

Shape of Sustainable Houses in Iran: A Climatic Analysis

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Abstract

Increasing mass production and mass consumption have put extra pressure on the mother earth's environment and resources. Therefore, environmental concerns have become an important issue in the past few decades. The population of Iran has been more than double in the past thirty years which has caused a rapid urbanization and a booming building industry. By looking at traditional houses in different climate regions of Iran, it becomes clear that these houses are different in different climatic regions. But contemporary houses are built almost the same in different regions. The first research question in this paper is how does the shape of traditional houses in Iran has been affected by the climate in different regions? The second question is what lessons can be learned from the traditional houses in Iran for the shape of contemporary houses? The qualitative research method is chosen to answer these questions and to understand and explain the character and essence of this phenomenon. In this study, three research method of historical, case study and ethnography study which are all part of qualitative research method are chosen to verify the findings. The conclusion of this research is that for human comfort, the form of traditional houses depended on the climate of each region of Iran. Contemporary houses depend on modern technology. But traditional climatic concerns can be updated and utilized for the shape of contemporary houses.

Keywords: Sustainable houses, Climatic design, Iran

Introduction

"Architecture in the 20th century began as a celebration of the Age of Industry and Technology but this is rapidly changing in response to a new Age of Information and Ecology." (Wine, 2000; 8). Rapid population growth and industrialization have caused many ecological problems in Iran like many other countries.

"Presently more than one third of the energy consumption in Iran is for buildings." (Hariri 2002, 3) Because of vast fossil fuel resources in Iran, oil and gas are used extensively as primary energy source in the country. Fossil fuel will finish in the next few decades and it is polluting the air and atmosphere.

In this new age there are lessons to be learned from traditional building practices. The aim of this paper is to analyze the effect of climatic conditions of each region of Iran on the shape of traditional houses and construction materials. It will be investigated whether these forms are environmental, friendly and sustainable and if they could be utilized for contemporary houses.

Literature Review

In 1974 "Construction of City and Architecture in the Hot and Arid Climate of Iran" was published (Tavasoli 1980). This was the first book written about climate architecture of Iran. Morteza Kasmaee wrote a book titled "Climate and Architecture" (Kasmaee 1984). In one section of book he briefly discussed about the traditional building of Iran in four climate regions. These two books were written in Persian language. "Sustainable Traditional Buildings of Iran- A climate Analysis" was published in 2009. (Ghobadian 2009) This was the first book about climate buildings of Iran which was written in English. In this book the effect of climate on traditional buildings in four different climate regions of Iran were analyzed. But in none of these books the effect of climate

on the shape of contemporary houses in Iran and the lessons to be learned from the traditional buildings in Iran were discussed.

Methodology

This is a practical research and the result can be used by the designers, contractor and clients. Data will be collected from field study, library research, internet and interview with experts. This is a qualitative research and the purpose is to understand and explain traditional climatic housing design in Iran and if possible, to present ways for the shape of contemporary houses in Iran. Inductive logic will be used and from scattered data, conclusion will be achieved. Historic, ethnography, phenomenology and case study which are all part of qualitative research will be utilized and triangulation between findings will be used to verify the findings. Iranian climate and traditional housing climatic design are independent variable. Contemporary housing climatic design in four different climatic regions of Iran is the dependent variable.

In the analyses, we shall see whether there are certain morphological and material types for typical traditional houses in each region. The relation between these types and climatic condition and also environmental sustainability will be analyzed as well. The analysis will be done in regard to the three cycles of construction, occupation and demolition of houses. It will be investigated whether those lessons can be updated for contemporary houses in Iran.

Climatic Regions of Iran

The Iranian plateau is situated in a dry geographic region. The dry climates of the Northern Africa and the Middle East continue into Iran and the Central Asia with the result that average precipitation in Iran is less than the global average (Koeppen, 2014). Even though Iran is generally classified as a dry country. In fact, it is climatically diverse and can be divided into four main climatic regions:

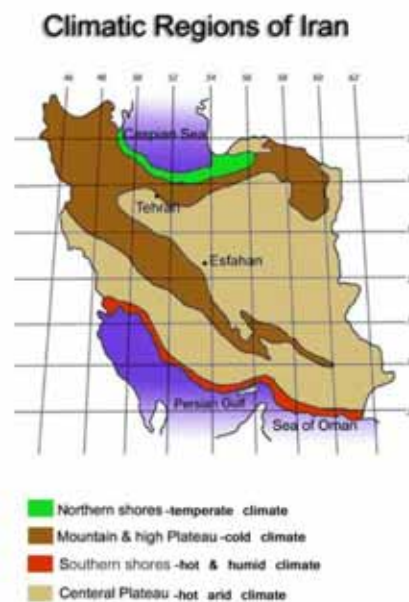


Figure 1. Map of Iran and its four climatic regions (Pakdaman, 1979)

I- The Northern Coastal Region – Temperate Climate

This region which stretches along the southern coasts of the Caspian Sea has the highest level of precipitation in the country. It has very dense forests in its highlands and its lowlands have been used intensively for agriculture. It is cold in the winter and hot and humid in the summer.

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Average annual precipitation is between one to two meters and relative humidity is above 70% throughout the year (Kasmai, 2004:220).

II- The Central Plateau Region – Hot and Dry Climate

This is the biggest climatic region in terms of surface area and covers most of the central Iranian plateau. It is cold in the winter and hot and dry in the summer. Average annual precipitation is between fifteen to thirty centimeters, and relative humidity is about 20% in the summer and 60% in the winter (Kasmai, 1984:244). The two large central deserts of Dasht-e Kavir and Dasht-e Lut which comprise one seventh of the total area of the country are in this region.

III- The Mountainous and High Plateau Region – Cold Climate

The high mountain ranges of Alborz and Zagros are situated to the north and west of the country respectively. This region is cold in the winter and mild and dry in the summer. Some of its mountain peaks such as Damavand and Sabalan are snowcapped all year round. Average annual precipitation is about thirty centimeters (Kasmai, 1984:240)

IV- The Southern Coastal Region – Hot and Humid Climate

The hottest region of Iran stretches along the coasts of the Persian Gulf and the Sea of Oman. It is mild in the winter and hot and humid during its long summer months. Its average annual rainfall is less than twenty centimeters, and relative humidity is above 50% throughout the year (Kasmai, 1984:238)

Traditional Houses in the Four Climatic Regions

Typical traditional houses in each of the four climatic regions will be analyzed in order to find out if there is a relation between the climatic condition and buildings' form and material.

I- Houses in the Northern Coastal Region

In this region (temperate climate) there is large cities like Rasht, Gorgan, Amol and Babol. The traditional urban places in these cities are rather open with detached buildings. The reason for this is to allow air circulation and wind to carry away the heavy and stagnant humid air from different parts of the city.



Figure 2 & 3 .Aerial view of Rasht, the capital city of the Gilan Province and the largest city in the region – left picture (Ghazabanpour, 2000:39) A traditional house form of the lowlands is shown in right picture (Source: Ali Tavakoli Dinani)

The traditional houses of this region were built in such way so as to provide human comfort against many adverse climatic factors. There were heavy rainfalls, high underground water tables, and hot and humid weather in the summer and cold in winter.

Houses were oriented to the outside by means of placing the openings on the external walls in order to maximize cross ventilation inside the building. This was important for human comfort during the hot months of the year. Houses were built above the ground to keep them away from the ground dampness.

This is the only region in Iran where we see gable roofs for traditional buildings. Because of the low rainfall, the form of the roofs of almost all of the traditional buildings of the other regions was either flat or curved. Here gable roofs were usually four sided in order to block rain from penetrating the building from every side, especially during windy days. Because of the region's high levels of relative humidity in the summer time, there is a need for cross ventilation for human comfort inside the buildings. Therefore, almost all buildings were detached and outward oriented. This means that all of the openings were placed on the external walls of buildings.

Balconies were very important and useful, especially in the case of houses. There were two reasons for this: first, because of the hot and humid conditions in the spring and summer, most activities such as socializing, eating, entertainment, working, sleeping, etc. would take place outside. The air inside the rooms would be stuffy and warm therefore, balconies were good places for such activities, since the occupants would always enjoy the shade and breeze in there.

The second one was that most of the walls, particularly those in the houses of the lowlands would be plastered with a mixture of mud and straw which means that they had to be protected against rainwater. This was achieved by placing a continuous balcony all around the building and extending the four sided gable roof over it.



Figure 4 & 5. Construction detail of interlocking log wall and roof tiles (Source: Author)

There were no basements because of high water tables; and the ground floors were separated from the damp natural ground either by providing wooden piers, a crawl space, or macadam. The form of the traditional houses in this region can be summarized according to the following characteristics:

- | | |
|--|--|
| I. Detached houses | |
| II. Four sided gable roofs | V. Extension of the gable roof above the |
| III. Outward orientation | VI. No basement |
| IV. A deep continuous balcony that surrounded the house on all sides | VII. Ground floor higher than the ground level |

In this region, timber framed and interlocking log buildings were the most common building type, especially for houses. The materials for walls were timber, branches and mud and straw mixture. In villages, thatched roof was the most common type of roofing for houses. Roof tiles were used for this purpose in the cities.

II- Houses in the Central Plateau Region

In the hot and dry region of the central plateau, the urban place of traditional cities like Esfahan, Yazd, Kerman and Kashan was compact with attached buildings. The reason was to protect buildings and urban spaces against harsh climate and frequent sand storms.

These buildings were inward oriented which means except the entrance door, all the doors and windows open to one or several courtyards. In this way the interiors of buildings were protected

from sand storms. The houses in this region are referred to as houses for four seasons. Because the northern wing of such houses which receives direct sunlight was used as family living quarters during the cold months of the year, while the southern wing which is always in shade was used during the summer months. Wind towers were usually built above the summer wing for ventilation during the hot season.



Figure 6 & 7. The Arial view and summer living quarter of the Brujerdiha House in the city of Kashan – between Tehran and Esfahan (Source: Ghobadian, 2009: 65 & 66)

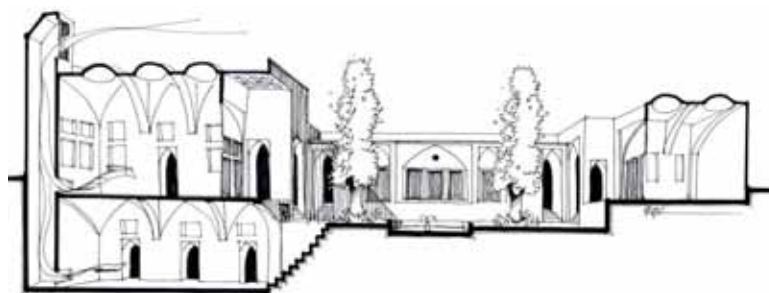


Figure 8. Schematic section of a “house for four seasons” with a one sided wind tower above the summer living quarter (Source: Ali Tavakoli Dinani)

The overall forms of the traditional houses in this region were as follows:

- Ground floor and courtyard lower than entrance and street level
- Buildings were adjoined
- Houses were inward oriented with a central courtyard
- Most buildings had basements, verandas and often wind towers
- Brick or adobe vaults or domes - convex roofs
- High ceilings, especially on the southern side of courtyards
- Thick walls

The only material that is abundant, cheap, and readily available in this region is clay. The three common building materials of mud, adobe, and brick are made with clay. Almost every part of the building fabric – walls, ceilings, and roofs- were made with these materials. The main climatic advantage of these building materials is that they have a high thermal capacity and minimize temperature fluctuations inside the building between day and night.

III- Houses in the Mountainous and High Plateau Region

Urban fabric and building form of houses in this region was designed mainly to deal with cold winter condition. Therefore the traditional urban fabric in cities like Tabriz, Hamadan, Arak and Shahrkord were compact and buildings were attached in order to protect the buildings and urban spaces against cold weather and winter wind.

As in the previous region, the houses of this region were inward oriented- around a central courtyard. Besides the entrance door, all other openings were located around the central courtyard. The main difference between the courtyard houses of the two regions is that in here the winter living quarter was the biggest and most important part of the house. The summer living quarter was either very small or was not included at all.

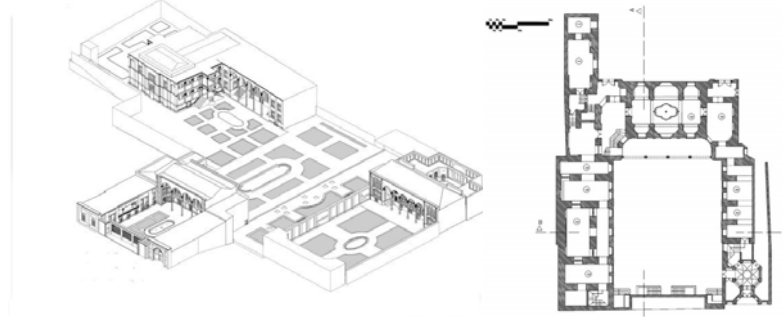


Figure 9 & 10. A south-east axonometric view of three traditional houses in Tabriz, from west to east: Ganjeii House, Gadaki House and Behnam House – left picture. Note that none of them has a summer living quarter. First floor plan of the Gadaki House – right picture (Source: Ghobadian, 2009: 78 & 81)

The form of traditional houses had the following characteristics:

- Buildings were adjoined.
- Houses were inward oriented with a central courtyard.
- Low ceilings
- Flat roofs for houses
- Small or no verandas
- Thick masonry walls

Similar to the construction materials in the other regions, the materials that were used for traditional buildings in this region were those that were easily accessible and economical. Therefore, rubble or ashlars and occasionally brick or adobe were used for walls depending on the availability of the material and the type of building. Because these masonry walls were heavy and thick, they had a good thermal mass and could retain daytime heat for nighttime. Timber was used for the roofs of houses, covered by small branches or sometimes mats straw, and finally twenty five centimeters of mud and straw mixture.

IV- Houses in the Southern Coastal Region

In any environment with such intolerable heat and humidity, the best way to bring about the conditions for human comfort by natural means is to provide shade and ventilation. For this reason, the traditional port cities like Bushehr, Bandar Abbas and Bandar Lengeh were oriented south towards the sea. In this way, advantage is taken of the currents of air between the land and the sea for cooling, while the buildings themselves can be protected from exposure to intense southern sunrays by deep awnings and verandas.

Central courtyard houses were also common in this hot and humid region. Courtyard houses were semi- inward oriented, to the effect that they had openings both around their central court yard and also on their external walls. In this way, cross ventilation could be facilitated for the rooms. Shade and cross ventilation was also provided with the help of wide balconies, large openings facing sea air, and wind towers.



Figure 11 & 12. A view of the port city of Lengeh with courtyard houses and balconies – left picture. The ceiling of a house in Lengeh consisted of palm tree fronds tied together with ropes. There is a thick layer of mud straw mixture on top of it – right picture (Ghobadian, 2009: 96 & 103)

The main characteristics of traditional houses in this region can be described as follows:

- Detached or semi-detached buildings
- Central courtyards
- Partly inward oriented
- High ceilings and windows
- Big and spacious verandas
- Flat roofs
- Ground floor above natural ground, mostly no basements
- Inclusion of Wind towers

Here, the walls of buildings were built with stone, brick, adobe, or coral stones. It depended on which material was more available and the importance of the building. Roofs were built with timber and covered with palm tree fronds tied with ropes and a twenty centimeter layer of a mixture of mud and straw.

The Shape of Traditional Houses

The research finding is that the forms of traditional houses varied in respect to the different climatic regions of Iran. In each region, climatic conditions had a direct effect on building form. Diagrammatic drawings of typical traditional houses (Figures 13 to 16) in different climatic regions demonstrated that in the sustainable traditional houses in Iran, form followed climate.

Because of the difficulty of transporting building materials in the past, there was one general rule for this. The materials had to be whatever that was readily and easily available in any particular area or region. For this reason, wood was used in forest areas, stone in mountainous areas, clay in desert, and materials made of plants in the fertile plains.



Figure 13 & 14. Diagrams of a typical simplified traditional house in the northern coastal region, left picture, and central plateau region, right picture (Source: Ehsan Sarabadani)

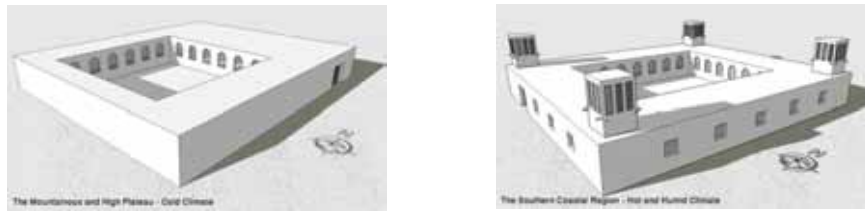


Figure 15 & 16. Diagrams of a typical simplified house form in the high plateau region, left picture, and southern coastal region, right picture (Source: Ehsan Sarabadani)

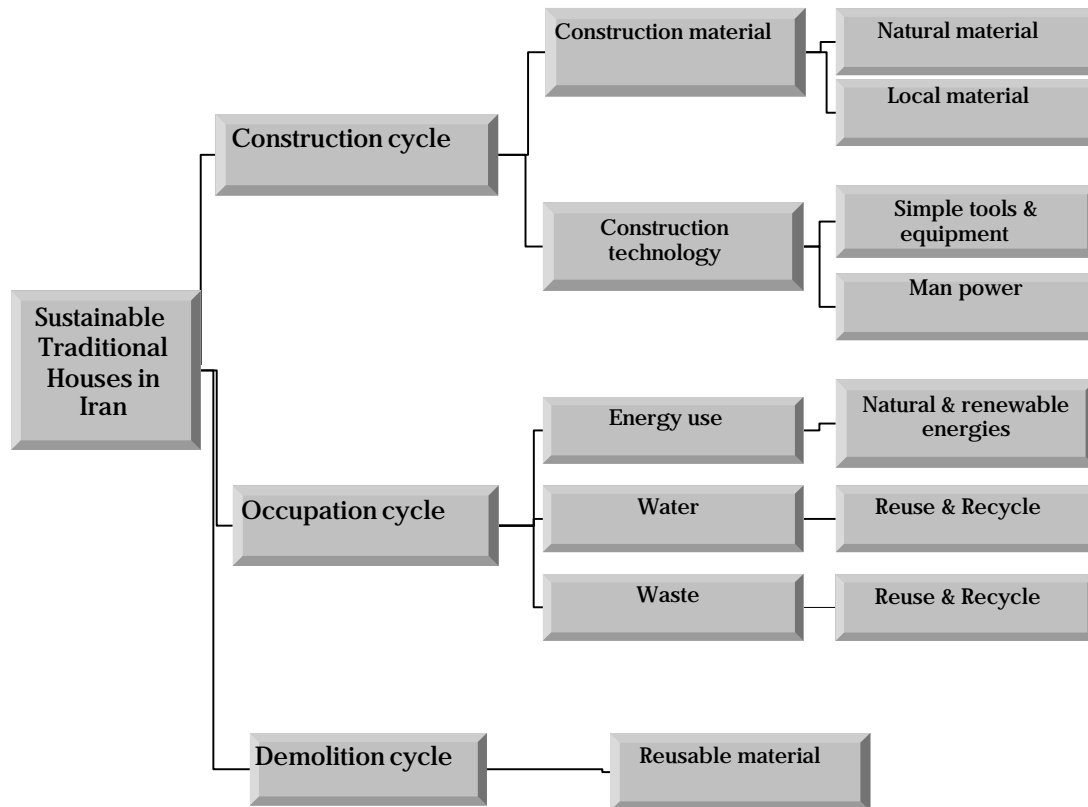


Chart 1. Sustainable traditional building practices in Iran (Ghobadian, 2009, 34)

Contemporary houses in Iran

In the 20th century, International Style was a very practical and economical way of building design and construction. In this style, form followed function. Climate, environment and regional concerns were not important issues.



Figure 17. Bird's eye view of contemporary Tehran, with many highways and modern buildings (Source: Farnaz Farshidrad)

Nowadays, many buildings in Iran are built in this style. Almost all buildings are cubic shape and built mostly with metal, concrete and glass. They look the same in Iran as other international styles in other countries.

But as traditional houses in Iran, contemporary buildings should be designed for human comfort with regard to the climate of each region. This would be one of the best ways to reduce energy and resource consumption and also reduce pollution, waste and greenhouse gases.

According to analysis of shape of traditional houses and to update those lessons for contemporary houses in Iran, the following building characteristics and forms can be suggested:

Northern Coastal Region- Temperate climate

- Orient the building toward the sea breeze
- Depth of building not more than one room
- Building above the ground on columns
- Transparent south openings and parapets
- Balconies all around the building
- Gable roofs
- Greenhouse under the gable roof



Figure 18. Northern Coastal Region (Source: Ehsan Sarabadani)

Central Plateau Region- Hot and Dry Climate

- Orient the building toward south
- Building in the ground especially on the East, West and North side
- Transparent south windows and parapets
- Basement with windows toward south
- Sunken courtyard
- Using the room above the staircase as greenhouse and wind tower



Figure 19. Central Plateau Region (Source: Ehsan Sarabadani)

Mountain and high plateau region- Cold climate

- Orient the building toward south
- Building in the ground especially on the East, West and North side
- Transparent south windows and parapets

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- Basement with windows toward south
- Using the room above the staircase as greenhouse



Figure 20. Mountain and high plateau region (Source: Ehsan Sarabadani)

Southern Coastal Region- Hot and humid climate

- Orienting the building toward the sea breeze
- Depth of building should not be more than one room
- Building should be above the ground on columns
- Using the room above the staircase as wind tower
- Deep balconies specially on the East, West and South side

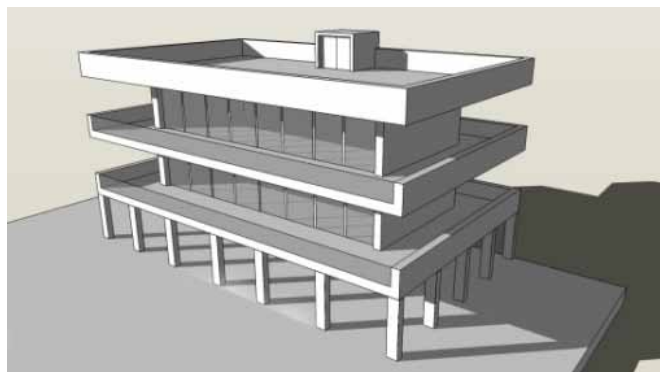


Figure 21. Southern Coastal Region (Source: Ehsan Sarabadani)

Conclusion

If in modern architecture, form follows function, in Iran's traditional climatic house, form followed climate. This means that in each climatic region in Iran, buildings' form and construction material are designed and built with regard to the climatic conditions and environmental sustainability. The traditional practices for the construction of houses in different climatic regions of Iran are resource efficient and has minimum of environmental impacts.

Maximum resource consumption and maximum waste production are our modern building practices. But in the past, reducing consumption and reusing and recycling resources were ways of sustainable traditional building practices in Iran(chart 1).

It should be mentioned that our ways and our standards of living have changed. Therefore, it is not possible to copy the past, but we should study to update and use those practices wherever possible.

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