Evaluation of Traditional architecture of Southern Shores of Caspian Sea Region in Iran

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Abstract: Climate has an important role in a building design. In addition energy consumption of a building depends on climatic consideration in the building design. Today we are facing some environmental problems such as global warming, ozone layer depletion and shortage of fossil fuels which make it more necessary to consider the climate in the building design. Traditional architecture has always been a good example of climatic design and represents the techniques which our ancestors have found to improve their living conditions. In addition, traditional architecture can be a source of inspiration for us in the contemporary building design to learn from it and try to adapt our buildings with the natural conditions as much as possible. In this paper traditional architecture of southern shores of Caspian Sea region in Iran is studied to find out the role of climate in the formation of the buildings and its different elements. Because in the studies on traditional architecture of Iran especially in the southern shores of Caspian Sea Region which have been done so far almost there is no study using evaluation methods to evaluate the techniques used in traditional buildings, this paper aims to evaluate traditional architecture of this particular region by using the Mahoney tables, as an evaluation tool, which provide design recommendations on the building design using climatic data.

1 Introduction
Throughout the history climate and environmental factors have been always one of the most important parameters in the designing process among the other forces such as social-cultural, economic, defensive, religious, involving the availability of materials, technical and constructive resources. In most of the historic buildings around the world climatic considerations can be clearly identified. For instance, in the schematic reconstruction of a part of Çatal Hüyük (located in Anatoly, 5900-6000 BC) climatic consideration can be seen. The compact form of the buildings for the minimum exposure to the sunlight and also for mutual sheltering, and small openings near the roof to provide diffuse light are some of passive techniques used in this place. (Gardner, 1986)
2. State of the Problem
Climatic considerations have been ignored or forgotten by architects in last few decades in architectural design decision making process. nowadays world is facing some important problems and some environmental issues such as global warming, ozone layer depletion, greenhouse effect, and energy crisis which make it necessary to seek for some solutions to avoid more damage to the nature. Traditional architecture-so often forgotten in official circles- is the result of centuries of optimization in the use of resources, materials, construction techniques and climate considerations which is achieved through a trial and error process. Traditional architecture can properly teach us how to assimilate bioclimatic approach in the practice of architectural design in the contemporary architecture.

Objective
Objective of this paper is to investigate climate responsive building design in mild and humid climatic zone of Iran by analyzing traditional architecture of this region and using Mahoney tables. Therefore, techniques used in traditional architecture of the region will be evaluated bay using the Mahoney tables.

Methodology
Effects of climatic elements on the formation of a sample house located in southern shores of Caspian Sea region at the Museum of Rural Houses, Rasht, Iran which represents the traditional architecture of this region is studied. By analyzing the sample building some climate responsive strategies used in that region were found to be compared with the results from the Mahoney tables. In the next step, Mahoney tables, proposed by Mahoney, as developed by Koenigsberger(Koenigsberger, 1974), were used. These tables used to provide design guidelines for Caspian Sea region, using local climatic data and calculations, and climate analysis that starts with the basic and monthly available climatic data of temperature, humidity and rainfall. Finally the results of analysis of the sample building and the result from the Mahoney tables were compared to find out that to what extent traditional architecture of this region were designed according to the climate.

2.1 Literature Review

Climate and Location
In Iran-a vast country with four different climatic zones (hot arid, hot humid, mild humid and cold(Kasmaee, 2003)) - contemporary architecture and urban design did not consider climatic and environmental parameters properly in designing
process and the result of that are buildings and urban spaces which are not comfortable enough for the people. Although traditional architecture and urbanism of Iran includes magnificent examples of climatic design, most of the modern buildings can not provide comfort conditions for their inhabitants most of the year without using mechanical devices. According to building bioclimatic charts (Givoni, 1976) and bioclimatic charts (Olgyay, 1963) and climatic analysis of traditional architecture of Iran (Kasmaee, 2003) it is possible to decrease energy consumption in these buildings significantly by using passive techniques.

Mild and humid climatic zone of Iran is located in southern shores of Caspian Sea and is particularly known as “Southern Shores of Caspian Sea Region”. It is located at 49°-36’ E longitude and 37°-16’ latitude and altitude of -7 m measured from the sea level.

Despite of the narrowness of this region it has two different parts. First is the prairie region which continues like 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. (Ghobadian, 2003)

Climatic specifications of this region are:

a) Extreme precipitation whole the year, especially in autumn and winter

b) High humidity ratio, whole the year

c) Low diurnal temperature changes

d) Extensive distribution of vegetations (Kasmaee, 2003)
2.2 Traditional architecture of the Southern shores of Caspian Sea region

Scattered buildings
In the southern shores of Caspian Sea region because of high amount of precipitation and extensive distribution of vegetations humidity level in the atmosphere and soil is high therefore one of the main problems in the buildings and urban spaces in this region is how to deal with the high humidity ratio. Humid air is heavier than the arid air and goes beneath the arid air, so if the spaces are closed and ventilation does not exist, spaces will become uncomfortable because of high density of moisture in the ambient air. Therefore, in traditional architecture of this region scattered buildings are preferred in order to create the possibility for natural ventilation.

Structure
There are different structural systems in the southern shores of Caspian Sea region such as wooden frame, timber structure, stone masonry systems, sun-dried brick and brick systems. But, the most commonly used structural systems are based on wooden systems. Wooden structures have many advantages, for example, they are resistant in earthquakes because of special structural behavior of woods they are light materials and available in the site. In addition, wood is a material with high thermal capacity which helps the building to encounter with temperature changes.

Fig 2. Wall structure which makes the wall more stable

Materials
Choose of building materials play a great role in the overall thermal performance and a standard recommendation about choosing the building materials is to use local materials as far as possible(Rosenland, 2000). One of the main principles of Iranian traditional architecture is self-sufficiency(Pirnia, 2004), it means building materials usually achieved from the place which they were going to be built. Because of the climate of the southern shores of Caspian Sea region and abundance of plants and forests the most common building materials are wood and other plants. In this region wood is the main construction material especially
for structural uses. Woods are divided to two types; hard woods such as boxwood, acacia, oak, mulberry tree, walnut tree and soft woods such as alder, poplar, plane tree, maple, pine tree. In this region hard woods usually were used in the foundation of the buildings because they are resistant against humidity, moisture and insects. Because hard woods are not straight and long enough to be used as beams and trusses soft woods such as poplar, alder or spruce pine were used as long beams and trusses.

Variety of materials were used to cover the roof in this region such as wooden laths, clay roof tiles and galvanized iron sheets but the most common used material was straw which was cheap, available, abundant and easy to work with. Floors and roofs and walls were made of mixture of clay, straw, salt and ashes on a wooden structure. Clay as a natural material absorbs the surrounding moisture in high-humidity conditions and discharges the moisture in low humidity conditions. In addition, it has relatively high thermal capacity and also its capacity for insulation is comparatively high. Therefore, the environment of the room is controlled according to the changes in the surrounding environment. Straw which is mixed with the clay prevents from splits on walls because of fluctuations in the moisture level in the surrounding atmosphere.

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

In this study only one type of residential buildings in the prairie part of the southern shores of Caspian Sea region is analyzed. These types of buildings are one of the best examples of traditional architecture of this region because they have all the specifications of other types. These buildings originally can be found in the city of LAHIJAN in Guilan province in Iran.

2.3.1. Rain

In this region precipitation is comparatively higher than other climatic zones of Iran and this makes the architecture of this region different from other parts of the country. Average rainfall in this region is 1338/4 mm and maximum daily rainfall is 133 mm in October (Bureau of Meteorology of Iran, 2008). Effects of rain on the architecture of this region are as fallows:

2.3.1.1. Plan

In Moderate climates one of the effective ways of protecting the buildings and external walls from the rain is use of verandas. In order to protect entrances, doors, windows and walls from the rain associated with the wind, semi-open spaces formed around the buildings or on the entrance side to create a buffer space.
2.3.1.2. External walls
The finishing layer on the walls is a layer of a mixture of clay, straw, salt and sometimes ashes when this layer becomes wet changes to a plastic layer which is almost water-proof.

2.3.1.3. Roof
Because of excessive amount of rain in this region, the roofs are very inclined with the slope of 100% to 150%. Most common type of roof in this region is hipped roof with four pitches and usually covered by straw. Traditional buildings in this region usually have large eaves in 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.
2.3.2. Moisture
Southern shores of Caspian Sea region is a humid area and the humidity ratio 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.

2.3.2.1. Plan
Creation of 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.

2.3.2.2. External walls
Because of excessive precipitation and intense vegetation, the moisture in the soil especially in the prairie part of southern shores of Caspian Sea region is very high. The excessive moisture in the soil has decaying effect on the wood components that are connected to the soil. To deal with this problem there are several ways which traditional builders used in their buildings. For instance, the walls are not connected to the soil and they start from ground floor which is 0.5m to 2m above the level of the earth and call Kursi. Kursi is like a platform made of rubble with lime as mortar or made of hard woods which called Shakili. (Museum of rural houses, 2008)
2.3.2.3. Roof
High amounts of moisture in the atmosphere and the soil makes it necessary to have ventilation in order to achieve the comfort. In vernacular houses in this region usually daily activities and cooking take place in semi-open spaces which are naturally ventilated but for a better ventilation in semi-open spaces and eaves the lower surface of roofs are not boarded and so polluted and humid air can be ventilated easily.

2.3.3. Wind
In the southern shores of Caspian Sea region appropriate winds blow from north-east 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). Inappropriate wind which is associated with the rain blows north-west direction and is the dominant direction of the wind in cold seasons. Effects of the wind on the buildings are as follows:

2.3.3.1. Plan
In traditional architecture of this region buildings are faced to the south direction and there is no entrance on the sides facing northerly-westerly winds.
2.3.3.2. External walls
On the walls facing the winds that do not create undesirable conditions in terms of heat and comfort especially in coldest times, there are more openings. On the other hand, there are a few openings on the walls facing north and northwest.

4.3.3. Exterior of the buildings
Designing the microclimate is known as one of the effective ways in saving energy a recent study in Japan demonstrates that buildings with micro-climate conscious planning consume significantly less electric power than others without. In the southern shores of 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.

2.3.4. Sunlight
High density of water vapour in the southern shores of 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:

2.3.4.1. 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.

2.3.4.2. External walls
Because of construction limitations and cold weather during the winters the openings on the walls even on the southern walls are small and natural illumination in most of traditional buildings of this region is far below the comfort level. In the other word, interior spaces in most of the traditional buildings do have the visual comfort and it is usually devoted for thermal comfort. The same problem can be seen in Turkish traditional architecture in the eastern Black sea region (Engin, 2006) which is almost in the same latitude with the southern shores of Caspian Sea region, but because of application of translucent material in Korean traditional architecture (Kim, D. K, 2008) visual comfort was provided in the interior spaces without interruption for the thermal comfort.

2.4. 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. Because of existence of natural ventilation these verandas also can be used as a comfortable place for daily activities or night sleeping during the summer. Because of high humidity ratio and high density of moisture there is no basement in the buildings of this region. 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.

In traditional architecture of this region people found use of breeze and natural ventilation as the best way of 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 upper levels is higher. [Fig 8]
According to role of the climate on the formation of traditional architecture of southern shores of Caspian Sea region and Ghobadian these characteristics are prevail in most of traditional buildings in this region:

1. Hipped roofs
2. Veranda around the buildings
3. There is no basement
4. Ground floor is built in a higher level than the level of the earth
5. Extrovert building form
6. Cross-ventilation

Fig 8. A climate Responsive House in city of Rasht southern shores of Caspian Sea region

1 All the figures and sketches belong to the author
2.5 Mahoney tables
Mahoney tables are a set of reference tables used as a guide to climatic design which have been proposed by Mahoney (1968) and developed by Konigsberger. These tables propose a climate analysis sequence that starts with the basic and monthly available climatic data of temperature, humidity and rainfall. These tables provide design guidelines by using climatic data and simple calculations. There are six tables; four are used to enter climatic data for comparison with the requirements for thermal comfort; and two reading off appropriate design criteria.

2.5.1 Design recommendations according to the Mahoney tables
After analyzing the climatic data in the tables1,2,3,4,5 and 6 of Mahoney tables, some preliminary design recommendations are formulated which give us some recommendations on the building layout, spacing, air movement, openings, walls, roofs and rain protection. The following is a summary of design recommendations for the southern shores of Caspian Sea region in the north of Iran:

1. Layout: Orientation north and south (long axis east-west)
2. Spacing: Open spaces for breeze penetration, but protection from hot and cold winds
3. Air movement: Rooms should be single banked with permanent provision for air movement
4. Openings: Medium level of openings, 25-40%
5. Position of openings: in windward side at body height
6. Walls: Light walls, low thermal capacity, short time lag
7. Light, insulated roofs
8. Protection of openings: protection from rain

Conclusion
By comparing the results of climatic analysis of vernacular architecture of the southern shores of Caspian Sea region with the design recommendations from the Mahoney tables it can be seen that traditional builders already have used these design guidelines if we ignore some exceptions. The result of this study shows that traditional architecture of this region and the techniques used in those buildings are according to climate and can be good examples of climate responsive design.
In vernacular architecture of the southern shores of Caspian Sea region the orientation of buildings is north and south slightly rotated toward east which is the same with the recommended building orientation in the Mahoney tables. Also in traditional buildings spaces are single banked and there is a good opportunity for natural ventilation which is as well recommended by the Mahoney tables. The Mahoney tables propose light walls with low thermal capacity medium openings on the walls which can not be seen in the most of traditional buildings. The reason for this is probably the construction systems that do not allow large openings or thin walls and also the fact that traditional builders put thermal comfort during the cold seasons prior to indoor visual comfort and indoor cross-ventilation. In addition, protection from the rain which is recommended by the Mahoney tables is obviously visible in traditional architecture of this region.

Same study in Katmandu valley shows that traditional buildings were more comfortable and climate responsive design strategies were used in traditional buildings while contemporary buildings do not follow these strategies (Opadhayay, 2006). Another study in turkey also shows that traditional buildings were better than contemporary buildings in terms of climatic design and thermal comfort.

It can be seen that traditional builders in the southern shores of Caspian Sea region knew how to build their buildings in harmony with the nature and how to use natural forces in a way that they could achieve a comfortable living condition in their dwellings. Once architects can improve the living qualities by following some simple rules in architectural and urban design, simply they ignore them or misunderstood them and make the situation worse.

References


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