

# Analysis of the Units Contributing Climate Comfort Conditions in Outdoor Spaces in Turkish Traditional Architecture

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**ABSTRACT:** In our country, the weather is generally hot in summer and according to the regions it is dry and hot. Due to the fact that the average outdoor temperature is 21<sup>0</sup>C in summer, semi-open and open spaces are used more than closed spaces. This usage is generally analyzed with units like *revak*, *courtyard* and *eyvan* in Turkish traditional dwelling culture which has a rooted past. The aim of these tree units is to provide comfort conditions in outdoor spaces with their physical features especially in hot summer days of dry climate regions. These semi-open spaces have been protected from heat effect of sunny due to their orientation and they keep the cool influence of wind in the area. In addition to this, they contribute to positive outside climate in hot summer months with their location in building, with their components and materials used for them and with their landscape components. In addition to their cooling and shadow influence in hot summer days, they are also social spaces where people assemble and share various and conventional activities together. Though these affirmative qualities, they aren't taken into consideration in contemporary architectural applications. They are not effectively applied in today's architecture, balconies and terraces are observed as semi open outside spaces in modern buildings in stead of *revak*, *eyvan* and *courtyard* in traditional architecture. From the point of view of providing the cool effect in outdoor spaces, balconies and terraces are not as effective as traditional architectural units. It is obvious that these space organizations which are passive energy sources shouldn't be overlooked in todays buildings which have high air conditioning cost. In this study, the analyses of these units which contribute outside climate comfort conditions and component of traditional houses chosen in the southeast part of Turkey were made. Their ratio on the ground floor to all area of traditional house was calculated and this ratio was compared with contemporary units. It has seen in the results that terraces are used instead of *eyvan* and *revak* on the ground floor of traditional houses. But it has been observed that they are not integrated with the mass as these traditional units. As it will be seen in the examples, there are quite important lessons that we must take from the traditional architecture in the context of sustainability and design concerning with contributing outside climate comfort conditions.

Keywords: Traditional architecture, outside climate comfort

## 1. INTRODUCTION

It has been observed that appropriate solutions which are sensitive to climate with its material, construction technique and space organization were produced for historical houses in dry and hot climatic regions. Architectural solutions in the settlements of south-east part of Turkey contribute to the comfort of people in hot summer days and also they soften the hard effect of climate. In urban scale, it has been observed that settlements had been located according to wind direction and they had been designed in order to provide shadowy places in the streets. In house scale, closed masses which store heat had been designed in order to be protected from cold for winter months. Open space organizations which aim at providing shady spaces had been seen for summer months. These spaces also procure natural ventilation, give possibility to live in open spaces and reduce the hot effect of high temperature. The main living units of summer

months are *courtyards*, *eyvan* and *revak* which were designed considering climate conditions. It can be said that these spaces which show the strong relation between closed spaces and nature, have changed greatly and their functional features were not considered in modern settlements. Only little terraces and balconies are designed in order to provide natural ventilation and to meet the necessity of sitting in the open air. Balconies which took the place of traditional space organizations don't provide comfort conditions as effective as traditional units. Mardin, Urfa and Diyarbakır, three cities of the south east part of Turkey were chosen for this study and their most significant space organizations *courtyard*, *eyvan* and *revak* were described with their plans and general features (Fig. 1). As a result of these analyses it has been concluded that social, urban and cultural features are effective on their arrangements. Also in this study, the percentage of these spaces in total area and ground floor of the house were calculated. In addition to this, their

percentages were compared with modern architectural units. The aim of this study is to analyze the traditional units with respect to climate in the working area and to compare the analyzes with new buildings located on the same area. Also the main of the study is to get sensitive solutions to climate from the traditional architecture in the context of the lessons which must be taken from traditional architecture. When it is thought that expensive and more energy consuming ventilation systems are used to provide appropriate thermal conditions in summer months, it will be seen that traditional architecture has functional and cheaper solutions as an example to sustainable new urban forming.



**Figure 1:** Location of three chosen city, Diyarbakir, Urfa and Mardin South-East Part of the Turkey.

## 2. GENERAL CLIMATE CHARACTERISTICS OF CITIES IN THE SOUTH –EAST PART OF TURKEY AND THEIR URBAN SETTLEMENTS

The temperature difference between summer and winter is quite a lot in this part of Turkey. In this region, the weather is generally very hot in summer and cold in winter. The average temperature is 3.7<sup>o</sup>C in the coldest month January, and the average temperature is 29.8<sup>o</sup>C in hottest month July. The annual average temperature is 16.4<sup>o</sup>C. Because of the low relative humidity in this region, amount of evaporation is high in summer and summer drought goes on long and dense in this region which has rare summer rains.

In the settlement tissue of this region, house and settlement design rationally aimed at utilizing sun and wind has prevailed. Nevertheless direction of land, inclination of land and its location are other changeable factors affecting the design of settlements. The most appropriate settlement place for hot-dry climate regions is the valley floor where cold weather lakes exist. Because of the fact that the valley floors are also flatter than slope of hills, the heating effect of weather is low and so, they are effective for providing appropriate summer comfort [1].

Urfa and surrounding urban settlements had been located on a large plain. For this reason, the streets are wider. In spite of this, settlement tissue of Mardin is located on inclined slopes of hills with terraces directed to prevailing wind. Mardin streets designed on upright of slope don't let transportation. So the streets are quite narrow and only for people.

Diyarbakir urban settlement had been designed very dense and closed. Diyarbakir is a city bordered with city wall in order to provide the military defense. The obligation of settlement to this limited area had caused to design the houses closely and dense [2]. While the basic factor is climate in their urban design, other factors have shown differences and settlement tissue and form of house are designed with the effect of these changeable factors.

In this region, space organizations with the courtyards square or similar to square are seen. Close spaces had been located on surrounding of the courtyard and they had been oriented to it. Because of the narrow streets, there are few and small windows on the outside surface of the house and they had been opened up in appropriate parts of the wall. The most significant factor had been privacy about opening the house to outside. And also it had been paid attention to that the windows should not be in direction of the neighbor yard. It is seen that the social factor was very effective in orientation of these houses. Thick walls providing thermal mass effect, terraces –flat roofs-, materials having high heat storage capacity and absorbing and light colored had been used.

## 3. TRADITIONAL ARCHITECTURAL SOLUTIONS PROVIDING MICROCLIMATE IN THE SOUTH EAST OF TURKEY

### 3.1 Courtyard

The most significant unit in designing the building and its form is courtyard in this region. The courtyard is an open space located among group of functions and surrounded with walls. The courtyard taking place at the entrances of many houses has been designed at different size depending on the parcel where the house located on.

The usage of each courtyard varies according the life styles, habits, customs, social and economic values of inhabitant people. Beside this, it has special features of distributing functions and being an enriched visual element between the house and the street door of the house. It has succeeded in setting up the life by collecting people and semi-open spaces around it. The feature of gathering and distributing functions has made the courtyard the center of the house. Out of these, it is spaces in order to have rest and to get cool and also social spaces where the family gathers talk and carry out their social activities.

The garden, landscape units and small pools make it richer from the point of view of visual and it lets people get cool. The eatable fruit trees also provide natural shadow spaces for people. This is important with the point of view that it makes people become closer to nature. These water units and small pools decrease the temperature by evaporating and storing the heat in hot summer months. And they also provide needed comfort conditions by increasing the ratio of relevant humidity in the weather. Keeping the humidity important for these regions has been obtained by transferring this microclimatic atmosphere to indoor spaces and by

preventing winds which take humidity in the courtyard [3].

Urfa courtyards are square or rectangle in general. After entering by the garden door, one reaches the courtyard while crossing a narrow corridor: the "*kapı arası*". In the traditional houses of Urfa, the toilets open either to this space '*kapı arası*' or to the courtyard. Before arriving of the drainage system, the lower part of the courtyard was designed especially for the septic hole on which there was a vault. There is no well in the gardens with this kind of Urfa houses. If there is a well, it is rather in the kitchen which has direct opening towards courtyard, not in the garden [4]. On the walls of the courtyard, there are several windows without glazing on a raised height. These windows are made by vacuums carried out in masonry jump of the high part of the walls and they are of use to take fume away from the space and the odors that chimney could not evacuate. The Urfa houses rooms which have an orientation towards north have a height between 1,5 and 2 meters from the courtyard, whereas the other rooms have a height in 0,50 meters [4]. The longest side of the room is located towards the courtyard and there are windows on this side. These rooms are ventilated with the small rectangle or round windows named "*ışık takası*" in Turkish. These small useful windows for ventilation are also effective in cold seasons; the large windows causing heat loss are not open thanks to this intervention. In the historical houses of Urfa, the water pool is generally located in the center of the courtyard. In the center of the courtyard, there is sometimes a well or a water trough named "*cürun*" in Turkish instead of the pool [5]. But nowadays these pools are used as a large vase of flowers by filling of ground. Near them, there is a part with the fruit trees, mulberry trees, pomegranates, orange trees, fig trees, vines or oleander.

The main character of Mardin houses is that the courtyards are transformed into vast terrace opening towards the valley. The heights of the walls are high in order to be able to ensure the intimacy and safety. In the large houses of Mardin there are several courtyards which are placed on different levels in order to ensure a sight on plain. Dense dwelling fabric of Mardin had prevented the development of gardens, as a result of this, vegetation had not take important place in the space organization of the courtyard. The principal trees of the courtyard are the mulberry trees, the plum trees and the grapevine. The courtyard is connected with a stone staircase towards the terraces. The relationship to interior spaces of the house is obtained by the courtyard, the terraces and by semi-open spaces which are the *eyvan*.

In dense fabric dwellings of Diyarbakır, the courtyards are the only natural spaces where the house is in relation with nature. The walls encircling the courtyard are generally completion or almost perpendicular whatever the land geometry is. Even the most deformed geometry is close to the rectangular form. There is in no case a triangular or a different form courtyard. If the lay out of the street obliges the deformation of the courtyard geometry,

one edge of the rectangle follows the layout of the street by obligation [6]. It arrives at the courtyard while passing by narrow and short street which is called "*sokak arası*" in Turkish. All the parts of the house and rooms are generally directed towards the courtyard. In the all plan types with courtyard, the space units are suitably in the direction of the sun. The orientation of the house directly has influenced the shape and led to the creation of specific winter, spring and aestival spaces. The aestival unit is always placed at the south of the courtyard. The winter units are generally in the north of the courtyard, which allows a southern orientation for spaces of this unit. In the houses where there is no unit in the north of the courtyard, winter spaces position in the east. If there is no unit in north and the west, winter spaces position is in the west. The spring unit is seen in the houses of the type of plan "U". This unit can be located in the east or the west of the courtyard [5]. The spring units are only in the houses of the rich families. The winter and aestival units are in all the traditional houses of Diyarbakır. The water pools of the courtyard are directed and always centered of the *eyvan*. The most important passive cooling system of Diyarbakır houses is named "*serdap*" in the region. They are cooling spaces located under the rooms at the level of the basement floor. These spaces have been known in the area since the old periods and they have the "*sesal*"- a kind of fountain- known as the name of "*sesal*" in this region, arrive at the pool by getting cooling to the space. Water arriving to the high channel goes down in bottom, while rising and passing by marble or earthenware inclined way covered. And water finally reached to the water pool after passing a decorated canal [7]. The courtyard is focus of the house, in the same way the garden is the focus of the courtyard. In the traditional houses of Diyarbakır, there are grapevine mulberry trees almost in every house. The garden is not limited in a particular place like the medium or the corner of the courtyard. It has been a general perception of the garden take place wherever it is seen from the rooms.

### 3.2 Eyvan

The *eyvan* is semi-open transition space between the courtyard and interior spaces (Fig. 2). They have important role in the forming of building according to land. Three sides of it and top of it is closed and top of it is generally covered with a dome and one side of it is open. The *eyvan* is the passageway in front of the rooms, which permits a common life inside. Its relation with the outside open areas is very important [8]. With the role of distribution of semi open spaces, the *eyvan* is shady cooling rest space for the summer. It is directed to the position of the sun of the summer. Especially the *eyvan* directed towards the south and the east are spaces which are appropriate for local climate against the midafternoon sun. The *eyvan* has generally a window directed to north. This window supplies natural ventilation with this window and make the space cool. The architectural and functional organization of the *eyvan* has common

points in the cities very characteristic of the Anatolian south-west of which we selected for our subject of study. It is possible to say that in Urfa, Diyarbakir or in Mardin, the *eyvan* constitutes a characteristic space of the traditional architecture of this region to the same degree of importance as the courtyards.

In historical Urfa houses, the *eyvan* provides an access to the rooms. The *eyvan* of summer directed in north have small empty niches. On these niches a chimney is located on which opens with the flat roof (Fig. 3). One of the walls of the chimney face is directed in north, while the other is directed in the west. The wind striking here has these walls of face cools the space while passing by the chimney. This effect ensures a pleasant cooling environment in summer in this semi open space [4]. This wind stones are used for "namaz" as a stone of "mihrab". (Mihrab is a niche in a mosque wall indicating the direction of Mecca.) Nowadays there does not remain any more this kind of chimney using the wind for natural ventilation. 'Seki' is placed on three sides of this space. (Seki is a kind of cushion for sitting stated parallel through the windows). In the middle of this space sometimes the pool is placed at water which reinforces the cooling of space. But these kinds of examples aren't seen today. In Urfa there are generally one or two *eyvan* directed towards the courtyard. In the houses with only one *eyvan*, by having two rooms in its two dimensioned, the orientation of it is in south. In historical Urfa houses, the balconies of an approximate 1 meter width named "gezenek" are cantilevers with stone columns on the courtyard which get the relation between the *eyvan* and the rooms of the top floor (Fig. 4). These open balconies related to the courtyard by staircases form integral part of the courtyard. Below the "eyvan" and rooms are cellars as fresh spaces where it is possible to preserve food.

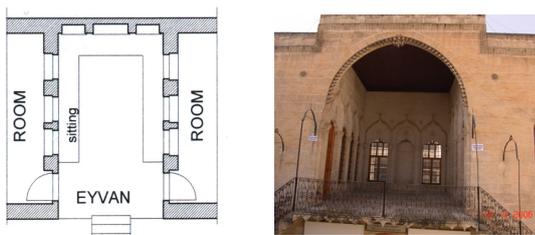


Figure 2: Place of "eyvan" in the plan.

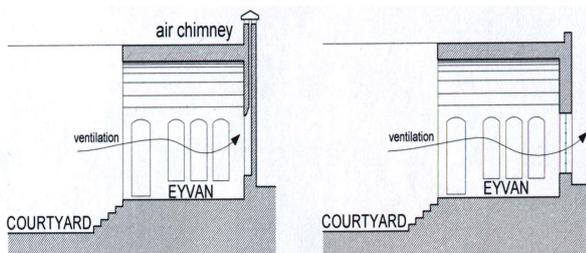


Figure 3: Air chimney which ensures a pleasant cooling environment.



Figure 4: A kind of balcony from Urfa (*gezenek*).

In historical Mardin houses, the *eyvan* developed like the extension of the courtyard to provide a horizontal widening. They are located between the rooms by forming a semi open shadow space which three sides of it and the top of it is closed. It is organized according to the direction of the hot summer day's sun in order to provide shadow spaces. There are *eyvan*'s directed towards the south against the morning sun and there are the others which are directed towards the east against the midafternoon sun. In these houses, these spaces open on the courtyard and sometimes on the terrace [9]. The space depth varies according to the orientation of width dimensions open. Those directed in the south have a depth from two to three modules, whereas those which have an east-west orientation have a depth not exceed a module. The limestone barrel vault which covers top of space is very widespread material. It is adorned by the ornaments and arcs in Mardin and its position between the rooms ensures a balance in the proportions of fullness and emptiness of the mass.

In Diyarbakir, the *eyvan* is the economic and social symbol of the family. There are of them which have one, two or three interior parts. Two or three of these parts can be transformed into higher room on the top floors. The *eyvan* on the top floor does not have a water pools. It and rooms are high 50 cm until 100cm or 170 cm compared to the level of the courtyard. Their height of it depends on the height and numbers of window of the cellar which are below the rooms of house. *Eyvan*'s ground stone is sprinkled with water in summer to decrease heat. Water penetrates in the stone progressively and gets the courtyard cool by vaporizing in this space. Its top cover is flat roof with wooden poplar beam or vault [7]. The *eyvan* is the largest space of the house with decorative arches. Beside these features, it is the more used space of house by having form according to the geometry of the land. It can widen and can have interior part in depth.

### 3.2 Revak

The *revak* has common peculiarities in the three cities. The *revak* is located throughout the courtyard on the ground floor. It is a semi open space of life, sitting and resting and also a place where the animals are attached. In the traditional houses of this area, the priority of using of land is devoted initially to closed interior spaces and the courtyard. If there is sufficient surface for the courtyard and other spaces,

the *revak* is built for making shady space on the remainder of the surface of the land [10]. When it is compared with the *eyvan*, the *revak* has more open frontages. The types with two and three opening are widespread. These spaces are conceived in time which opens semi open space of circulation rather than of space of life.

### 3.4 "Kabaltı" (room on the top of the street)

The room with the top of the street is a hot climate solution in dense dwelling fabric of the cities which developed on the flat grounds in hot climatic regions. These rooms cross the narrow streets by creating shade, which allows an effect of cooling in outside space in summer (Fig. 5). This shaded space becomes a place of plays for the children and a place of rest for the old people. The technique of construction is in beam of wood or in lathing - *bagdadi*-, this flexible constructive system allows the reduction in static on the close house where it sticks. In Urfa, where the aestival period lasts more than six months, it is possible to meet covered streets of vault which provide cooling outside spaces. The cover of the ground of these shady streets is made of basalt stone and they covered top of the street in the distance of 5- 10 meters.



Figure 5: Kabaltı from Urfa.

	<p>Large corner balcony on apartment house.</p>
	<p>Narrow corner balcony on apartment house.</p>
	<p>Balcony, between the close spaces on apartment house.</p>

	<p>Balcony, surrounding the close spaces on apartment house.</p>
	<p>A typical large terrace related with garden on villa.</p>
	<p>Another typical large terrace related with garden on villa.</p>

Figure 6: General typologies of open and semi open spaces in current houses.



Figure 7: Widespread balcony examples on apartments in this region



Figure 8: Widespread terrace and balcony examples on villas in this region



**Figure 9:** Current widespread urban tissue not with respect to climate and without under consideration orientation and climate conditions.

#### 4. OPEN AND SEMI OPEN SPACES IN CURRENT HOUSES

It has been seen that balconies and terraces took the place of the “courtyard”, the *eyan* and the *revak* today current houses. They are designed in various types in current architectural practices. As it is seen in the figure 6, terraces are in relation with closed spaces, especially with living rooms and kitchens. And also they are related with the garden. Due to the changes in social structure of society, it means that families became nuclear family, terraces are smaller when they are compared with courtyards and the others. But, it mustn't be forgotten that, current building laws, regulations and town planning codes are very effective in forming them. These units are mores used in summer for shady spaces. And also family come together and sits or eats their meals here. Their size changes with the parcel of the house and it is generally limited with the building planning codes. They haven't any wall surrounding it like courtyard. And it is significant that using local material for floor is overlooked today not only for terraces but also for the balconies. For their floor, modern materials have been used instead of regional ones (Fig. 8). Balconies are located on the top floors of the house and their square meter is less than terraces. In our town planning codes, cantilever distance is limited with 1.5 meter. This is why the balconies are generally small. And they generally related with the living rooms and the kitchens like terraces (Fig. 7-9).

#### 5. EVALUATION

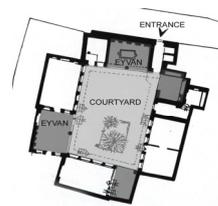
It has been observed that traditional houses and settlements showed the way to respectful design to climate, even in the time that the technology was not developed as it today. We can see that utilizing from natural energy sources was thought in the maximum level at that time. These settlements with respect to climate and aiming at the sustainable environment are the topics must be taken under consideration by today's architects.

It is obvious that humidity and wind analyses provide many advantages in the context of sustainability and contribution to country economy in today's new buildings designed by considering regional climate features.

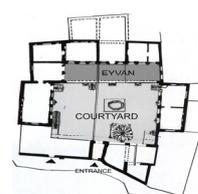
As it is seen on the figures, in spite of the fact that modern units have landscape elements in their garden as courtyard, they are not specialized and designed as courtyards. Their integration with the building is not as strong as the courtyards'. And these gardens designed today, are not effective in not only from the point of view of form, but also microclimatic effect as the courtyard. Thick walls around the courtyard providing microclimatic effect and it's at least one side is shady because of the highness are not found around the garden today. So their microclimatic effect is not effective when it is compared with the courtyard and need shady space has been met under the trees. Water elements which balance the humidity by evaporation and make a cooling effect in the courtyards are not designed and thought today as in traditional. Today, these small pools and water canals also having the spiritual aspect are far from their traditional form. Due to the lack of the high and thick walls which support the evaporation and contribute outside climate, these polls take part in design whatever the user wants and their cooling effect is low.

The ratio of fullness and emptiness of the mass and care in the arrangement of closed, semi open and open space is not seen today's architectural examples as in the past. Semi open spaces *eyvan* and *revak* is seen the ground floor of today examples as terrace, they are seen as balcony on the top floors today. But these terraces don't become a united whole with the mass like courtyard.

As it is seen the analyses, when the ratio of semi open spaces to closed spaces are examined, it is seen that balconies don't have part in a big ration in this percentage as *revak* and *eyvan*. Small niches in the *eyvans* are only seen in the past as a design. These kinds of chimneys were done away with roof cladding. Today these chimneys are transformed into heating chimneys. And it is not thought to utilize from the wind energy with chimneys. And it is not thought to utilize from the wind energy with chimneys.



**Figure 10:** The house on 197 part 11 parcel in Diyarbakir[6].



**Figure 11:** Another house in Diyarbakir[6].

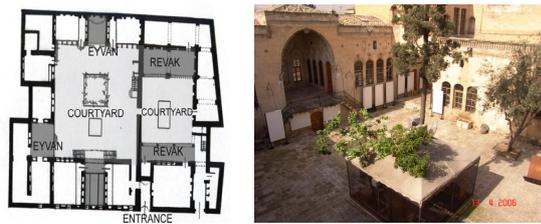


Figure 12: Drawing [4] and photo of Hacı Hafızlar House in Urfa.



Figure 13: Drawing [4] and photo of Hacı Tevfik Saraç House in Urfa.

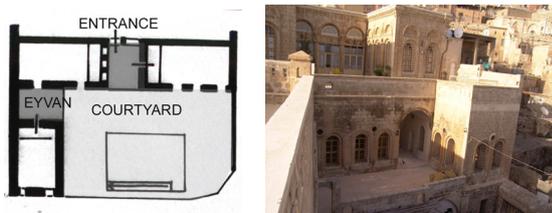


Figure 14: Drawing [10] and photo the house at 113 street no:18 in Mardin.

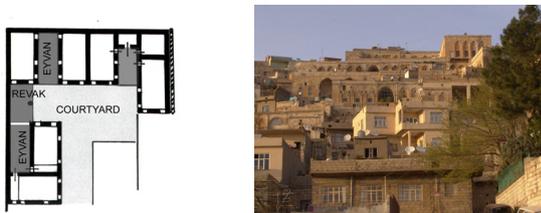


Figure 15: Drawing[10] and photo the house at 110 street no:8 in Mardin.

'Kabalti' seen in traditional streets as shady and cooling spaces and contributes the outside climate with their microclimatic effect are the details which don't repeat today architectural examples.

In this study, two traditional houses in Diyarbakır, Mardin and Urfa were chosen and the percentage of the closed, semi opens and open spaces on the ground floor to all area of the house was calculated.

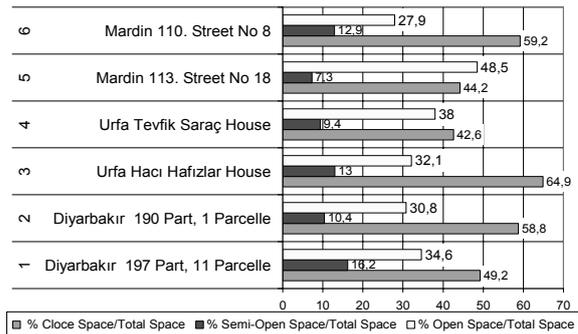


Figure 16: The percentage of close, semi-open and open space to total space on the ground floor of historical buildings.

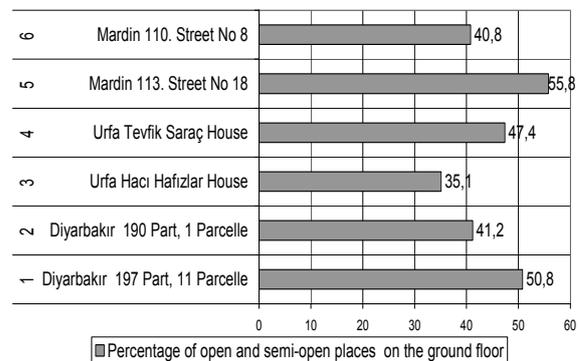


Figure 17: The percentage of total open and semi-open spaces to total space on the ground floor of historical buildings.

According to these results, in the house on 197 part 11 parcel in Diyarbakır, the percentage of closed spaces to all area is %30.9, semi open spaces to all area is %16.2 and open spaces to all area is %34.6 (Fig. 10). In another house in Diyarbakır, in the house on 190 part 1 parcel, the percentage of closed spaces to all area is %38.5, semi open spaces to all area is %10.4 and open spaces to all area is %30.8(Fig. 11).

In Hacı Hafızlar House in Urfa, the percentage of closed spaces to all area of the house is %32.8, semi open spaces to all area is %13 and open spaces to all area is %32.1(Fig. 12). In Hacı Tevfik Saraç House in Urfa, the percentage of closed spaces to all area is %34.1, semi open spaces to all area is %9.4 and open spaces to all area is %38(Fig. 13).

In 113 street no:18 house in Mardin, the percentage of closed spaces to all area is %22.5, semi open spaces to all area is %7.3 and open spaces to all area is %48.5(Fig. 14). In 110 street no:8 house in Mardin, the percentage of closed spaces to all area is %27.4, semi open spaces to all area is %12.9 and open spaces to all area is %27.9 (Fig. 15).

All these ratios are for the ground floor. For the todays examples, the most widespread ones were chosen.

In the modern houses, there isn't any designed open space like courtyard. For the semi open spaces, in modern houses, today, we can see the

terraces on the ground floor instead of “*eyvan*” and “*revak*”. For this study the percentage of terraces on the ground floor was calculated.

Though, in traditional houses, the percentage of total open and semi-open spaces to total space on the ground floor of historical buildings is average %40-%45, in the modern today houses, average percentage of terraces to ground floor area varies between %20-%25(Fig.16-17). Terraces are today's semi open spaces in the modern houses. But they are not designed and they are not integrated with the mass as *revak* or *eyvan*.

## 6. CONCLUSIONS

The decrease of energy sources gradually, air pollution increasing with more usage of active energy systems and nevertheless various environmental problems make obligations for architects to take into consideration of energy effective building design. But in today's architectural practices, it has been observed that a design comprehension aiming to utilize from unexhausted energy sources like sun and wind, is not taken into consideration data of regional climate conditions, topography and orientation. Unconsciousness and limiting effect of laws and regulations are effective in not developing and not becoming widespread of this design comprehension. Actually designed buildings according to regional data and using the passive energy sources in the high level contribute to energy control and to usage in low price.

In design of new buildings, local parameters must be rightly defined in the level of design. And also it is necessary that appropriate values providing suitable climate control must be taken into consideration in the design process. Straight decisions made before starting design can reduce the building cost and energy cost using for heating and cooling the building in the important ratio.

In this study, the analyses of the units contributing outside climate comfort conditions of traditional houses chosen in the southeast part of Turkey were made. In addition to these analyses, it has explained that physical and social feature of these spaces and how they contribute to outside climate comfort conditions.

As it is seen in the examples of Urfa, Mardin, Diyarbakır, there are quite important lessons that we must take from the traditional architecture in the context of sustainability.

Not seeing these kinds of applications in today's examples and providing summer comfort with passive air conditioner systems instead of natural ventilation show that the design with respect to climate has been ignored today. But these solutions must take part in today architectural examples.

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