and Gioni methods and 6-year data (1986-2001) of 16 meteorological stations in Ardabil and Azarbayjan e Sharqi and Azarbayjan Gharghab. His thesis was named "Climatic regionalization related to educational areas design" in above-mentioned provinces (Baghban, 2002, 5). Asgari and Moeini (2002) introduced climatic comfort bounds for many provinces of Iran in their research named "Climate and peace" (Asgari & Moeini, 2002, 8). Ataei and Basatzadeh (2004) provided bioclimatic map of a 40-year course using Terjung Method of 8 synoptic stations in an article named "Analysis of seasonal bioclimatic of Chaharmahal O Bakhtiary" (Atei & Basatzadeh, 2004, 46-51). Mohammad and Saedi (2004) have studied comfort and discomfort using Terjung and Biker, nerve pressure, and termohigrometric as bioclimatic factors in an article named "Bioclimatic indices effective on assessment of human comfort in Qom (Mohammad and Saedi, 2004, 72). David Mollon and his colleagues (2004) classified Mexico using Olgi and Gioni method and fenger equation during a year all twelve months. But there is a limitation in use of above-mentioned cases, because they can't be used the entire year (David Mollon et al., 2004, 311-318). Khoshhal and his colleagues (2006) classified bioclimatic of Esfahan using Mahani, Olgi and Terjung methods in an article named "Using cluster classification for human bioclimatic regionalization in Esfahan". Among above-mentioned methods Ghasemi has proposed the best one. Etemad Sheikholeslam and his colleagues have studied climate properties and climatic need of an area considering human comfort in the life space based on Gioni factor in an article named "Techniques of building design harmonious with Hamedan climate" (Khoshhal et al., 2006, 171-186). Ghasemzadeh and his colleagues (2006) have determined construction bioclimatic chart. It's followed by introduction of effective factors on institutes and students' thermal comfort bound in various seasons considering covering and activities in an article named "Determination of thermal comfort bound in the closed educational area in Yazd" (Ghasemzadeh et al., 2006). Zeitounli (2006) has evaluated effective, Olgi and Gioni as climatic comfort indices while considering climatic factors of Golestan Province in his thesis named "Evaluation of climatic comfort factors emphasizing on the role of tourism in Golestan Province". Oeheir and colleagues have studied bases of biometrology for tourism industry. They analysed biometrological conditions by thermal perception frequency and identified equal temperature of human's physiology during ten specific days. Then they determined comfort areas for tourism compounding this factor with other metrolological factors such as temperature, sun shine rate and number of days with precipitation and storm (Oeheir, 2007, 234). Tplin and his colleagues (2007) have stated: tourism industry is effected by possible alteration of world climate in a research named "Bioclimatic comfort in Taiwan National Park." They also have analysed temperature and rain factors separately and then simultaneously. Finally the comfort temperature and tolerable temperature for tourism were discovered (Tpilin, 2007, 146). Mahmoudi (2008) has used effective temperature and accumulative tension indices in an article named “Tourism and evaluation of its comfort area in Marivan”. It’s represented by a conclusion that Marivan isn’t in comfort area, nor isn’t in approximate comfort area at no hours of a day in January, February, March, April, November and December (Mahmoudi, 2008, 44-49). Bazrpeh and his colleagues (2008) have evaluated Mahani, Biker and Terjung methods as climatic comfort indices in an article named "Evaluation of climatic comfort in outdoors for the purpose of ecotourism in Babolsar." During the research they discovered that nature and outdoors in Babolsar have the best conditions as thermal comfort since second month of spring to second month of fall for tourism (Bazrpeh et al., 2008, 93-108). Zengin and his colleagues (2009) using meteorological date of 9 stations in summer in an article named "Determination of bioclimatic comfort along the road of Turkey using GIS" concluded that topography have been an effective factor in Turkey and an area in south of Meseit Mount is out of comfort (Zengin et al., 2009, 158-164). Ping Lin and his colleagues (2010) in an article named "Shading effect on long-term outdoor thermal comfort in Taiwan." Using PET index (physiological Equal temperature) and SVF (sky vastness factor) considered 10-years meteorological data. First they determined climatical comfort area for the Taiwanese during a particular year. Then using SVF rates displayed that high SVF rates in summer and low ones in winter causes discomfort. After that they stated that shading effect of building and trees should be fitted with climate of area so that provide comfort (Ping Lin et al., 2010, 213-221). Zolfagrari (2010) following assessment of indices, stated that climatic comfort course is restricted to 45 days from early third month of spring to the middle of first month of summer in an article named "Evaluation of appropriate time to tour in Tabriz using physiologic equal temperature (PET) and predicted men view (PMV)" (Zolfagrari, 2010, 141-139). Pinglin and his colleagues (2011) in an article named "Tourism and climatic information based on human thermal perception in Taiwan and Easter China" studied the area using PET index and TPS (thermal peace classifications). According to the conclusion, Taiwan and Eastern China are pleasant for people in the humid area in spring and north of subtropical area in summer (Ping Lin et al., 2011, 492-500).

**AREA AND DISCUSSION**

Semnan province has 4 cities (Semnan, Damgan, Shahroud and Garmsar) 12 districts, 28 collection of villages, 16 towns and 829 villages. Its total area is approximately 97491 km² that is located between 51 51’ to 57 3’ E and 52 50’ to 35 40’ N. Tabriz has a population of 825966 people in 2006. In this city 30% of people are workers. The number of workers and number of services are the highest in Tabriz. The number of workers is 283375 persons. The number of services is 401227 persons.
13°37’ to 37°20’ N. Khorasan e Shomali, Golestan and Mazandaran from north, Yazd and Esfahan from south, Khorasan e Razavi from east and Tehran and Qom from west have limited Semnan Province.

![Fig (1) location of Semnan Province in Iran](image)

**MATERIALS AND METHODS**

The 15-years data (1994-2008) of 4 synoptic stations and 14 climatological stations and average of maximum and minimum temperature in Fahrenheit, average of maximum and minimum relative humidity in percent, average of sunshine hours (real and possible and average of wind speed in m/s, for chronological and locality analysis and to provide map of human biochimate regions of Semnan Province based on Terjung index have been used. Following analysis of factor and computing comfort and wind-child coefficient of regions were determined by using Autocad map software based on altitudinal gradient and the output was transmitted to Arcmap and finally it was turned into map.

- **Terjung Method**

To classify United State in 1966, Terjung used his method.

He used all significant climatic factors that control body’s thermal condition including temperature, radiation, relative humidity and wind altogether. That’s the privilege of this method.

Classification is based on comfort and wind-child indices following various examinations on people. The result has been displayed in Figure (2), (3) in the shape of monograph. Figure (2) is used to determine comfort coefficient. The monograph shows human’s sense in various temperature and humidity and normal condition of ordinal covering, without physical activity. X-axis represents temperature in fahrenheit and curves represent relative humidity in percent in the diagram. These two climatic factors meet each other in different sites in various situations. They have been shown by numbers and samples.

![Fig (2) Comfort area based on Terjuing method (1966)](image)

*Source: Kaviani: 1993*
Table (1) comfort concepts symbols and monographic signs based on Terjuing method

<table>
<thead>
<tr>
<th>Dominant sense</th>
<th>group</th>
<th>symbol</th>
<th>Dominant sense</th>
<th>group</th>
<th>symbol</th>
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<th>group</th>
<th>symbol</th>
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<td>very cold / very cold</td>
<td>VC1</td>
<td>-4/-4</td>
<td>pleasant / pleasant</td>
<td>M1</td>
<td>0/0</td>
<td>very / extremely hot</td>
<td>EH1</td>
<td>3/+2b</td>
</tr>
<tr>
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<td>VC2</td>
<td>-4/-5</td>
<td>cool / pleasant</td>
<td>M2</td>
<td>0/-1</td>
<td>hot / extremely</td>
<td>EH2</td>
<td>+3/+2a</td>
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<td>0/-2</td>
<td>warm / extremely</td>
<td>EH3</td>
<td>+3/-1</td>
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<td>-</td>
<td>cold / pleasant</td>
<td>M4</td>
<td>0/-3</td>
<td>/ extremely pleasant</td>
<td>EH4</td>
<td>+3/0</td>
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<td>EC1</td>
<td>-5/-5</td>
<td>cool /cool</td>
<td>C1</td>
<td>-1/-1</td>
<td>very hot / very hot</td>
<td>S1</td>
<td>+2b/+2b</td>
</tr>
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<td>C2</td>
<td>-1/-2</td>
<td>hot / very hot</td>
<td>S2</td>
<td>+2b/+2a</td>
</tr>
<tr>
<td>coldness</td>
<td>-</td>
<td>-</td>
<td>cold /cool</td>
<td>C3</td>
<td>-1/-3</td>
<td>warm / very hot</td>
<td>S3</td>
<td>+2b/1</td>
</tr>
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<td>UC1</td>
<td>-6/-6</td>
<td>very cool /very cool</td>
<td>K1</td>
<td>-2/-2</td>
<td>hot / hot</td>
<td>H1</td>
<td>+2a/+2a</td>
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<td>-</td>
<td>-</td>
<td>very cold /very cool</td>
<td>K2</td>
<td>-2/-3</td>
<td>warm / hot</td>
<td>H2</td>
<td>+2a/+1</td>
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<td>-</td>
<td>very cold /very cool</td>
<td>K3</td>
<td>-2/-4</td>
<td>pleasant / hot</td>
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<td>+2a/0</td>
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<td>extremely / very cool</td>
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<td>cool / hot</td>
<td>H4</td>
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<td>very cool /hot</td>
<td>H5</td>
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<td>-</td>
<td>very cold / cold</td>
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<td>warm / warm</td>
<td>W1</td>
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<td>CD2</td>
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<td>+1</td>
</tr>
<tr>
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<td>very cool / warm</td>
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<td>+1/-2</td>
<td></td>
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<tr>
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<td>-</td>
<td>cold / warm</td>
<td>W5</td>
<td>+1/-3</td>
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</tbody>
</table>

Source: Kaviani: 1993

Second factor is related to effect of wind-child.
Paul Saiple used this term for the first time in 1939.
After that wind-child got an important factor in bioclimatic evaluation.
It represents amount of heat extrusion in kcal h/m² under standard condition (without physical activity and in ordinal temperature equal 33°C or 91.4°F)
H= (10/45+10√r-V) × (33-T)  (1)
H: heat extrusion in kcal/m²/h
V: speed of wind in m/s
T: Average temperature (°C)
It can be understood easier in Fig (3)

Fig (3) effect of wind & heat exclusion in kcal/m²
Source: Kaviani: 1993
Seasonal human bioclimate in Semnan Province was searched using Terjung Method as follows:

**DISCUSSION**

Spring bioclimate

Five physiological Climatic types is observed in Semnan (Fig 4). C2 type with cool days and very cool nights includes Sadaqlen and Mojen (-1/-2). M2 type with pleasant days and cool nights is observed solely in Damqan station (0/-1). M3 type with pleasant day and very cool nights includes Froumad, Biarjmand, Mayamey, Shahroud, Bastam, Cheheldokhtar, Nardin, Shahmirzad, Mehdishahr and Garmser Stations (0/-2). W1 type with warm days and cool nights is observed in Hosseinian and Toroud stations (+1/-1). W4 with warm days and very cool night includes Kouhan, Semnan and Ivankey stations (+1/-2).

Wind causes warm days and cool nights in Ivankey and Garmser, Semnan, Hosseinian, Toroud, Biarjmand, Froumad, Mayamey, Shahroud and Kouhan stations during summer (n3)ordinary days and very cool nights is followed by wind in Nardin, Shahmirzad and Mehdishahr stations (-a3). Pleasant and desirable sense during days and very cool at nights are felt Sadaqlen and Cheheldokhtar stations (-b3). Pleasant days and cool nights is effect of wind in Mojen station (-b3).Ordinary days and cool nights is result of wind in Bastam and Damqan stations (-a3).
Summer bioclimate

With drawal of outward factors and domination of local factors in summer, seven physiologic bioclimatic types in Semnan are forming. Fig (6).

$H_3$ type covers southern, central, eastern and western areas including Garmgar, Semnan, Hosseinian, Toroud, Bjarjand, Damgan, Fromad stations because of this comfort coefficient shows hot days and Pleasant nights (+2a/0). $W_4$ type results in hot days and very cool nights. It often covers northern stations including Sodaglen, Nardin, Chehel dokhtar, Bastam, Shahmirzad, Mehdishahr stations except Mojen (+1/-2).

$M_1$ type with pleasant days and nights includes solely Ivankey station in northwest of Semnan Province (0/0). $M_3$ type with pleasant days and very cool nights is observed solely in Mojen station (0/-2). $H_4$ type with hot days and very cool nights dominates just in Kouhan station (+2a/0). $H_4$ type with hot days and cool nights is seen solely in Mayamey (+2a/-1).

Wind has more various effect in Summer. So that too over unpleasant heat during day and pleasant one at night is felt in Ivankey, Garmgar, Semman stations (c_2). Too over unpleasant heat during day and cool wind at night is felt in Fromad, Bjarjand, Kouhan, Mayamey and Damgan stations (b_3). Warm wind during days and cool wind at nights is felt in Sodaglen, Nardin, Chehel dokhtar, Mojen and Shahmirzad stations (n_3). Days with too over unpleasant heat and ordinary night is effect of wind in Hosseinian and Toroud stations (c_1). Heat is felt on the skin by wind during days and cool wind is sensed at nights in Shahroud station (a_2). Ordinary wind during day and pleasant wind at night is felt in Bastam (-a_3). Wind blowing is accompanied by heat sense during days and cool sense at nights in Mehdishahr (a_3). Fig(7).
Three physiologic climatic types are observed in fall in Semnan Fig (8).

Because of alteration in outward and local factors dominating in fall, the number of types in this season is lower than summer. C_2 type often covers central areas of province like Semnan, Damgan, Ivankey, Biarjmand and some areas of west like Froumad, Kouhan and Mayamey. Evaluation of comfort coefficient represents cool days and very cool nights (-1/2). K_1 type with very cool days and nights includes all northern stations (Sodaglon, Nardin, Cheheldonokhtar, Bastam, Mojen, Shahmirzad, Mahdishahr and Shahroud) (-2/2). M_3 type with pleasant days and very cool nights has just covered south stations (Hosseinian and Toroud) and Garmsar (0/2). Ordinary days and cool nights in Evankey, Semnun, Toroud, Biarjmand, Froumad, Meyamey, Shahroud and Bastam in fall is effect of wind-chill (-a_3). Effect of wind is pleasant during days and very cool at nights in Shahmirzad, Mehdishahr and Damgan stations (-b_3). Warm days and cool nights is felt by wind in Garmsar, Hosseinian and Kouhan (n_3). Cool days and very cool nights is effect of wind in Nardin and Cheheldonokhtar (-c_3).Cool wind during days and cold wind at night is felt in Sodaglen and Mojen stations (-c_3).Fig (9).
Winter bioclimate:
Three physiologic climatic types are available in Semnan in winter. Fig (10)
Evankey, Garmsar, Hosseinian, Toroud, Biarjmand, Kouhan, Shahmirzad and Mehdishahr stations are covered by $K_1$ type, so they are very cool during days and night (\(-2/2\)). $K_2$ type with very cool days and cold night has surrounded Froumad, Shahroud, Sadaqlen and Semnan stations (\(-2/3\)). $K_4$ type with very cool days and extremely cold nights has covered Nardin, Cheheldonkhtar, Mayamey, Bastam, Mojen and Damqan station (\(-2/5\))
Cool days and very cool nights are followed by wind-chill index in Ivankey, Garmsar, Semnan, Hosseinian, Toroud, Mayamey, Bastam, Kouhan and Biarjmand in winter (\(-c_2\)). Cool days and cold nights is effect of wind in Shahmirzad, Mehdishahr and Damqan (\(-c_3\)). Wind causes very cool days and cold nights in Nardin and cheheldonkhtar (\(-d_2\)) and its effect in Shahroud and Froumad is cool days and very cool night (\(-c_2\)), in Sadaqlen is very cool days and very cold nights (\(-d_3\)). Cool wind during days and very cold wind at night is blowing in Mojen (\(-c_4\)). Fig (11).
Table (4) wind chill end comfort coefficient of Semnan Province in different seasons

<table>
<thead>
<tr>
<th>Station</th>
<th>Comfort coefficient</th>
<th>Wind-chill coefficient</th>
<th>Comfort coefficient</th>
<th>Wind-chill coefficient</th>
<th>Comfort coefficient</th>
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<td>a_2</td>
<td>M_1</td>
<td>n_1</td>
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<td>M_1</td>
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<td>-c_2</td>
<td>C_2</td>
<td>-b_2</td>
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<td>n_1</td>
<td>H_1</td>
<td>c_1</td>
<td>W_1</td>
<td>n_2</td>
<td>Chehel Dokhtar</td>
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<td>K_1</td>
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<td>C_2</td>
<td>-b_2</td>
<td>H_1</td>
<td>b_1</td>
<td>M_5</td>
<td>n_3</td>
<td>Nardiz</td>
<td>-a_1</td>
</tr>
<tr>
<td>Nardiz</td>
<td>K_2</td>
<td>-c_2</td>
<td>K_1</td>
<td>-n_1</td>
<td>W_4</td>
<td>n_1</td>
<td>M_6</td>
<td>-a_1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig (10) regionalization of comfort coefficient in Winter

Fig (12) regionalization of Wind-Chill coefficient in Winter
According to classification of stations in Semnan province based on comfort and wind-chill coefficients in spring (chart (4)) these are resulted:

Semnan, Ivankey and Kouhan in \((W_{2}/n_{2})\) group, Mehdishahr, Nardin and Shahmirzad in \((M_{i}-a_{i})\) group, Biarjmand, Froumad, Shahroud, Garmsar and Mayamey in \((M_{y}/n_{y})\) group. Hosseinian and Toroud in \((W_{y}/n_{y})\) group.

In summer:

Semnan and Garmsar are in \((H_{2}/c_{2})\) group, Cheheldokhtar, Shahmirzad, Sodaqlen and Nardin are in \((W_{y}/n_{y})\) group. Damqan, Biarjmand and Froumad are in \((H_{y}/b_{y})\) group. Hosseinian and Toroud are in \((H_{y}/c_{y})\) group.

In fall:

Ivankey, Semnan, Biarjmand and Mayamey are in \((c_{y}/-a_{y})\) group. Sodaqlen and Mojen are in \((K_{y}/-c_{y})\) group. Shahmirzad and Mehdishahr are in \((K_{y}/-b_{y})\) group. Bastam and Shahroud are in \((K_{y}/-a_{y})\) group. Hosseinian and Garmsar are in \((M_{y}/n_{y})\) group.

In winter:

Garmsar, Ivankey, Hosseinian, Kouhan, Biarjmand and Toroud are in \((K_{y}/-c_{y})\) group. Shahroud and Froumad are in \((K_{y}/-c_{y})\) group. Mehdishahr and Sahmirzad are in \((K_{y}/-c_{y})\) group. Cheheldokhtar and Nardin are in \((K_{y}/-d_{y})\) group. Bastam and Mayamey are in \((K_{y}/-c_{y})\) group.

Result:

In spite of this fact that Semnan is a vast province and it has various topography and different ranges of bioclimate.

So that summer is more various than winter and it represents that local and outward factors don’t have the same effect on formation of regions in different seasons.

Just three of above-mentioned types are observed in winter and seven different types in summer.

Three types \((k_{1}, k_{2}, k_{3})\) are appeared in winter because of domination of outward factors.

Both of local and outward factors cause five types \((C_{2}, M_{z}, M_{t}, W_{z}, W_{t})\) in spring.

Seven types \((H_{z}, H_{t}, H_{s}, M_{t}, M_{s}, W_{t}, W_{s})\) are formed solely by local factors in summer.

Effective factors (outward and local) are changing in fall so three types \((M_{t}, K_{t}, C_{z})\) dominate in this season.

Bioclimate of Semnan Province is steady rather than other seasons because of lower temperature and receiving lower humidity. In lower temperature effect of humidity alteration depends less on humidity in human’s sense alteration against thermal conditions.

Finally about classification of stations in Semnan Province based on comfort coefficient and wind-chill, these are resulted:

In spring:

Ivankey and Kouhan are in \((W_{2}/n_{2})\) group. Mehdishahr and Shahmirzad are in \((M_{z}, -a_{z})\) group. In summer:

Semnan and Garmsar are in \((H_{2}/c_{2})\) group. Cheheldokhtar, Shahmirzad, Sodaqlen and Nardin are in \((W_{y}/n_{y})\) group. Hosseinian and Toroud are in \((H_{y}, C_{y})\) group. In fall:

Ivankey, Semnan, Biarjmand, Froumad and Mayamey are in \((c_{y}/-a_{y})\) group. Bastam and Mojen in \((K_{y}/-c_{y})\) group. In winter:

Garmsar, Ivankey, Hosseinian, Kouhan and Toroud are in \((K_{y}/-c_{y})\) group. Shahroud and Froumad are in \((K_{y}/-c_{y})\) group. Cheheldokhtar and Nardin are in \((K_{y}/-d_{y})\) group. Bastam and Mayamey are in \((K_{y}/-c_{y})\) group.

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