COVER SHEET

Climatic considerations in the formation of vernacular architecture of Turkish arid zones

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Abstract

Throughout history human beings have tried to overcome the restrictions of the natural environment and to shape it according to their needs. The traditional forms of shelter were formed according to socio-cultural forces and as an appropriate response to bio-climatic regions. Looking at examples of vernacular architecture it can be seen that the harsher the environmental conditions, the more interesting and richer is the architecture.

Within the framework of this paper, those dwellings of Turkey occurring in hot-arid regions are described. The subject of the paper is centuries old inward looking courtyarded buildings from Sanliurfa, Mardin, and Diyarbakir as well as coniformed or "beehive" houses of Harran. These buildings have many interesting features like water elements in the form of public and private wells, selsebil, pools; vegetation in the form of shrubs, just one or two trees depending on the existing amount of water; materials like the magnificent stonework of arches, vaults, and domes or wooden engraved and latticework, sun dried mud and straw bricks; separation of spaces as winter and summer quarters and as open, semi-closed and enclosed spaces; large earthen jars installed into the ceilings; top windows above main windows; projecting kiosks showing a beautiful blend of the culture, religion, as well as the response to climate.

1. Introduction

Social and cultural influences have shaped dwellings and centuries of accumulated experience and the struggle with physical conditions have led human beings to build the best possible dwellings for themselves in which they can survive and develop.

Though it cannot be claimed that the climate is the major influence on in the formation of buildings, its effects cannot be neglected among the other factors. A good example, which shows how important a role religion has in shaping dwellings, can be

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seen in the orientation of the buildings in some parts of Central Anatolia. For generations people tended to build their houses with the main facade facing toward "qibla", that is the direction towards Mecca, the Holy Land of Islam. An optimum orientation study based on 15° increments for five cities of Turkey for unilateral dwellings showed that the direction of Mecca from these is either almost exactly optimum or in an acceptable range (Demirbilek, 1984). Is it fair then to conclude that traditions and religion are the only factors, which affect the orientation?

In this paper, the towns of Mardin, Diyarbakir, Sanliurfa, and Harran in south-eastern Anatolia will be discussed as examples of the vernacular architecture of Turkish hot-arid zones.

2. About the region:

Anatolia, where Turkey is located, has been a centre for many civilisations for centuries due to its very strategic geographical location. The importance of the place is not any different today because Anatolia continues to be a bridge between Asia and Europe and is also a gateway to the Commonwealth of Independent States after the recent political developments in the Soviet Union.

The Turkish Government started an integrated irrigation and agricultural project in the south-eastern part of the country known as the GAP Project. This project, which started in 1980's, will be completed at the year 2010 and 21 dams and 19 hydroelectric power plants will be constructed on the historically famous Euphirates and Tigris Rivers. This massive irrigation project is expected to contribute significantly to the economic welfare of the region and the country as a whole and of course change the climate of this dry land as well. Some of the provinces in the region such as Diyarbakir, Mardin Sanliurfa, and Harran, which the project covers, have been the commercial and cultural centres for South-East Anatolia and the Middle East for centuries and their establishment date back to the third or fourth millennium BC. Visitors going to Harran, a village of Sanliurfa, today can see the ruins of one of the first Universities in the World. Mosques, churches, and old shopping malls are the major attractions. Hittites, Assyrians, Babylonians, Persians, Romans, Seljuks, and Ottomans have occupied this region at different times and many ethnic groups and religions have existed. Being a home for different civilisations, as well as the hot and arid climate, has resulted in a different and interesting architecture. Unfortunately, changing life-style, rapid increases

in population, and economic factors have given way to the rapid and uncared growth of these cities.

3. Climate of the region:

The high mountains that surround the South-eastern parts of Anatolia from the north have an important impact on its climate. The high-pressure system, which forms in winter, causes the winters to be cold. In summer, since these mountains prevent the air masses coming from the north to pass over to the region, the weather is quite hot. Summers are long and stressful with high solar radiation and low relative humidity. The daily temperature fluctuations are very high (Çölasan, 1960). The climatic data showing the temperature and relative humidity is given in Table 1. From the table it can be seen that there is a difference in day-time heating or cooling demand of these three cities. During the heating season Mardin has the lowest maximum temperature, then Diyarbakir and Sanliurfa follow it. On the other hand, day-time highest temperatures of Sanliurfa are higher than Diyarbakir, and Mardin follows Diyarbakir. As a result, capturing solar ray in winter in Mardin and protecting from solar rays in summer in Sanliurfa become more important compared to the others.

4. Effect of climate on the architecture of the region:

The dominant architecture style of houses in the region has emerged through the synthesis of the Turkish and Islamic cultures, and the local conditions. In the formation of this style, the Islamic needs and the climatic factors have played an important role. The architectural features can be pointed out under two headings: city and building scales.

4.1. City scale:

Diyarbakir and Sanliurfa are laid out on plateaus, benefiting from the night-time cool air pools, whereas Mardin is located on a south-facing slope having a tilt angle of 20-25° with the horizontal (Fig.1). The equatorial-facing slope helps the city to benefit from the winter solar radiation. This becomes an advantage to the city which has lowest daytime temperatures compared to the others as mentioned in Section 3.

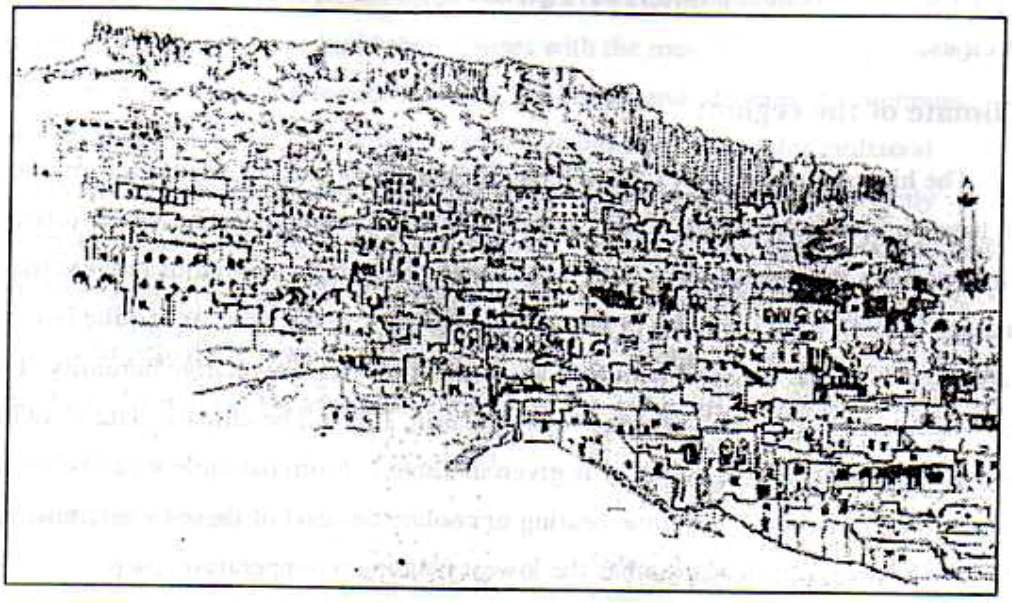

Figure 1 A view of Mardin (from a photograph by Mete TURAN).

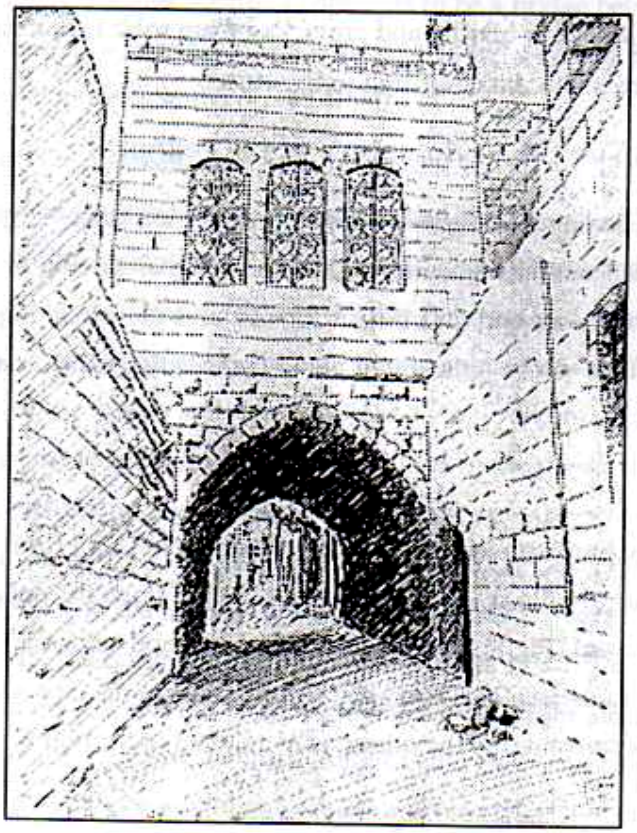

Figure 2 A shaded street of Sanliurfa and a bridge-like passage (from a photograph by Cihat KÜRKÇÜOGLU).

Old parts of the cities of the region have very tight, dense, and shaded layout. Vernacular houses are very close to each other, surrounded by high walls, forming narrow streets in between. They are shading each other, pedestrian roads, and streets and decrease the thermal discomfort by reducing solar heat gains. The three-dimensional complex forms such as bridge-like passages connecting a building to another, or rooms connecting one part of a building to another, mean the street underneath remains cooler (Fig. 2).

Public fountains and wells serve many houses close by, especially ones which do not have their own water supply. They become social gathering points as well as providing comfort to the passing pedestrians of this hot and dry land by quenching their thirst and for splashing cool water to be refreshed.

4.2. Building scale:

The houses are inward looking with very few openings to outside. The entrance door, opening from the street either directly to the house or to the courtyard, usually has a roof like structure. This structure protects the person who is waiting for the door to be answered from sun or rain.

Due to seasonal needs, the houses are divided into two sections as summer and winter quarters either in horizontal or vertical planes. They are composed of open spaces in the form of courtyards and terraces, semi-open places called eyvans, and closed spaces.

4.2.1. Open spaces:

The necessity to let the solar radiation in during winter months led to an average Mardin house being u-shaped in plan and having a terrace in the middle oriented to south (equator). In Diyarbakir and Sanliurfa houses, the courtyard is usually at the centre, in the form of an uncovered room open to the sky, shaded during the day.

Courtyards and terraces are private quarters, the centre of family living, places not to be seen by outsiders. They are surrounded by rooms, eyvans and/or high walls, which help them to be shaded during the day-time and to become cool air pools during the night-time where comfortable outdoor sleeping on summer nights by the family members take place.

Depending on the amount of water available, a water element like a private well, pool, or fountain and some greenery like shrubs, trees, or flowers increase the quality of the environment both physically and psychologically (Fig. 3). Tight terraced housing and shortage of water in Mardin do not give much opportunity for these elements in courtyards, whereas in Diyarbakir courtyards are alive and colourful with pools, fountains, and vegetation. Those elements also have an important role in moderating the temperatures by providing shade and evaporative cooling. The floors are almost always paved with stone, locally available material, which, when sprinkled with water, provide cooling by evaporative heat loss.

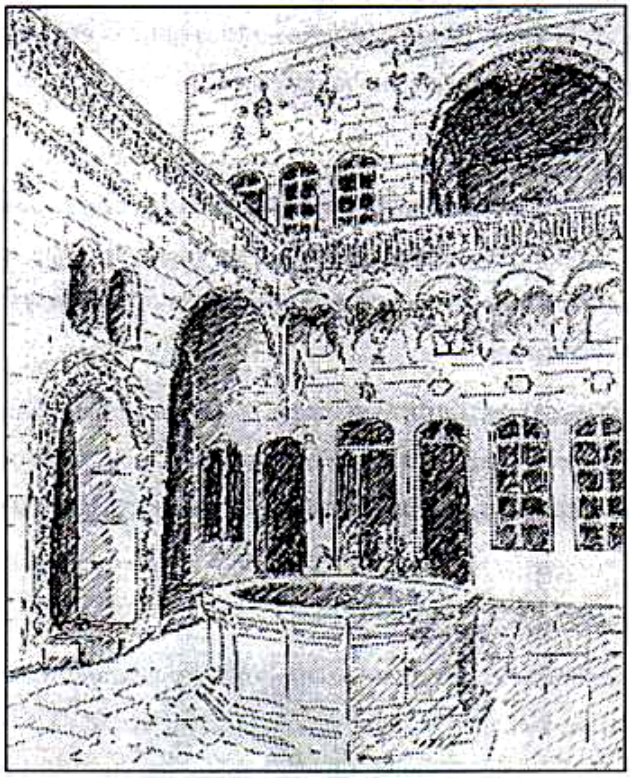

Figure 3 An inward looking Sanliurfa house from the stone paved courtyard with a pool. Note the eyvan of first floor and the stonework of arches and vaults (from a photograph by Cihat KÜRKÇÜOGLU).

4.2.2. Semi-open spaces:

Although open spaces are the centres for the family living for almost the whole day, high angles cause them to be undesirable during summer mid-days and use of a well-shaded open space, as a living room becomes a necessity. Semi-open spaces of the region have various names like eyvan, livan, iwan, or exedra. It is either on the same

level with, or a few steps higher than, the courtyard. Three sides and the top of it are always closed, sometimes covered with a vault. The fourth side directly opens to the courtyard, usually with an arch. The open side of a Mardin house faces south, whereas in Diyarbakir and Urfa it is oriented to the north.

4.2.3. Closed spaces:

During winter-time south facing rooms enjoying sun are occupied, whereas the rooms facing north are kept for summer use. Winter rooms are smaller in size and are situated at the protected parts of the house. Summer rooms have the highest ceilings, sometimes reaching up to 5 m. If the building is not a big one, the upper floor serves for summer and the other for winter. Some houses have a summer room on the ground level, dug into the ground, benefiting from the temperature modifying characteristics of the earth. They sometimes contain a water element called "selsal" or "selsebil" designed to have a cooling effect on the physical environment by evaporation and relaxing effect by its sound. Selsal is a waterfall system, water sliding down on a sloping marble or ceramic surface and terminating in a pool underneath.

The high heat capacity of very thick stone walls (varying from 50 to 110 cm.) help to absorb the solar radiation for increasing time-lag effect rather than transmitting it immediately to the interior. After sunset the ambient air temperature drops rapidly, resulting in a 15 to 40° C temperature difference between day and night. A great portion of the heat that is stored in the walls during the day begins to be released towards the outside. Around 8:00 p.m. ventilation can be provided by opening all the windows of the closed spaces. The vertical windows are generally arched. A second row of smaller top windows placed over the others help the rising hot air within the spaces to escape to outside drawing cool and fresh air to inside (Fig. 4). This re-radiative and convective cooling continue until 8:00 a.m. when the windows are shut tight again. Wooden shutters, sometimes highly ornate, are installed on mainly out-facing windows. These provide both privacy and sun protection.

The roofs of the region are generally flat and built with high heat capacity materials which increase the time-lag effect. The earthen jars placed at the corners of cross vaults or along the sides of the barrel-vaults create large air spaces due to the spherical shapes. In this way both the insulation value of the roof is increased and the dead load of the structure is decreased.

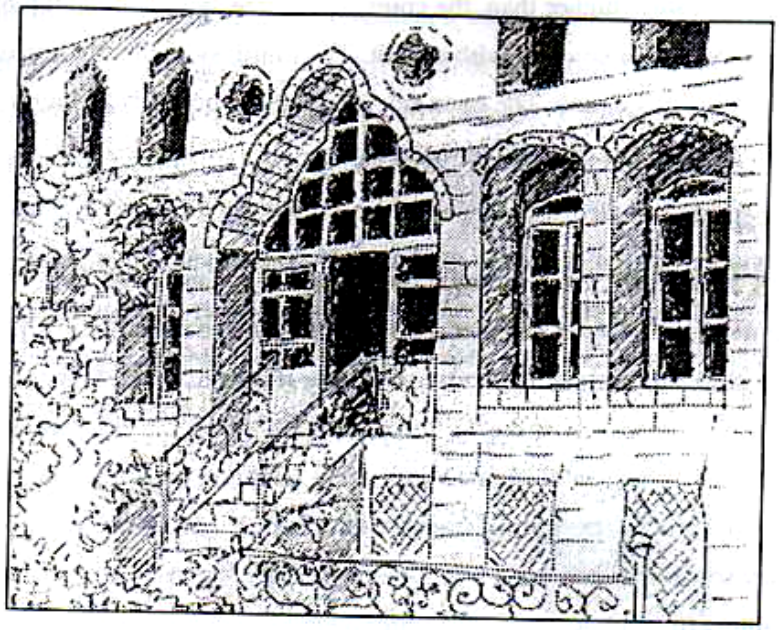

Figure 4 A view from a Diyarbakir House. Note the thick stone walls and the small top windows (from a photograph by Cahit KÜRKÇÜOGLU).

The houses of Harran show a somewhat different characteristic than the other cities of the region in form and material. The striking form of "beehive" dwellings resembling the "trulli" in Apulia in Italy increases the volume of the space (Fig. 5). This volume provides extra space for the heated air to be accumulated away from the occupants. Its increased height also helps to create a stack effect providing ventilation.

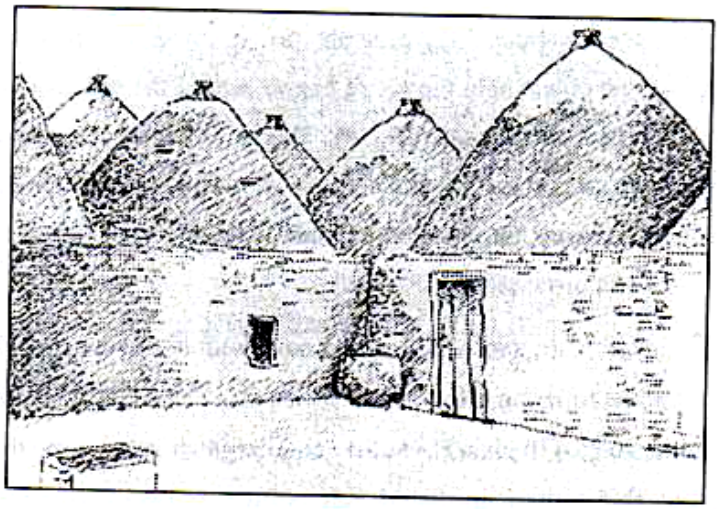

Figure 5 "Beehive" dwellings of Harran. Note the top opening (from a photograph by Cihat KÜRKÇÜOGLU).

When necessary, hot air can be given out from the small openings placed at the top of the coniformed roof by opening the door to let fresh and cool night air in. The building material is sun baked adobe brick with a high heat storage capacity. The bricks are made of mud with addition of clay for impermeability and straw for reinforcement. Mortar of mud is used for cohesion and sealing and plastered from inside and outside.

5. Conclusion:

In contemporary buildings the increase of comfort due to the use of mechanical equipment for space heating and cooling increases the dependence on conventional energy sources, which in turn affect the economy of countries and increase environmental problems.

Today, some examples of vernacular architecture can be considered as primitive but they were simple and efficient solutions, derived from direct experiences with nature, oriented towards avoiding waste and protecting the environment.

It is still not too late for reconsidering the ideas behind the formation of these shelters and applying them to the architecture of our century. Vernacular architecture examples are the precious belongings of countries and they have to be preserved for future generations that will still have to learn from them. The aim of such an approach is not to look at the past with nostalgia but to compensate a certain amount of the climatic requirements with time-tested principles. The centuries old design is not directly applicable today anyway, due to changes in socio-cultural and economical conditions.

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Table 1. Climatic Data showing mean, mean high/low temperatures, diurnal maximum temperature difference, mean and minimum relative humidity of Diyarbakir (D), Mardin (M), and Sanliurfa (S) (Source Meteoroloji Bulteni, 1974).

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean Temp. (°C)	D	1.8	3.6	8.1	13.8	19.3	25.9	31.0	30.5	24.9	17.2	10.0	4.2
	M	2.7	3.8	7.3	13.1	19.3	25.4	29.6	29.6	24.9	17.9	11.2	5.2
	S	5.1	6.6	10.1	15.8	21.8	27.8	31.7	31.4	26.6	19.9	13.1	7.4
Mean High Temp. (°C)	D	6.6	8.9	14.2	20.4	26.5	33.2	38.2	38.2	33.2	25.3	16.7	9.2
	M	5.1	6.5	10.5	16.8	23.4	30.0	34.3	34.2	29.5	21.9	14.4	7.6
	S	9.3	11.5	15.7	21.8	28.4	34.3	38.5	38.3	33.7	26.8	19.0	12.0
Mean Low Temp. (°C)	D	-2.4	-1.1	2.0	6.8	11.0	16.0	21.6	20.9	15.7	19.6	4.4	-0.2
	M	0.2	1.0	4.0	9.3	14.7	19.9	23.8	24.3	20.4	14.0	8.2	2.9
	S	1.4	2.4	4.8	9.3	14.2	19.5	23.5	23.4	19.3	13.6	8.4	3.7
Diurnal Max. Temp. Difference	D	22.1	21.2	27.1	26.2	28.6	32.0	27.5	31.2	28.6	28.9	25.3	27.0
	M	15.0	11.9	14.8	17.0	18.0	19.4	17.3	16.5	16.8	17.5	18.5	11.1
	S	19.3	16.7	21.2	22.0	22.8	21.6	22.4	22.7	20.7	21.8	20.4	19.3
Mean Relative Humidity (%)	D	77	73	65	61	55	34	24	24	28	46	67	77
	M	76	70	64	57	46	33	30	32	36	47	59	70
	S	71	67	60	53	43	30	27	28	32	42	58	69
Min. Relative Humidity (%)	D	13	7	10	7	6	5	1	2	3	2	3	10
	M	7	11	3	6	4	1	2	2	0	3		12
	S	8	1	1	4	1	1	1	1	2	0	2	1