The Effects of Climatic Factors on Urban Context and Vernacular Architecture of Cold and Temperate Regions of Iran

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***Abstract*—Throughout the history, climate and environmental factors have been always one of the most important aspects in the designing process among the other forces. Climate is clearly one of the prime factors in culture, and therefore built environment. As climate responsive design strategies were used in the past, traditional buildings were more comfortable. In Iran, traditional urban contexts are proper evidences of climatic adaptability of urbanism and architecture. A brief explanation on climatic conditions and the strategies used in two different regions of Iran i.e. cold region and temperate one are explained in this paper. The method used in this research is an analysis of data gathered through library study. Cold climate is the main complicated factor in mountain region of Iran. Primary principles in cold climate region is based on maximum absorption of sun, minimum heat wasting, avoidance of winter coldness existing in majority of a year, resistance against long-time freezing, protection of building against cold wind. The urban context of cold region is concentrated and dense. On the other hand in Temperate Climate of Iran, rainfall is very common and in summer as a rainstorm. To reduce the unpleasant effects of humidity, in the traditional architecture of this region scattered buildings are preferred in order to create the possibility for natural ventilation.**

Keywords- cold climate, temperate climate, vernacular architecture, urban context

I. INTRODUCTION

Throughout the history, climate and environmental factors have been always one of the most important aspects in the designing process among the other forces such as social-cultural, economic, religious, involving the availability of materials, technical and constructive resources. Furthermore, human tendency to climatic design in every time motivates him or her to provide a suitable life environment and architecture on the basis of climate conditions which contributes to enhance space qualities such as comfortability. Climate is clearly one of the prime factors in culture, and therefore built environment. Consequently, climate plays the main role in giving a logical shape to the urban structure and architectural form of historical cities. The most important problems people in the past had with climatic issues have led them to find some solutions which remarkably reduce the bothering aspects of climate. In most of the traditional buildings around the world climatic considerations can be clearly identified [1]. Some studies in Nepal and in Turkey also show that traditional buildings were better than contemporary buildings regarding climatic design and human comfort [2]. Moreover, in a country such as Iran, with different climatic regions, flexibility of urban structure, application of lifestyle to the natural environment and climate also have been of great importance in the traditional urban pattern and architecture, which they were considered as the principal factors and have motivated traditional builders to present logical solutions for human comfort. Iran has four different climatic regions and traditional urban textures which exist in these areas are one of the most evident examples of adaptability of urbanism and architecture with climate.

This paper will introduce a brief explanation on climatic conditions and the strategies used for adaptability with the climate and environmental conditions in an urban context and building forms of two zones, mild humid and cold region of Iran.

II. CLASSIFICATION OF CLIMATE IN IRAN

There are different geographical locations in Iran and this provides various climates. Every climate has its special characteristics. Iranian researchers, like M. Tavasoli, M. Kasmaee, Dr. Memarian and Dr. H.Ganjee worked on climatic divisions of Iran. Dr. H. Ganjee divided Iran based on Koppen's method who divided the world based on growing of plants. Kasmaee [3] has also identified four different climatic zones for Iran based on their location i.e. hot arid, hot humid, mild humid and cold. On the other hand, the Red Crescent organization has divided Iran into four climatic zones [4]:

- Southern shores of the Caspian Sea – Temperate Climate (high moisture content and abundant amount of rain)
- Northern shores of the Persian Gulf & Sea of Oman – Hot and Humid Climate (high temperature and irritating moisture)
- Mountains and High Plateau Regions – Cold Climate (low temperature and long winters)
- Central Plateau Regions – Hot and dry Climate (stifling heat, dry weather, and desert winds)

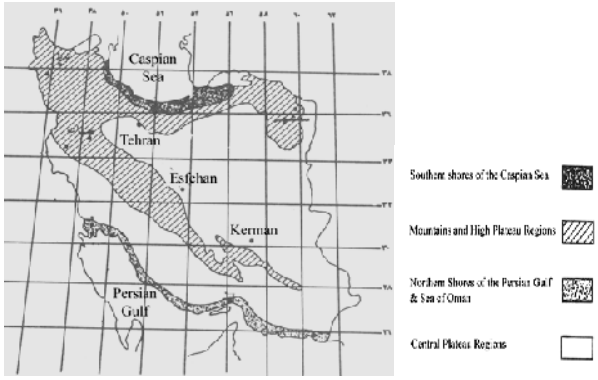

Figure 1. Climatic zones of Iran [5]

As contemporary architecture and urban design did not consider climatic and environmental factors properly in designing and the studies in urban form and sustainability of these climatic zones are on the whole inadequate, so this

paper will introduce the strategies used for adaptability with the climate and environmental conditions in urban textures and building forms of mild humid and cold region of Iran.

III. COLD CLIMATE ZONE OF IRAN

In this part, the environmental condition of Mountains and High Plateau Regions of Iran (Cold Climate) is studied to find out the role of climate in the urban texture and the formation of the buildings and its different elements.

A. Environmental and climatic conditions in cold region

Cold region of Iran lies along the west and north mountain chains in Iran which are known as Zagros and Alborz Mountain. This region has very cold winters and mild summers. The average temperature in the hottest month of the year is more than 10 º centigrade which is -3º centigrade in the coldest month. West mountain chains prevent the penetration of Mediterranean humid weather into the Iran Plateau and maintain the humidity in its slopes. The amount and intensity of the sunlight is high in summer and very low in winter. Winter is long, hard and cold and several months of the year, the ice covers the area [5]. In all over of this area, from Azerbaijan to Fars, winter is very hard and the coldness begins from the beginning of November and continues more and less until the end of March. The amount of the rainfall is low in summer and high in winter in the shape of snowfall. Snow covers the mountains in the heights more than 3000 meters. In general, in this zone, the short spring separates winter from summer. Tabriz, Oroumieh and Hamadan are located in this zone.

B. The urban texture and architectural form according to environmental conditions of cold zone

The complicated and interrelated factors that have been shaped the urban texture and architectural form in cold regions are most affected by cold climate which determine the aspects of well-being in this region [5]. In other words, suggestive principles on the basis of cold climate analysis are maximum absorption of sun, minimum heat wasting, avoidance of winter coldness existing in the majority of a year, the resistance against long-time freezing, protection of building against cold wind (west south). Therefore, heat exchange must be decreased to minimum from walls, roof and openings in buildings so that heat waste can be prevented. So maximum sun radiation must be used for heating, penetration of cold winds to the buildings must be prevented, the problem of snow and freezing must be decreased, cross ventilation must be used necessary time and shadow must be controlled [6].

1) Urban context: The urban context of cold region is concentrated and dense. Furthermore, the settlement of solid and void spaces is such that full spaces are built behind each other because there are full spaces in two north and south fronts and also, they combined with each other in a way that the border between them cannot be identified (see Figure 2). The compression and combination of buildings have led the external surface of each building to the least and as a result each home can conserve the needed energy inside of it for a long time. This play a vital role in reducing heat exchange of building with open space and the walls attached to open spaces are decreased. Therefore, organization of open and closed spaces in the buildings of cold region is of great importance. On the other hand, the structure of the villages and cities of cold regions are planned in a way which arteries open in the direction of maximum sun radiation with special arrangements [7].

In general, the main traits of the urban and rural contexts of the region include:

- Urban structure is condensed and the buildings are linked to each other.
- Urban spaces are small and enclosed
- Streets and paths usually have narrow widths

Figure 2. Kandovan village as an example of condensed urban context in cold region (Source: author photography, 2005)

C. Characteristics of buildings form

In cold region, all buildings are completely introverted and have central yards [6]. Courtyard as one of the determining and organizing factor of traditional architecture, is usually the heart of the dwelling spatially, socially, and environmentally. On the other hand, it is built orderly, geometrically and narrow enough to maintain a shaded area during the heat of the day in summer, but wide enough to receive solar radiation in winter [8].

Traditional buildings in this region consist of one floor or two with basement and are generally divided into main zones of winter house and summer house. Winter living space, located in the basement, is situated beneath the first floor orthogonally to be enclosed with a closed space when it is cold. The basement is adjoining to the ground while it uses the heat of earth depth (heat fluctuation decreases with the depth increase) [5].

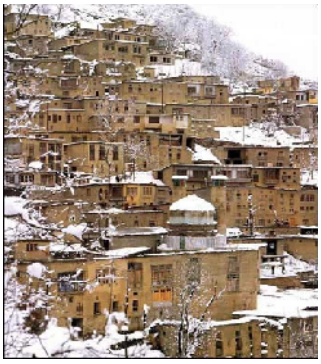

Figure 3. In the traditional mountain village of Masouleh, buildings are combined with each other. (Source: author photography, 2006)

Furthermore, Rooms are fairly short with flat roofing while openings are comparatively small as are porches and courtyards. The floor of these buildings is lower than the street level which fades into a series of steps or ramp in the entrance. Therefore the ground surrounds the houses as heat insulation and reduces the heat transfer inside and outside the buildings. On the other hand, the reduction of building volume to the passage causes the passage to have more sunlight and also, the rectangular shape of the buildings is more suitable for the comfort of the residents [6].

Vernacular architectures in this region cause the materials which are used for construction are just available ones, such as stone, wood, mud and straw. The buildings are well-insulated as a result of having thick walls and small openings. Masonry materials of thick walls serve as heat storage, absorbing the heat during daytime and spreading it into the house during the night. At the end, balcony acts as the intermediate space between open and closed spaces in cold region. The other sign of cold climate compatibility is the existence of low depth balconies in ancient houses which led to the maximum absorption of sunlight in winter while preventing summer sunlight [5].

IV. TEMPERATE CLIMATE ZONE OF IRAN

Mild and humid climatic zone of Iran is located in North of Iran which is in the southern shores of Caspian Sea and is particularly known as "Sothern Shores of Caspian Sea Region" [4]. In other words this region is called mild and humid climate in Iran.

A. Environmental and climatic conditions in Temperate Climate

It is located at 49˚-36' E longitude and 37˚- 16' latitude and altitude of -7 m measured from the sea level. High humidity of the weather is its main characteristic. The temperature in summer is between 25º and 30º centigrade. To reduce the effects of humidity, the people living in this area have well utilized the air flow. Climatic specifications of this region are [5]:

- Extreme rainfall whole the year, especially in autumn and winter
- High humidity ratio, whole the year
- Low diurnal temperature changes
- Extensive distribution of vegetations [3]

Rasht, Sari and Gorgan are located in this region. This area is like a band between the Caspian Sea and mountain chains of Alborz, with low plains; the more it goes towards the east, the more the humidity and the temperate decreases. In spite of of the narrowness of this region it has two different parts. First is the prairie region which continues as a narrow strip along the coastline and includes big cities and broad plantations and fields. The second part is the mountainous region (the northern parts of Alborz mountains) which includes forests [5].

B. The urban context of Temperate Climate zone

According to environmental conditions, this region has its specific urban context which contains scattered buildings.

1) Scattered building: Because of the high amount of rainfall and extensive distribution of vegetations, in this region one of the main problems of urban spaces and its buildings is how to deal with the high humidity ratio in the atmosphere and soil. As humid air is heavier than the arid air and goes beneath the arid air, high density of moisture in closed spaces without proper ventilation will cause uncomfortable feeling. Therefore, in the traditional architecture of this region scattered buildings are preferred in order to create the possibility for natural ventilation [9].

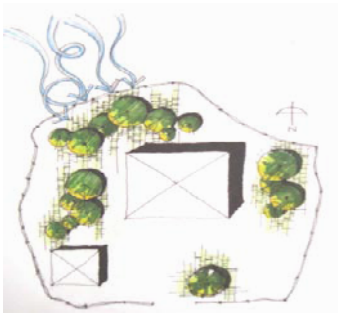

Figure 4. Designing the site to protect the building from unpleasant northerly-westerly winds

C. Role of climatic factors on traditional architecture of the southern shores of Caspian Sea region

According to the role of the climate on the formation of traditional architecture of southern shores of Caspian Sea region, some characteristics are prevail in most of traditional buildings in this region [1]:

- Hipped roofs
- Veranda around the buildings
- There is no basement
- Ground floor is built on a higher level than the level of the earth
- Extrovert building form
- Cross-ventilation

1) Rain: Effects of rain on the architecture of this region are as follows:

a) Plan: use of verandas is the effective ways of protecting the buildings and external walls from the rain.

b) Roof: Because of the extreme amount of rain in this region, the roofs are very inclined with the slope of 100% to 150%. The buildings in this region usually have large eaves on all sides except southern side. The function of eaves is to protect the walls from the rain and also to provide a temporary protection for some households and agricultural tools from the rain.

Figure 5. High slope of roofs in order to protect buildings from the rain and snow

*2) Moisture: T*he humidity ratio in Southern shores of the Caspian Sea region is above 80% almost whole the year. In addition the amount of humidity in the prairie part of this region is higher than mountainous part.

a) Plan : Providing the condition for air movement in the plan is the main strategy to deal with the humidity ratio therefore opposing entrances and windows, single layer spaces and semi-open spaces were used to create airflow to remove the moisture.

b) Roof: In vernacular houses of this region, usually daily activities such as resting and cooking occur in semi-open spaces which are naturally ventilated but for a better ventilation in these spaces and eaves the lower surface of roofs are not boarded and so polluted and humid air can be ventilated easily.

Figure 6. Provision of air movement around the building to avoid the bad effects of high humidity

3) Wind: In the southern shores of the Caspian Sea region appropriate winds blow from northeast and sea to the land during the day and land to the sea during the night which is called breeze (breeze is only effective in areas near the coast). Effects of the wind on the buildings are as follows:

a) Plan: Based on the vernacular architecture of this region buildings are faced to the south direction and there is no entrance on the sides facing northerly-westerly winds.

b) Exterior of the buildings: In the southern shores of the Caspian Sea region the site is designed to create a micro-climate which improves the comfort level in the surrounding spaces of the building and the building as well. In the case of winds, curtaining with the evergreen trees is the most commonly used strategy.

4) Sunlight: High density of water vapour in the southern shores of the Caspian Sea region blocks the sunlight and reduces its density. In addition, number of cloudy days during the cold seasons is significant. The sides facing north does not receive direct sunlight except in spring and summer during the morning. The sides facing east does not receive direct sunlight in the afternoons and the sides facing west does not receive it in the mornings. Effects of sunlight on the buildings in this region are as follows:

a) Plan: In this area plans have east-west direction and the main elevation is facing to the south and sometimes plans are slightly rotated to the Southeast. Verandas in these buildings protect the building from direct sunlight during the summer while letting the light come in during the winter [1].

D. Characteristics of the buildings form

In the southern shores of Caspian Sea region buildings have pitched roofs with the slope of 100% to 150% and there is a veranda around the building which serves as a buffer space to protect the external walls from the rain and also direct sunlight in summer. As results of natural ventilation, these verandas also can be used as a comfortable place for daily activities or night sleeping during the summer. In addition, in order to protect the building from moisture ground floors has been built in a higher level than the level of the earth and the buildings don not have a basement [5].

Figure 7. Use of veranda as a buffer space to protect the building from rain.

In traditional architecture of this region people found use of breeze and natural ventilation as the best way of the natural environmental control system to create comfortable life conditions in their dwellings. In order to take the advantage of natural ventilation buildings in this region are extroverts (outdoor dominant) and usually have two stories because wind speed in the upper levels is higher [9].

One of the main principles of Iranian traditional architecture is self-sufficiency, which means building materials usually achieved from the place which they were going to be built [10]. As the climate of this region is the prime reason for existence of plenty of plants and forests, so the most common building materials are wood and other plants. Wood is the main construction material especially for structural uses. Floors and roofs and walls were made of a mixture of clay, straw, salt and ashes on a wooden structure [5].

CONCLUSION

Traditional architecture-so often forgotten - is the result of centuries of optimization in climate considerations. It is achieved through a trial and error method and also the use of resources, materials and construction techniques. Based on the climatic factors and environmental conditions, in Iran each of the cold or the temperate region has its own patterns. Traditional builders of these two regions knew how to build their buildings in harmony with the nature and how to use natural forces in a way that they could achieve comfortable living conditions in their dwellings.

In cold region, in order to maximize sun absorption, minimize heat wasting, avoid the coldness existing in the majority of a year, resist against long-time freezing and protect buildings against cold wind, the urban context of is concentrated and compact. On the other hand in temperate climate of Iran, as rainfall is very common, in order to reduce the unpleasant effects of humidity, in traditional architecture, scattered buildings are preferred because they provide the possibility for natural ventilation.

The result of this study shows that Iranian vernacular architecture and urban planning in different climatic regions are based on climatic factor which is a representation of coherent planning for providing human comfort and it can be good examples of climate responsive design. Furthermore, most of the ideas and techniques of city planning and building form in a cold and temperate climate can be used as a good model for designing in contemporary architecture.

REFERENCES

[1] E. Khoshsima et al, “Evaluation of Traditional architecture of Southern Shores of Caspian Sea Region in Iran,” Conference of the International Journal of Arts and Sciences, 1(6): 164 – 177, 2009.

[2] A.K. Opadhayay, ”Climate Responsive building design in the Katmando Valley” 2006.

[3] M. Kasmaei,” Climate and architecture,” 2003.

[4] D. Watson, “Climatic Design”, Tehran University Publications, Tehran, Iran, 1994.

[5] V. Ghobadian, “Climatic analysis of the traditional Iranian buildings,” Tehran University Publications, Tehran, Iran,2003.

[6]Gh. H. Memarian, “Introduction to house typology in Iran, introvert houses”, University of Science and Technology, Tehran, 1995.

[7] F. E. Sheikholeslami, M. Tahbaz, “Climatic Study of cold dwelling (Case study: Hamedan city),” PLEA 2008 –25th Conference on Passive and Low Energy Architecture, Dublin, 22nd to 24th October 2008.

[8] M. K Pirnia “Iran Islamic architecture”, Iran University of Science & Technology, 2004

[9] Gh. H. Memarian, “Introduction to house typology in Iran, extroverts houses”, University of Science and Technology, Tehran, 1998.

[10] M. Pirnia, “Styles of Iranian Architecture” Tehran: Sorush Danesh. 2004