THE ANALYSIS OF COMPATIBLE ARCHITECTURE WITH CLIMATE IN SANANDAJ CITY
BASED ON ECO-CLIMATIC INDICATORS

Saeid KAMYABI¹, Darya NOSRATPOUR²

¹Assistant Professor, Department of Architecture, Seman Branch, Islamic Azad University, Semnan, Iran
²PhD Scholar, Department of Architecture, Seman Branch, Islamic Azad University, Semnan, Iran

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Abstract. Today, the discussion of climatic conditions has become the first priority of architects to build buildings. Although a regional architectural design has been used as one of the most important and the most appropriate method in saving energy as well as keeping the spaces sustainable, the analysis of the technical construction process based on climate condition can have considerable impact on saving energy. This study was conducted to evaluate and determine the optimal conditions of climate and climatic design in Sanandaj City based on eco-climatic indicators such as Mahani, Algyy and Gioni during the statistical period of 15 years (2010-1996) from Sanandaj synoptic station. The aim of this study was to use the provided suggestions in the architecture of each indicator for platform compatibility according with their environment and maximum use of environmental potentials and reduce its problems in order to save energy and enhance the quality of life. After obtaining the results, the General architecture guidelines in the field of cold and semi-arid climate is presented with the approach of sustainable architecture. And finally it has reviewed one of the traditional houses of Sanandaj city- Asif house-in terms of its compatibility with cold and semi-arid climate.

Keywords: Sanandaj, Mahani indicators, climatic architecture, Gioni indicator, Asif House, cold climate

INTRODUCTION

Climatic design is a method to reduce overall energy costs of a building. The design of the building is the first defense line against climatic factors outside the building. In all climates, buildings which were built according to the principles of ecological design reduce the necessity of mechanical heating and cooling to its minimum as well as using the natural energy surrounding the building. Climatic design makes the building to have a better situation.

Buildings built on the climatic conditions not only have a good performance in bad weather, but also provide a healthy and beautiful environment for human life. Due to the widespread impact of climate on human welfare, people were always looking to provide the maximum benefit from the climatic comfort. Scholars have raised different ideas and principles to achieve human prosperity in the past which here we will point to some important ones. Algyy has presented an eco-climatic chart in which regional characteristic of human comfort is determined based on dry air temperature and relative humidity. Later on he completed and extended this chart using the cooling effect with two properties of sun heat. Gioni has also presented an eco-climatic chart in which the influence of the building wall is carefully considered on the heat inside. He believes that the type and the extent of the impact of the building on the effective factors on comfort is calculable and if the weather conditions would change into optimal condition on Psychrometrics chart , eco-climatic chart of the building can be abstained. Mahani has presented his comfort criteria and climatic architecture through specific tables. In these tables the comfort zone of day and night is determined according to the average annual temperature relative humidity of the same month as well as monthly temperature fluctuation, rain drop and wind direction. Mahani has also provided series of suggestions for architecture according to the climate condition.

* Corresponding author. Darya NOSRATPOUR

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Evans has determine comfort zone with the four elements of human activity, relative humidity of the air flow and human clothing as well as dry temperature which the results are provided in a special table. After determining the comfort zone he presented suggestions through using these tables regarding the appropriate architecture compatible with the climate condition. The importance and necessity of this study is so clear since in recent years there was little attention to climatic criteria and more attention to faster construction or less consumption of building materials and the cheaper final cost. That’s why the residents of these buildings are forced to use large amount of fuel and energy for heating and cooling consumption. In recent years, there has been little attention on regional climate in construction of new houses in Kurdistan province. In the building industry which is one of the most important industries in all countries, cultural and climatic issues have to be paid attention to in order to gain the most and pay fewer costs.

**Objectives of the study**

The objectives of the study is to analyze the compatible architecture with the climate of Sanandaj city based on Mahani indicators, Algyy eco-climatic as well as building eco-climatic in accordance with sustainable architecture. Finally, reviewing one of the traditional houses of Sanandaj city- Asif house in terms of its compatibility with cold and semi-arid climate.

The most important **questions** of the research:

1. Is compatible architecture with Sanandaj City's climate capable of being investigated and analyzed based on eco-climatic indicators and Mahani model in line with sustainable architecture?
2. Can we achieve sustainable architecture through using the above mentioned results and methods in order to coordinate buildings with climate of the region?
3. Is Asif Vaziri’s house an example of compatible architecture with climate?

Based on the above research questions the following hypotheses are listed:

-it seems that using climatic comfort models is effective in achieving eco-climate in line with sustainable architecture
-it seems that applying the climatic comfort indicators in line with sustainable architecture in the city of Sanandaj can reduce heating and cooling costs.

Regarding the literature review there have been good deal of studies conducted in the past few years that some of which are as follows:


**METHODOLOGY AND MATERIALS**

**The region under study**

The research was conducted in Sanandaj, Kurdistan Province (northwest Iran). Sanandaj is located at the height of 1,450 to 1,538 meters above sea level in the mountainous area of the Zagros. This city is limited to Abidar mount from the west, to Sheikh Mount from the north and
to Seraj-ed-dind mount from the south. The population of the city based on the Population and Housing Census of 2011 was about 373,987 people. [http://fa.wikipedia.org/wiki/]

Table 1. Characteristics and situations of studied stations.

<table>
<thead>
<tr>
<th>Population</th>
<th>Height from sea level</th>
<th>Size</th>
<th>Geographical characteristics</th>
<th>Type of the station</th>
<th>Name of the station</th>
</tr>
</thead>
<tbody>
<tr>
<td>373,987</td>
<td>1373</td>
<td>3688.6</td>
<td>27</td>
<td>Synoptic</td>
<td>Sanandaj</td>
</tr>
</tbody>
</table>

Methodology

This research was conducted through using library and field studies as well as statistics coming from meteorological station in Sanandaj during the past 15 years (1996-2010). In the library phase, books, journals, and articles related to the research topic were used. Collecting maps and needed climatic data was done by going to the Meteorology Bureau of Kurdistan province as well as website of Meteorological Organization of country. Through using computer software such as Word, Excel, Autocad and Photoshop we tried to create tables and graphs in order to clarify the 15-year average of the required parameters.

Data Analysis

Human beings comfort zone based on eco-climatic indicators of Algyy

Charts or eco-climatic indicators of human beings which is known as Algyy indicator, is an indicator that reflects the weather condition of one station or region in terms of its comfort. In this diagram, the human comfort zone for dry air temperature and relative humidity of Sanandaj is determined.
According to the Algyy eco-climatic Chart, Sanandaj is located in D zone eight months of the year and it means that in these months, people do not feel comfortable unless they are exposed to radiant heat (from the sun or any other source). In contrast, a degree decrease in the temperature need 150 watt of solar radiant heat in order to provide a sense of comfort (Razjoyan, 2010).

**The amount of comfort in Sanandaj based on Gioni method**

In this way, the features which a building needs to make its internal air under the influence of climatic conditions in the comfort zone is determined in relation with the weather changes surrounding the building. Gioni has determined usefulness, amount of natural ventilation, construction materials properties, adding moisture to the inside air as well as the necessity of the using mechanical devices in relation with various thermal conditions of building through drawing curves on Psychrometrics table (which determines the relationship between human being comfort and heat condition of his environment). In this diagram the dry air temperature for comfort zone and the relative humidity in Sanandaj is determined.
According to the chart, eco-climatic indicator of the building refers to the appropriate architecture properties with some architecture recommendations which are as follows:

**Heat exchange through the wall of the prospective building.**

**External surface of the building:** While shrinking, less resistant surfaces (in terms of heat), such as doors and windows, sum of the external surfaces of the building needs to be minimized. In other words, the design of the building has to be densified.

**Thermal resistance of building’s wall:** Sometimes, creating a dense plan is not possible due to rapid ventilation or the use of a view. As a result, the external walls of the building have to be equipped with thermal insulation, and in this way, the amount of exchanged heat between the Interior and exterior of the building decreases.

**Temperature difference between inside and outside:** There has to be enough attention to the building’s location as well as its plan in order to minimize the optimum temperature of the inside with undesirable temperature of the outside. In some cases, if the living conditions of the place is appropriate, they can build the building inside ground instead of building it on the ground.

**Preventing air-penetration through door, window joints in the construction**

The air-penetration through windows wastes the energy. That’s why, in the buildings, there is a lot attention to both the doors, windows and their joints. There needs to be enough attention on the location of the building in order to minimize the wind penetration through doors and windows as well.

**The use of solar heat**

- Transparent parts of the wall of the building have to be in such a way in order to minimizes the other objects blocking sunshine or windows.
- The building wall’s materials have to be in such a way in order to absorb too much radiation (Razjoyan, 2010).

**Table 2.** The building materials ability to absorb and release heat (in percentage terms) (Razjoyan, 2010).

<table>
<thead>
<tr>
<th>Heat absorption and radiation , when the the source of radiative ray is a hot device with temperture of about 10 to 40 c</th>
<th>Heat absorption and radiation , when the the source of radiative ray is sun</th>
<th>The material of the surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiative ray %90-98</td>
<td>radiative ray %85-98</td>
<td>black Non-metallic</td>
</tr>
<tr>
<td>radiative ray %85-95</td>
<td>radiative ray %65-80</td>
<td>Brick, stone and red tile</td>
</tr>
<tr>
<td>radiative ray %85-95</td>
<td>radiative ray %50-70</td>
<td>Brick, stone and yellow</td>
</tr>
<tr>
<td>radiative ray %30-50</td>
<td>radiative ray %30-50</td>
<td>cream Brick, tile</td>
</tr>
<tr>
<td>radiative ray %30-50</td>
<td>radiative ray %30-50</td>
<td>Transparent aluminum, bronze</td>
</tr>
<tr>
<td>radiative ray %40-65</td>
<td>radiative ray %40-65</td>
<td>Dark aluminum and Galvanized iron</td>
</tr>
<tr>
<td>radiative ray %30-50</td>
<td>radiative ray %30-50</td>
<td>polished</td>
</tr>
<tr>
<td>radiative ray %10-240</td>
<td>radiative ray %10-240</td>
<td>Bronze and copper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>polished Aluminium</td>
</tr>
</tbody>
</table>

**Ccompatible architecture with the climate of Sanandaj city based on Mahani indicators**

Mahani tables have determined day and night comfort zones of each month according to the annual average of the studied place temperture as well as its relative humiduty average. Table 2 has specified the monthly temperture average, relative humidity, rain drop, wind direction and the average of temperture fluctuations. In order to determine the humidity group, the below table is used which Sanandaj city is placed in column one with its annual temperture average.

**Table 3.** The first part of Mahani table.

<table>
<thead>
<tr>
<th>December</th>
<th>November</th>
<th>October</th>
<th>September</th>
<th>August</th>
<th>July</th>
<th>June</th>
<th>May</th>
<th>April</th>
<th>March</th>
<th>February</th>
<th>January</th>
<th>Temperature in centigrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>15</td>
<td>25</td>
<td>32</td>
<td>37</td>
<td>37</td>
<td>33</td>
<td>26</td>
<td>20</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>The monthly average of maximum temperture</td>
</tr>
<tr>
<td>-1.4</td>
<td>1.8</td>
<td>6.8</td>
<td>11.17</td>
<td>18</td>
<td>13</td>
<td>9</td>
<td>5.5</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>2.3</td>
<td>The monthly average of minimum temperture</td>
</tr>
<tr>
<td>7.8</td>
<td>.13</td>
<td>.18</td>
<td>.21</td>
<td>.18</td>
<td>.20</td>
<td>.17</td>
<td>.14</td>
<td>.13</td>
<td>.7</td>
<td>.2</td>
<td>monthly temperture fluctuations</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>Annual fluctuations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-3.9</td>
<td>37.3</td>
<td>4.33</td>
<td>Annual temperture average</td>
<td>14.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>86</td>
<td>85</td>
<td>69</td>
<td>55</td>
<td>46</td>
<td>45</td>
<td>52</td>
<td>74</td>
<td>81</td>
<td>80</td>
<td>86</td>
<td>88</td>
<td>Relative humidity</td>
</tr>
<tr>
<td>43</td>
<td>35</td>
<td>21</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>21</td>
<td>27</td>
<td>29</td>
<td>40</td>
<td>48</td>
<td>Relative humidity group</td>
</tr>
<tr>
<td>64</td>
<td>60</td>
<td>45</td>
<td>33</td>
<td>28</td>
<td>28</td>
<td>31</td>
<td>47</td>
<td>54</td>
<td>54</td>
<td>63</td>
<td>68</td>
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</tr>
<tr>
<td>3</td>
<td>3</td>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
The Analysis Of Compatible Architecture With Climate In Sanandaj City Based On Eco-Climatic Indicators

**Table 3.** Part two of Mahani table.

<table>
<thead>
<tr>
<th>Month</th>
<th>10.1</th>
<th>15.5</th>
<th>25.3</th>
<th>32.3</th>
<th>37.3</th>
<th>37.3</th>
<th>33.8</th>
<th>26.6</th>
<th>20.4</th>
<th>15.4</th>
<th>9.6</th>
<th>6.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>26</td>
<td>26</td>
<td>31</td>
<td>27</td>
<td>30</td>
<td>30</td>
<td>27</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>2018</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>25</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>2019</td>
<td>-1.4</td>
<td>1.8</td>
<td>6.8</td>
<td>11.1</td>
<td>17.2</td>
<td>18.4</td>
<td>13</td>
<td>9</td>
<td>5.5</td>
<td>1.5</td>
<td>-2.3</td>
<td>3.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>6.2</td>
<td>9.6</td>
<td>15.4</td>
<td>20.4</td>
<td>26.6</td>
<td>33.8</td>
<td>37.3</td>
<td>37.3</td>
<td>32.3</td>
<td>25.3</td>
<td>32.3</td>
<td>37.3</td>
</tr>
<tr>
<td>2018</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
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<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2019</td>
<td>-3.9</td>
<td>-2.3</td>
<td>1.5</td>
<td>9</td>
<td>13</td>
<td>18.4</td>
<td>17.2</td>
<td>11.1</td>
<td>6.8</td>
<td>1.8</td>
<td>-1.4</td>
<td>6.8</td>
</tr>
</tbody>
</table>

The necessity of airflow
H1

Appropriateness of airflow
H2

The necessity of acting against rain
H3

The necessity of heat storage in the walls
A1

Night sleep in the outside
A2

Cold month problems
A3

**Table 4.** Heat indicators.

<table>
<thead>
<tr>
<th>total</th>
<th>December</th>
<th>November</th>
<th>October</th>
<th>September</th>
<th>August</th>
<th>July</th>
<th>June</th>
<th>May</th>
<th>April</th>
<th>March</th>
<th>February</th>
<th>January</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

The necessity of airflow
H1

Appropriateness of airflow
H2

The necessity of acting against rain
H3

The necessity of heat storage in the walls
A1

Night sleep in the outside
A2

Cold month problems
A3

The maximum avrage of temperature
Comfort zone during day

The minimum avrage of temperature
Night's Comfort zones Determining Heat condition
Table 5. The primary recommendations for Sanandaj architecture

<table>
<thead>
<tr>
<th>Thermal status indicators</th>
<th>recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1H 2H 3H 1A 2A 3A</td>
<td></td>
</tr>
<tr>
<td>0 0 0 9 3 5</td>
<td></td>
</tr>
</tbody>
</table>

### The buildings' location

| 11 2 1 2 | 1- Buildings' length along with east and west |
| 0 0 0 0 0 | 2-dense architecture with the environment |
| 0 0 0 0 3 | 3-great and open space in order to use wind |
| 1 0 1 0 6 | 4- as above and in order to prevent cold and hot wind |
| 0 0 0 0 5 | 5-dense set |

### The space between the buildings

| 3 1 2 | 6- single rooms |
| 1 0 1 0 1 2 | 7- connected rooms and predicting temporary airflow |
| 0 0 0 0 2 1 3 | 8-no need for airflow |

### Airflow in the building

| 0 1 2 | 9-big windows up to 40 to 80% of north and south walls |
| 1 0 1 0 1 2 | 10-very small windows up to 10 to 20% |
| 0 0 0 0 0 1 2 | 11-medium windows up to 20 to 40% |

### Windows

| 0 1 2 | 12-light walls-delay time-short |
| 1 0 1 0 1 2 | 13-heavy walls-internal and external |

### Walls

| 0 2 1 | 14-light roof with heat insulation |
| 3 1 2 | 15-heavy roofs-delay time more than 8 hours |

### Roofs

| 0 5 1 | 16-space for night sleep is necessary |
| 6 1 2 | 17-protection in heavy rain is necessary |

### Other conditions

| 0 1 2 | 11-medium windows up to 20 to 40% |
Recommnedations of the study

The following items are recommended based on Mahani tables in designing residential buildings in the Sanandaj city (Razjoyan, 2010)

Extended Form towards the east - west
Compact space design Predicting airflow is not necessary A small window with 20 and 40% of the related design Heavy walls and floors with a delay time of more than 8 hours Heavy roof with a delay time of more than 8 hours for designing external space for sleep

Other useful recommendations about climatic architecture of Sanandaj city can be as follows:

- Using dark colored materials and rough construction
- Using materials with low transmission coefficient.
- Orientation of the building should be in such a way in order to maximize the use of radiant energy.
- Using southern large porches in order for sun to shine in winters as well as blocking the sun in summer.
- The use of flat roof in order to use the maximum sun radiation in winter.
- The use of double or triple glasses with injected argon gas between them
- Using suitable canopy for the windows in order to lead sunshine into the house in winter as well as blocking it in summer
- Using thermal insulation in the floors, roof and external walls
- Considering wind direction in the winter in order to determine the building's location
- Raising the level of the main entrance from the bottom in order to reduce the effects of wind.
- Locating the heating spaces like the kitchen in the middle of the building.
- Dividing the internal space into smaller spaces and installing overall doors for them
- Using hot water pipes in the floor in order to heat the building.
- Using appropriate ventilation and electric wherever water vapor is produced, like kitchen
- Using Atryum in order for the horizontal and vertical ventilation
- Using the roof garden (green roof) in the building for heating in the winter and cooling in summer as well creating elegant and graceful view.
- Using dynamic movements in some parts of the building
- Using sensors that will automatically adjust the room temperature and light based on the situation.
- Using smart glasses by applying nanotechnology that in the intense sunshine they turn black and dark and light sunshine they turn to be brighter

Climatic Assessment of Asif Vaziri mansion (Kord House)

Asif mansion which is known as Kord House in Sanandaj, is one of the oldest buildings in the city. It is 4500 square meters and the house is one of the aristocratic residential house which is the center of architecture attention. It has been registered as a national historical house in the year 1996 by the code of 1822. The construction of the building dates back to Safavid dynasty which in the late Safavid period, Qajar and Reza Khan some other parts were added. The founder of the building was Asif Azam (Mirza Ali Naqi Khan Lashgar Nevis). In the last few years, the house has become the Museum of Anthropology (Kord House), which is located on Imam Street (former Shahpur).
The house has vestibule, entrance, water room, four inside and outer yards as well as kitchen. The outer courtyard which is also the main yard has a rectangular plan, two verandas, water view and a garden which on its north side there is the main Hall with a unique decorations, including stucco, beautiful paintings as well as geometric motifs.

On the east side of the outer yard there is a passageway, some doors and a four-door as well a room and on its west side there exist an overall veranda with brick pillars. There is also a beautiful hall behind this veranda as well as two rooms on its sides. The other important part of the yard is the bathroom which is known as the most beautiful historical bathroom of Sanandaj. The bathroom has inscribed stone pillars.

Interior courtyard is located on the north side of the building which was built according to local architecture at the beginning of Pahlavi period. Interior courtyard spaces are two floors, with the ground floor and a porch with six pillars made of wood and stucco decorations as well as a water view with gardens around. The servants’ yard is located on the south side of the entrance corridor. The general architecture of these sections had been destroyed in recent years and there is no evidence about its construction. That’s why the servants’ yard reconstruction was based on a new design in accordance with the principles of traditional architecture consisting of a central courtyard with, galleries, restrooms and sleeping facilities.
The Analysis Of Compatible Architecture With Climate In Sanandaj City Based On Eco-Climatic Indicators

There is a small courtyard around the south side of the building which is known as kitchen courtyard. It has a stone water view as well as a stone-roofed space which opens to the courtyard. The needed water of Asif building is provided through series of subterranean water requirements which is set by the West of Sanandaj to the building.

The form of the building and the climate

Since Sanandaj is located in the cold and mountainous area, buildings with open forms with the forms that north and south sides are higher than their east and west is not appropriate and it is better for the building to have intense plan as well as having square form. Buildings with cubic form are the best ones in terms of the internal heat control in winter. The main part of the house is constructed in the northern part of the yard in order for it to use more sunshine as well as facing Mecca. To reduce cold in winter thick walls and ceilings have been used as well.

A traditional building in cold climates, such as the central plateau of Iran has a central courtyard and other parts surround the courtyard. Rooms which are located on north side of the yard are bigger than other parts and the Halls or living rooms are located in this side in order to use more sunshine in cold seasons.

Southern side of the building is rarely used due to short and mild summer. Therefore, the south, east and west rooms are used as storage rooms or rest rooms.

Figure 7. Plan of Asif house

Figure 8. The central yard and southern rooms.
Unlike temperate and humid southern coast of the Caspian Sea, the houses of this area have often short and low height basement, which are used as a living room in the summer because of its cold condition. Since most of the days of the year in cold mountainous areas is very cold, most of everyday activities is done inside the rooms. Therefore, the yards' size is a bit smaller than central plateau of Iran. The buildings in this climate are always having veranda, but veranda in this climate have less depth in comparison with southern regions of the country. The veranda are not used as a living rooms like Caspian region and they are just there to prevent snow and rain to get into the building.

**Figure 9.** Asif house yard.

**Vernadaof Asif House**

In cold and mountainous climate, buildings have a dense plan and construction. The form of the building has to be in a way to prevent heat and energy waste. Therefore, cubic plans like a rectangle or a square are used in order to minimize the external surface of the building in comparison with its internal volume.

There should not be big rooms and spaces inside the building in cold regions since heating up such spaces may need a lot of energy as well wasting a lot of energy as well. In order to prevent the heat exchange between inside and outside, small and low-doors are used as well. (Figure 10).

**Figure 10.** Small doors and small spaces of Asif house.
Another point is how the yards are located for about 1 to 1.5 metres beneath the sidewalks in order for the rain water to get into the yard for watering the gardens as well as other use. On the other hand, the ground acts like a thermal insulation around the building and prevents heat exchange between the building and the outside.

**Figure 11.** Use of canopy.

**Figure 12.** Low yards.

In this region and in order to prevent heat exchange between inside and outside of the building a few small doors are used. In case the windows are big there has to be a use of canopy.

Doors on the South side are bigger in order to use more sunshine and canopy is used here as well. There should not be doors on cold wind sides as well. The size of doors has to be bigger than the size of the doors in hot and arid climate in order to get the most sunshine. Windows on south side of the Asif mansion are larger as well as being equipped with canopy.

In order to prevent the transfer of inside heat to the outside, there has to be little ventilation. It is worth mentioning that the thickness of the walls prevents such a waste of heat as well. Thick walls act like a insulation by absorbing sun heat during the day and keeping the house warm during the night. In the local architecture of this region, there is an attempt to use heaters, presence of people, cooking or presence of animals. It is important to use low height rooms in cold regions and all of which have been paid attention to in Asif house.

**CONCLUSION**

Investigating Alguy, Gioni and Mahani tables of indicators in Sanandaj city show that in terms of climate overcoming the cold weather is difficult and the lack of humidity and temperature fluctuations above 10 ° C in all months of the year create troubles. It is needed to use heating system for 8 months of the year. Although using the design of traditional houses like Asif House can be a great help in this cold climate, but given that the new construction in Sanandaj is mostly going to be the apartment in which traditional recommendations can not be applied. Therefore, it is necessary to use more modern and intelligent materials in order to save more energy and waste alittle. So architects who intend to design and build houses in this kind of
climate are highly recommended to use intelligent, modern and smart materials, nano-materials, insulation materials.

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