

RECOGNITION IMPACT OF CLIMATE AND ENVIRONMENTAL PARAMETERS ON PATTERN OF TRADITIONAL HOUSES CASE STUDY: HOUSE OF SHARBAT OGHLI, GHADKI AND BEHNAM IN TABRIZ CITY

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ABSTRACT

Different climatic conditions might have left different impact on people's lives, so that unfavorable climatic conditions, in addition to, physical and mental inconvenience and hardship, leads to loss of different efficiency and kind of person's disorders, while favorable climate condition and Comfort criteria leaves a positive impact. Mountain cold climate of northwestern of Tabriz city have a significant impacts on shaping of the city's monuments and architectural elements and details, in order to investigate the cold mountainous climate of Tabriz have been considered as a case study. In this study, we have tried to assess the climatic characteristics of Tabriz, the influence of climatic factors at different angles. For this reason, using the deductive method with a general study of architectural design, effective details in design and architecture including wind effects on the orientation of buildings, how to harness the winds to make a comfort climate, impact of cold weather on the placement of the buildings beside each other, how to design spaces for the use of sunlight in winter, the impact of building materials on indoor thermal comfort, explained. The effect of the solar cycle on cold climate housing is investigated. Moreover, the effect of the solar cycle on heating and cooling load cold heating and cooling load of climate housing is investigated. The calculations of the study have been done by simulation in Autodesk Ecotect Analysis 2011 software, which is an energy intensive computing one. Accordingly, in northern latitude of 38 degrees with establishment of building direction or about deviation of 45 degrees to the East or West, maximum and minimum light shade in the streets surrounding the building is obtained.

Keywords: *Climate, Environmental Parameters, Ecotect Analysis, Sharbat Oghli, Behnam, Ghadki, Tabriz*

INTRODUCTION

Weather conditions along with other environmental factors are the most effective and important factors in shaping cities and urban survival lifetime. Cities, urban elements, the form of the buildings have been affected by weather factors. Therefore, the climate is one of the most important factors that influence the design of cities. In the past, thermal comfort and lighting through the design and construction of a limited number of construction equipment would be created. Considering spaces in plan, selection of proportional skin, the architectural design of the openings and other matters are focused. Some of these factors are personal characteristics of the individual such as activity and compatibility with environment and person's clothing and others such as air temperature, humidity, solar radiation and air flow collectively form environment's temperature conditions.

Duty of a designer is collecting the best possible condition in internal spaces, because control and adjusting of external spaces is not practical (Givoni, 1989). In every culture and civilization, environment and housing and buildings are human's new and permanent invention and have yet preserved excellence, utility and complexity in all dimensions. In today's world, gravity and the shortage of fossil energy and cost savings have been observed. Construction system appropriate to the climate and optimal use of natural resources in developing world has been observed by designer. So it investigate the effect of

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climate elements on thermal comfort and style designed residential units of Tabriz and provide guidance consistent with the climate, to bring comfort conditions inside the building (Meteorological Organization, 2003). Climate- harmonized or climate- designed buildings have better thermal comfort. Environmental conditions in these buildings are safer and better. Diversity and daily and seasonal changes of light, temperature and air flow in building's spaces can cause varied and pleasant. But in cold and harsh climates, it is not possible to adjust condition of discordant building to provide persons with comfort easily. Obviously, different buildings, in comparison to performance measures and their use, as well as context of economic resources, have different influence on climatic conditions. Small buildings are affected by climate conditions. Buildings with simple operation and a few inside heating elements as well as internal operations and planning functions are less dependent on climatic conditions. Building orientation is one of the most important issues for using of sunlight in winter and in cold climates and mountainous regions (Brebba and Beriatos, 2011). Of course, nowadays, determination and evaluation of climate's role on texture and traditional buildings are the most important energy saving programs and priorities (Coch, 1996). Using of natural resources instead of mechanical systems and creating a comfortable living space, is safe and durable. The aim of this study is obtaining suitable method for the effect of climate on the architecture of the building with emphasis on Tabriz. In this article we will try to answer above-mentioned questions. Are structure's orders on the basis of climatic conditions? Had the plan and design of the buildings been on the base of climate?

MATERIALS AND METHODS

In this study, we initially investigated characteristics mountainous homes of tabriz, Sharbat Oghli, ghadki and behnam's home were chosen as case study. One of these two examples is considered as a prototype in Autodesk Ecotect Analysis 2011 software and extracted charts of shadows and sunlight's movements in different seasons. Data collection method is a type of documental study and software modeling which is analyzed by qualitative content analysis to received information.

RESULTS AND DISCUSSION

Scope of Research

In the middle of the historical land of Azerbaijan and Tabriz, Tabriz is more or less located in a high plain. The plain is one of the most talented plain which is widen to almost 3,000 square kilometers and a height of about 1300 meters above sea level. All directions except west and north of west are limited to surrounding steep slopes. Geographical condition of city is located about 38 degrees and 8 minutes of north latitude and 46 degrees and 15 minutes of east latitude from the Greenwich meridian of longitude.

Understanding Thermal Comfort Indexes and its Reflection in the Studied Houses

The effect of climate on climate design process determines the dissipation of body heat. Four climate factors must be considered at the same time. Comfort region Specification have been mentioned in comfort zone. It means set of thermal conditions which is appropriated for at least 80% of human. Four elements of temperature, humidity, wind and radiation play a role in shaping comfort condition (Berger, 1989). In order to determine these conditions, different relaxation parameters and models are applied which four models are selected (Lahoordi, 2010)

Investigation of Wind Parameter in Climate Comfort

Direction, wind speed and skirt are main features and indeed distinction point of winds is its direction and speed. Winds are also influenced by geographical factors.

Mountain chains have influence on the broad surface, water temperature and direction of wind. Vast plains increases wind speed and grounds with ups and downs leads to lack of wind energy (Mashhoodi, 1996). Structure's arrangement should be in a way which air flows conducted and do not create dust and wind. Moreover, wind's effect should be analyzed.

Remember if a short building block is located in the wind shadow, the wind blows in the opposite direction of itself and toward short building. If buildings are placed in rows and behind of each other, we

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will have the most wind's blowing among building's rows. Then we would rather alternative arrangement. (Mofidi, 2008)

Table 1: Parameters of the wind characteristics at different times of Tabriz's weather station 1985 - 1957, References: Meteorological Department, Tabriz

Quiet	North	Northeast	Eastern	Southeast	South	South West	Western	North West	Wind direction	Time
										Parameter
%	2/6	3/1	3/5	2/6	3/2	4/2	3/2	3/1	The average speed m/sec	fall
335	25	63	65	20	10	42	46	27	Number scout	
52/9	3/9	10	4/30	3/2	1/6	6/6	7/3	4/2	Direction %	
%	3	3/2	3/2	3	3/8	4/6	3/3	3/5	The average speed m/sec	Winter
268	24	82	70	18	11	50	56	30	Number scout	
44	3/9	13/5	11/5	3	1/8	8/2	9/2	9/4	Direction %	
	3/8	4	4/2	3/2	4/30	5/2	4	4/30	The average speed m/sec	Spring
209	26	86	74	32	16	81	66	28	Number scout	
33/8	4/2	13/9	12	5/2	2/6	13/1	10/7	4/5	Direction %	
	4/5	4/6	4/7	3/2	3/1	4/4	3/8	3/6	The average speed m/sec	Summer
198	19	148	151	36	9	46	36	16	Number scout	
30	2/9	22/4	22/9	5/5	1/4	7	5/5	2/4	Direction %	
	3/9	3/7	3/9	3	3/6	4/6	3/6	3/6	The average speed m/sec	Annual
1010	94	379	360	106	46	219	204	101	Number scout	
40/1	3/7	15/1	14/3	4/2	1/8	8/7	1/8	4	Direction %	
208	23/8	7/7	8/3	9/2	15/5	12/9	6/7	14/4	The average speed m/sec	

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Light and Shadow Parameters for Evaluating the Climate Comfort

In cold climates, the maximum sun exposures, is very important due to the harsh cold and this is possible when solar energy can be harnessed and used in cold conditions. Creating comfort conditions is also very important, not only inside of building, but also around and outside of it (Mofidi, 2008).

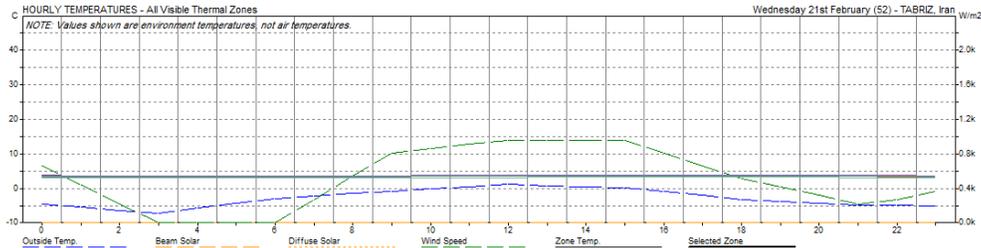


Figure 1: Thermal Analysis of Sharbat Oghli House in the coldest days of the year, References: authors

Investigation of Parameters of the Vegetation on Climate Comfort

In cold areas, it should be consider to plant trees don't create shade in cold seasons and also prevent unfavorable wind (10). For this purpose, the deciduous trees are suitable as summer shelter against sun's rays. This kind of trees which lose their leaves in the fall, are also suitable for better absorption of sunlight in winter. Evergreen trees should be planted as a windbreak from northwest direction to southeast and to exploit sun radiations, deciduous trees planted in the East and West and South of the buildings.



Figure 2: Using deciduous trees on the south side (Ghadaki's home), References: The authors

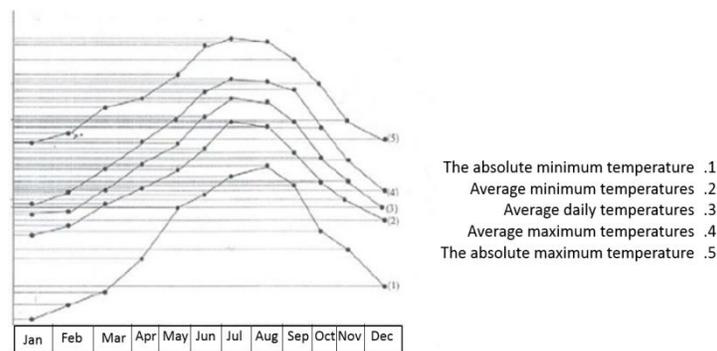


Figure 3: Using of evergreen trees from northwest to southeast (Sharbat Oghli's home), References: authors

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The Impact of Climate Parameters

Tabriz's climatic characteristics: cold and harsh winters are long and, the ground is covered with ice and snow in several months of year. Because of Iran's western mountain chains, summer rainfall is low. Rainfall in winter, mostly fall as snow and generally winter and summer are separated in this short spring region analyzing Tabriz's temperature data we find that 62% of time whether is cold and so cold and 17% of the time it is warm, generally it is not very warm, and 21% of cases it is temperate (Shaghaghi, 2004).



Monthly changes in the thermal regime in Tabriz station

Figure 4: Chart of monthly temperature regime changes in Tabriz's Synoptic station

Table 2: Average of monthly temperature and rainfall of Tabriz's weather station 1985-1957, References: Tabriz Meteorological Organization

December	November	October	September	August	July	June	May	April	March	February	January	Months and Parameter
1.2	6.9	13.8	21.4	25.6	26	21.7	16.4	11.2	5.3	Zero	-2.3	The average temperature C
18.7	29.3	26.9	8.8	3.3	4.4	17.5	11.7	53.2	47.1	25.5	29	The average monthly rainfall (Mm)

The Effects of Climate Change and Urban Structure

In general, the traditional context form of cold-region towns of Iran like Azarbayejan are product of thousands years of continuous work and coherent experience. In the first view, physical structure of city is looking for answers in acute climate and geographical conditions of region (Kasmaee, 2003).

The Effects of Climate Parameters on Residence

Study of residence's history shows that human obligatory adapt himself with space around in order to harmonize with the climate conditions. It can be found that three major factors are primary factors for creating man-made shelter including: 1- continent where they live, 2-types of available materials, 3-Forecast and devise ways to avoid possible dangers (Purdehimi, 2001). Climate and other environmental factors are the most important factors to form and create urban as well as durability of urban life time. In fact, urban, urban elements and their performance have been affected by the weather elements. Before advent of large metropolitan and cities they have been one-sided affected. Then, cities have influenced surrounding area's climate and created micro climate changes; in such a manner that today a geographical territory has been appeared known as "Chris micro-urban" and proposed relevant studies called "Urban climatology".

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The Effects of Climate on the Shell of the Building

In Moeen's Dictionary, shell has been defined as part of plants' structure that has formed the outer part of limbs and in fact is a class which covers other parts of plant (Moin, 2003). Harald Daylman reviews 4 expected functions of shells, briefly:

(1) Protection, (2) communication, (3) Introduction, (4) a component of urban space

The most basic and task was historically undertaken by Shell, was protecting the people against external threats. To protect human against atmospheric and climatic factors, and confront with malign animals and intruder human, space called home was created (Pakzad, 2003).

At first glance, the main components of the shell are particularly, the entrance and window openings. House entrance involves many concepts. Issues such as how to access, impact on the urban landscape, beauty, security, privacy, climate comfort, environmental comfort, visibility, and the important question of civilization are effective and efficient in entrance concept and residential environment design is favorable (Doosti, 2009).

Window will apparently is known by three factors: luminosity, providing visibility and inner and outer connection. Traditional houses in west of Iran and Tabriz, are kind of houses with veranda face with sun and transmit sunshine and warmth through tall windows of south yard (Parsa, 2011).

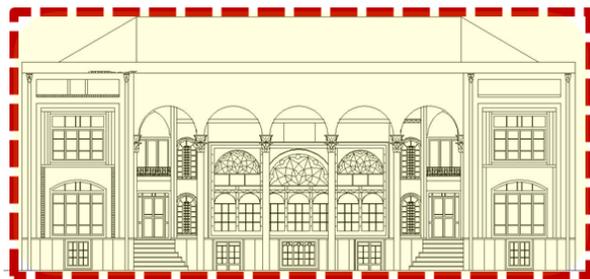


Figure 5: Southern View of Behnam's Home

Looking at the structure of biological complexes shows that the using of renewable energy such as solar, wind and... have been focused by humans from long time ago. While we have not ignored contribution or weight of cultural, social, political and economic, used housing placement, full or blank spaces, the planning and building establishment, the size and original elements, the spatial relationship of key elements of the plan, the distribution of architecture materials have defined, the dimensions of space and all phenomena related to climate were defined and regulated. Obviously, these relationships are not existed all at once existed, it occurs by trial and error elements, and local experience achievement. It is found that this knowledge is very valuable and it is often used as background (modern bioclimatic design) in climatic design (Coch, 1996).

In order to understand the influence of climate on the formation of Tabriz's old houses following readings has offered:

Effect of Climate Parameters on Historical Homes of Tabriz

Human always needs shelter or home during his life. The characteristics of the human need for housing includes creating very small climate in spite of incompatible climate conditions such as wind, rain, snow, intense solar radiation and very high temperatures or very low temperatures and ambient air to provide thermal comfort. Human has noticed comfortable and convenience appropriate residence as well as beauty for long time. For centuries Iranian architects and engineers tried to create masterpieces by wind, the temperature difference between day and night and over the years in which could create thermal comfort in buildings for region's weather conditions, with the lowest energy consumption.

This masterpiece includes a deflector design, chimney, spaces for summer with tall or dome roofs, courtyards, cellars, basements, warehouses, underground water and natural icehouse (Bahaduri, 2006).

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The solar radiation and wind direction have played an important role in the formation of streets and houses in the historical context of Tabriz design. Formation of the historic context of the cities and towns, have been influenced by climatic factors prevailing in the region's security and the culture factor. Narrow streets while have provided security lead to make shade and create natural air flow inside the neighborhoods and homes. Natural air flow follows wind blowing and in result of temperature difference between the street and the inner courtyard of the house, it arrive inner environment through porch and atrium. Then, part of the natural ventilation air is done as mentioned. We could indicate issues such as solar energy absorbed by the walls, solar energy penetrated through windows, Temperature difference between internal and external space, air flow rate in open and closed and covered spaces and vapor pressure of inner air as effective climate factors in home designation. Building shape could be effective in building coordination with climate conditions as well as balance it to transfer outside air into the building in crisis situations. In order to find thermal condition's role of each region in shaping buildings of the same region, we should specify importance of each factor of temperature and the intensity of sunlight. Generally, we conclude cold whether make building more compact and intensity of sunlight stretches it toward direction of east-west axis. It should also be noted that the best form of the building, is one which lose the lowest form of heat calories in the winter and in summer, the least amount of heat received from the sun and its surroundings. Then square plan form is the best one, because even with highest volume, prosper lowest external surface (Kasmae, 2003).



Figure 6: Front elongation in the east-west (Ghadki's home), References: The authors

High-level differences has been influenced by the climate in these homes including a basement level, courtyard, lower house, the upper house, the roof and high-level difference in height including roof of the pool house, royal seat, three doors, closets and a porch.

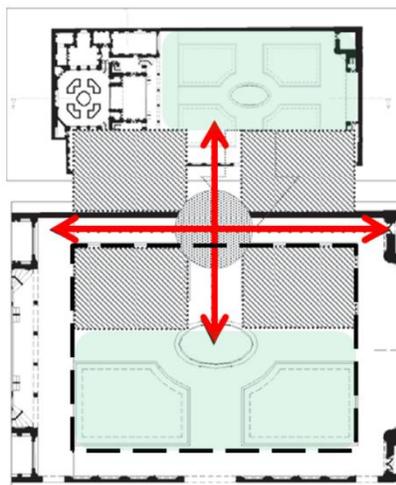


Figure 7: Using minimum of open spaces

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The historic-native homes have been designed in such a way that at most times of the year are suitable, without the use of additional heat and cold equipment for the greatest number of performance between private and public domains, such as: living room, bedroom, meeting room and dining room. Rooms of these homes were shaped on the basis of climate design, in a way include self-cold rooms or self-warm rooms and rooms with air current. Local winds have made residents of region to obtain this factor for ventilation effectively. So it made inhabitants of the towns and villages to use specific structures to take advantage of favorable winds and avoid damaging winds.

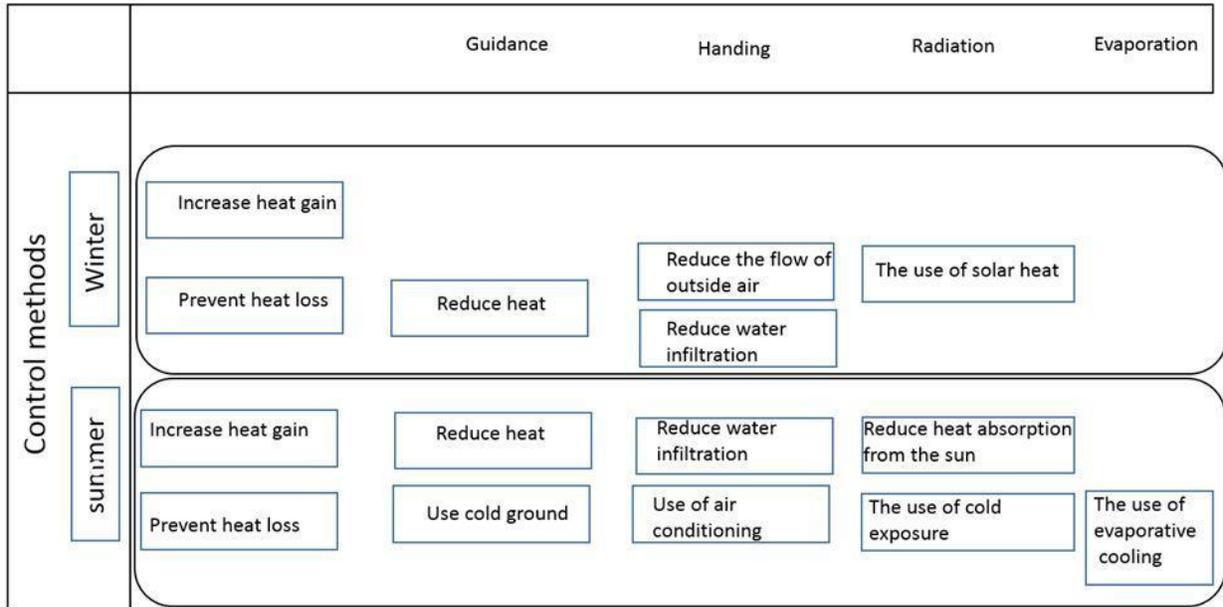


Table 2: Summary of principles and climatic design’s methods, References: Watson and LABS 1937

Sharbat ogli home	Behnam home	Ghadaki home	Specifications	Parameter
			Capacity and high heat resistance	Type of material
			Flat	Type of material
			On Earth	building
			Dark	Exterior color

Table 3: Characteristics of cold climate buildings (Tabriz), References: The authors

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Recognition of Volumetric Structure of Spaces

Tabriz traditional home have introverted texture and main spaces have not often made a pilgrimage to the outside and light and ventilation have been supplied by courtyard. Main part of house is located mostly in the northern of courtyard; then, sun shine is well used in the winter.

Most of these homes have been designed in a two-floored block with a basement in which some large or medium-sized residential units, pool house designed that in combination with adjacent spaces, has been considered a suitable environment to relax, life and leisure (Soltanzadeh, 1997). In many cases, basement was averagely located about one meter above the surface of the courtyard in order to provide rooms with easy skylight and ventilation. Spaces of traditional houses are subjected to order on the basis of Iranian pattern in the vertical and horizontal directions and it is done by a hierarchical order, availability of a public field to the private field. Portal entrance-porch-corridor and courtyard are rows of hierarchy which allows access to inside houses (Bani, 2009).

Climatic Design Principles

- Density

Cold weather region's designation, low density and compact, is used as dependent series (depending on slope). Density must be in extent to which they do not block sunlight to each other. Studies show that old urban areas have high density and their shape indicate that this strategy is a reaction against coldness in this area and provide better physical condition (Mohammadi, 2002).

Advantages of utilizing this method are given below:

- To reduce the ratio of surface to volume
- Using classified buildings and a set in order to reduce heat shortage
- Decreasing contact of urban with the wind in winter
- Decreasing composite and single shadow



Figure 8: Density of Tabriz's city texture (Source: Tabriz.ir)

- Orientation

Suitable direction is south to southeast of habitat which lead to create spaces to absorb sun shine in the early hours of the morning. Southern spaces are ideal orientation. This direction is suitable for the main facade of the building and main entrance. Factors to select this facade:

- To use the sun
- To increase heat absorption
- To protect against the prevailing northern winds

In order to minimize shady and cold spaces, we should avoid putting spaces in the east and north direction. Spaces in western direction are used for cold periods or severe cold region and extreme ventilation in the afternoon.

We investigate climate conditions of Shabat oghli's home by Ecotect software. According to the survey, the southern side entirely benefits from the sun in the winter (Figure 5) and northern side is completely in shadow in the summer (figure 6), then southern side is winter-residential and northern one is summer-residential.

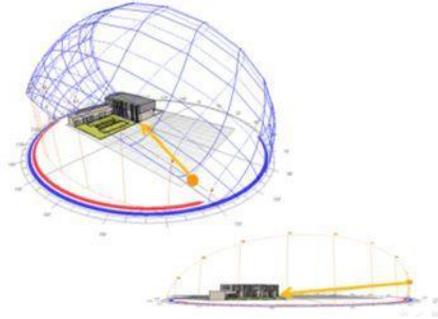


Figure 9: Rotation of Sharbat oghli’s home model Home by Ecotect and study of energy absorption in a December at 8.30 References: The authors

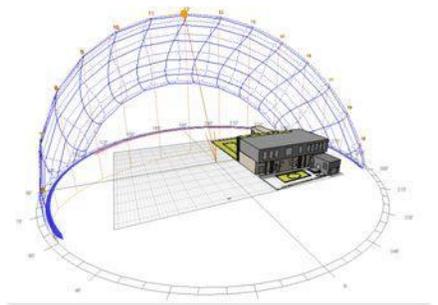


Figure 10: Rotation of Sharbat in a Jun at 12, References: The authors

Size and Proportion of Space

Size and space’s proportion depends on amount of sunlight absorption and wind prevention. Size and proportion of open space in the cold regions plays an important role in the comfort measure and it is very important in determining the shape of urban. These spaces should be take place in the south and east of the mass. The open spaces are very important elements in designing of a comfortable climate and could influence shape of city. Reasons to use these elements include:

- Increasing the early morning sunlight’s absorption
- Reduction of compound and single shade in open spaces.

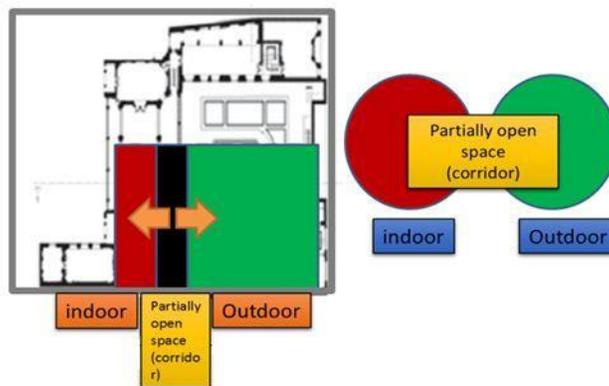


Figure 11: Relationship between open and closed spaces (Source: Authors)

These spaces are dispersed between residential complexes. This cool region is observable in all habitats. Distribution of these areas helps to properly distribute the sun's energy and balance full and empty spaces

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in sidewalks and will provide pedestrians with comfort. It would rather private open spaces have been located in the south to absorb the sun shine as much as possible. Southern yard play an important role in balancing of urban spaces in cold regions.

- Arrangement

It is better to set buildings in singular and compact form and avoid arrangements that create wind tunnel and ice. The size of open spaces (courtyards) is in connection with the need to absorb sunlight and prevent wind and set more in south to east of volumes in order to use sun shine more efficiently and stop creating central yard due to shades. The compact arrangement of interior space in the basement with several global warming is very convenient to use. Access between the spaces should be minimized. Parking spaces on the west side is designed to remove heat and cold and work as insulation. Water pipe located in outside walls, especially walls in northwest and southeast side.

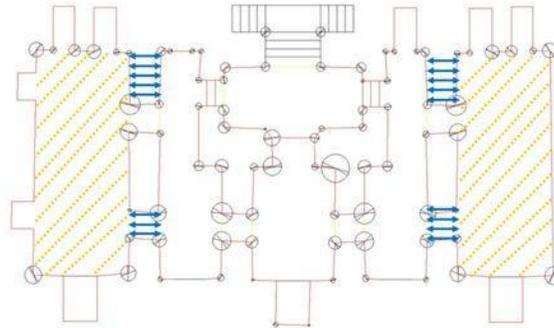


Figure 12: Basement plan of Sahrbat Oghli's home

- Physical Form

In the case of optimal utilization of solar radiation energy, we require a stretched building with bigger southern facade and smaller Western- eastern facade (Schiller, Evans, 2000). In the case of the building's establishment in cold climates, Mohammad Karim Pir Niya, has spoken about "ron" (Sanskrit root meaning store of Secrets) that is located in the north-east to south-west and has been proposed for cities such as Tabriz (Kasmaee, 2003).

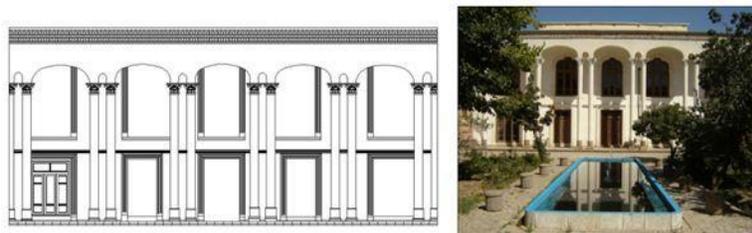


Figure 13: Physical Form of Sharbat oghli's home (source: authors)

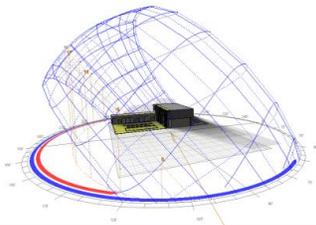


Figure 14: shading and sun moves from 7 to 17 in winter (Sharbat Oghli's home) References: The authors

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- Orientation and Proportions of the Buildings

Houses made of two parts: winter and summer part. Summer rooms in the north to which their surface is always in the shade and prevent frost penetration into the interior of the house in winter. In winter part of home rooms are located at south side. South direction is ideal for the main facade and entrance. It is better when building have been considered with larger south view and deviation of 12.5 degrees to 12.5 degrees toward the southeast to southwest.

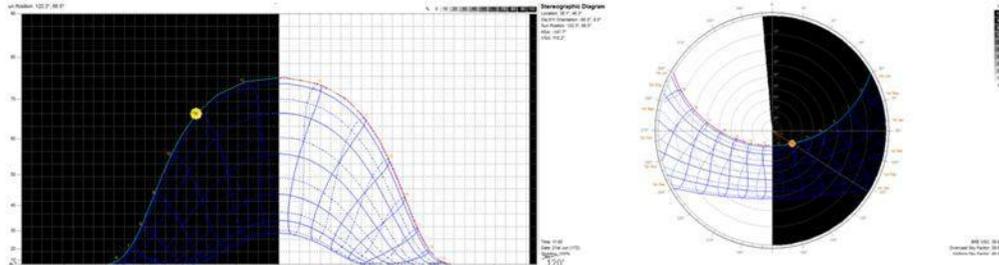


Figure 15: Status of the southern part of Sharbat Oghli's home in 21th Jun at 11'oclock in solar the diagram, Sources: Researchers

- Windows

Skylights penetrate on both floors' spaces of the building through the wooden, wide and tall windows which are located in relatively deep covered porch.

But in spite of high width of porch, all windows fully absorb sun shine, because it is too high. Some buildings have been equipped by double-duo windows to protect rooms from the cold winter; in the other words, it is made up of two shutter windows which inside one open towards room and other open outward.



Figure 16: Using window to absorb sun light in the winter (Behnam's House) References: The authors

Table 4: Energy indicators in selected samples

Percentage of shading	Area of shade with ambition angle of 28 degree in the early of january	Frame of windows and Thermal transition value	Thermal transition value	Thermal resistance of wall	Thickness (meter)	Percentage of openings	Area of openings (m ²)	Area (m ²)	Home
13	22.9	Wooden-5	1.58	0.63	0.5	36	60.39	164.72	Ghadaki home
9	23.04	Wooden-5	1.58	0.63	0.5	32	77.34	241.64	Behnam home
14	15.68	Wooden-5	1.08	0.92	0.5	21	22.8	108.42	Sharbat Oghlil home

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The following table investigates the outer shells of Behnam and Ghadki and Sharbat Oghli's and the energy's indicators of the samples were calculated according to the brick facade.

Conclusion

The design of the building is the first line of defense against the outside climate. Climate design is a method to reduce the overall energy cost of a building. In all weather, buildings that have been built in accordance with the principles of climate design, reduces necessity of mechanical heating and cooling and instead of it uses surrounding natural energy of the buildings (Watson *et al.*, 1937). Studies of native building in each climate obviously show that all of them are completely designed on the basis of climate principles and efficient usage of natural energy to cope with uncomfortable heat and cold. This is perfectly consistent with the culture of each region and is defined native architecture.

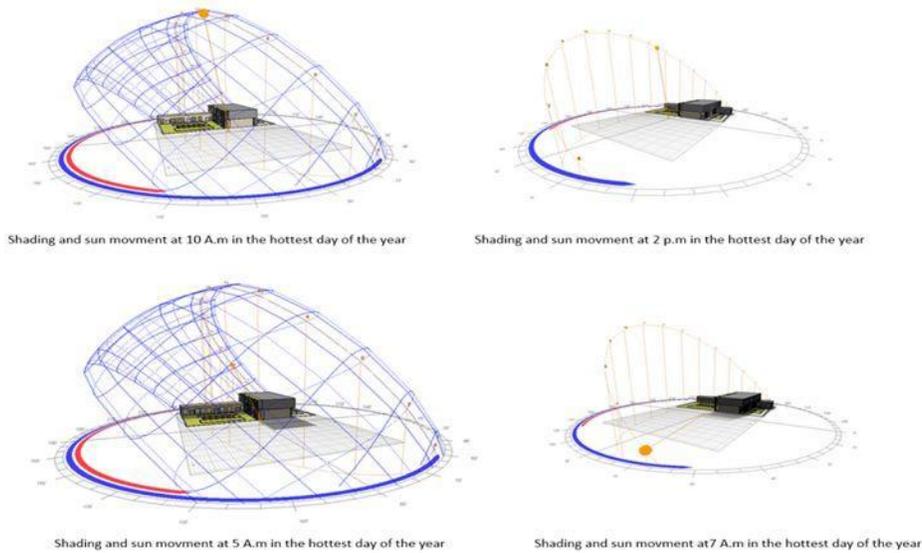


Figure 17: The sun shading during the hottest day of the year (references: authors)

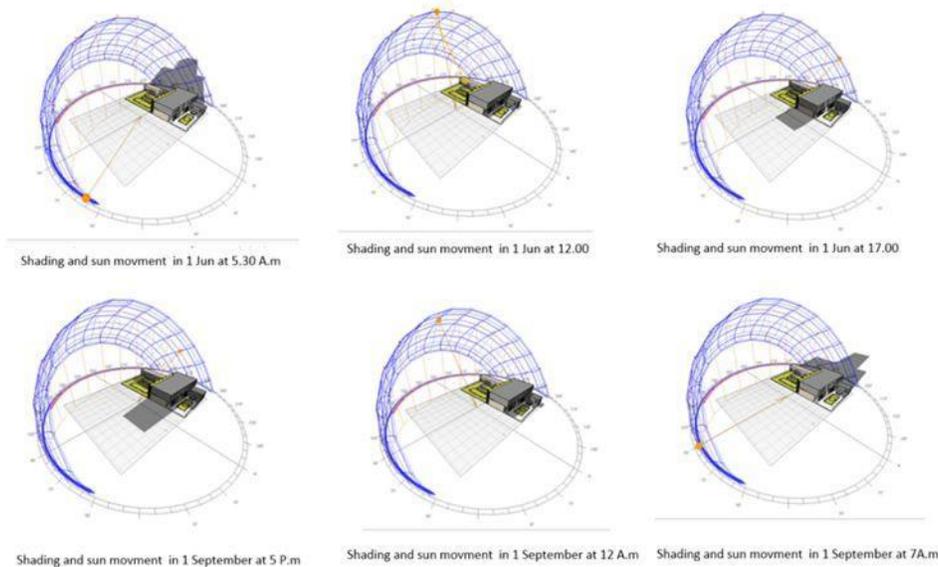


Figure 18: The sun shading in June and September, (references: The authors)

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We concluded Sharbat Oghli's home is built on the basis of climate conditions through investigation of Tabriz houses and modeling of Sharbat Oghli's homes in Ecotect software. In this region, sun doubly shines to southern side of building in the winter. In summer, east and west sides prosper sunshine double and half more than winter. The northern side of building receives very small amount of radiation. Therefore, in order to establishment of structures and communication axis should be in a way that northern sides of building receive daily direct sunlight in the cold months of year. While average number of ice days is over 100 days, the southern parts of communicational paths should be able to enjoy direct sunlight for hours during a day. The angle of the sun shows that northern side of buildings would not reap the benefits of direct sunlight from 1th October to 21th March. This can be solved by deviation of building to west or east side. Whereas direct sunlight from east and west make trouble in warm seasons, deviation from north and south line won't be suitable more than 45 degrees. According to studies conducted in the northern latitude of 38 degrees and building deviation of about 45 degrees to the east or west, maximum building lighting and minimum shade in the streets surrounding the building is obtained.

ACKNOWLEDGEMENT

We are grateful to Islamic Azad University, Tehran Shomal branch authorities, for their useful collaboration.

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