Sjournals
Scientific Journals
Scientific Journal of Pure and Applied Sciences (2014) 3(7) 538-545
ISSN 2322-2956
doi: 10.14196/sjpas.v3i7.1582

Contents lists available at Sjournals
Scientific Journal of
Pure and Applied Sciences
Journal homepage: www.Sjournals.com

Original article

The bioenvironmental modeling of Bahar city based on climate-consistent architecture

P. Kazemian
Department of Architecture, College of Art and Architecture, East Azarbaijan Science and Research Branch, Islamic Azad University, Tabriz, IRAN.

*Corresponding author; Department of Architecture, College of Art and Architecture, East Azarbaijan Science and Research Branch, Islamic Azad University, Tabriz, IRAN.

A R T I C L E I N F O

Article history,
Received 27 June 2014
Accepted 23 July 2014
Available online 25 July 2014

Keywords,
Olgyay's bioclimatic building standards
Mahoney's chart
Comfort temperature
Climatic designing
Bahar city

A B S T R A C T

The identification of the climate of a particular place and the analysis of the climatic needs in terms of human comfort and the use of construction materials is one of the prerequisites of a climate-consistent design. In studies on climate and weather, using illustrative reports, first a picture of the state of climate is offered. Then, based on the obtained results, the range of changes is determined, and the cause-effect relationships at different scales are identified. Finally, by a general examination of the obtained information, on the one hand, the range of changes is identified, and, on the other hand, their practical uses in the future are selected. In the present paper, the bioclimatic conditions of Bahar city, according to the 29-year-long statistics of the synoptic station between 1976 and 2005 was examined, using Olgyay and Mahoney indexes. It should be added that, because of the short distance between Bahar and Hamedan, they have a single synoptic station. The results indicate that Bahar city has dominantly cold weather during most of the months. Therefore, based on the implications of each method, the principles of the suggestive architectural designing can be integrated and improved in order to achieve sustainable development.

1. Introduction

One of the factors influencing human beings' life, comfort, and health is the climatic and weather conditions since human beings are, directly or indirectly, affected by them since their birth. Therefore, human beings should always be able to control the exchange of temperature between inside and outside of his living environment and create comfortable conditions (Akhtar Kavan, 2011, p. 111). However, it is noteworthy that, after the industrial revolution, for the stabilization of comfortable heating inside a house, the use of fossil fuel became so prevalent, and gradually it caused the waste of resources in some cases to the extent that, due to the serious lack of energy, today we have to resort to the use of non-fossil fuels including the solar energy and the wind (Razjuyan, 2009, p. 77).

Therefore, innovating new ideas and adopting measures about this type of architecture for improving the current state has been a priority, and the set of thoughts and related actions has been recognized as "sustainable architecture" (Bideli & Gajarbeigi, 2011, p.1).Designing the sustainable architecture is not a formal style and does not result from the passing conditions and emotions, but it basically includes deep concepts that connect human beings, nature, and the architecture (Mahmudi, 2009, p.6). In the process of development matching environment-consistent development, the environmental studies play a major role, which may can be the basis for activities on architecture, urban planning, tourism, etc. (Sadeghi Ravesh, 2010, p. 77).

In creating comfortable conditions for human beings, four conditions including temperature, humidity, wind, and radiation have important roles, and temperature and humidity have greater effect on human health and comfort; therefore, most of the indexes and models for evaluating human comfort are based on the mentioned two elements (Akhtarkavan, 2011, p.112).

2. Statement of the problem

A glance at the contemporary architecture in our country reveals that we have had double mistake in following the western architecture since not only have we repeated the mistakes of the West in terms of our views, but we have also used their unreasonable architecture model with a lower quality (Razjuyan, 2009, p. 1). The wasteful use of the fossil fuels in the 20'th century has led to numerous problems and troubles for the human beings including the environmental pollution and the threat of diminishing fossil fuels (Tahbaz & Jalilian, 2008, p. 1). Today the most important purpose of all societies is ensuring and maintaining sustainable development besides continuing the physical life which facilitates material power and political potentials as well as implementing the plans or national causes. Naturally, the continuation of human life necessitates working and the consumption of energy. Therefore, the identification of the consequences of different sources of energy can be a suitable and probable solution for facing the mentioned problem (Ghiabaklu, 2011, p. 2). Since climate affects the type and form of the life of human beings more than any other factor and because of the great effect of climate on human comfort, human beings have always sought for optimum use of the climate of their environment (Khosh Akhlagh, Negahban, Rowshan, Baghbani, Gharibi, 2010, p. 168). Climate-consistent designing refers to keeping the microclimate internal state of the buildings in a comfort range, regardless of their external state. Comfort zone is a state in which 80% of the people feel comfortable (Farajzadeh Asl, Ghorbani, Lashkari, 2008, p. 162).

Today, studying the effect of climatic state on life, health, and human being's actions and behavior is studied as a scientific index labeled as bio climate of human beings (Akhtarkavan, 2011, p. 112). A lot of effort has been allotted to evaluating the bioclimatic state, an issue that has attracted the attention of many scholars including Olgyay, Mahoney, Olgyay, Evans, etc. The prerequisite for right bio climate planning in any weather condition is the analysis of meteorological statistics and the requirements of human comfort (Watson & Leb, 2001, p. 38).

3. Methodology

In the present study, different models and methods were used for comprehensive evaluation of the environmental-climatic conditions in terms of the concept of human comfort for the purpose of comparing the results against those of the other methods. In this way, a high significance level can be obtained about the bioclimatic state. For data analysis, the 29-year-long statistics from Bahar Synoptic Station between 1976 and 2005 was used. The climate-related indexes under study included Olgyay and Mohaney. Moreover, the climate-related data contained the following information 1. Maximum and minimum temperature, 2. Average monthly changes in temperature, 3.Average yearly changes in temperature, 4. Average maximum and minimum comparative humidity, 5. Average monthly comparative humidity, 6.Total yearly rainfall, and 7.wind.

4. The purposes of the study

1. The study of the bioclimatic coefficients of Bahar in Olgyay method
2. The study of the bioclimatic coefficients of Bahar in Mahoney's method

5. Significance of the study

1. being economical
2. The mental and psychological need for it
3. Its cultural and social significance

6. Olgyay method

In 1970's Baruch Giony offered bioclimatic chart for buildings, which both determines the comfort zone more accurately in terms of temperature and humidity and shows the benefit range of different elements of the building (Akhtarkavan, 2011, P. 114). Using the 29-year-long data from Bahar Synoptic Station, the bioclimatic chart was prepared in the following way:

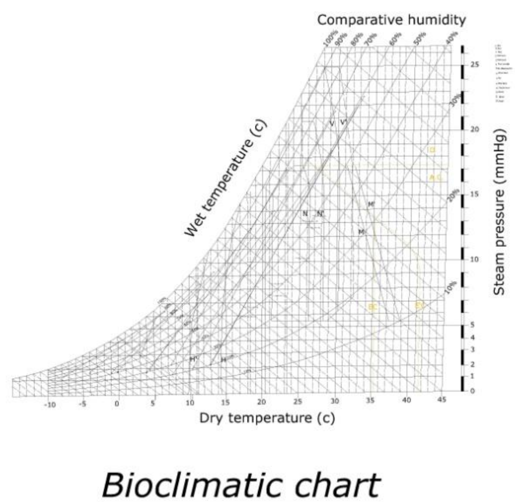

Fig. 1. The building bioclimatic chart of Olgyay about Bahar City, based on the 29-year-old statistics between 1976 and 2005.

●Max	■Min
1. January	7. July
2. February	8. August
3. March	9. September
4. April	10. October
5. May	11. November
6. June	12. December

The period of 9 days in Farvardin (April) H': It shows an external climatic condition in which the conditions of the minimum internal temperature do not necessitate heating the air. During the other days of Farvardin (April) for creating comfort inside the buildings the heating equipment is definitely needed. The period of 22 days in Ordibehesht (May): It shows an external climatic condition in which the conditions of the minimum internal temperature do not necessitate heating the air. During the other days of the same month, heating equipment should definitely be used for creating comfort inside the buildings. The period of 12 days in Khordad (June): They are in acceptable temperature conditions, and the rest of the days show weather conditions in which the value of minimum internal weather is in a range that there is no need for heating the air. The period of 5 days in Tir (July): In this period, air circulation is used in the buildings that have been designed for natural air conditioning. During 4 days of this period using natural air conditioning (air circulation) makes it possible to create comfort inside the building. In a period of 3 days during Mordad (August) air circulation is used for buildings that have been designed for natural air conditioning.

During the same month, 4 days is the period in which the conditions for comfort inside the building have been facilitated by the use of natural conditioning (air circulation), and 4 days is in the period of acceptable temperature conditions. Besides, 7 days are in comfort conditions while the rest of the month is in low comfort state. A period of 7 days in Shahrivar (September) the weather conditions outside the building make it possible to create comfort conditions using natural conditioning (air circulation). Five days of the same month is in standable temperature conditions, and 9 days have comfort conditions. In Mehr (October) 3 days are in stand able temperature conditions, and the rest of the days have low comfort conditions. Aban (November), Azar (December), Dey (January), Bahman (February), and Esfand (March) are in low comfort conditions, and during the mentioned months, mechanical heating systems should be used.

7. Mahoney method

Mahoney method was offered in 1970’s by a person called Carl Mahoney. Using table 4, the effect of climatic conditions on forming the building and some details about architecture was evaluated the results of which will be discussed. According to Table 1, the weather conditions in daytime in two months of the year, namely Aban and Esfand (November and February) and the nights in the other 6 months of the year including March, April, June, September, November, and December (Esfand, Farvardin, Ordibehesht, Shahrivar, Mehr, and Aban) was in desirable conditions. During the days and nights of 3 months of the year or December, January, February (Azar, Dey, and Bahman) the weather was cold, and the rest of the months was warm.

Having clarified the temperature state of the station and having determined the comfort of the different months in terms of human comfort, the dryness or humidity of each month was calculated, and the results were prepared in Table 2 and Table 3. Based on Table …., for March (Esfand) and November (Aban), the index of dryness was selected as A1 which shows a condition in which, because of great changes in day time heat (more than 10 degrees of Centigrade) and low comparative humidity, some discomfort was created.

According to Mahoney tables, in the climatic conditions of Bahar City, the following architectural suggestions are offered:

1. The length of the building should be extended to eastwards and westwards.

2. The building complexes should have a yard, and they should be densely-located.

3. There is a need for wide and open complexes for using the wind, provided that cold and warm winds are blocked.

4. The isolated rooms should be designed for constant use of air circulation. Moreover, with a prior prediction of air current, adjacent rooms are temporarily needed. Moreover, in architectural design in Bahar City, there is no need to consider the tangible flow of air current.

5. The building materials for the internal and external walls as well as the roofs should be strong enough for keeping the heat for more than two months with a time lapse of more than 8 hours.

6. A place should be predesigned for sleeping at nights.

7. Due to the cold climate of Bahar City, suggestion 14 is selected. In other words, building a heavy roof with a time lapse of 8 hours is recommended.

Table 1
The study of climate-compatible architecture in Bahar City based on Mahoney in a statistical period of 29 years (1976-2005).

The location under study: Bahar, between 1976 and 2005, Geographical Longitude N 3452, Geographical Lattitude E 4832, height from the sea level : 1741.5 meters

	Temperature in degrees of Centigrade		**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
A	The average of maximum monthly temperature		2.9	5.1	11.3	18.3	23.8	30.1	34.2	34.1	29.4	21.6	13.3	6.4
	The average of minimum monthly temperature		-7.9	-6.3	-1.1	4.4	7.3	10.4	13.9	12.8	7.5	3.8	-0.4	-4.3
	Monthly Temperature Changes		10.8	11.4	12.4	22.7	16	19.7	20.3	21.3	21.9	17.8	13.7	10.7
B	Comparative Humidity	The average of maximum monthly temperature	90	89	85	80	78	67	59	58	62	75	84	89
		The average of minimum monthly temperature	59	54	42	33	30	23	21	20	21	29	41	54
		Total	74.5	71.5	63.5	56.5	54	45.5	40	39	41.5	52	62.5	71.5
	Relative humidity Group		4	4	3	3	3	2	2	2	2	3	3	4
	Rainfall in millimeters		37.7	40.6	55.2	42.4	26.4	2.7	3.3	2.6	0.5	24.9	35.1	46.3
	wind	Dominant Wind	NW	NW	SW	SW	SW	SW	SW	SE	SE	SE	SW	NS
C	The average of maximum monthly temperature		2.9	5.1	11.3	18.3	23.3	30.1	34.2	34.1	29.4	21.6	13.3	6.4
	The Comfort Zone in day	Maximum	24	24	26	26	26	29	29	31	31	29	28	24
		Minimum	18	18	19	19	19	23	23	25	25	23	21	18
	The average of minimum monthly temperature		-7.9	-6.3	-1.1	4.4	7.3	10.4	13.9	12.8	7.5	3.8	-0.4	-4.3
	The Comfort zone at Night	Maximum	18	18	19	19	19	19	19	20	20	19	19	18
		Minimum	12	12	12	12	12	12	12	12	12	12	12	12
D	Determining the State	Day	C	C	C	C	O	H	H	H	O	O	C	C
		Night	C	C	C	C	C	C	O	O	C	C	C	C
Heat Index														
	The Need for Air Current H1	3	✓	✓	_	_	_	_	_	_	_	_	_	✓
	The Desirability of Air Current H2	0	_	_	_	_	_	_	_	_	_	_	_	_
	The need to confront rainfall H3	0	_	_	_	_	_	_	_	_	_	_	_	_

need for Storing Heat in the Wall Buildings A1	9	–	–	✓	✓	✓	✓	✓	✓	✓	✓	✓	–
Night time Sleep in Open Air A2	3	–	–	✓	–	–	–	–	✓	✓	–	–	–
E The Problem of Cold Months A3	0	–	–	–	–	–	–	–	–	–	–	–	–

Source: The researcher.

In the next step, the number of months, identified as dry or humid, were transferred to Mohaney's building table on preliminery and detail suggestions according to the concepts of Mohaney index, and they were later analyzed.

Table 2
The preliminary suggestions of the architecture of Bahar City in a 29-year-long period (1976-2005).

1	**Suggestions**				**The Index of Heat Conditions**			
			A3	**A2**	**A1**	**H3**	**H2**	**H1**
			0	**3**	**9**	**0**	**0**	**3**
The Location of the Building								
2	1. The length of the building to the east and west✓	1	5-12		0-10 ×	11, 12		
	2. Dense Architecture with a Yard✓	2	0-4 ×					
The Space between the Buildings								
3	3. The Spread and Open Complex for using the Wind	3						11&12
	4. As for 3, in case of the use of cold and warm wind ✓	4						2-10×
	5. Dense Complex	5						0&10
The air flow inside the building								
4	6. Isolated rooms for the use of constant wind✓	6			0-5			3-12× 1,2
	7. Adjacent rooms and prediction of air flow if needed ✓	7			6-12 ×			
	8. Lack of the need for tangible air flow	8						
Windows								
5	9. Big windows that take up 40 % to 80% of the northern and southern walls ✓	9	0		0&1			
	10. Very small windows that take up 10-20 % ✓	10	0, 1		11, 12			
	11. Medium Windows of 20-40 %	11						
Walls								
6	12. Light walls with short delay time	12			0-2			
	13. Heavy internal and external walls ✓	13			3-12 ×			
Roofs								

			A3	A2	A1	H3	H2	H1
7	14. Light roofs with heat insulation	14			0-5			
	15. Heavy roofs with a delay time of more than 8 hours ✓	15			6-12			
Nighttime Sleep in Open Spaces								
8	16. The need to predict space for nighttime sleep ✓	16		2-12 ×				
Protection against Rain								
9	17. The need to protect against heavy rain	17				3-12		

Source: The researcher.

Table 3

The suggestions on the details of the architecture of Bahar City in a period of 29 years (1976-2005).

1	**Suggestions on the details of the building**		**The Index of the State of Heat**					
			A3	**A2**	**A1**	**H3**	**H2**	**H1**
			0	**3**	**9**	**0**	**0**	**3**
Lighting space, holes, and windows								
2	1. 40-80 % of the northern and	1	0		0, 1			
	southern walls	2	1-12					
	2. Medium: 40-80 % of the wall's area				2-5			
	. Small: 15-25 % of the wall area ✓	3			4-10×			
	4. Very Small : 20 % of the wall area ✓	4	0-3 ×		11, 12			
	5. Medium: 20-45 % of the wall area	5	4-12					
The Location of the Hole								
3	6. In the northern and southern	6						3-12×
	walls towards the wind flow at a human being's reach✓				0-5			1,2
	7. As for 6, it should be built in	7			6-12 ×			
	the inner walls as well ✓						2-12	
Protecting the Wall								
4	8. It should be protected against direct sunlight ✓	8	0-2×					
	9. It should be protected against rain	9				2-12		
The walls and the ceiling								
5	10. Light and Low heat capacity	10			0-2			
	11. Heavy with more than 8 hours of delay ✓	11			3-12 ×			
Roofs								
6	12. Light, a reflecting surface and double-walled	12			0-2			10,12
	13. Light, good insulation ✓	13			3-12 ×			
					0-5			0,9
	14. Heavy with more than 8 hours of delay ✓	14			6-12 ×			
Outer Space								

7	15. The space for sleeping in open space ✓	15	1-12 ✗	
	16. Previous measures for passing water through it	16		1-12

Source: The researcher.

8. Conclusion

In the present study the bioclimatic indexes were studied based on Olgyay and Mahoney methods. First, the 29-year-long statistics from the synoptic station of Bahar was fed into bioclimatic table. Then according to the position of the months in the table (graph), the data was analyzed. The results indicated that most of the months during the year were in lower than the comfort zone, and there was a need for mechanical heating. Some days during Tir (July), Mordad (August), Shahrivar (September), and Mehr (October) are in comfort zone. The next method in the study was Mahoney. The data analysis showed that Dey (January), Bahman (February), Esfand (March), Aban (November), and Azar (December) are in cold conditions while Farvardin (April) and Ordibehesht (May) were in comfort zone, and Khordad (June), Tir (July), Mordad (August), Shahrivar (September) and Mehr (October) are in warm climatic conditions. Finally, the comparison of the bioclimatic conditions indicated that the results from the two methods confirm each other, and the architectural preparations for the methods can be generalized. Therefore, by the use of the building climatology, which emphasizes building compatibility with the environmental factors for achieving spatial quality and suitable form and appearance in architectural designing, and by including the new conditions of construction, we can recover and develop climate-compatible architecture in Bahar City in line with sustainable development programs.

References

Akhtarkaven, M., 2011. Regulating conditions compatible with the climate and environment in Iran., V.1 (Climate, architecture, and energy). Tehran: Kolhar Publishers.

Bideli, M., Ghajarbeigi, M.M., 2011. The traditional architecture of Iran: a reflection of sustainable architecture. Hamedan. 2’nd Confer. Sust. Architect.

Farajzadeh Asl, M., Ghorbani, A., Lashkari, H., 2007. The study of the compatibility of the architecture of the buildings in Sanandaj with the bioclimatic conditions in Mahoney’s method. The Periodical of the Instr. Human Sci., 2, p. 161-180.

Ghiabaklu, Z., 2011. The principles of the building physics (adjusting the environmental conditions) (1’st Volume). Tehran: Jahade Daneshgahi Publishers of Amir Kabir University’s Industrial Unit.

Mahmudi, M., 2009. The principles of sustainable designing in line with the goals of sustainable development. www.irancivilcenter.com.

Razjuyan, M., 2009. Comfort in the light of climate compatible architecture (2’nd Volume). Tehran: Shahid Beheshti Univ.Publ.

Sadeghi Ravesh, M.H., Ghorbani., 2010. The evaluation of the coefficients of bioclimate affecting human comfort: A case study of Yazd. Natur. Geogr.Period., 4, 77-92.

Tahbaz, M., 2009. The statistical analysis method for designing climate-compatible architectural designing. Te Period. Fine Arts Urban Plann., 1(38), p.61-72.

Tahbaz, M., Jalilian, Sh.B., 2009. The principles of designing compatible with the climate in Iran with an approach to the architecture of mosques (1’st volume). Shahid Beheshti Univ. Publ.

Watson, D.L., Kont., 2001. Climatic Planning, the theoretical and executive principles of the use of energy in buildings, Tehran: Tehran University Press.